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A Study of the Economic Impact of Water Impoundment Through Validity Testing of a Comparative-Projection Model

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RESEARCH PROJECT TECHNICAL COMPLETION REPORT

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A STUDY OF THE ECONOMIC IMPACT OF WATER IMPOUNDMENT THROUGH VALIDITY TESTING OF A COMPARATIVE-PROJECTION MODEL

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ACKNOWLEDGEMENTS

This report represents a terminal point in a continuous line of research which developed a computer simulation model to measure economic impact and tested this model over a wide range of different types of water reservoirs. The research has continued smoothly from one phase to another because the training responsibilities in the program enabled the investigators to bring in exceptionally capable graduate students as research assistants. One of the students who started on the present project, but was a carry-over from the previous one, was Robert L. Beatty. Bob assisted in choosing the reservoirs which were to test the model, and with George C. Fowler collected input data on each reservoir. Both George and Frederick Boyd Cherry made valuable contributions to the model development in determing what modifications would be appropriate. George and Boyd assisted in reprograming changes in the model, gathering additional input data, and in preparation of this final report. The researchers are grateful to all these young men for contributing tedious work, talent, and enthusiasm to the research project.

Secretarial assistance was provided, at different times in the project, by Jaqueline Mitchell, Johnette Jarvis and Celia Williams. The investigators are particularly grateful to these skilled ladies for their professional work and their personal interest in the research. Also, Dianne Hart and Joyce Woods assisted in preparing this final report,

which was contributed in addition to their regular secretarial duties in the College of Business Administration.

The researchers have experienced moments of elation and moments of disappointment, and personnel associated with the project have shared these. This type of teamwork and the congenial associations it promotes made the research project very rewarding professionally and personally.

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ABSTRACT

An established economic simulation model for reservoir development was applied to ten reservoir projects throughout Texas. The model as a predictor of economic impact was given a difficult test because of the diversity of geographic, economic, and social characteristics surrounding the reservoirs. Additional difficulty was provided because the reservoirs were in different development stages--Construction, Fill-up, and Post Fill-Up.

The simulation model was developed in a previous research effort on two central Texas reservoir areas--Belton Reservoir and Whitney Reservoir--and these areas were retained in the study for check purposes. A third reservoir area--Somerville Reservoir--for which earlier predictions were made was observed for differences between model predictions and actual development.

A synthetic (or "business activity") index was developed for measuring accuracy of the model in the thirteen reservoir areas. Initial applications pointed out weaknesses in recreation projection and total impact calculations.

Only partial success with an early application of the model to all reservoir areas necessitated a detailed analysis of all internal model relationships. Revisions were incorporated by using primary data from on-site observations at each area and secondary data from various sources. A reapplication of the model showed the revisions had increased the accuracy for all but two reservoir areas. The revised simulation

model provided a systematic and relatively accurate tool for measuring and projecting economic impact surrounding a developing reservoir area.

The project data, the results and recommendations of the study are published as Technical Report No. 20 of the Water Resources Institute, Texas A&M University. Copies of the report have been sent to all persons cooperating and furnishing data for the study.

Pearson, John E., and Heideman, Kenneth E.

A Study of the Economic Impact of Water Impoundment through Validity Testing of a Comparative-Projection Model. Technical Report No. 20, Water Resources Institute, Texas A&M University, August, 1969.

KEYWORDS--*Economics/Economic Impact/Computer Model/Texas/*Simulation Model/*Model Studies/Project Planning/Reservoir Stages/ Simulation/*Economic Prediction/

Part I

The association between water and economic development has been a close and long one. Early development in the United States was concentrated around rivers and streams because agriculture, transportation, commerce, and economic survival depended upon water. Today, technology for tapping underground water and transporting water over distances has changed some of the locational dependency of commerce and industry. Water is no longer a primary source of transportation or the sole source of power for industry. However, economic development still needs water in large amounts and water development needs economic growth to absorb some of the tremendous costs of providing an adequate water source and supply.

When water is impounded, a number of things with economic consequences happen in the immediate area. The construction of the reservoir and dam usually costs millions of dollars and causes a significant boost to most local economies. After a dam has been constructed and the reservoir begins to fill, fertile lands are reclaimed from flood damage, land development is active, and recreationally related businesses (boat marinas, boat dealers, boat supply stores, motor shops, fishing supply businesses, restaurants, etc.) are started. Permanent homes and commercial resort accomodations are built, water supply industries establish operations, and industrial location experts study sites for industries utilizing both hydroelectric power and water. Most of these activities are visible and evident, but without adequate measures, the size, rate or direction of these responses is unknown.

Recent research has led to the development of a model which can simulate the economy surrounding a proposed impoundment site. [26] Research reported here shows the application of this model to twelve reservoirs which are heterogenous in economic circumstances and sufficiently developed to allow empirical testing of the model.

Previous Research

A rather large variety of ways have been proposed for measuring economic impact, but they may be summarized in five basic approaches. They are: (1) personal income or buying power estimates by counties, (2) synthetic indexes, (3) interindustry (input-output) studies, (4) land price differentials, and (5) simulation models. Each approach has had some degree of success and each has certain limitations. Use of a particular approach may depend on the size of the study area, the magnitude of the inputs, or the type of exogenous forces generating economic change. Many times, however, the approach chosen depends on the researcher and the methods with which he is most familar and in which he has the most confidence.

Income Estimates by Counties

The first method listed above has variations because personal income for areas such as cities, counties or census tracts has been estimated in several acceptable ways [24][25]. The most common way is a complete survey of family-unit incomes, but this is expensive and time consumming because it must be repeated to show changes resulting from structural economic activity. A variation to this procedure takes state income estimates as a starting point and allocates income to smaller regions based on population estimates. These allocations are then reconciled with related series of data on wage and salary disbursements along with other incomes.

Predictions from this method are limited when used for water impoundment areas because these areas do not normally follow county boundaries or census tracts and further estimates must be made, thus lowering the reliability. This method does not reflect the potential of a recreation site, with its temporary increases in population and income, and this is an important economic aspect of water impoundment.

Synthetic Indexes

The synthetic index, which "validates" available data as reliably reported, is an accepted technique for measuring economic impact [30]. The inputs, usually a combination of building permits, utility connections, average daily bank debits, electricity usage, visitor expenditures, etc., are easily constructed from secondary data. Also, they are fairly reliable for small areas and have low data collection costs. However, these "business acitivity" indexes provide a *post hoc* view of the economy and cannot project the effects of structural economic changes or exogenous inputs, although they can provide a valid test of other methods which use different inputs. This limitation is serious for projection activity in a water impoundment area because the impoundment itself may change the surrounding economy rather dramatically.

Interindustry Analysis

One of the more widely accepted approaches for measuring economic impact is the interindustry analysis [17]. This approach has recently been used for water based recreation areas in Wisconsin [15] as well as being used by economists for measuring regional economic activity in the United States for over two decades [14][22][23]. The basic strategy of this approach assumes the study area is a closed economy and measures the economic inflow and outflow through industry sector purchases and sales. The establishment of the degree of interdependence between industry sectors determined by correct production coefficients is very critical to the success of this approach. There is usually considerable expense involved with establishing the degree of interdependence, making the cost of using interindustry analysis prohibitive for small nonindustrialized areas. The interindustry analysis, while quite useful for large water impoundment areas, is both costly and inaccurate for small rural or semi-rural areas.

Land Price Differentials

A fourth way to measure economic impact is to measure the reflection of changing incomes in changing land prices [2][16]. This approach makes comparisons between land prices within one time period with those of another time period. Normally transaction prices are used because appraised values vary too much. Exchange prices around a water impoundment are difficult to gather and some form of sampling must be employed [5]. Although sampling may result in the loss of accuracy, several types of weighting adjustments can be used to overcome the problem.

Land price differentials can usually measure economic impact. There is a significant correlation between land prices and personal income because income capitalization of monetary surpluses in the price of productive assets is not uncommon. However, when land use is diversified, has mineral differences, or surface differences, a low or no covariation is found between land prices and personal income, and the reliability of their economic measurement is lost.

Simulation Model

The fifth approach to measuring economic impact is the model which simulates economic activity with symbols, and then fits in area characteristics and growth factors to define the local economy and its direction. Two general types of simulation models may be used: one approximates reality and the other does not, but each has value as a measuring instrument. If the purpose is to approximate reality, then it must empirically represent reality in all essential characteristics. Since most individual variables of its structure are empirically tested before being made a part of the model, and internal relationships must be realistic, the empirical model contains a potential and limitation to the extent that it predicts accurately.

Previous research had as its objective the development of a simulation model which would predict the economic impact of the Somerville Dam and Reservoir at Somerville, Texas [26]. The model, named the *Comparative-Projection Model*, showed encouraging promise for predicting economic growth caused by a reservoir constructed in a relatively sparce population area which is not industrialized

Comparative-Projection Model

Development of the comparative-projection model began with specification of things which happen with an accompaning economic consequence when a water impoundment project is developed. This included the injection of public funds, investments of private funds, expenditures of visitors and a multiplier effect of the inputs on the local economy. The activities divided into three stages of reservoir development: (1) construction, (2) fill-up and (3) post fill-up. Each stage has unique economic characteristics and all interrelate with the existing regional economic characteristics. A detailed listing of the mathematical model is presented in Appendix A, and only the general form of the model is described here.

Time Stage Inputs

The construction period in the model starts when basin land is purchased, wages are paid, materials and supplies bought, and equipment put into action. Execution of construction costs into the money flow signals the beginning of construction and it continues until dam, dikes, and access roads are completed. During this period all lands for inundation are purchased, brush is cleared from the basin, earthen embankments are raised, channels are cut, roads are moved, the spillway is constructed, etc. Although the close of the water gates terminates the construction period, some construction, such as peripheral roads, parks, and installation of hydroelectric generators (if the dam is designed for such) continues.

Economic impact associated with the construction stage results mainly from construction and related activities such as payrolls and purchases. The extent to which these affect and are multiplied in the local economy depends on available manpower and supplies in the area as well as investment in expansion. Secondary impact from payrolls and purchasing is a function of total regional incomes, agricultural income, population density and distance from a metropolitan center.

Completion of the dam to a point when the gates can be closed begins the fill-up period. During this period, which lasts until water reaches desired levels, there is a loss of construction income, but indirect impact from the previous period is still evident. Other economic activities such as reservoir maintenance expenditures, construction of public recreational facilities, land development costs and new business construction generate new income.

During the fill-up period money is generated from a variety of sources, but once the reservoir has filled most of the initial investment is over and a return on this investment is anticipated before additions are made. If returns are not adequate there is a net loss of economic impact. Conversely adequate returns will attract new capital for investment causing a net increase in economic impact.

The primary factor determining economic impact during the post fill-up stage of a reservoir is the number of lake visitors and their expenditures. Visitor expenditures vary as much as their purpose in attending the reservoir area. Surveys have shown wide expenditure differences between campers, fishermen, boaters, etc., and the model includes these categorical breakdowns, their expenditures in the impoundment area, and whether or not they live in the immediate area.

This post fill-up stage exists from the defined fill-up period until the reservoir ceases to exist; but for purposes of model measurement the post fill-up was defined as five years following fill-up. The duration of this period allows for the initial and sustained growth of the impoundment as a recreational attraction.

Impoundment Project Tests

Two completed reservoirs in Texas were selected for initial testing the comparative-projection model: the Whitney Dam and Reservoir on the Brazos River and the Belton Dam and Reservoir on the Leon River. These two reservoirs were selected because of comparable locations, construction times, and size.

Another reservoir, then under construction, was the first true application of the model. This reservoir was the Somerville Dam and Reservoir on Yegua Creek. Observation of primary data sources was then the only check for the model. The success of the three applications indicated that the model had possibilities as an economic predictor.

Research Objectives

The objective of the current research reported here was twofold: (1) to establish the accuracy of the comparative-projection model through observation and collection of primary data of the Somerville Dam and Reservoir and (2) to test the accuracy of the model on other completed reservoirs through use of secondary data.

Each part of the objective was to be accomplished through a three step sequence. Since the Somerville Reservoir was in the fill-up stage, close on-site observation was to be used to reconcile development around the reservoir with earlier model projections. As deviations were noted the model was to be reexamined for possible modifications and then these changes were to be implemented. The model was then to be applied to the data from the Somerville Area for a revised projection.

Ten established reservoir areas were to be selected for accomplishing the second objective. The same sequence as used on Somerville Reservoir was to be used with these reservoirs except decisions were to be based on secondary data. The economic variables and inputs for these reservoirs were to be tabulated, and the model then applied to all of the reservoirs as a test of prediction accuracy. Generated prediction data was to be studied for observable economic differences between it and a synthetic economic index used as a target.

The anticipated results were a reasonably accurate measure of economic impact for each of the reservoir areas using accessible data. Differences that did occur were to be evaluated and if necessary, modifications were to be made to the model. After possible revisions the model was to be reapplied to all ten reservoirs for modified results. This sequence was to be repeated until satisfactory results were obtained with each model modification applied concurrently to the Somerville application. Final results were to be a generalized model capable of measuring and predicting economic impact of any new economic stimulus with a minimum of effort and expense.

Procedure

The state of Texas, with many man-made reservoirs and water storage problems, was chosen as the universe for the study. Ideally, all reservoirs in the state should have been used in the test; but after considering over 20 reservoirs, ten were selected to represent the total variability of economic locations and construction circumstances in the state.

Reservoirs chosen were located in east Texas, central Texas, west Texas, and on the Texas-Mexico border. Size variation was accomplished through selective choosing in the areas, giving a range from 510 to 114,000 surface acres. Stage variation was included in the selection and ranged from reservoirs completed over 20 years to one still under construction. Diversification of economies around the reservoirs ranged from one having an estimated aggregate income of $9.9 million with 49% from agriculture to one with an income of over $378.0 million and only 9% from agriculture. Variation also existed in populations, cities, and other economic characteristics. The result was a wide array and varied combination of inputs for the model.

Following reservoir selection, economic data necessary for inputs to the model were collected. Along with this data another type of data was collected for the test areas. The accuracy of the model could be tested only against a parallel system designed specifically for measurement. A synthetic index using bank debits, bank deposits, postal receipts, and retail sales was constructed for each area to serve as a target. This index had functioned with aceptable accuracy in the initial applications of the model on the Belton and Whitney Areas [26].

The initial computer run of the model was made for each reservoir area giving predictions for economic growth based on initial input data. Predictions were made for attendance, investment, and the total impact of the reservoir on the local economy. When errors were detected in the projection of total impact, attention was turned to the inputs generated internally by the model. Inaccuracies which appeared were concentrated in the area of attendance and total impact predictions with a slight error being injected with the investment projections.

First, modifications were undertaken to correct the attendance algorithm. Variables which had been used originally were retained with only relationships between them being changed and new variables being added to the structure. Once attendance had been checked out, the total impact projections required alterations. Part of these changes were effected by making small changes to the commercial and residential projection equations. The same rule which applied to attendance modifications was observed with changes in total impact. Relationships were expressed differently and limits were required on some variables in order to meet the demands of the empirical data.

Other parts of the model were retained in their original form. No changes were necessary in the basic concept of time-stage inputs. The economic indicators associated with the economic development of a reservoir continued to pinpoint the capabilities of the local economies and require no additions. The establishment of a degree of reliability in the model predictions indicated the modifications had been successful.

Findings

The two reservoir areas, Belton and Whitney, selected orginally to test the comparative-projection model were retained in this study as test patterns. Although similar in many aspects, the two reservoirs were sufficiently different to provide a contrast for the model. Any hypothesized changes to the model throughout the study were first piloted on these two reservoir areas because of the availability of large amounts of compiled data, changes to the model were implemented only if their application on the Belton and Whitney areas did not substantially alter the original impact calculations. Although several changes were necessary to increase the accuracy of the model the results obtained earlier for the Belton and Whitney areas were not changed significantly.

Continued observation and study of the Somerville Dam and Reservoir Area showed increased activity after the reservoir had filled. Previous predictions made by the model, when the fill-up period started, were thought to be on the high side. On-site studies during the past two years have reversed the direction of bias, and the original projections now appear to have underestimated the impact of the Somerville Reservoir. The primary reason for this can be attributed to an underestimation of the number of recreators that would be attracted to the area. Once the model equations for predicting recreational attendance had been modified, a reapplication of the model showed the attendance projections closely approximated the measured attendance for the most recent years. Based on the increase in recreational attendance a revised impact projection was made. Survey data of the entire area surrounding the Somerville Reservoir validates the projections and shows the reservoir will have a continuing large economic impact on the area.

Success with the model was determined for the Belton and Whitney areas by comparing the model results to a synthetic index measure. This same measure, adjusted to the particular locale of each reservoir, was used to check model accuracy on the other ten reservoirs. The initial application of the model met with only limited success. Four of the ten reservoir applications projected within ten percent of the target index, but the remaining reservoir areas missed the index by varying percentages up to fifty percent.

Close examination of differentials indicated that the primary source of variation was in the recreational attendance algorithm. The equations had reacted as anticipated with average sized reservoirs, but inputs from very large or very small reservoirs resulted in unreasonable projections. A major revision of this section of the model was necessary before even a close approximation was made of the tabulated attendance data for each of the reservoirs. The attendance algorithm was revised so that it successfully predicted attendance at all but two of the thirteen reservoirs, and the two exceptions do not have acceptable data to serve as a checkpoint.

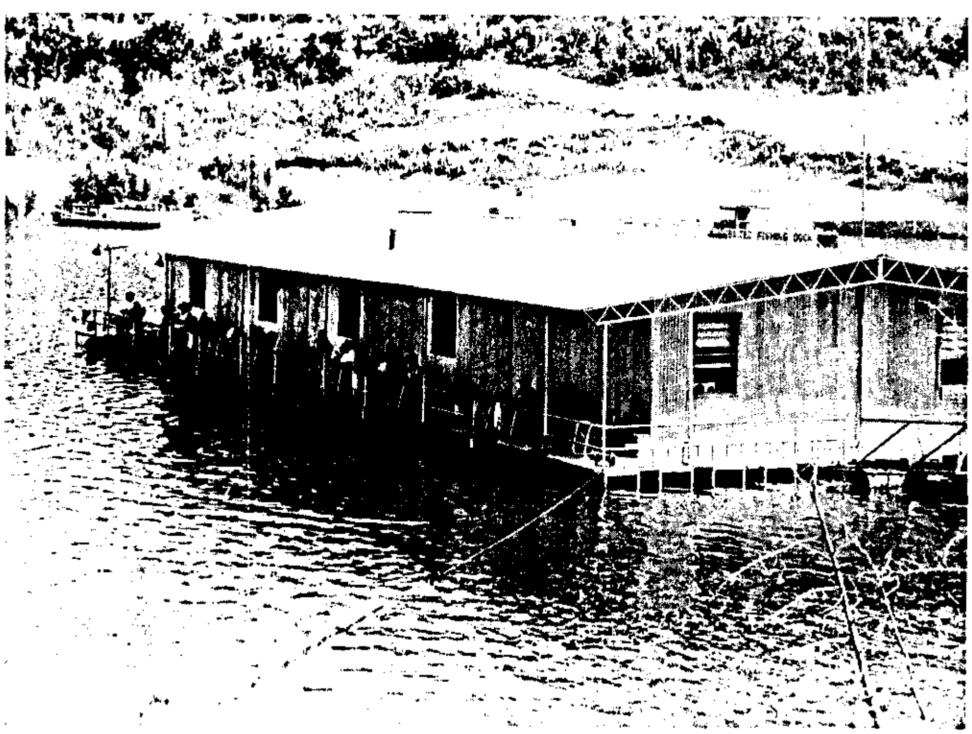
More adjustments in the model were needed, because correction of attendance equations alone did not resolve all inaccuracies. The very large and small reservoir areas were consistently inaccurate until the multiplier was redesigned and minor changes made in the investment equations. The revision of the multiplier provided the change which gave accurate measurements for the two comparative areas, eight of the new reservoir areas, and the Somerville Area. A revision of the investment equations gave a further refinement necessary to approximate the empirical data. The remaining two areas showing variation are unique cases and could be accurately predicted, but data limitations do not allow a complete check of model accuracy.

The model in its modified form is a logical, orderly simulator of economic activity for small sub-regions. Its prediction accuracy was proven to be acceptable with reservoir areas varying in size, economic characteristics, terrain, and periods of development. The generalized application of the comparative-projection model was supported by a "business activity" index based on secondary data and field observation of the reservoir areas. The validation of the model by this parallel system of measurement shows it as a useful predictive tool. When utilized with other decision criteria, the comparative-projection model can make valuable contributions to locating and planning of water reservoirs.

PICNIC AREA AND MARINA,
SOMERVILLE RESERVOIR, TEXAS, 1968
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

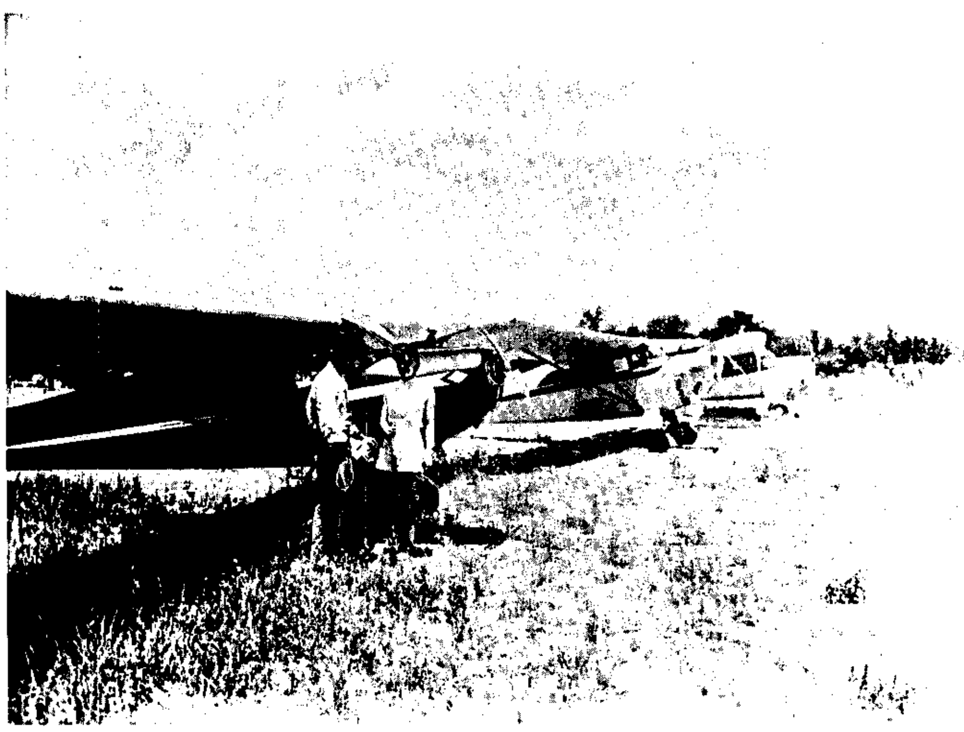
OVERLOOK MARINA,
SOMERVILLE RESERVOIR, TEXAS, 1968
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

BEACH AND SWIMMING AREA,
BELTON RESERVOIR, TEXAS, 1961
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)



FISHING DOCK,
BELTON RESERVOIR, TEXAS, 1961
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

BOAT DOCK AND RAMP,
WHITNEY RESERVOIR, TEXAS, 1956
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)



AIR FIELD,
WHITNEY RESERVOIR, TEXAS, 1956
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

CAMP SITE, HARBOR BAY AREA,
LAKE MEREDITH, TEXAS, 1966
(Source: Bureau of Reclamation, U.S. Department of the Interior, Amarillo, Texas)

Part II

APPLICATIONS

The success of the comparative-projection model as a predictive instrument of economic activity for small regions was determined by applying it empirically to areas diverse in economic characteristics. The ten reservoir areas, plus the two original comparative areas and the Somerville Reservoir, provided a great variety of test cases. The reservoirs and their respective local economies (shown in Figure 1) are described below in detail.

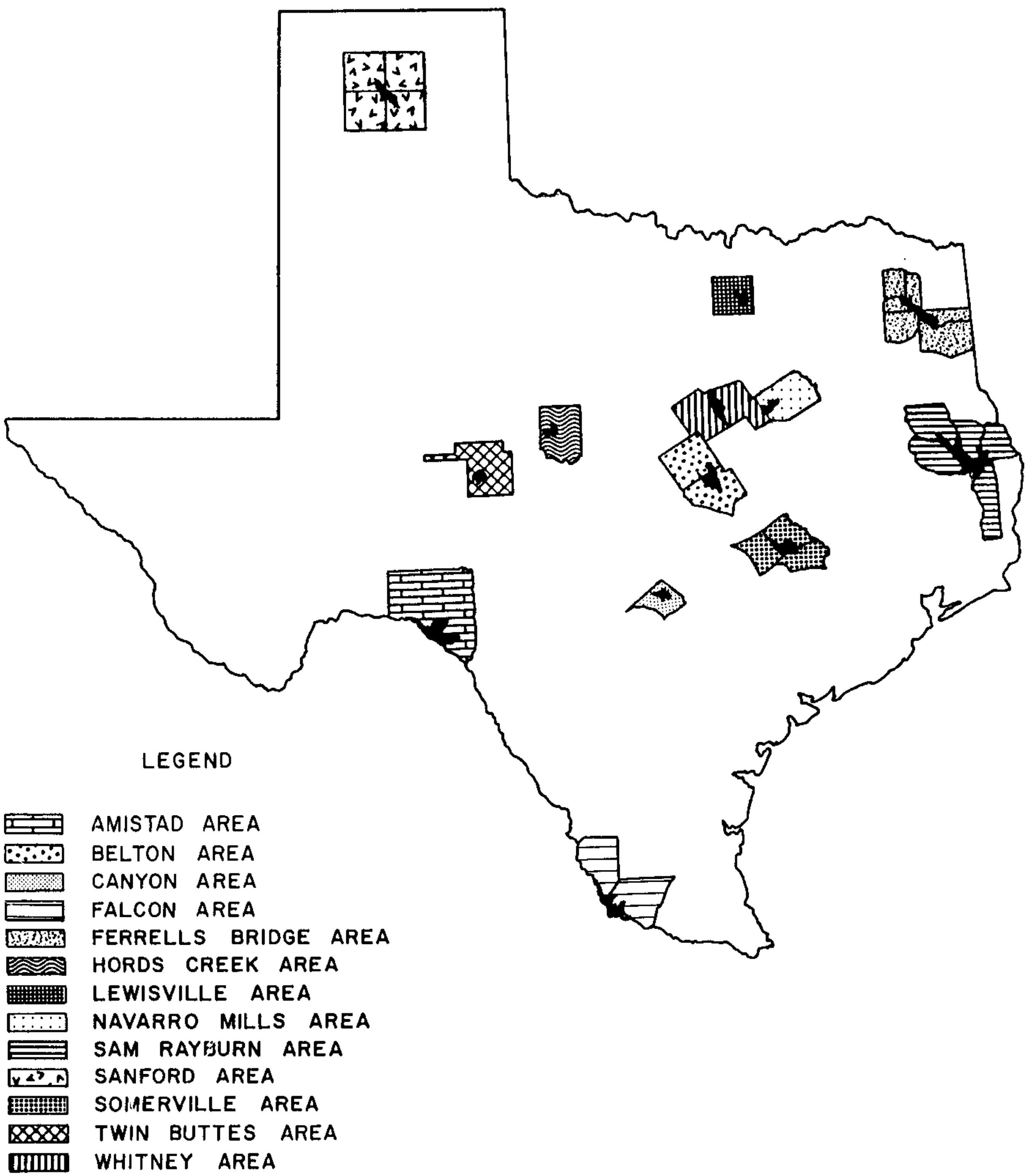
Geographically the reservoirs are located throughout the State to reflect differences in terrains, climates, and uses. Time period variations are reflected by the different stages of development for each reservoir. Reservoir sizes, type of terrain, climate and economic variations are reflected by differences in the local economy surrounding each reservoir. The heterogeneity of conditions in the existing economies and the inputs to the model provided a sufficiently extensive testing of intra-model relationships.

Successful Applications

A complete tabulation of all required data was made for each reservoir area before it was compared with projections generated by the model. This included data for model inputs as well as inputs to the target index. The first total application of the

FIGURE I

LOCATION MAP OF STUDY AREAS



model generated five apparently accurate data sets plus the two original comparative areas and the Somerville area. Five areas were not predicted accurately by the model in its original form.

Comparative Areas

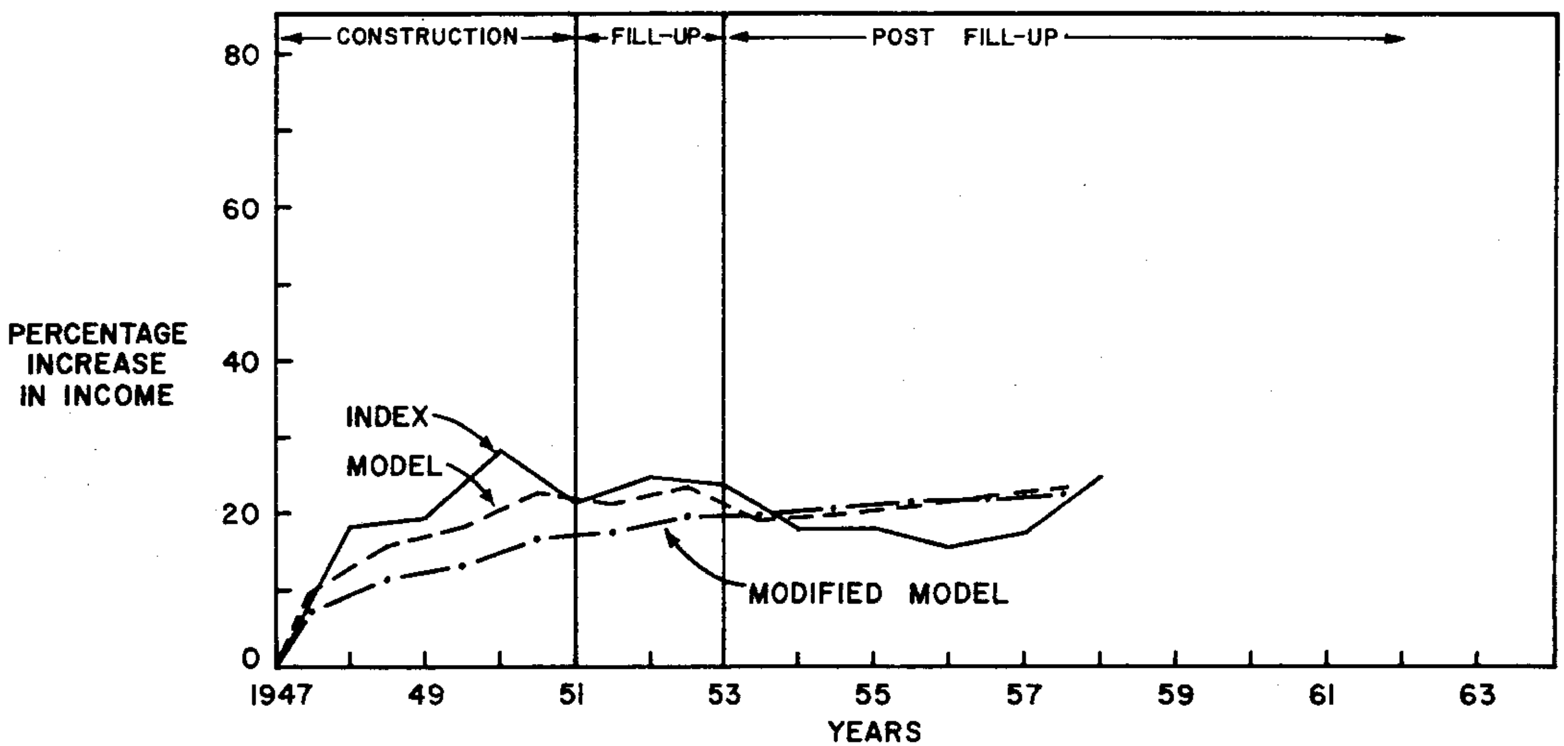
The two original study areas on which the model was developed, Belton and Whitney, were retained for this study so that all model adjustments would have to satisfy the prediction requirements of these areas. Both reservoirs had similar construction times and geographical regions, but the economies provide some contrast in development. The index and model for these two areas (presented graphically 2 and 3) show variation in economic activity. When the model was revised, continued applications were made to the Belton and Whitney Areas so that these measurements were retained. Some changes were effected, but the model predictions were still acceptably accurate, as shown by the modified model curve.

Primary Area

Following the development of the model on the Whitney and Belton reservoirs, projections were made for the Somerville Dam and Reservoir which was under construction at the time. This area was retained for use as a check point in model changes and revisions because it was easily observed by on-site visits. Somerville Dam and Reservoir, located on the Yegua Creek, has experienced rapid development around the reservoir. Based on field surveys the original model projections (as shown in Figure 4) have underpredicted economic activity generated by the reservoir. On-site tabulations aided certain revisions in the model and revised projections for the area are shown as the modified model. An

FIGURE 2

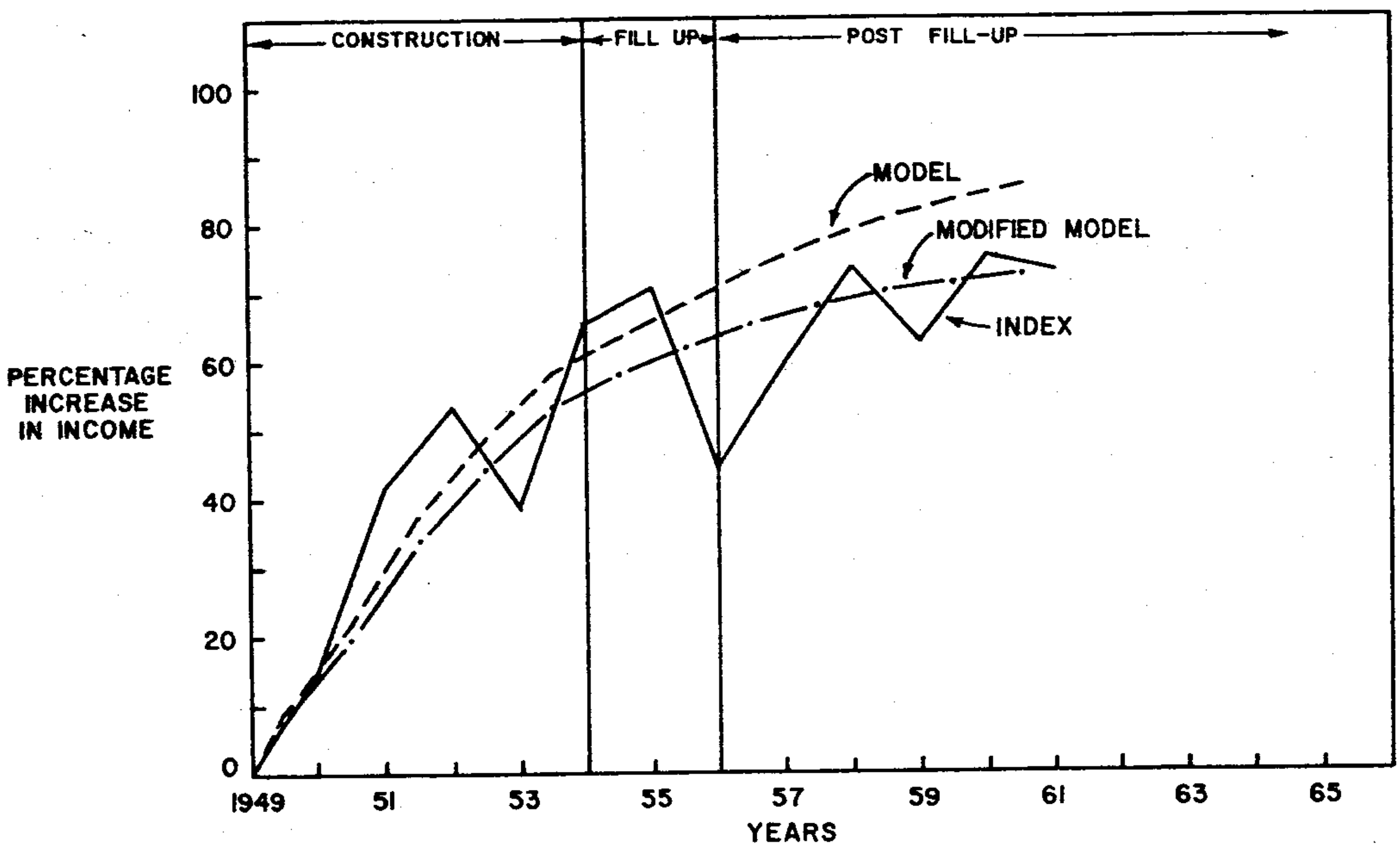
ECONOMIC IMPACT AS MEASURED BY
THE INDEX AND MODEL FOR THE WHITNEY AREA



SOURCE: TABLE 13e, APPENDIX E.

FIGURE 3

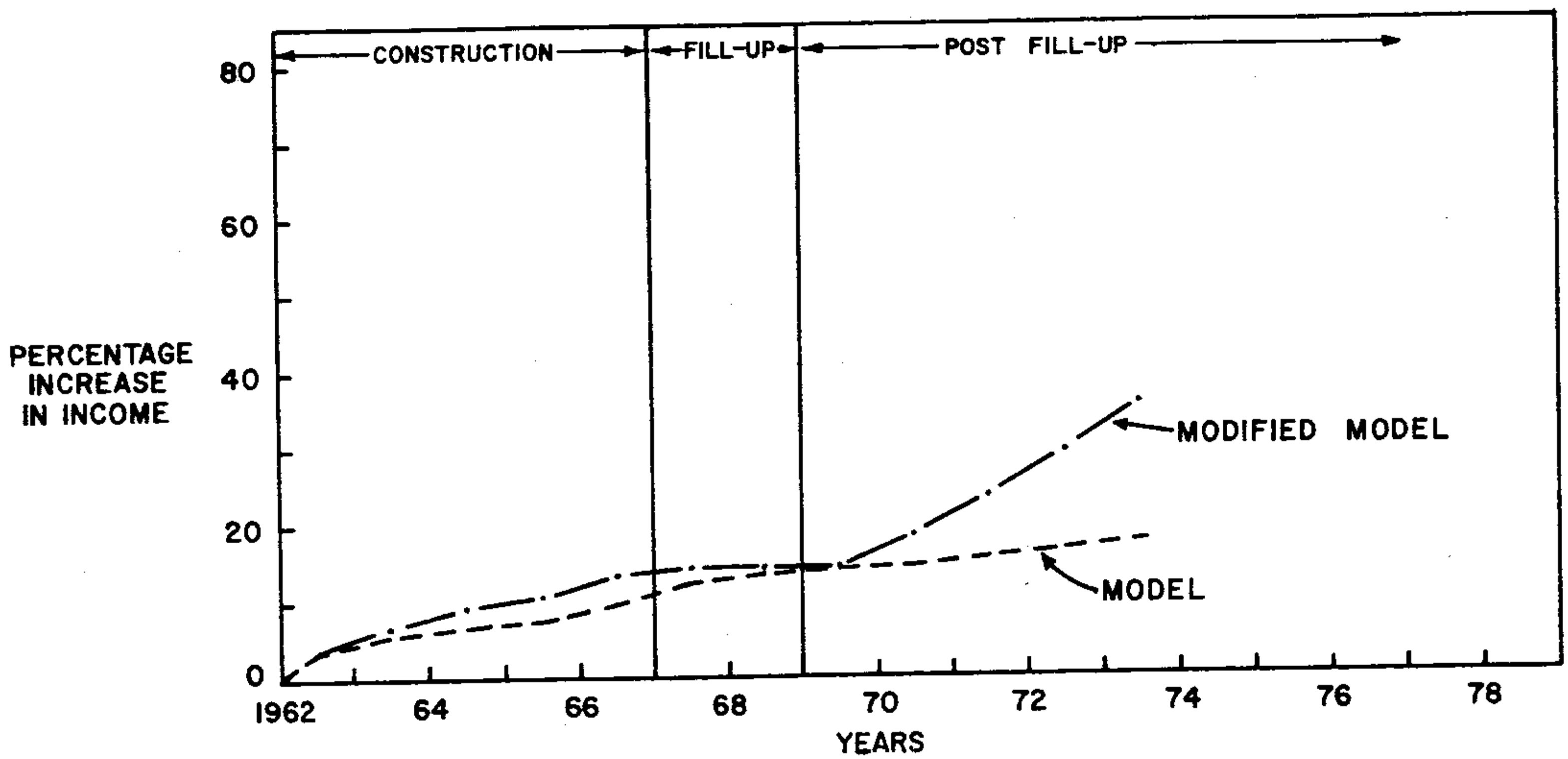
ECONOMIC IMPACT AS MEASURED BY
THE INDEX AND MODEL FOR THE BELTON AREA



SOURCE: TABLE 2e, APPENDIX E.

FIGURE 4

ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE SOMERVILLE AREA



SOURCE: TABLE IIe, APPENDIX E.

increase over the original predictions were made because the area now has had sufficient time to establish its developmental pattern for all years of fill-up.

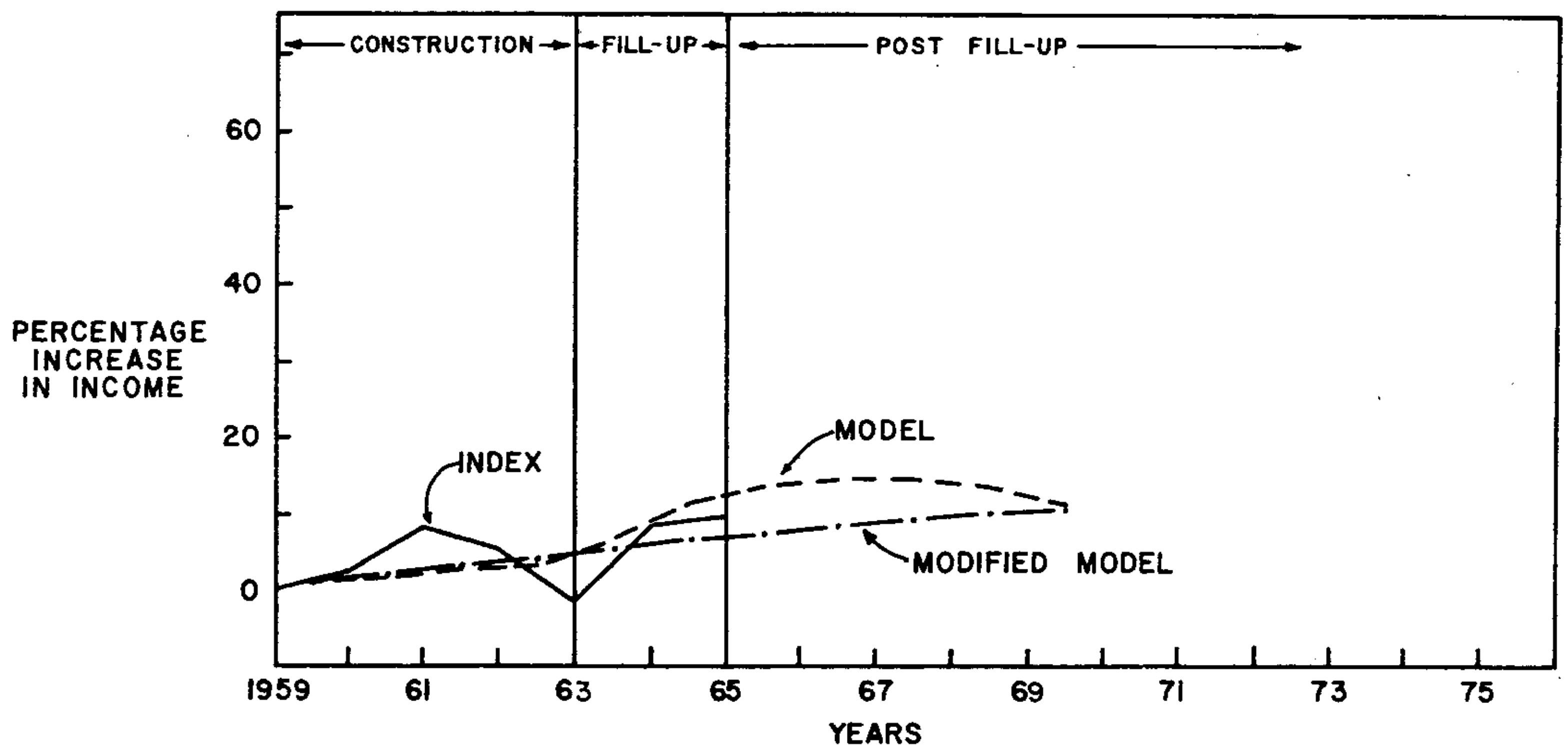
Navarro Mills Area

The Navarro Mills Dam and Reservoir is located on Richland Creek, a tributary of the Trinity River, about 16 miles southwest of Corsicana, Texas. Authorized under the Congressional Acts of 1954 and 1958, the reservoir was built by the Corps of Engineers, U.S. Army, and is operated under Corps supervision. The dam is located in Navarro County with the upper reaches of the impounded water in Hill County. Work on the reservoir was initiated in 1959 and was sufficiently completed in 1963 so that deliberate impoundment could begin. Presently the reservoir is in a post fill-up stage of development. The total cost of the project was $10 million.

Results of the synthetic target index and model for Navarro Mills are shown in Figure 5. The index curve, only complete through 1965, shows a net growth in the area surrounding the reservoir, but in a slightly erratic pattern with a notable decrease in 1963. During early years of construction an increase in economic impact was evident, but as construction dollars were terminated a decrease was experienced in the rate of growth. A positive effect appears again in the fill-up period. The original projection closely approximates the trend for the period through 1963, but rises too high for subsequent years. The modified model shows a more realistic prediction, one of slow but steady growth.

FIGURE 5

ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE NAVARRO MILLS AREA



SOURCE: TABLE 8e, APPENDIX E.

Approximations show the model capable of measuring this type of pattern and accurately identifies the impact of Navarro Mills Reservoir.

Twin Buttes Area

Twin Buttes Dam and Reservoir, located in Tom Green County, regulates the flow of the South and Middle Concho Rivers and Spring Creek. The dam site is located approximately ten miles west of San Angelo, Texas. Authorized as a Bureau of Reclamation project in 1959, construction was started in 1960. The reservoir became operational in 1964 and was to serve as a source of irrigation water for 10,000 acres in Tom Green County. Lack of rainfall in the upper drainage area has prevented the reservoir from functioning as planned. The total construction cost of the impoundment project was $24 million.

Development attributable to the Twin Buttes Reservoir has not followed a pattern identifiable at other reservoirs, but the economy is very similar to one of the comparative areas. Since the reservoir has never filled to capacity, and during most of the time from 1964 has been operated at well below normal pool, the reservoir has not attracted visitors. The empirical study for the Twin Buttes area (shown in Figure 6) shows both the index and original model predicting only slight growth. A slight increase in the economy is noted during the construction stage, and this growth carries over into the model fill-up period. By definitions, the reservoir is still in the fill-up stage. Under normal conditions the fill-up would have been completed, attendance would be higher, and the pattern of increase would probably have been more pronounced for both methods of measurement as is indicated by the modified model curve. The unusual climatic conditions have caused the reservoir to fall short of expectations and the existing project has had only a slight effect on the surrounding economy.

Lake Meredith Area

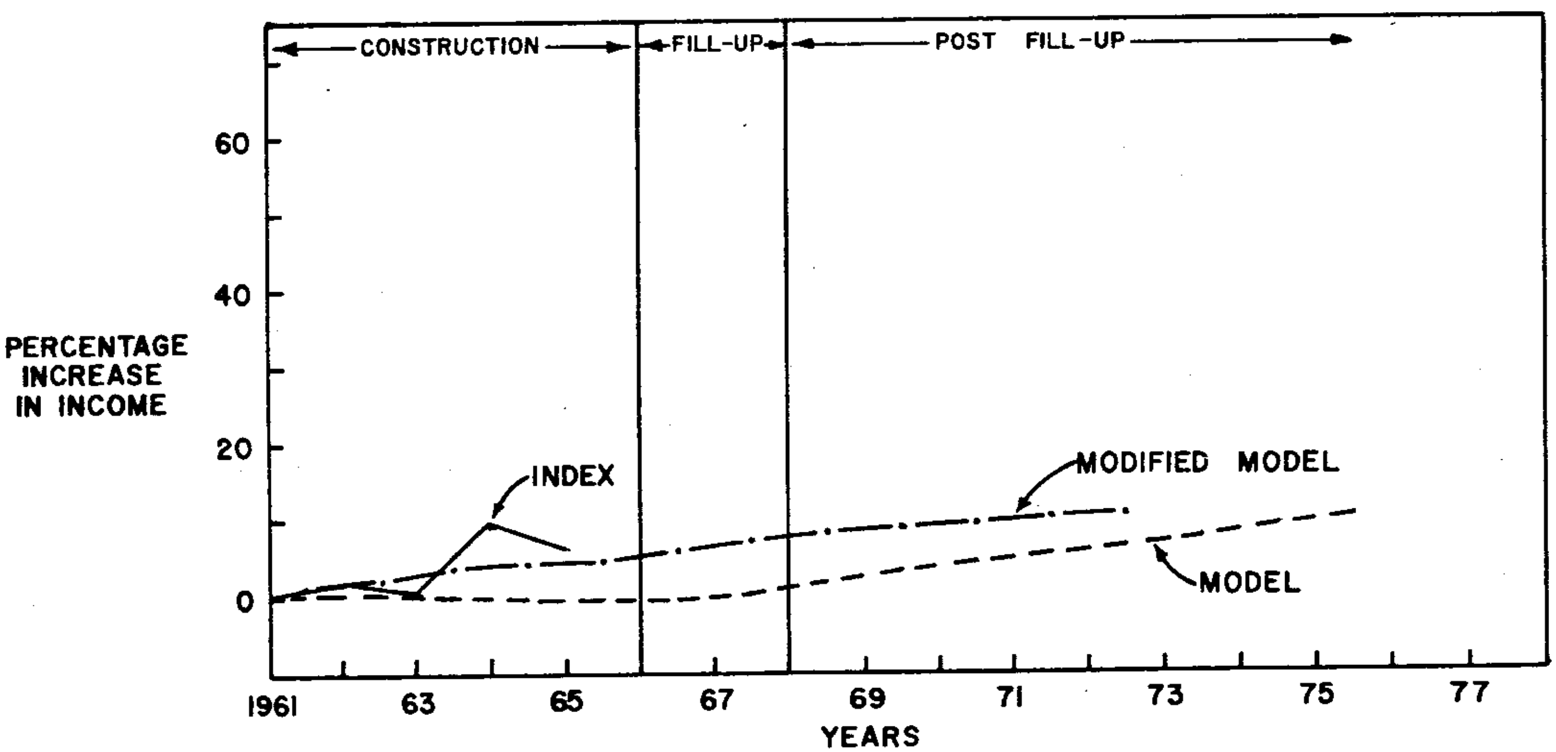
The Sanford Dam, which impounds Lake Meredith, is located about 40 miles northeast of Amarillo, Texas and 9 miles west of Borger, Texas. Lake Meredith was authorized in 1950 as a part of the Canadian River Project under the supervision of the Bureau of Reclamation. This reservoir differs from others under study because the reservoir is the source of water for an extensive aqueduct system which delivers municipal and industrial water to cities of the "Texas Panhandle." Sanford Dam impounds water inundating parts of Hutchinson, Moore, and Potter Counties. Because of the aqueduct system, the entire Canadian River Project was under construction for a longer period than other reservoirs. However, the reservoir proper was begun in 1962 and completed sufficiently so that deliberate impoundment could begin in 1966. Other major construction was completed in 1968 and the reservoir is currently in the post fill-up stage.

The impact of Lake Meredith relative to a comparable control area (an area which did not have a reservoir) is shown in Figure 7. Data tabulation was possible only to 1965, and this does not cover the entire construction period. Measurement by the index indicates slight growth during the early years of construction, but data limitations prevent a view of an established pattern. The original model apparently has a

FIGURE 7

ECONOMIC IMPACT AS MEASURED BY

THE INDEX AND MODEL FOR THE SANFORD AREA



SOURCE: TABLE 9e, APPENDIX E.

time lag in measuring impact, and an increase in economic activity for the Lake Meredith area is not evident until after all construction and fill-up. The modified model depicts a somewhat faster growth, but still indicates the reservoir produced a slow growth. Both model curves underestimate the effects of Lake Meredith in the short run, but the consistent growth pattern established by the index is closely simulated by the modified model.

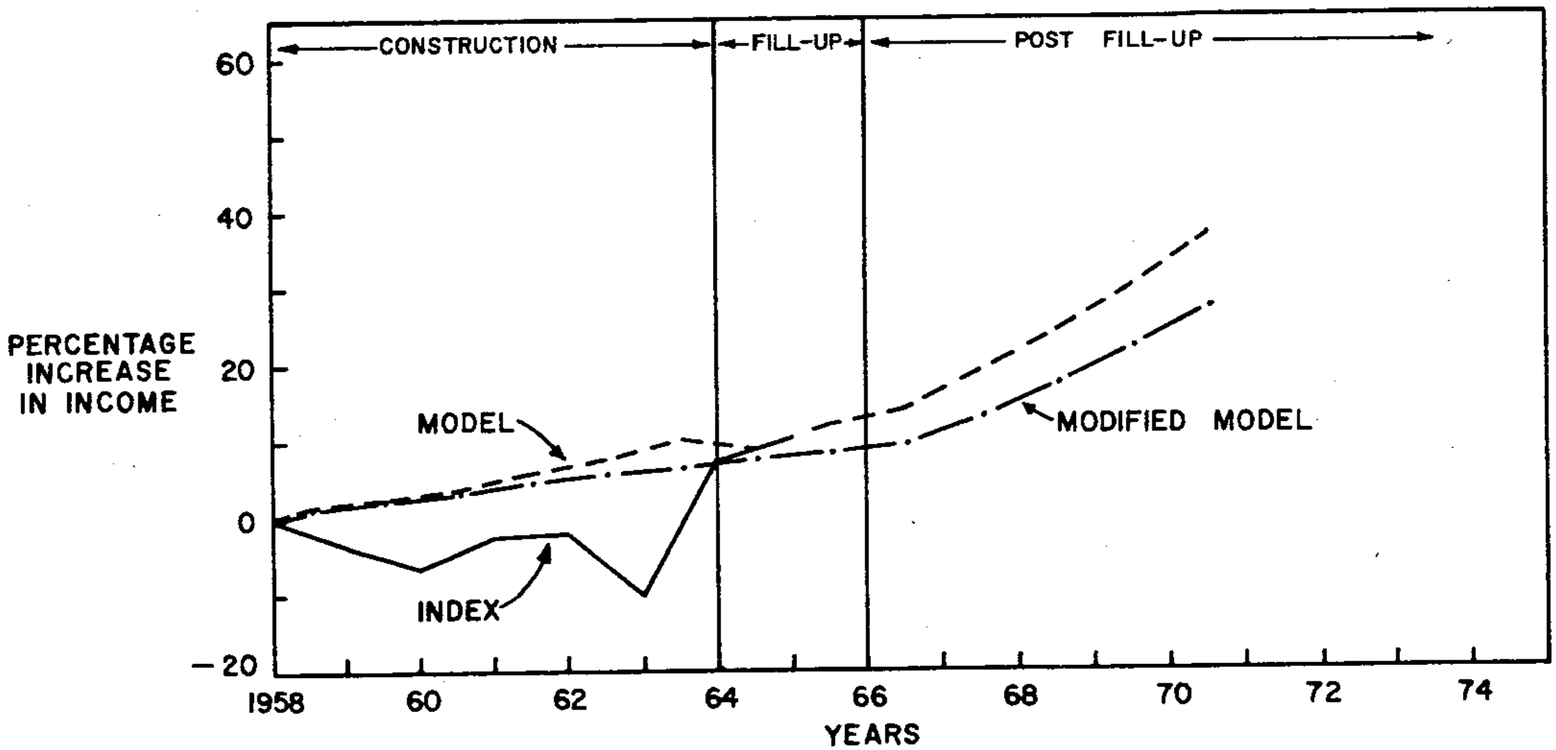
Canyon Area

Canyon Dam and Reservoir is located in the Texas hill country on the Guadalupe River about 12 miles northwest of New Braunfels, Texas. All of the land inundated by the reservoir lies in Comal County. This reservoir was authorized as a Corps of Engineer project by Congressional Acts of 1945 and 1954. Construction of the earthfill embankment was initiated in 1958, took about six years, and cost approximately $19 million. Deliberate impoundment was begun in 1964 and the project is now in its post fill-up stage.

The area surrounding the Canyon Reservoir has long been a tourist and recreational center. As a result, the impact of Canyon Reservoir as measured by the index in Figure 8 reflects a substantial lack of increase. The area surrounding Canyon Reservoir has not experienced a decrease in economic activity, but when compared with a similar control area, the reservoir area does show a lack of growth attributable to the reservoir. An increase in impact is not reflected by the index until the last years of construction. The original model, on the other hand, anticipated an initial increase and a further increase in the post fill-up period. A

FIGURE 8

ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE CANYON AREA



SOURCE: TABLE 3e, APPENDIX E.

revised projection gives basically the same results as the model curve. The disparity existing between the model and index during construction cannot be explained, but on-site observations indicate the model projections are probably more accurate than the index.

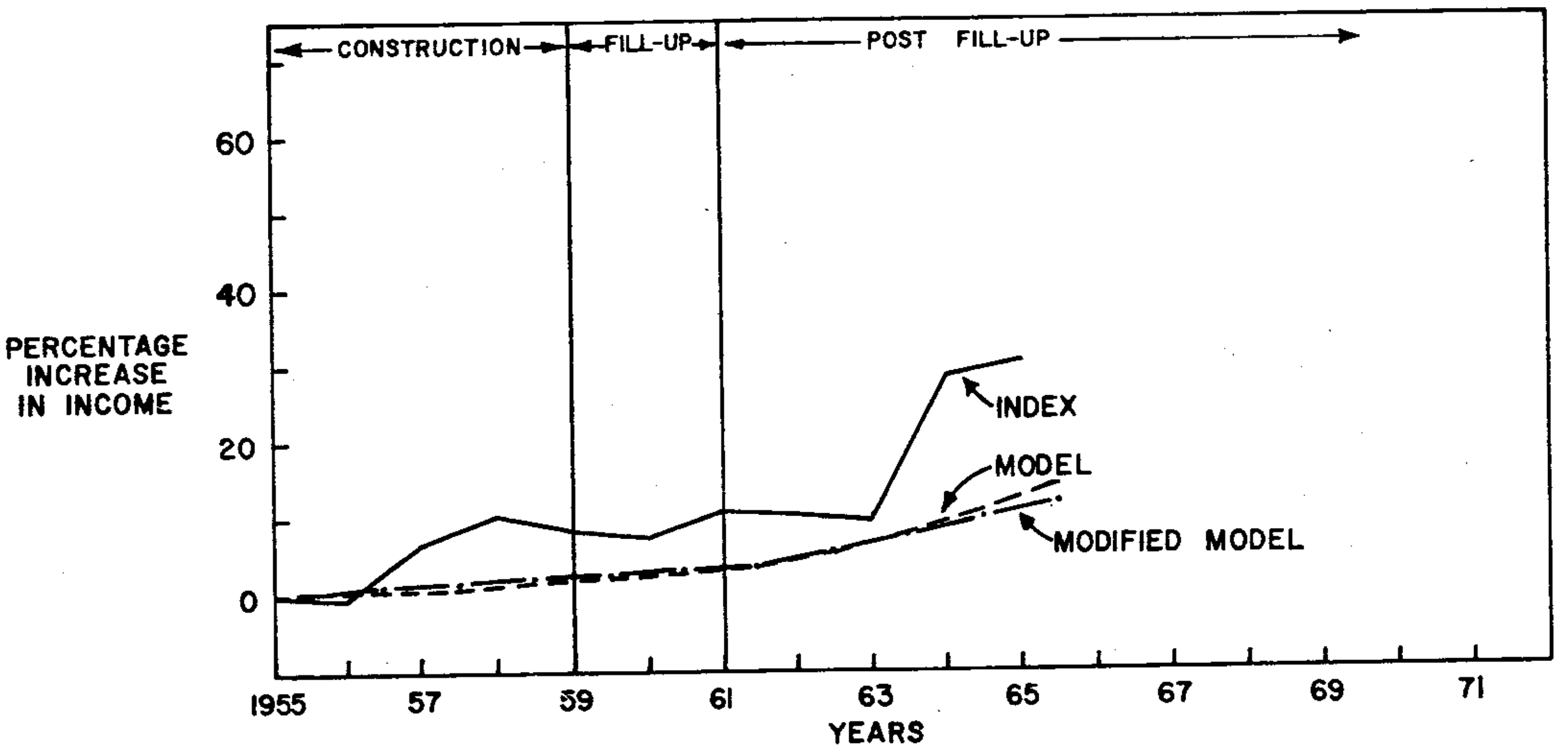
<u>Ferrells Bridge Area</u>

The Ferrells Bridge Dam and Reservoir is located on the Big Cypress Creek about 9 miles west of Jefferson, Texas, and is a part of the comprehensive plan for flood control in the Red River Basin. The dam site is in Marion County with the reservoir inundating parts of five Texas counties: Camp, Harrison, Morris, Titus, and Upshur. Authorization for reservoir construction was granted to the Corps of Engineers in 1946 and construction began in 1955. The dam is of an earthfill type and its construction was completed in 1959. Primarily designed for flood control and water supply, the reservoir cost approximately $16 million. It is currently in the post fill-up stage.

The impact of Ferrells Bridge Reservoir on the surrounding area has been significant. The most notable effects are observed in the second and third years of construction, as shown by the index in Figure 9. The upward trend in impact continued through 1965 with a slight decrease in 1960 and 1963. Measurement by the model underestimates the impact indicated by the index, and the modified model provided similar results. The modified model, although not corresponding projections to the target index, indicates Ferrells Bridge Reservoir has had a favorable economic impact on the local economy.

FIGURE 9

ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE FERRELLS BRIDGE AREA



SOURCE: TABLE 5e, APPENDIX E.

Hords Creek Area

The oldest and smallest reservoir of those selected for study is the Hords Creek Dam and Reservoir, located in the Colorado River Basin on Hords Creek. The dam and reservoir are entirely in Coleman County, about 10 miles west of Coleman, Texas. Authorized by Congressional Acts of 1941 and 1944, construction was begun in 1946 and completed in 1948. The dam is an earthfill type and impounds water with a surface area of 510 acres.

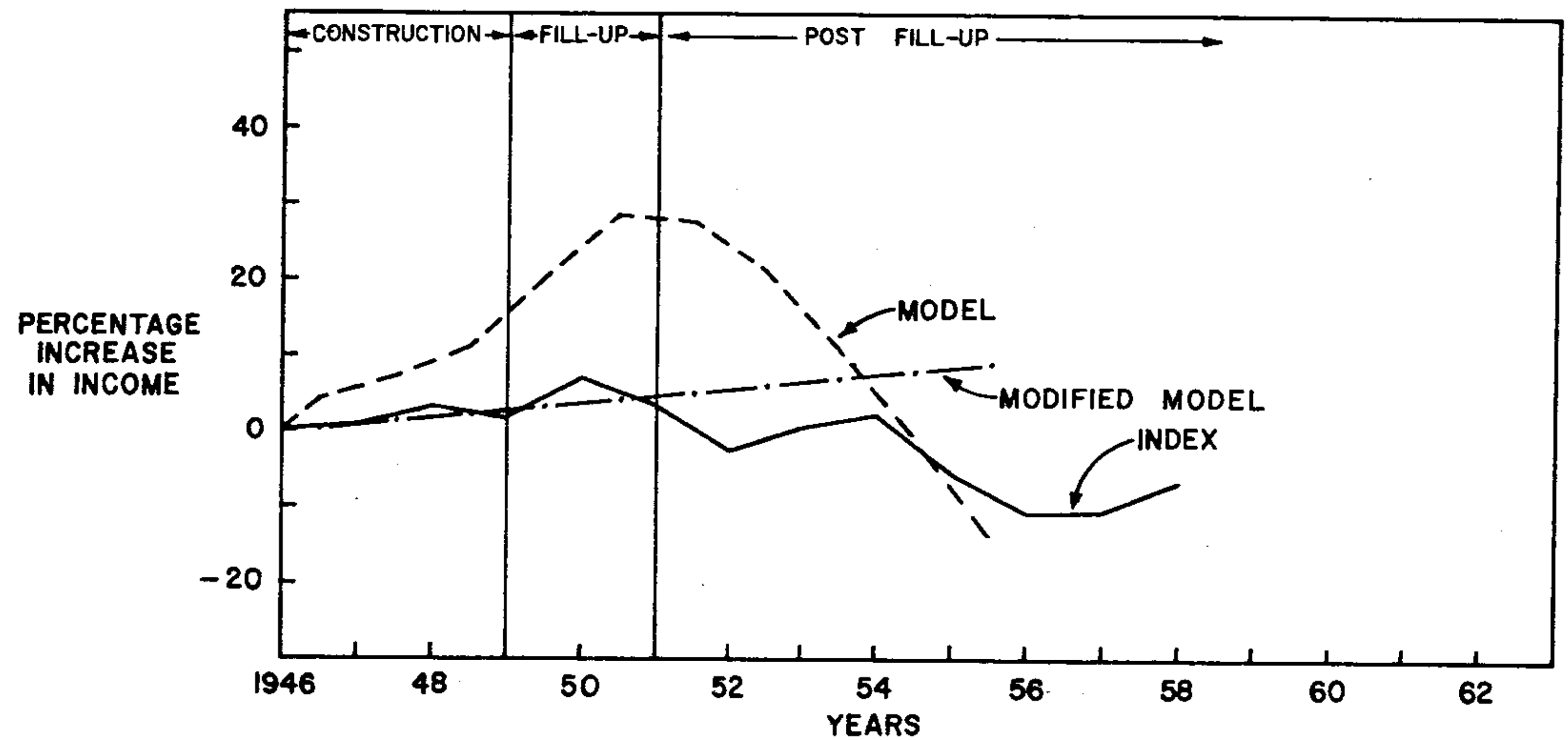
Results from the index and the model are presented in Figure 10 and show the index curve reflecting an economy of sustained growth during the construction and fill-up. Following fill-up the net effect dropped to a point where money generated by the reservoir facility could not offset the economic decline of the region. This is observed in 1952, and again after 1954, when the index curve showed a negative gain.

Wide differences were observed between the model curve and the index. The smallness of the reservoir, together with an extremely small income base for the Coleman County economy, caused the model to make inconsistent measurements. Although the model reflected a decline similar to the index following 1954, it did not approximate the regional economy.

The modified model failed to approximate the index of economic impact, but it did come much closer. A basic bias built in the model, both the original and modified is that the reservoir has some positive economic effects on the surrounding area. Thus, net negative effects cannot be predicted accurately with the model.

FIGURE 10

ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE HORDS CREEK AREA



SOURCE: TABLE 6e, APPENDIX E.

Sam Rayburn Area

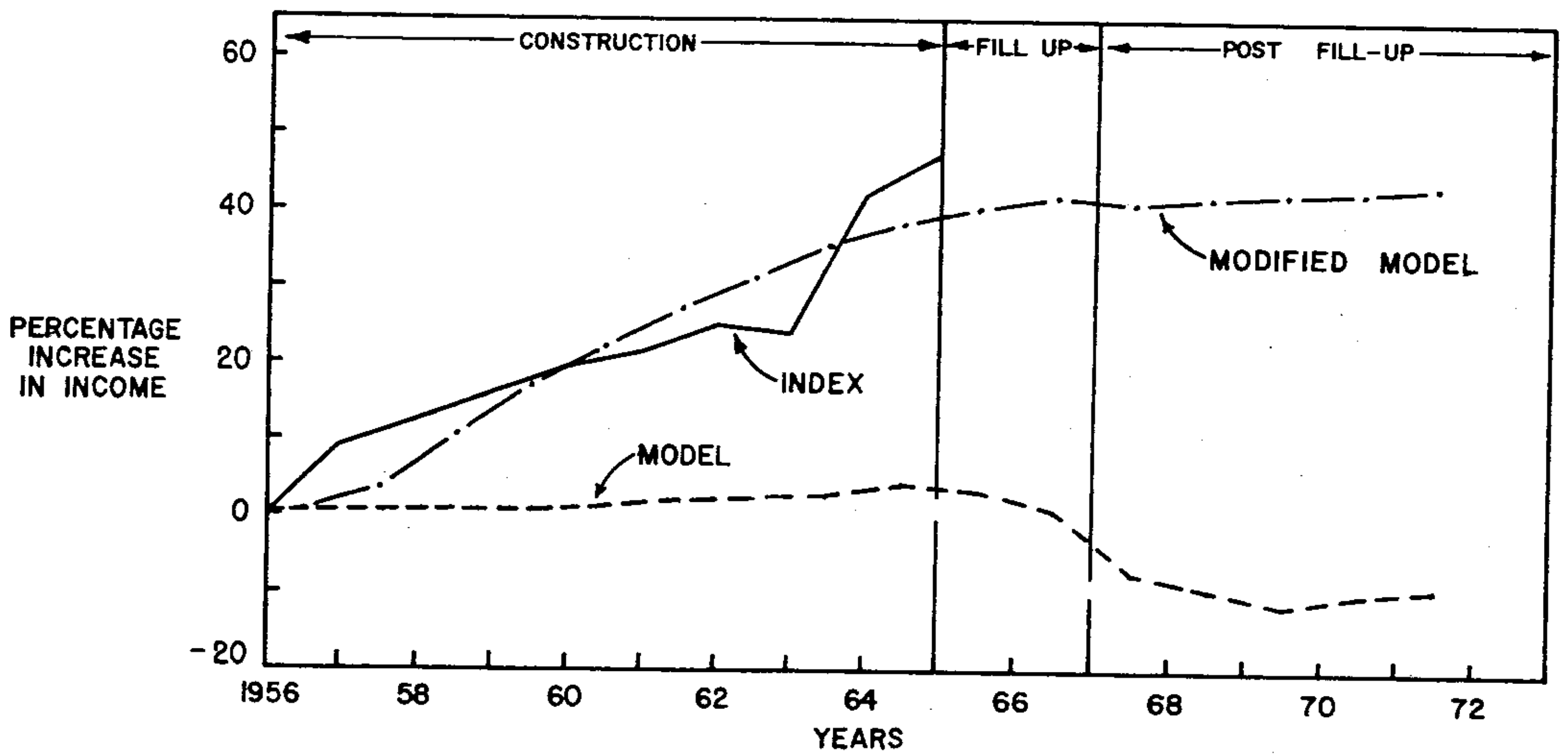
The Sam Rayburn Reservoir, located on the Angelina River in East Texas, impounds water covering five counties. The dam is approximately fifteen miles northwest of Jasper, Texas. At the top of its power pool Sam Rayburn Reservoir has a surface area of 114,500 acres and is the largest water-impoundment project totally within the State of Texas.

The reservoir is one of four projects authorized by Congress for the Neches and Angelina River basins. The reservoir, built and supervised by the Corps of Engineers, is designed for flood control, water supply, and the generation of hydroelectric power. Construction of the dam started in 1956, and in 1965 was sufficiently completed to allow deliberate impoundment. The reservoir is currently in the post fill-up stage of development.

The injection of a $61 million project into an economy produced a dynamic increase in economic activity, as indicated by the index in Figure 11. The net effect of the reservoir has been positive and continually increasing from the beginning. As a very small reservoir had generated unrealistic results when subjected to the original model an extremely large reservoir had the same effect except in a different magnitude. Wide differences were found between the model (original) curve and index. This wide variation in some part was attributable to a defect in the recreational attendance projection as well as a lack of sufficient reaction capabilities in the model.

FIGURE II

ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE SAM RAYBURN AREA



SOURCE: TABLE 10e, APPENDIX E.

The modified model simulated the initial growth pattern and carried this forward into the later periods. Since a nine year pattern has been characterized by growth, the Sam Rayburn Area economy is predicted to enjoy even more growth during the post fill-up period.

Amistad Area

Amistad Dam and Reservoir is located on the Rio Grande River, the international boundary between Mexico and the United States. The dam site is approximately 12 miles northwest of Del Rio, Texas, with inundated land on the United States side in Val Verde County and on the Mexico side in the state of Coahuila. Reservoir construction has been a joint undertaking between the United States and Mexico under the terms of the 1944 Water Treaty. Each country's share in the cost of the reservoir is in proportion to the conservation capacity of the reservoir allotted to each. For the United States this was 56.2% of the total cost or over $35 million just for construction of the dam itself. Construction started in 1965 with the concrete and earthfill dam being completed in 1969. The completion is to be followed by installation of power plant facilities on the United States side costing approximately $7 million. The operation of the reservoir is under supervision of the International Boundary and Water Commission.

Only that portion of money put into the project by the United States is considered for inputs and the impact area considered includes only United States territory.

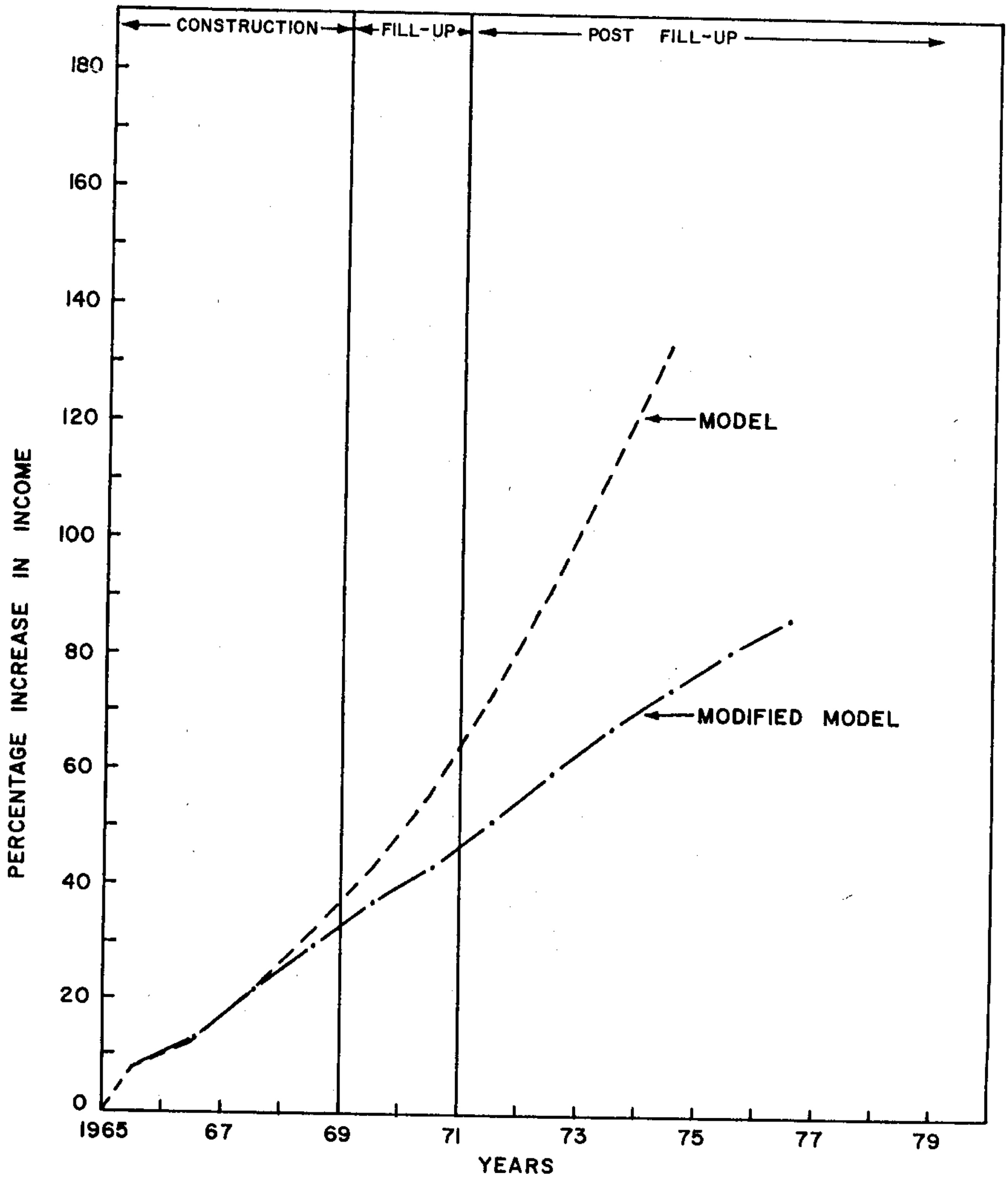
The relatively recent construction of the Amistad Reservoir places limitations on the accessibility of secondary data and an index measurement is not possible. Currently the reservoir is in the fill-up stage of development and only unrelatable projections are made. Predictions made by the original model are shown in Figure 12. The area shows an increase during the construction stage with the same trend continuing into the latter two stages. This economic growth appears to be overprojected by the model since the pattern of activity prior to construction was much slower.

A refinement in the model based on an increased accuracy criteria produced results as shown with the modified model. Here, the curve of income increase appears to be more consistent with the trend observed prior to construction. An increase in income is observed for the entire development of the reservoir project. The magnitude of these increases is less than originally projected but is probably too high because of a low income base.

Falcon Area

The Falcon Reservoir is also located on the Rio Grande and is another of the international water projects. The dam site is approximately 30 miles southeast of Zapata, Texas, and causes impounded water to flood parts of Starr and Zapata Counties in Texas and parts of Tamaulipas, Mexico. Again, the reservoir is part of the 1944 Water Treaty between the United States and Mexico. The cost sharing plan was proportional to storage capacity for each country. Based on conservation

FIGURE 12
ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE AMISTAD AREA



SOURCE: TABLE Ie, APPENDIX E.

storage the United States paid for 58.6% of the construction in addition to its own power plant. Construction began in 1950 and was sufficiently completed for impoundment to begin in early 1954. The reservoir, constructed primarily for flood control and power generation, is supervised by the International Boundary and Water Commission.

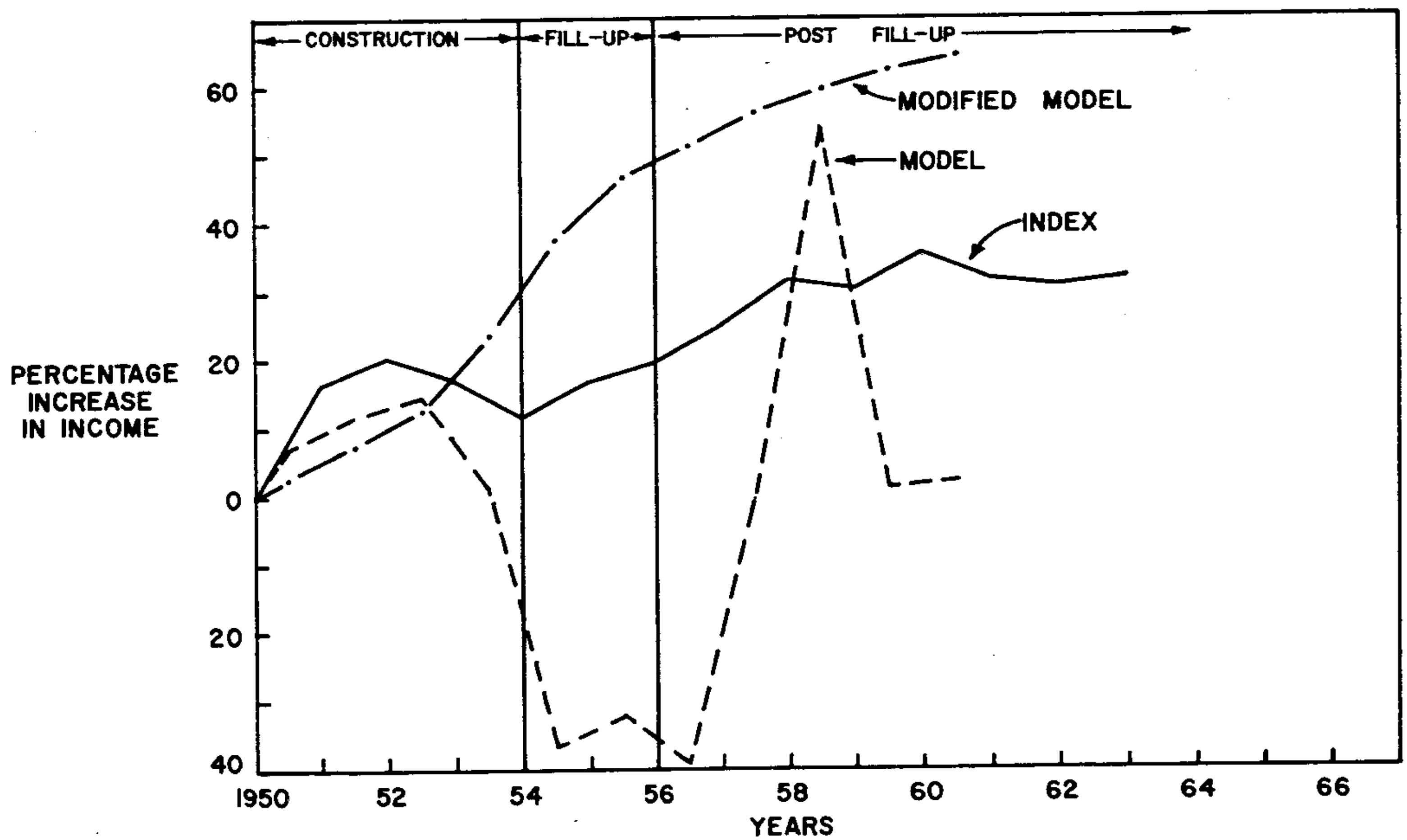
Net economic activity defined in terms of a control area is shown in Figure 13. The economy of the counties shows a definite general upward trend throughout the period with only one slight downward variation which is restricted to a one-year duration. The original model exhibited a definite variance from the index measure. Again, a large reservoir with a small economic base is under study. These two factors caused the model to generate atypical results. The modified model, measuring a more rapid growth than the index, is a more accurate projection for the area even though it over-projects in later years. This variation can be attributed partially to the international aspects of the reservoir, and to a greater degree the small economic base.

Garza-Little Elm Area

The Garza-Little Elm Reservoir is located on the Elm fork of the Trinity River about 22 miles northwest of Dallas, Texas. This reservoir is one of four built by the Corps of Engineers in the Trinity River basin. Congressional authorization was given in 1945, construction of the Lewisville Dam began in late 1948, and the project was finished in 1956. The dam is an earthfill type impounding water with a surface area of 23,280 acres.

FIGURE 13

ECONOMIC IMPACT AS MEASURED BY
THE INDEX AND MODEL FOR THE FALCON AREA



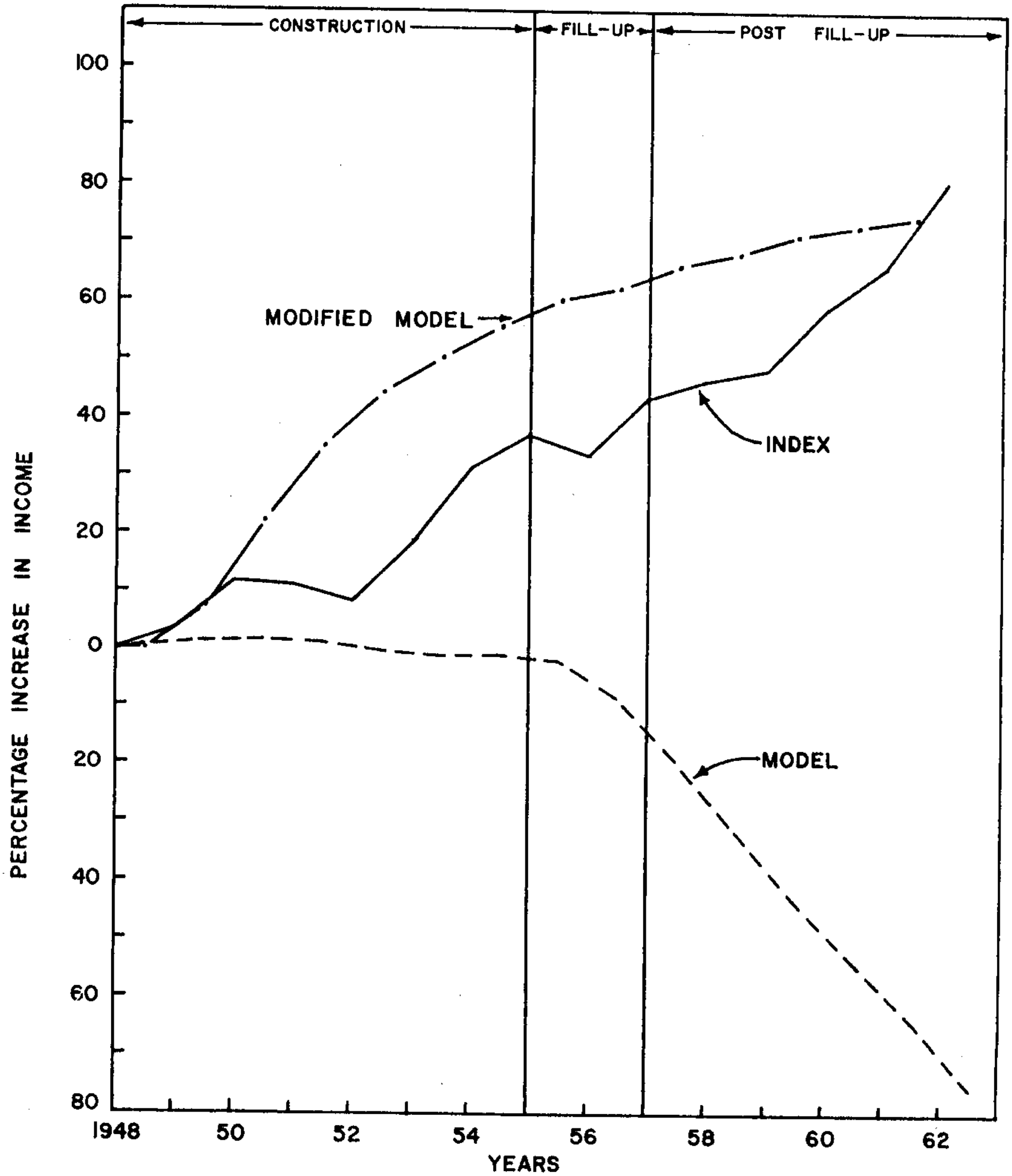
SOURCE: TABLE 4e, APPENDIX E.

Garza-Little Elm Reservoir is unique because it is an enlargement of an older reservoir, Lake Dallas. Although the Lewisville Dam was newly constructed, much of the early reservoir storage was filled with water from Lake Dallas when a cut was made in that dam. As a result, partial fill-up was more rapid than for most reservoirs which depend on normal rainfall and drainage. The old Lake Dallas also had many established concessions which were immediately on the new Garza-Little Elm Reservoir. New developments after construction were limited to the area and shoreline below the old Lake Dallas and this somewhat distorts the perhaps otherwise rapid increase in activity.

Curves shown in Figure 14 indicate continued growth following the beginning of construction and impact on the economy was apparently a positive one. Decreases from year to year are noted at several points, but in no case does this decrease indicate that the reservoir did not have expanding effect.

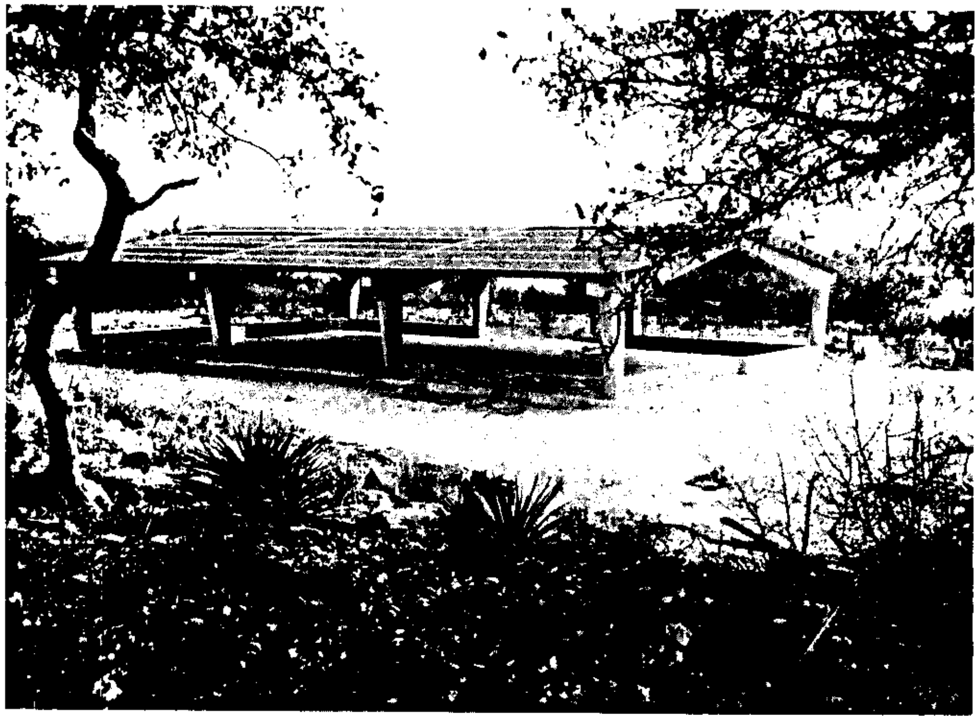
The original model indicated a less expanding economy than the index. Various reasons could have been responsible for this variation but the primary cause was in the attendance projections for the reservoir. This faulty algorithm caused the model to yield unreasonable results. A revision of the attendance equation and several internal relationships resulted in a much better measurement and a closer approximation of the index. Differences still exist between the index and the modified model, but within limits the modified model gives a reasonable measurement of increase in economic activity.

FIGURE 14
ECONOMIC IMPACT AS MEASURED BY THE INDEX AND MODEL FOR THE LEWISVILLE AREA



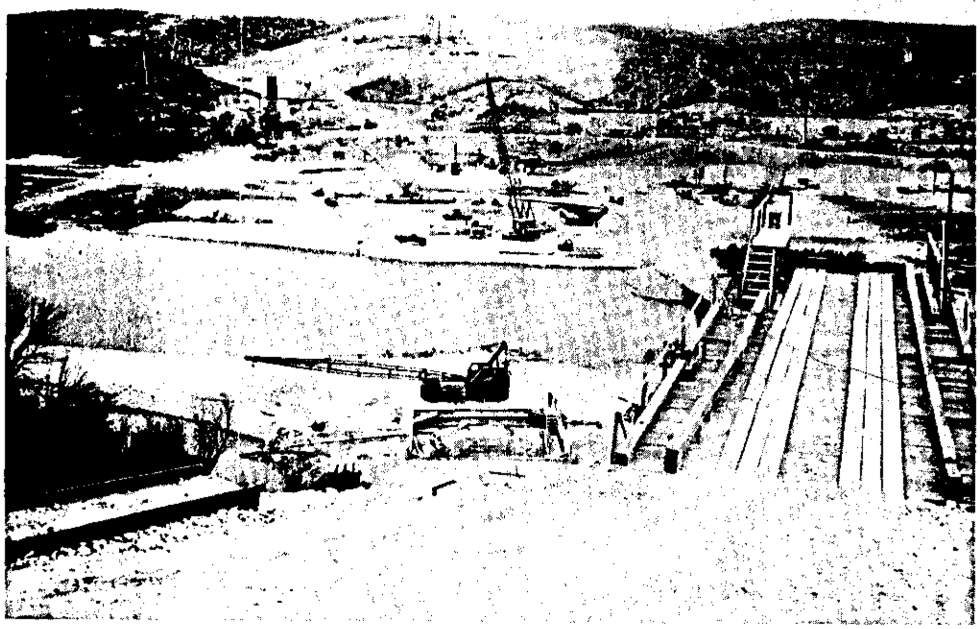
SOURCE: TABLE 7e, APPENDIX E.

Comparisons and explanations of index-model variations demonstrate the relative reliability of the original and modified comparative-projection model. A synthetic index developed for each reservoir was used as the target, and was assumed to represent the actual economic changes. Five reservoir areas, in addition to the original comparative areas and the primary study area, provided evidence that the original model was a reliable predictor. Conversely, the other five applications showed the original model had an unrealistic sensitivity to some situations. A detailed study was undertaken to revise and modify those parts of the model which caused unrealistic outcomes. Revisions and modifications were necessary in the very basic inputs to the model along with changes to the over-all model. The results were an improved accuracy in economic projections.

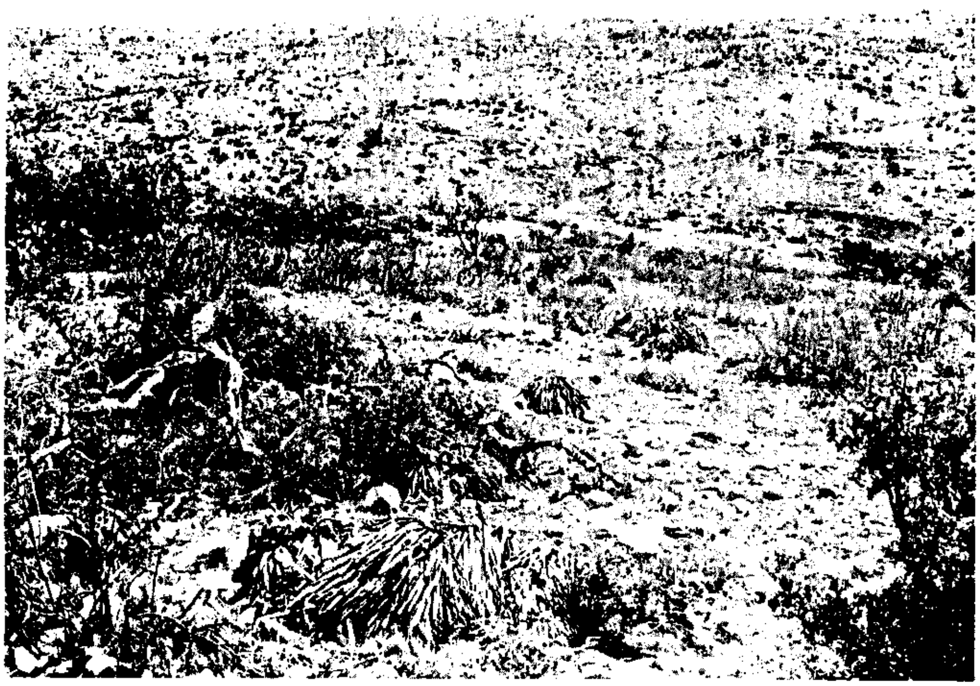


PICNIC AREA AND PAVILLION,
CANYON RESERVOIR, TEXAS, 1966
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

PICNIC TABLES,
CANYON RESERVOIR, TEXAS, 1966
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)



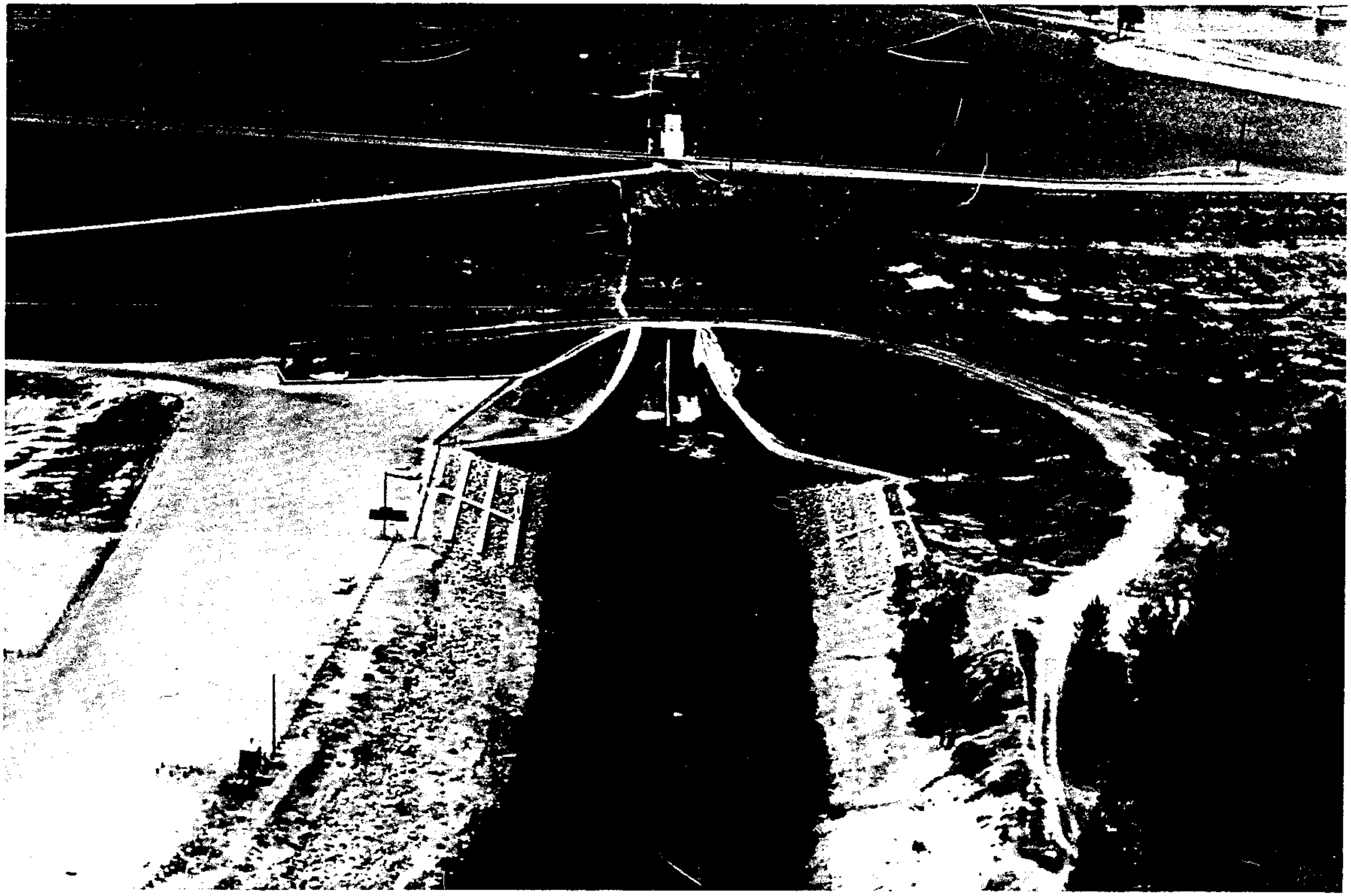
ROAD RELOCATION,
AMISTAD RESERVOIR, TEXAS, 1962
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)



SURROUNDING TERRAIN,
AMISTAD RESERVOIR, TEXAS, 1961
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

LAKE FISHING
HORDS CREEK RESERVOIR, TEXAS, 1962
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

SHORELINE FISHING,
HORDS CREEK RESERVOIR, TEXAS, 1951
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)



FISHING PLATFORM ON OUTLET CHANNEL,
LAKE O' THE PINES, TEXAS, 1969
(Source: Corps of Engineers, U.S. Army, New Orleans, Louisiana)

Part III

MODEL CORRECTIONS

Generated outputs from the initial application of the comparative projection model indicated a need for a variety of adjustments. When results were compared to the economic activity index used as a target, unexplained variation existed between the two. Some results exceeded those of the index, while other results fell short of the index.

This array of results led to a detailed analysis of each area to determine whether the model was basically faulty or whether the areas were so unique that secondary data could not reflect a true picture of the local economy. A preliminary evaluation of the model indicated a primary weakness in the recreational projections and secondary problems in the investment projections and total impact projections. An analysis of the problem areas, using detailed secondary data of each reservoir area and primary data resulting from on-site surveys, pointed to some general modifications using quantitative and descriptive techniques.

Recreation Adjustments

A primary justification for many reservoir projects is recreational benefits. Recreation expenditures become increasingly important with fill-up and become the largest money inflow into an impoundment area [26].

Recreation money begins coming into the impoundment economy even before construction is completed, and attendance will increase at a decreasing rate for a period of approximately seven years after the gates of the reservoir have been closed.

Because measurement must deal with social behavior, projection of recreation expenditure is difficult. However various methods for projecting the stream of visitors have been proposed [26].

The recreation attendance combined with the actual dollar figure serves as a direct input into the comparative-projection model. This technique is in agreement with methods used by most reseachers, but several other variables were added. The demand area was considered to include all those counties which touched a circle of 100-mile radius using the dam as the center. Once this is determined, a growth factor [26] is calculated for the total population of the demand area.

Projected populations, as determinants of potential recreation demand for an area, are of primary importance but several other factors are also significant. The potential demand is for all recreation, and proposed reservoir recreational facilities must be considered in relation to other reservoirs in size and facilities available. Two impoundment projects were used to provide general comparative parameters for the recreation phase of the model. The first year measured attendance was found to be thirty per cent of the population within a hundred mile radius. From this observation the first year's attendance at a proposed reservoir was set at thirty per cent of the 100 mile population.

It was also observed that the attendance at each lake follows a different pattern after the initial year. Investigations were made to determine what unique factors influenced patterns of attendance. A general attendance factor was established [26]. When it was tested on other projects it became apparent that the variables needed to be associated differently and that possibly other variables were needed.

This phase of the investigation affirmed that no one equation could be used in all cases. The variables were the same, but at certain population ranges they needed to be weighted differently. The following are the general parts used in all cases.

Part I:

$$\frac{\sqrt{RESAR \cdot SHORE}}{\sqrt{TOTLAK \cdot 0.24 \cdot RESNO}}$$

Part II:

$$\frac{RESAR}{TOTLAK} \cdot 100 \cdot \sum_{i=1}^{NCITY} \frac{POPFAC_i \cdot NCITY}{\sqrt{CITYDI_i}}$$

Part III:

$$150 \div PCI$$

The variables are:

RESAR surface area of the proposed reservoir,

TOTLAK total surface area of all lakes over 2,500 acres within the 100-miles radius,

SHORE shoreline of the proposed lake,

RESNO number of lakes used to calculate TOTLAK,

NCITY number of cities, with population greater than 20,000, that are within the area encompassed,

$POPFAC_i$ numerical factor assigned to the population of each city included in NCITY,

$CITYDI_i$ distance of the city from the reservoir,

PCI per capita income of the area.

Each part of the equation is concerned with a certain aspect of the impoundment's ability to attract recreators. The first part relates the variables having to do with the actual reservoir statistics. They are related so that the attendance factor will reflect the size of the reservoir. This term is also sensitive to the presence of other reservoirs in the area. The second part of the equation contributes to the general model a method of relating the number of cities, their populations, and their distance from the reservoir. Part III introduces the per capita income of the area into the general model. It is inversely related to the attendance factor, based on the hypothesis that the higher the income of an area, the higher the percentage of the population that will visit the reservoir.

When each part of the equation is calculated, the reservoir is placed into one of seven population ranges. Within each range, the size of the first term dictates the specific equation to be used in calculating the attendance factor. Use of a particular equation will increase or decrease the value of the attendance factor. Following are the seven equations presented in decending order according to weights.

$ATTFAC_2$ = 1st Part + 2nd Part - 3rd Part

$ATTFAC_2$ = Log(1st Part + 2nd Part - 3rd Part) - 0.35

$ATTFAC_2$ = Log(1st Part + 1/2 2nd Part - 3rd Part) - 0.35

$ATTFAC_2$ = Log(1st Part + Log 2nd Part) - 3rd Part - 0.35

$ATTFAC_2$ = Log(1st Part + Log 1/2 2nd Part) - 3rd Part - 0.35

$ATTFAC_2$ = Log(1st Part + 1/2 Log 2nd Part) - 3rd Part - 0.35

$ATTFAC_2$ = Log(1/2 1st Part + 1/2 Log 2nd Part) - 3rd Part - 0.35

Not all seven equations appear under each population range but as the population increases the set of equations is shifted to include those possibilities that could arise with the reservoirs in this study (See Table 1).

The calculation of the attendance factors from the third year forward is done with the following equation:

$$ATTFAC_i = ATTFAC_{i-1} + ((ATTFAC_{i-1} - ATTFAC_{i-2})/2 \cdot ARES)$$

where i is greater than 2, and ARES is the number of reservoirs in the contiguous counties.

The division by ARES was added to the original equation because investigation revealed that multiple reservoirs in the same county would decrease the attendance at any one reservoir. Apparently, the reservoirs compete for the attendance.

Once population projections have been made, and the attendance factor established for each year, projections for attendance can be made. These are based on the assumption that all water recreation demand can be satisfied by the existing facilities and the proposed lake. Total projections for each area are presented in Appendix C.

A wide variation has been observed in the number of people participating in different recreational activities, and the resulting variation in respective expenditure patterns. In order to reduce this variation, total lake attendance was divided into two geographical categories and a breakdown was made in recreational activities.

In the original study it was found that attendance could be broken down geographically. Attendance was projected from the area outside the

TABLE 1

DECISION TABLE

FOR USE OF RECREATION EQUATIONS

Populations																												
≤100,000	X	X	X	X																								
≤500,000					X	X	X	X																				
≤1,000,000																												
≤1,500,000													X	X	X	X												
≤2,000,000																	X	X	X	X								
≤2,500,000																												
≤3,000,000																									X	X	X	X

First Part Values																												
< 0.5																												X
> 0.5																											X	
< 1								X																				
≥ 1							X																					
> 1																										X		
> 1.5																									X			
< 2																				X								
≥ 2																			X									
> 2					X																							
> 2.5																		X										
< 5																X												
≤ 5				X																								
≥ 5															X													
> 5			X														X											
> 10					X									X														
≥ 12													X															
> 50		X																										
> 60	X																											

EQUATION 1				X				X																				
EQUATION 2			X				X																					
EQUATION 3		X				X														X								X
EQUATION 4	X				X											X			X								X	
EQUATION 5															X			X								X		
EQUATION 6														X			X								X			
EQUATION 7													X															

contiguous counties on the basis of existing population at the time of projection [26]. The equations used in the original model were all linear equations. These were changed to curvilinear in order to expand the range of the model and eliminate the possibility of a negative projection on attendance.

The equation used for outside attendance projection became:

$$OUTATT_i = (.65e^{-15POPPER} + \sqrt{(-.1225\ (POPPER - 1))}\ ) \cdot ATTEND_i$$

where,

$OUTATT_i$ attendance from outside the contiguous counties,

POPPER population of the contiguous counties as a percent of the population for the 100-mile radius, and

$ATTEND_i$ total yearly attendance as projected by combining the attendance factor and projected population.

Once the outside attendance was established, attendance of the recreational groups [26] was projected.

The number in the camping activity is:

$$CAMPAT_i = [0.8e^{-PERDEN^2} - 0.25e^{-PERDEN^3} + 0.1 + (\frac{0.12695}{PERDEN + 0.564201})] \cdot OUTATT_i$$

This equation was not only converted from linear to curvilinear, but it was also changed to reflect the theory that the larger the contiguous county population the smaller the percentage of campers.

The boating and fishing activity is:

$$BOATAT_i = (\frac{2.464711}{PERDEN + 11.906818}) \cdot OUTATT_i$$

The above logic was also used in the revision of the BOATAT equation because it was felt that the number of boaters from outside would be inversely related to the contiguous population.

The swimming, skiing, picnicking, and sightseeing activity is:

$$OTHATT_i = OUTATT_i - CAMPAT_i - BOATAT_i$$

All variables in the equations remain the same, as in the equation for outside attendance, except for the addition of:

PERDEN population density of the contiguous counties divided by one-hundred

The recreational dollar figure associated with the attendance is derived by the following equation:

$$REC_i = \$4.09 \cdot CAMPAT_i + \$3.26 \cdot BOATAT_i + \$1.75 \cdot OTHATT_i$$

The constants in the equation were determined in the original survey where it was found the average expenditure for camping activity was $4.09; for the boating and fishing activity, $3.26; and the third category $1.75 [26].

The revisions above were necessary because of inaccurate projections from the orginal model when applied to a variety of reservoirs. With the revisions the model projections of recreation were more acceptable; however, there were still discrepancies in the total impact figures when the model was applied to some reservoirs.

Initial Model Adjustments

Completion of the recreational modifications required reevaluation of the total impact calculations generated by the model. The initial computer runs prior to recreational revisions had shown success with average sized reservoirs, but unreasonable results with either small or large reservoirs. Since recreational projections are a function of reservoir size, part of the problem was thought to be eliminated once the recreational portion of the model had been corrected. Closer examination of the total impact output revealed that extremes of reservoir size were still generating unacceptable results. Any reservoir below 1,000 surface acres or over 20,000 surface acres was being measured incorrectly, and included Amistad, Falcon, Garza-Little Elm, Hords Creek, and Sam Rayburn.

The model had first been perceived theoretically with a universal applicability but a localization criteria. Localization criteria were provided by using population density, income, agricultural income and distance to a metropolitan area. These variables were combined as in Equation 24, Appendix A, to give the growth potential of the local economy surrounding a reservoir. Even in the developmental stages the model was modified in terms of a g factor to meet the demands of the empirical data.

A decision point for modifications within the model had been included following the calculation of the initial g. If $g_{1,1}$ was positive a progressive economic growth was indicated and few adjustments were needed to correct the growth curve. A negative $g_{1,1}$ represented a slow growth economy characterized by a high percentage of agriculture, low population density and relatively long distances from metropolitan centers. Such an economic situation required more pronounced adjustments in the model in order to dampen the growth curve. The wider range of empirical data provided by applications to ten additional reservoirs tested the validity of this hypothesis.

Closer examination of the g's generated for each of the ten areas and the three original ones showed all but one negative, indicating a majority of slow economies. The reservoir area generating the positive $g_{1,1}$ was yielding accurate results because it was one of the original comparative areas. Seven of the reservoir areas producing a negative $g_{1,1}$ were also giving relatively accurate results. The others, however, were producing unreasonable total impact results with some of these generating impact data far below the target index and others above the index, but not in a consistent pattern.

A detailed study of the surrounding economies for these reservoirs and the economic variables used as inputs to the model revealed that for each reservoir not being measured accurately there was at least one extreme data input and for some reservoirs there were two. Three of the reservoir areas, Amistad, Falcon, and Hords Creek, provided basically the same type of surrounding economies. All were somewhat slow in development after the reservoir was started, as indicated by the target index, and a study of the model inputs reflected this condition. Output from the model was less indicative because the output from Amistad and Hords Creek was over projected and from Falcon the results were erratic and unreliable when compared to the index. One input which each of these local areas had in common was a very low population density. The calculation of $g_{1,1}$ appeared to be weighting this factor more than necessary when density was less than 15 people per square mile. Attempts to correct this calculation were made after deciding whether $g_{1,1}$ was negative or positive. A lower limit of density was set at 15 people per square mile and trial constants ranging from .1 to 1.0 were added back to $g_{1,1}$ in an effort to increase the value and offset the effects of a density below 15. This action over the entire range of constants provided limited success and was successful in increasing the prediction accuracy of only the Hords Creek Area.

Empirical data demonstrated that of the five reservoir areas not producing correct responses several had large percentages of agriculture. Since this factor strongly influences the development of an economic system and strongly influences the value of $g_{1,1}$, attempts were made to use the percent of agriculture as a correction criterion. Here, an arbitrary value of 40 percent was chosen to place a limit on this data input. If the percentage exceeded 40 percent $g_{1,1}$ was adjusted by a constant less than 1 in order to increase the value of $g_{1,1}$. Only two reservoir areas, Falcon and Hords Creek, were affected by this adjustment and the inability of the model to correct the erratic pattern for the Falcon Area did not justify its use.

A wide variation in aggregate incomes was observed for those reservoirs which were showing inaccuracies. This input was analyzed to determine if it was causing some of the projection inaccuracies. Since the model expresses impact as a percentage of a base year income, a very low income figure could cause over projections; thus, a lower limit was attempted and set at \$15 million. If the aggregate income level was below \$15 million an algorithm was used to adjust this level upward to a \$45 million base. This third adjustment increased the accuracy for the

Hords Creek Area and somewhat reduced the erratic pattern for the Falcon Area, but since these areas had previously been affected by adjustments the results did not warrant this attempted correction.

The original comparative areas had what was considered average construction periods and around these years the multipliers were developed. Applications of the model to the other reservoir areas gave a range of from three years to nine years for construction. Since the multiplier was designed to gradually decrease over the construction period and then remain constant, the longer construction periods were over adjusting the multiplier. Tests of the longer construction period were available only with a negative $g_{1,1}$. A restriction was designed to limit n (the number of years of construction) to five if construction was indicated to be longer. This adjustment was used only for determining the multiplier and did not affect the chronological development of recreation, investment, etc., within the model. Two of the inaccurate reservoir areas were affected by this adjustment and showed positive responses during the later years of construction. However, the initial growth for these two areas as measured by the index was not being simulated by the model.

All of these early modifications met with only limited success. Some areas had shown more accuracy as a result of the adjustments, but others did not react sufficiently to justify a modification. Further study of the empirical data did not reveal a pattern which could be used in making internal model adjustments. The conclusion was that the relationship expressed by g was not sensitive enough to variations in local economic situations. A change in this relationship was the only avenue remaining in order to have $g_{1,1}$ take on positive values for more reservoir areas and in this way more closely approximate the activity reflected by the target index.

Additional Modifications

Using the two comparative areas, Belton and Whitney, and those reservoir areas which had been successfully approximated, a new equation for $g_{1,1}$ was developed. Since the model must rely on data available at the point in time when a reservoir is proposed, the same economic inputs were retained. The redesign of g retained the basic relationship of the variables, but changed the weighting of the variable in order to increase the sensitivity. The new equation replacing Equation 24, Appendix A is as follows:

$$(1)\quad g_{1,1} = \frac{(P/AR) \cdot \sqrt{A/ENC}}{DIST - .81 \cdot \sqrt{2 \cdot DIST}} - 1$$

with,

AR	area in square miles,
P	population for year of projection,
A	agricultural income, most recent agricultural census,
DIST	distance in miles between the reservoir and nearest population center of 25,000 or more.

Successive years of $g_{1,1}$ and $g_{2,i}$ are determined by the same method employed in the original model and illustrated in Appendix A. The redesigned g caused some further changes in the basic form of the model. If a negative g was calculated the original model provided uniqueness for a slow moving economy with Equations 32 through 36, Appendix A. A revision of g required these equations to be modified and similar equations introduced if $g_{1,1}$ was positive.

A positive $g_{1,1}$ with no hydroelectric facilities to be installed would use the following series of equations:

$$(2) \qquad E_i = \left(M_i \int_0^1 e^{g_{1,1}t}\, dt + \sum_{j=1}^{i} E_{i-j} \int_{j-1}^{j} e^{g_{2,i}t}\, dt\right)/ENC \qquad \begin{matrix} i=1,\ldots,n-3 \\ j=1,\ldots,n-3 \end{matrix}$$

$$(3) \qquad E_i = (I_i - .125 \cdot M_i)/ENC \qquad i=n-2,\ldots,n+1$$

$$(4) \qquad E_i = (I_i - .25 \cdot M_i)/ENC \qquad i=n+2,\ldots,m$$

The installation of hydroelectric facilities has an influence on the pattern of development. Up to year $n+1$ of development the equations are used as above; i.e., through Equation 3. After that year the impact is measured as follows:

$$(5) \qquad E_i = (I_i - .25 \cdot M_i)/ENC \qquad i=n+2$$

$$(6) \qquad E_i = (I_i - .5 \cdot M_i)/ENC \qquad i=n+3$$

$$(7) \qquad E_i = (I_i - .25 \cdot M_i)/ENC \qquad i=n+4,\ldots,m$$

Here I is defined as:

$$(8) \qquad I_i = M_i \int_0^1 e^{g_{1,1}t}\, dt + \sum_{j=1}^{i} I_{i-j} \int_{j-1}^{j} e^{g_{2,i}t}\, dt \qquad \begin{matrix} i=n-2,\ldots,m \\ j=n-2,\ldots,m \end{matrix}$$

$I_0 = 0.$

The result obtained when a $g_{1,1}$ is negative also has to be slightly modified. Originally adjustments were made as given in Equations 32 through 36 of Appendix A. If no hydroelectric facilities are to be installed, the following series of equations gives impact:

$$(9) \quad E_i = (I_i - .25 \cdot M_i)/ENC \qquad i=1,\ldots,n+3$$

$$(10) \quad E_i = (I_i - .125 \cdot M_i)/ENC \qquad i=n+4,\ldots,m$$

If hydroelectric facilities are installed the impact is:

$$(11) \quad E_i = (I_i - .25 \cdot M_i)/ENC \qquad i=1,\ldots,n \ \& \ n+1 \ \& \ n+4,\ldots,m$$

$$(12) \quad E_i = (I_i - .33 \cdot M_i)/ENC \qquad i=n+1 \ \& \ n+3$$

The I is defined as in Equation 8 above.

Total impact projections from the revised equations showed minor variation still existed and two reservoirs were still far from the target index. Certain adjustments attempted earlier were again tried in an effort to reduce projection variation.

The first such revision to be implemented was the limitation placed on the construction period for reservoirs exceeding the average. A limit set at five years was imposed to calculate the multiplier, but the reported construction period was employed for all other chronological projections attributable to a reservoir.

A second imposition which had been attempted earlier was again incorporated into the total impact projections. Limits were placed on the base income and if it exceeded these the base was adjusted accordingly. The limits are $15 million or less and $350 million or more. If the income is less than $15 million it is adjusted upward to be at least $45 million. If the base income exceeds $350 million the base is reduced to .75 of its value. This adjustment reflects the inherent limits which are within the model and can only be overcome by use of input data adjustments.

The calculation of g is an attempt to reflect the possible growth and internalization a small economy can expect from outside sources of funds. Included in the g factor, as stated earlier, is distance from the reservoir to a metropolitan center. If the center is located within the local economy greater use is made of new money because facilities are available which utilize large inputs of new money. Further from the reservoir, and eventually outside the local economy, the city's influence should cause a decrease in impact. This reasoning continues to a certain distance, but beyond that distance the effects are minute in relation to other factors. Several reservoirs were long distances from a metropolitan center and consistently being inaccurately projected by the model. Even though a change had been effected in the relationship of g, distance was now being over weighted. To correct for these inaccuracies a limit of fifty miles was set for the distance variable; and, if this limit was exceeded, an adjustment was made to $g_{1,1}$ immediately after it was calculated. The following form was used:

$$g_{1,1} = g_{1,1} + 1.0.$$

This adjustment of a constant restores the immediate effects of the reservoir back to the local area.

Included in the group of reservoir applications are two international reservoirs. These reservoirs were selected to test the results of the model under most unique conditions, that of multi-national construction and operation. Certain peculiarities of these two areas are impossible to separate into specifics because of their international nature; however, a general code key was used to identify these reservoirs in order to bring their projections within reasonable limits of the index. This adjustment is made by altering $g_{1,1}$ before it is tested for either positive or negative results. A constant is used as follows:

$$g_{1,1} = g_{1,1} - 0.08.$$

The modification is very slight but brings the projections within range of the target index.

Most reservoir areas at this point showed reasonable success when the model was applied, but inaccuracies were still evident on the two largest reservoirs. Attention was focused on the investment projections. In all cases of inaccuracy, the investment units were being overstated based on on-site surveys. Major modifications were not indicated, but Equations 1 through 6, Appendix A, were not reacting to sufficiently indicate the pattern of development around reservoirs.

Using shoreline as a delimiter several constants were made variables and other constants were changed in value. Equation 1, Appendix A, was changed completely and now is the following:

$$RESINV_i = \sqrt[4]{SHORE} \cdot SHONO$$

where,

$RESINV_i$	number of residences in year i,
SHORE	miles of shoreline,
SHONO	constant of either 2,4,6, or 8 depending on the miles of shoreline.

Equations 2 and 3, Appendix A, are changed only with different constants as follows:

$$RESINV_i = 1.5 \cdot RESINV_{i-1} \qquad i=n+1,\ldots,n+3$$

$$RESINV_i = RESINV_{i-1} - .4 \cdot RESINV_{i-1} \qquad i=n+4,\ldots,m$$

Commercial investment units were suffering the same overprojections as residential. A test of shoreline similar to that used for the residential units was used. The first year of commercial investment units was changed to the following:

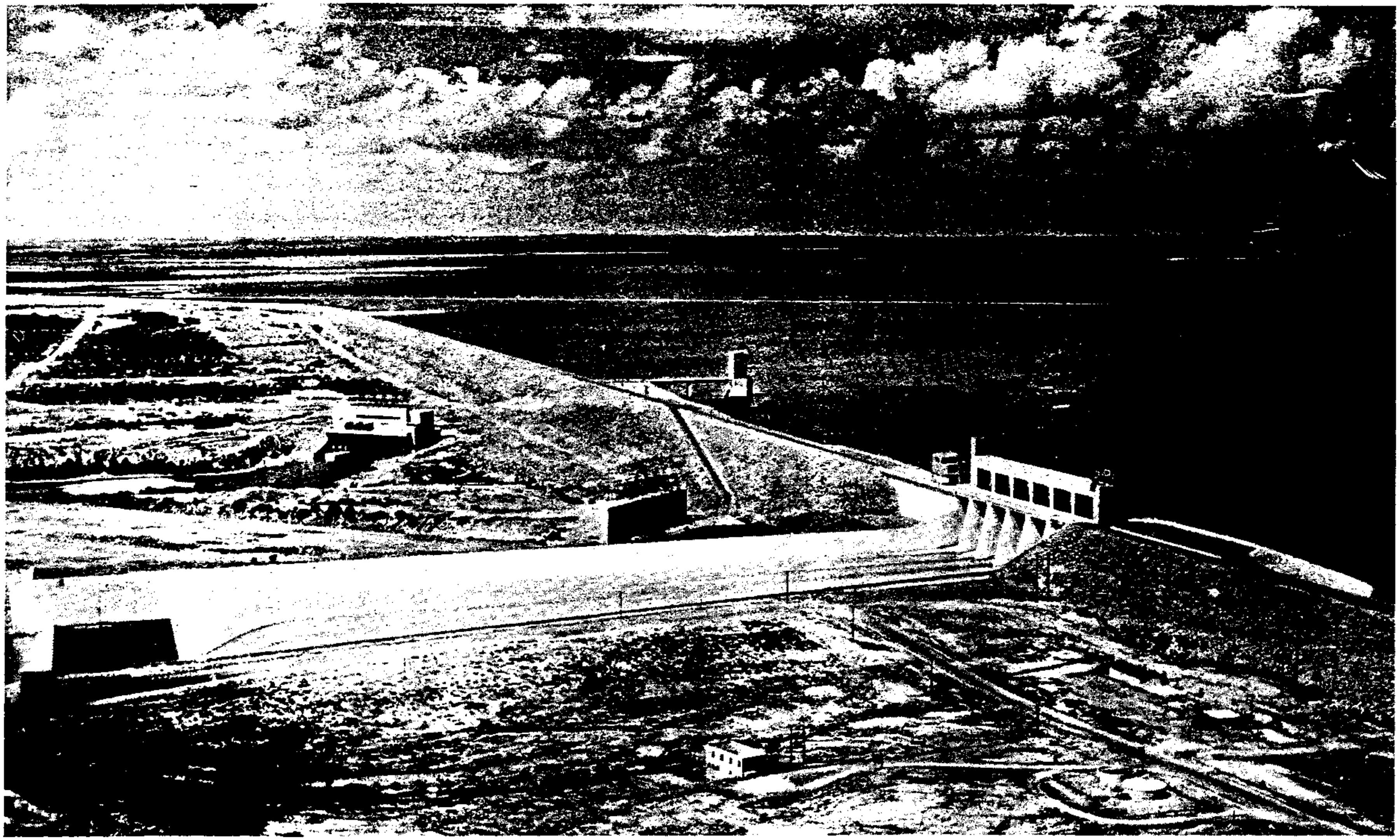
$$COMINV_i = \frac{[(TOTATT + TOTRIN)/1000] \cdot \sqrt{DIST}}{SHON \cdot SHORE} \qquad i=n+1$$

where,

$COMINV_i$	number of commercial investments in year i,
TOTATT	total projected attendance for the first seven years,
TOTRIN	total number of projected residential investments for the first seven years,
DIST	distance from reservoir to major metropolitan center,
SHON	constant of 50, 100, 200, 300, or 500 depending on miles of shoreline,
SHORE	miles of shoreline.

The other commercial investment equations were retained.

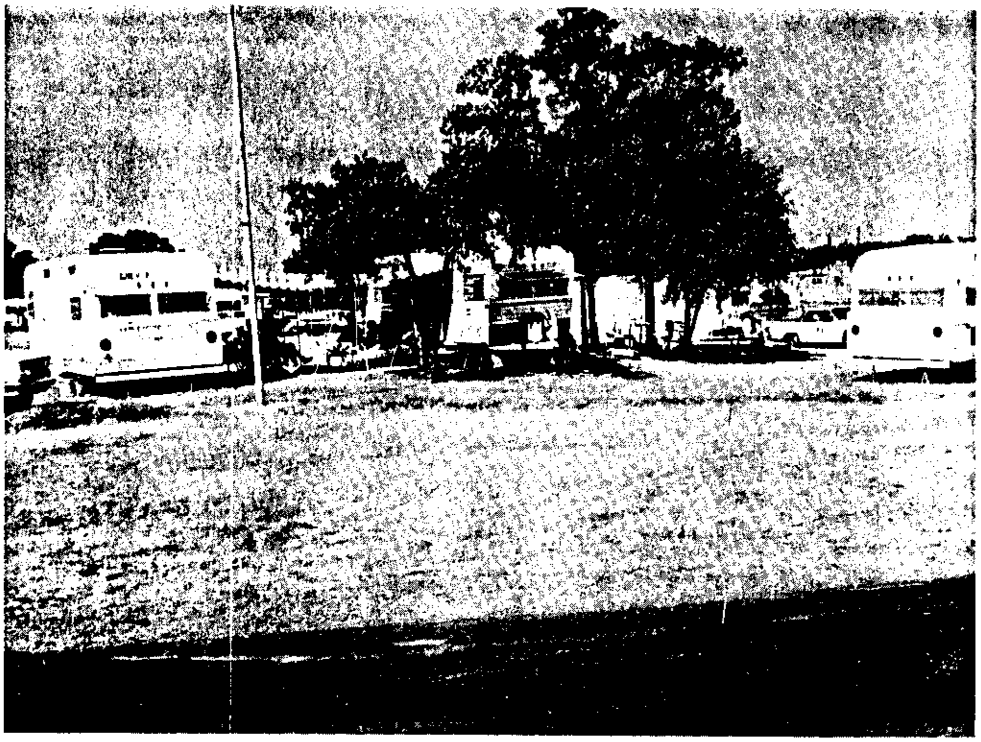
The modifications and changes appeared necessary in light of new empirical data. Changes were undertaken to increase the reliability of the model for several reservoir areas. The recreational adjustments, although not universal, provide for many combinations of empirical data. Major changes in the total impact calculations were proposed after all possibilities of internal adjustments had been considered. The result was a new growth factor utilizing all of the same inputs but able to react to some conditions with more sensitivity, and minor adjustments were yet needed for some of the input data including investment inputs, but these were incorporated and placed only slight limitations on the use of the model. The effects of all changes accepted produced a model which reacted sufficiently to the empirical tests.



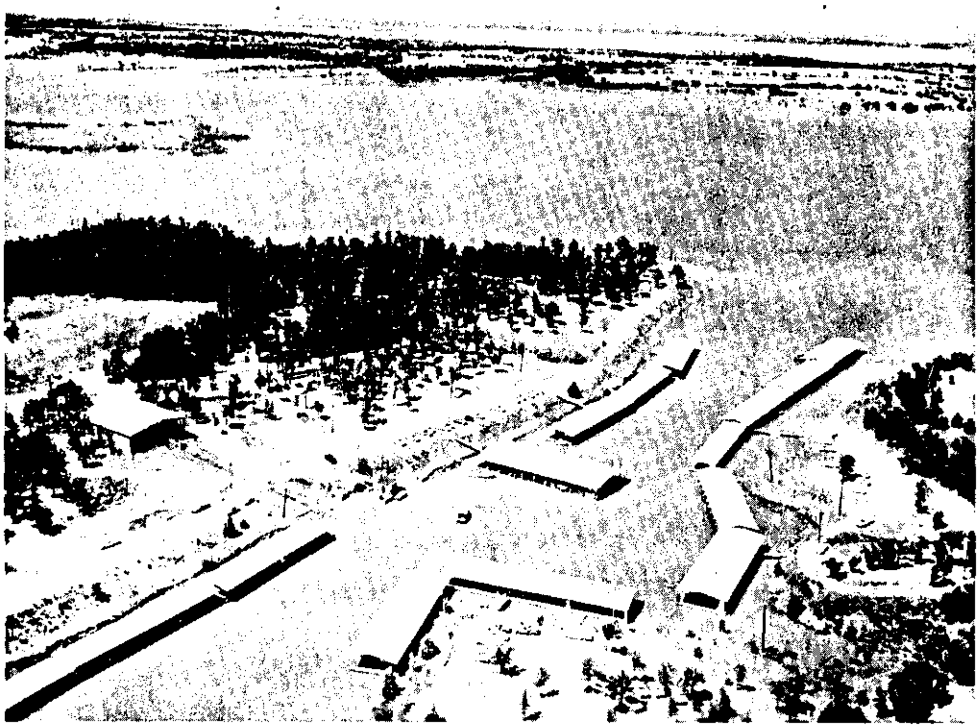
DAM, UNITED STATES AND MEXICO POWERHOUSES AND SPILLWAY,
FALCON RESERVOIR, TEXAS, 1953
(Source: International Boundary and Water Commission, El Paso, Texas)

SWIMMING AREA,
NAVARRO MILLS RESERVOIR, TEXAS, 1966
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

CAMPING GROUNDS,
NAVARRO MILLS RESERVOIR, TEXAS, 1966
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)



TRAILER CAMP SITE,
LEWISVILLE RESERVOIR, TEXAS, 1965
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

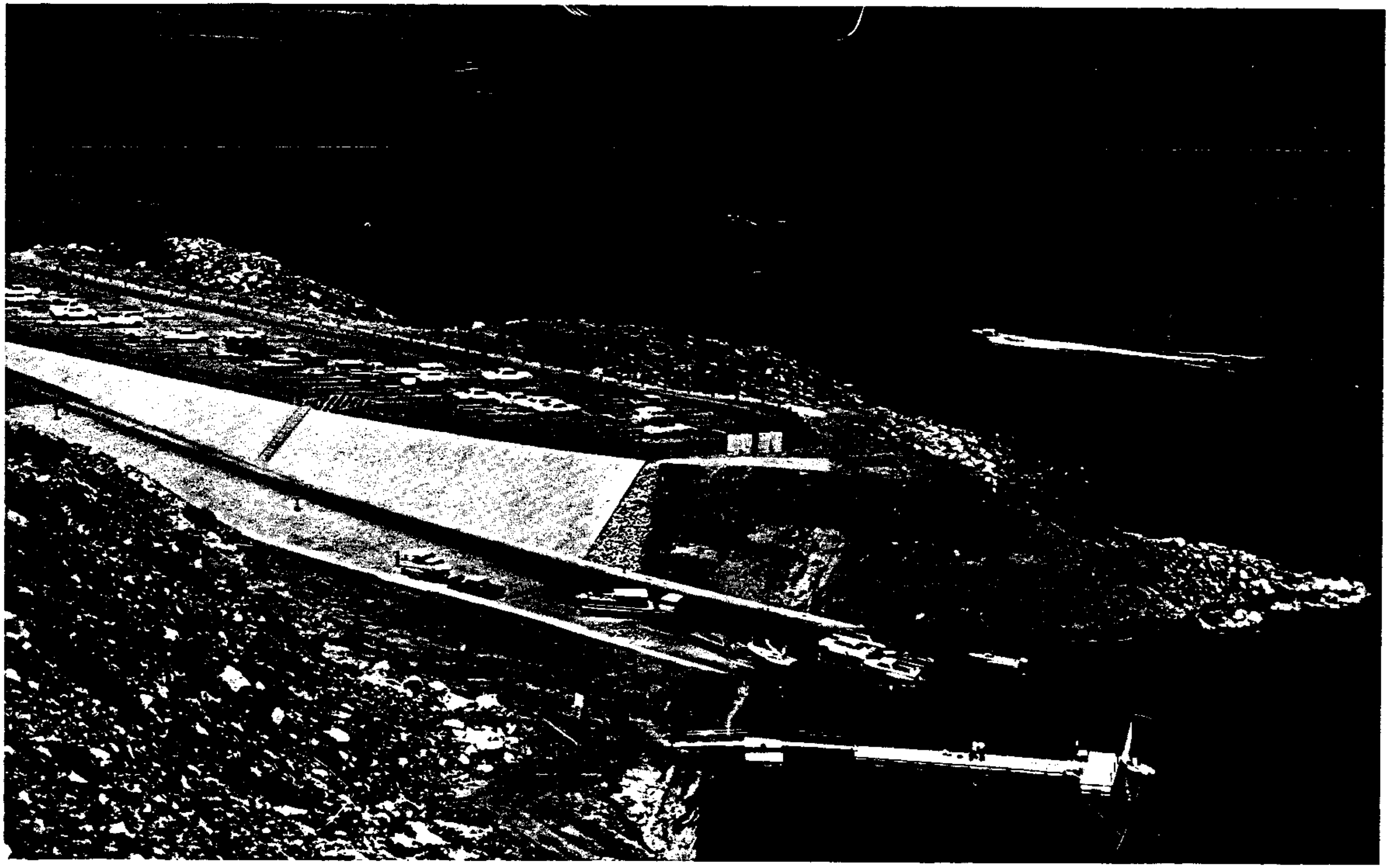


BOAT MARINA,
LEWISVILLE RESERVOIR, TEXAS, 1961
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

WOODED CAMP SITE,
SAM RAYBURN RESERVOIR, TEXAS, 1966
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

MARINA,
SAM RAYBURN RESERVOIR, TEXAS, 1967
(Source: Corps of Engineers, U.S. Army, Fort Worth, Texas)

BOAT LAUNCHING AND PARKING FACILITIES,
LAKE MEREDITH, TEXAS, 1967
(Source: Bureau of Reclamation, U.S. Department of the Interior, Amarillo, Texas)



Part IV

EVALUATIONS AND CONCLUSIONS

Testing of the comparative-projection model was made by applying the model to thirteen reservoir areas in Texas. Two of these areas were Belton and Whitney, used to develop the model, and a third was Somerville for which predictions had been made earlier by the model. The other ten areas were carefully selected to provide as much variation as possible in unique economic situations and physical characteristics.

Application of the model to the original comparative reservoir areas of Belton and Whitney and the Somerville Area provided check points and prevented the introduction into the model of invalid relationships. Any changes to the model were first tested on the two comparative reservoirs. Close on-site observation of the Somerville Area, as it was developing, proved that earlier model predictions were below activity generated by the reservoir. Revisions were required in order to bring recreational and total impact projections closer to actual growth conditions for many of the other ten reservoir areas, and these revisions increased the accuracy of projections for the Somerville Area.

Initial application of the model to the ten reservoir areas showed five apparent successful measurements of total impact, four areas yielding illogical results, and one with no secondary check points. Comparisons of model results to the target index showed successful approximations for the five to be within ten percent of the index. Four others, with differences from above ten percent to nearly fifty percent and one with even larger differences indicated that the model was not adequate as a predictive instrument in its present form.

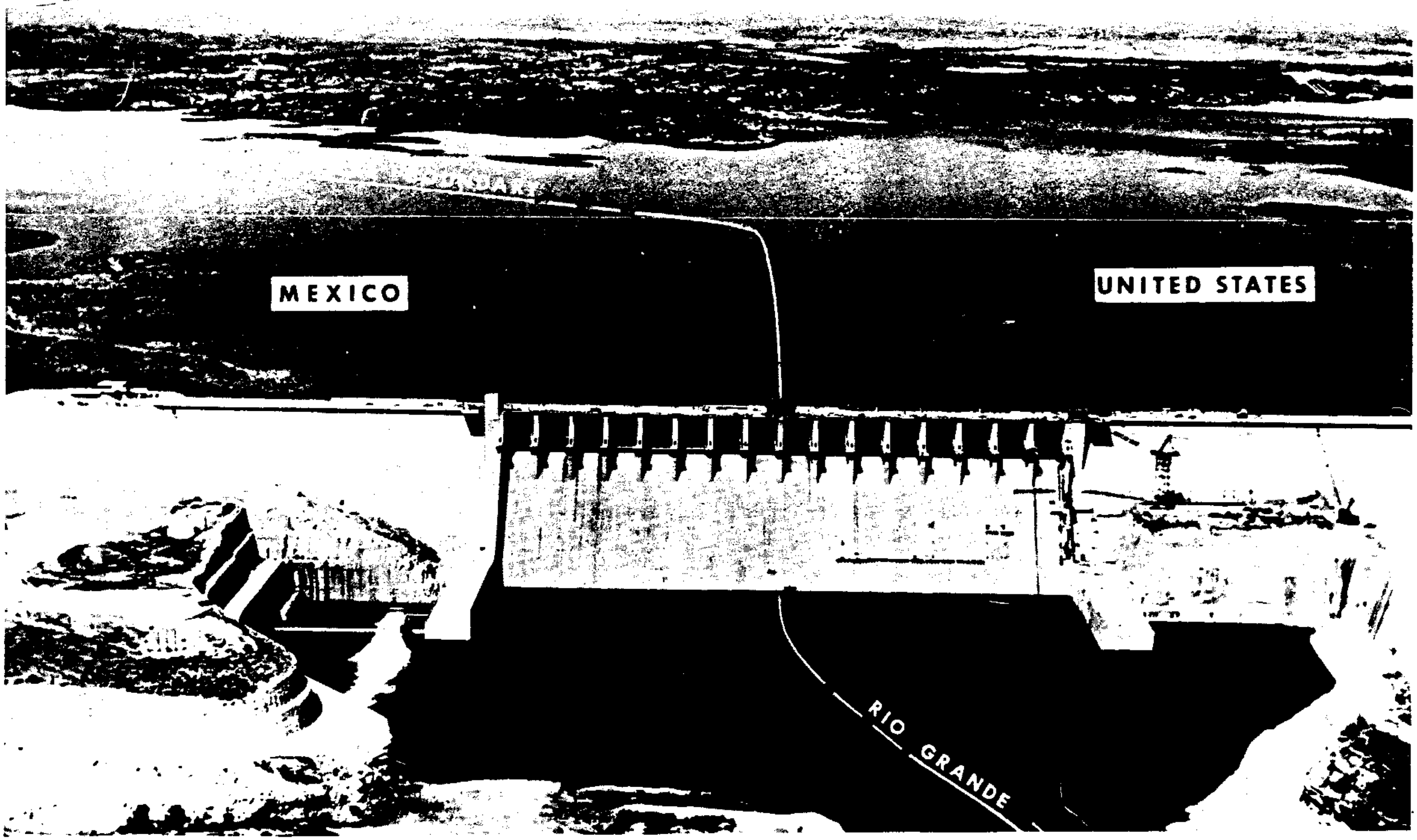
A study of possible adjustments in the model indicated that recreational measurements within the model were responsible for much of the inaccuracy and that resulting total impact calculations were incorrect. The recreational portion of the model was completely revised and, after revision, provided accurate prediction data in that phase for each of the thirteen test areas. The revision of the total impact equations was not quite as easily accomplished. Revisions, including a complete redesign of the multiplier, were implemented and certain limitations imposed on input data because the model functioned only within certain ranges. These adjustments provided reasonable measurement of eleven of the thirteen reservoir areas. The remaining two reservoir areas yielded unuseable results; however, due to index data limitations and conclusions of the on-site surveys of these reservoir areas, the accuracy of the target index is questionable.

Conclusions

The testing of the comparative-projection model did not meet with unlimited success, but the model can be used with caution as a prediction tool. Revisions to the model, necessitated after failure during the initial application were trial and error in approach. A parallel study for theoretically testing the model would have pin-pointed possible areas of weakness and aided in their correction, but this study was not possible and revisions were quite tedious.

The revised model can fill a needed gap in the measurement of economic impact for small areas. Interindustry analysis, although detailed, is limited in application for small areas because of cost and data restrictions. The comparative-projection model, designed for an orderly and logical analysis, provides a simple and easily applied tool for projecting the economic impact of a new stimulus in a small subregion.

The partial success of the comparative-projection model in the present study is encouraging and indicates a wide range of possibilites for applications. These applications may include evaluating the effects of proposed highway interchanges, non-water recreational facilities, housing complexes, industry, research complexes, etc. Although some shortcomings remain, further testing of the model, similar to that done in this study, can provide a useful tool for measuring and projecting economic impact.



DAM, PARTIALLY FILLED RESERVOIR AND FLOOD BASIN,
AMISTAD RESERVOIR, TEXAS, 1969
(Source: International Boundary and Water Commission, El Paso, Texas)

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APPENDIX A

The Comparative-Projection Model

Time-inputs to the model--construction expenditures, operations and maintenance expenditures, investment expenditures, and recreational expenditures--flow into an economy throughout the life of an impoundment project. Construction expenditure represents the single largest inflow of money into a local micro economy, and these inflows over a period of several years are normally estimated by the supervising agency. Operations and maintenance inputs are yearly expenditures for additional construction and reservoir upkeep, and are usually estimated by the operating agency. Investment and recreational expenditures are projected inputs to the model. These amounts are described as follows:

C_i construction expenditures,

EXP_i expenditures for operation and maintenance,

INV_i investment expenditures both residential and commercial,

REC_i recreational expenditures.

Investment expenditures are generated in two parts: residential and commercial investment. Using the following index notation:

n number of years of construction,

m total number of years for projections,

the residential investment units are determined as follows:

(1) $$RESINV_i = 2.0 \cdot (SHORE/10.0) \qquad i=3$$

(2) $$RESINV_i = 2.0 \cdot RESINV_{i-1} \qquad i=n+1,\ldots,n+3$$

(3) $$RESINV_i = RESINV_{i-1} - .3 \cdot RESINV_{i-1} \qquad i=n+4,\ldots,m$$

where,

$RESINV_i$ number of residences in year i,

SHORE number of miles of shoreline.

Growth of commercial investment units develops in a different pattern from residential. These units are expressed as follows:

$$(4) \qquad COMINV_i = \frac{[(TOTATT + TOTRIN)/1000] \cdot (DIST/100)}{SHORE/2} \qquad i=n+1$$

$$(5) \qquad COMINV_i = COMINV_{i-1} \cdot 2.0 \qquad i=n+2$$

$$(6) \qquad COMINV_i = COMINV_{i-1} - .4 \cdot COMINV_{i-1} \qquad i=n+3,\ldots,n+7$$

where,

$COMINV_i$ number of commercial investments in year i,

TOTATT total projected attendance for the first seven years,

TOTRIN total number of projected residential investments for the first seven years.

The numbers generated by equations (1) through (6) are combined with average investment dollars for the money input to the model as follows:

$$(7) \qquad INV_i = \$6,000 \cdot RESINV_i + \$31,000 \cdot COMINV_i \quad i=n,\ldots,n+7$$

Recreational expenditures is the other generated input to the model. An attendance factor based on regional and reservoir characteristics combined with the estimated population of a one-hundred mile area gives the total attendance for each year. These factors are:

$$(8) \qquad ATTFAC_0 = 0$$

$$(9) \qquad ATTFAC_1 = .3$$

$$(10) \qquad ATTFAC_2 = \frac{\sqrt{RESAR/TOTLAK} \cdot (SHORE/10)}{1.45 \cdot \sqrt{RESNO}} - (DIST/60)$$

$$(11) \qquad ATTFAC_i = ATTFAC_{i-1} + .5 \cdot (ATTFAC_{i-1} - ATTFAC_{i-2}) \qquad i=n+3,\ldots,n+7$$

and are related to projected population as follows:

$$(12) \qquad ATTEND_i = POP_i \cdot ATTFAC_i \qquad i=n+1,\ldots,n+7 \text{ or, } i=n,\ldots,n+7$$

with,

$ATTEND_i$ yearly attendance as projected for year i,

$ATTFAC_i$ attendance factor for year i,

POP_i population of the region within a 100-mile radius,

RESAR surface area of proposed reservoir,

TOTLAK total surface area of reservoirs over 2,500 acres within 100-mile radius,

RESNO number of reservoirs included for TOTLAK.

The model is designed to measure only income flows generated by the reservoir from outside the micro region. Assuming linearity the attendance is divided into those originating from contiguous counties and those from outside this area. That portion from outside contiguous counties is given as follows:

$$(13) \qquad OUTATT_i = [(-27.31 \cdot POPPER) + 1.6147] \cdot ATTEND_i \qquad i=n+1,\ldots,n+7$$

where,

$OUTATT_i$ attendance from outside the contiguous counties, POPPER population of the contiguous counties as a percent of the population for the 100-mile radius.

To account for expenditures of different recreational groups the outside attendance is further divided. The categories are:

(14) $CAMPAT_i = [(-12.38 \cdot POPPER) + 1.0472] \cdot OUTATT_i$

(15) $BOATAT_i = [(-1.124 \cdot POPPER) + .2411] \cdot OUTATT_i$

(16) $OTHATT_i = [(13.50 \cdot POPPER) - .2894] \cdot OUTATT_i$

$i=n,\ldots,n+7$ or,

$i=n+1,\ldots,n+7$

where,

$CAMPAT_i$ number of campers,

$BOATAT_i$ number of boaters and fishermen,

$OTHATT_i$ number of skiers, swimmers, picnickers, and sightseers.

A combination of the results of Equations (14), (15), and (16) with the correct expenditures gives the following input:

(17) $REC_i = \$4.09 \cdot CAMPAT_i + \$3.26 \cdot BOATAT_i + \$1.75 \cdot OTHATT_i$

The model employs an exponential multiplier to simulate the micro-region economies. Certain notations and definitions are necessary for descriptions of the model:

E_i yearly impact for an individual year of development,

E_t total impact for the defined number of years,

M_i money inputs into the economy during each of the three stages of development (in thousands of dollars),

$g_{1,i}$ economic growth factor, the first subscript denoting initial year growth factor, and the second indexing the year of development,

$g_{2,i}$ economic growth factor, the first subscript denoting the residual growth factor and the second indexing the year of development,

ENC aggregate income of the micro region,

t the integration parameter time.

The multipliers along with the periodic money inputs and residual impact of earlier years gives total impact. A given year has one or all parts of the following input:

$$M_i = C_i + EXP_i + INV_i + REC_i \qquad i=1,\ldots,m \tag{18}$$

The model can be described with equations from one to m years as follows:

$$E_1 = \left(M_1 \int_0^1 e^{g_{1,1}t}\,dt\right)/ENC \qquad i=1 \tag{19}$$

$$E_2 = \left(M_2 \int_0^1 e^{g_{1,2}t}\,dt + E_1 \int_0^1 e^{-g_{2,1}t}\,dt\right)/ENC \qquad i=2 \tag{20}$$

$$E_3 = \left(M_3 \int_0^1 e^{g_{1,3}t}\,dt + E_2 \int_0^1 e^{-g_{2,2}t}\,dt + E_1 \int_1^2 e^{-g_{2,1}t}\,dt\right)/ENC \qquad i=3 \tag{21}$$

$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$

$$E_m = \left(M_m \int_0^1 e^{g_{1,m}t}\,dt + E_{m-1} \int_0^1 e^{-g_{2,m-1}t}\,dt + \ldots E_1 \int_{m-2}^{m-1} e^{-g_{2,1}t}\,dt\right)/ENC \qquad i=m \tag{22}$$

with $E_0 = 0$.

Integrating with respect to time and summing over the stages, reservoir impact is:

$$(23)\quad E_T = \frac{\sum_{i=1}^{n} E_i}{ENC} + \frac{\sum_{i=n+1}^{n+2} E_i}{ENC} + \frac{\sum_{i=n+3}^{m} E_i}{ENC}$$

The growth factor *g*, a combination of endogenous variables, provides flexibility. The initial *g* makes the following combinations of the endogenous variables:

$$(24)\quad g_{1,1} = \frac{(P/AR)^2\ (A/ENC)^2}{\frac{DIST^2}{4}} - 1$$

where,

AR	area in square miles,
P	population in year of projection,
A	agricultural income, most recent agricultural census,
DIST	distance in miles between the reservoir and nearest population center of 25,000 or more population.

This relationship is then tested for positive or negative results to determine necessary adjustments for later years. If positive, *g* is in the following form:

$$(25)\quad g_{1,i} = g_{1,1} + .5 \qquad i=2,\ldots,n-2$$

$$(26)\quad g_{1,n-1} = g_{1,1} - 1.5$$

$$(27)\quad g_{1,n} = g_{1,1} - 2.0$$

$$(28)\quad g_{1,i} = g_{1,1} - (2.5 + 5j) \qquad i=n+1,\ldots,m;\ j=0,\ldots,m-1$$

Secondary impact is measured with:

$$(29) \qquad g_{2,i} = g_{1,1} + 2.0 \qquad i=2,\ldots,m$$

If the $g_{1,1}$ is negative then the later growth factors are adjusted as well as the Equations (19) through (22). Later years for a negative g are as follows:

$$(30) \qquad g_{1,i} = \frac{(P/AR)^2 \; (A/ENC)^2}{\frac{DIST^2}{4}} - (1+2i) \qquad i=2,\ldots,n$$

$$(31) \qquad g_{1,i} = g_{1,n} \qquad i=n+1,\ldots,m$$

The $g_{2,j}$ for secondary impact is the same as described in Equation (29) above.

The alterations to Equation (19) to (22) and similar ones is as follows:

$$(32) \qquad E_i = \left(M_i \int_0^1 e^{g_{1,i}t} dt\right)/ENC \qquad i=1$$

$$(33) \qquad E_i = \left(I_i - 1/2\ M_i\right)/ENC \qquad i=2,\ldots,n$$

$$(34) \qquad E_i = \left(I_i - 1/2\ M_i\right)/ENC \qquad i=n+1,\&\ n+3$$

$$(35) \qquad E_i = \left(I_i - 1/3\ M_i\right)/ENC \qquad i=n+2,\&\ n+4,\ldots,m$$

The I in the above equation is:

$$(36) \qquad I_i = M_i \int_0^1 e^{g_{1,i}t} dt + \sum_{j=1}^{i} I_{i-j} \int_{j-1}^{j} e^{g_{2,j}t} dt \qquad i=2,\ldots,m$$

$I_0 = 0.$

APPENDIX B

TABLE 1b

BASIC MODEL INPUT DATA
AMISTAD DAM

Type	Input
Name of project	Amistad Dam
Total land area of contiguous counties	3,242 sq. miles
Population of contiguous counties for year of construction	25,000
Estimated income of the contiguous counties for year of construction (000)	$45,395
Estimated agricultural income of the contiguous counties for year of construction (000)	$4,225
Distance from the nearest population center over 25,000	13 miles
Number of reservoirs in the contiguous counties	1
Year construction began	1964
Year construction ended	1969
Yearly construction expenditures (000)	
Year 1	$5,504
Year 2	$13,126
Year 3	$4,673
Year 4	$7,037
Year 5	$4,829
Year 6	$5,178
Year 7	$2,589
Estimated average yearly expenditure for operations and maintenance (000)	$150
Population of counties within 100-mile radius beginning of last decennial census	75,114
Population of counties within 100-mile radius ending of last decennial census	85,875
Number of cities within 100-mile radius of reservoir (over 10,000)	1
Population of cities within 100-mile radius of reservoir	
City 1	19,950
Distance from the reservoir of cities within 100-mile radius (miles)	
City 1	13
Per Capita income of counties within 100-mile radius of reservoir	$1,498
Surface area of reservoir	67,000 acres
Shoreline of reservoir	547 miles

TABLE 1b (cont.)

Type	Input
Total area of all lakes* within 100-mile radius of reservoir	67,000 acres
Number of lakes* within 100-mile radius of reservoir	1

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1959, Sales Management's, Survey of Buying Power, U.S. Census, 1950 and 1960.

Amistad Area

Amistad Dam, one of the three largest reservoirs in the study group, was constructed primarily for flood control, conservation, and hydroelectric power.

In using the comparative-projection model to project economic impact several unique factors were noted. Amistad is an international reservoir, and since monetary inputs were considered only for the United States only model input data of the United States were used.

The shoreline used was the United States side only. And even though the city of Del Rio only had a population of 20,800, the distance of the closest city of 25,000 people was set at 13 miles because of the presence of Cuidad Acuna which put the total population above the minimum requirement.

Another unique combination of factors is that Amistad is located in an area with an extremely small population and was one of the largest reservoirs used in testing the model. These factors are opposites as far as effects on projections with neither appearing to be dominant.

Prior to construction the economy of the Amistad Area had shown no growth, but after construction began and during construction the economy has shown a definite upward trend. The reservoir is a new reservoir (1965-1968) and cannot be checked against actual (secondary) data.

TABLE 2b

BASIC MODEL INPUT DATA
BELTON DAM

Type	Input
Name of project	Belton Dam
Total land area of contiguous counties	2,087 sq. miles
Population of contiguous counties for year of construction	87,100
Estimated income of the contiguous counties for year of construction (000)	$75,440
Estimated agricultural income of the contiguous counties for year of construction (000)	$16,025
Distance from the nearest population center over 25,000	10 miles
Number of reservoirs in contiguous counties	1
Year construction began	1949
Year construction ended	1954
Yearly construction expenditures (000)	
Year 1	$1,835
Year 2	$1,690
Year 3	$1,913
Year 4	$4,419
Year 5	$2,911
Estimated average yearly expenditure for operations and maintenance (000)	$150
Population of counties within 100-mile radius beginning of last decennial census	2,081,929
Population of counties within 100-mile radius ending of last decennial census	2,384,762
Number of cities within 100-mile radius of reservoir (over 10,000)	7
Population of cities within 100-mile radius of reservoir	
City 1	25,000
City 2	78,000
City 3	140,000
City 4	22,500
City 5	22,500
City 6	596,765
City 7	267,000
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	10

TABLE 2b (cont.)

Type	Input
City 2	43
City 3	69
City 4	93
City 5	123
City 6	138
City 7	131
Per Capita income of counties within 100-mile radius of reservoir	$973
Surface area of reservoir	7,400 acres
Shoreline of reservoir	110 miles
Total area of all lakes* within 100-mile radius of reservoir	139,150 acres
Number of lakes* within 100-mile radius of reservoir	13

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1945, Sales Management's, Survey of Buying Power, U.S. Census, 1940 and 1950.

Belton Area

Belton Dam, one of the two original comparative areas, is located in Central Texas about three miles north of the city of Belton. The reservoir was constructed mainly to supply flood control, conservation, and water supply to the surrounding area.

At the time of construction, the closest center of population (of 25,000 or more) was Temple, which is 10 miles from the Dam. However, in recent years a major concentration has developed in Killeen, Texas, which is the site of Fort Hood, a large military base.

It should also be noted that there are 13 reservoirs or lakes within a 100-mile radius of Belton and at present a new reservoir is being constructed just south of Belton Dam. The economy in the area appears to be dynamic, progressive and diversified; and even though there is considerable farming in the area, the major source of income is attributed to Fort Hood.

TABLE 3b

BASIC MODEL INPUT DATA
CANYON DAM

Type	Input
Name of project	Canyon Dam
Total land area of contiguous counties	567 sq. miles
Population of contiguous counties for year of construction	21,600
Estimated income of the contiguous counties for year of construction (000)	$29,089
Estimated agricultural income of the contiguous counties for year of construction (000)	$2,440
Distance from the nearest population center over 25,000	48 miles
Number of reservoirs in the contiguous counties	1
Year construction began	1958
Year construction ended	1964
Yearly construction expenditures (000)	
Year 1	$710
Year 2	$2,246
Year 3	$2,600
Year 4	$2,275
Year 5	$3,519
Year 6	$2,750
Year 7	$1,044
Year 8	$1,265
Estimated average yearly expenditure for operations and maintenance (000)	$158
Population of counties within 100-mile radius beginning of last decennial census	1,240,672
Population of counties within 100-mile radius ending of last decennial census	1,475,678
Number of cities within 100-mile radius of reservoir (over 10,000)	4
Population of cities within 100-mile radius of reservoir	
City 1	35,000
City 2	22,000
City 3	186,000
City 4	545,000

TABLE 3b (cont.)

Type	Input
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	105
City 2	114
City 3	56
City 4	48
Per Capita income of counties within 100-mile radius of reservoir	$1,573
Surface area of reservoir	8,240 acres
Shoreline of reservoir	80 miles
Total area of all lakes* within 100-mile radius of reservoir	67,750 acres
Number of lakes* within 100-mile radius of reservoir	6

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1954, Sales Management's, Survey of Buying Power, U.S. Census, 1950 and 1960.

Canyon Area

Canyon Dam and Reservoir is located in the west Texas hill country about 48 miles northeast of San Antonio, Texas. Flood control and water conservation are its chief functions, although like most reservoirs it also serves as a center of recreation.

The economy of the surrounding area has been one of growth. Population has been increasing along with retail sales and per capita income. This is attributable to the area's tourist traffic and its history as a recreation center. Because of this the reservoir itself has not greatly influenced the economy of the area.

In the Canyon demand area there are six other reservoirs, but none located in the same county. There are four cities in the area with populations of 10,000 or more; the closest, with a population of 25,000, is 48 miles from the dam.

TABLE 4b

BASIC MODEL INPUT DATA
FALCON DAM

Type	Input
Name of project	Falcon Dam
Total land area of contiguous counties	2,207 sq. miles
Population of contiguous counties for year of construction	18,353
Estimated income of the contiguous counties for year of construction (000)	$9,885
Estimated agricultural income of the contiguous counties for year of construction (000)	$4,902
Distance from the nearest population center over 25,000	80 miles
Number of reservoirs in the contiguous counties	1
Year construction began	1950
Year construction ended	1954
Yearly construction expenditures (000)	
Year 1	$1,138
Year 2	$1,622
Year 3	$3,496
Year 4	$12,974
Year 5	$12,769
Year 6	$3,000
Estimated average yearly expenditure for operations and maintenance (000)	$259
Population of counties within 100-mile radius beginning of last decennial census	204,518
Population of counties within 100-mile radius ending of last decennial census	293,790
Number of cities within 100-mile radius of reservoir (over 10,000)	1
Population of cities within 100-mile radius of reservoir	
City 1	47,500
Distance from the reservoir of cities within 100-mile radius (miles)	
City 1	80
Per Capita income of counties within 100-mile radius of reservoir	$875
Surface area of reservoir	78,300 acres
Shoreline of reservoir	227 miles

TABLE 4b (cont.)

Type	Input
Total area of all lakes* within 100-mile radius of reservoir	78,300 acres
Number of lakes* within 100-mile radius of reservoir	1

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1945, Sales Management's, Survey of Buying Power, U.S. Census, 1940 and 1950.

Falcon Area

Falcon Dam, one of the three largest reservoirs in the study group, was constructed primarily for flood control, conservation, and hydroelectric power.

The economy of Starr and Zapata counties, the contiguous counties, had been erratic before construction. However, during and after construction the economy has exhibited a decidedly upward trend.

These affects are closely approximated by the model, but only after making adjustments for the fact that Falcon is an International Reservoir.

The money inputs used were only those attributed to the United States since only the economic impact of the American side was under consideration. Also, the shoreline used was miles of shore on the United States side only.

Other unique factors that should be noted about the Falcon Area are that it is 80 miles from the closest city of over 25,000 population, and the immediate area is one of very small population. Falcon is one of the three largest reservoirs in the study.

TABLE 5b

BASIC MODEL INPUT DATA
FERRELLS BRIDGE DAM

Type	Input
Name of project	Ferrells Bridge Dam
Total land area of contiguous counties	2,721 sq. miles
Population of contiguous counties for year of construction	107,500
Estimated income of the contiguous counties for year of construction (000)	$99,980
Estimated agricultural income of the contiguous counties for year of construction (000)	$7,614
Distance from the nearest population center over 25,000	26 miles
Number of reservoirs in the contiguous counties	1
Year construction began	1955
Year construction ended	1959
Yearly construction expenditures (000)	
Year 1	$646
Year 2	$2,595
Year 3	$4,506
Year 4	$2,880
Estimated average yearly expenditure for operation and maintenance (000)	$445
Population of counties within 100-mile radius beginning of last decennial census	1,271,373
Population of counties within 100-mile radius ending of last decennial census	1,248,133
Number of cities within 100-mile radius of reservoir (over 10,000)	8
Population of cities within 100-mile radius of reservoir	
City 1	18,000
City 2	40,628
City 3	24,502
City 4	22,327
City 5	21,643
City 6	38,968
City 7	24,700
City 8	164,100
Distance from the reservoir of cities within 100-mile radius (miles)	
City 1	115
City 2	67

TABLE 5b (cont.)

Type	Input
City 3	34
City 4	26
City 5	100
City 6	86
City 7	65
City 8	65
Per Capita income of counties within 100-mile radius of reservoir	$1,077
Surface area of reservoir	18,700 acres
Shoreline of reservoir	138 miles
Total area of all lakes* within 100-mile radius of reservoir	55,390 acres
Number of lakes* within 100-mile radius of reservoir	3

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, _Texas Almanac_, _Agricultural Census, 1954_, _Sales Management's_, _Survey of Buying Power_, U.S. Census, 1940 and 1950.

Lake O'Pines Area

Ferrells Bridge Dam is located in northeast Texas near the Texas-Louisiana border. Its primary purpose is that of flood control.

The economy of the area exhibited a decreasing trend prior to construction. This trend was reversed significantly during and since construction. In fact, this reservoir has affected the economy of its area much more than any other reservoir in the study.

The reservoir covers parts of six counties and is the only reservoir in these counties. Only three reservoirs are in the entire demand area. There are eight cities in the area that have populations of 10,000 or better.

TABLE 6b

BASIC MODEL INPUT DATA
HORDS CREEK DAM

Type	Input
Name of project	Hords Creek Dam
Total land area of contiguous counties	1,282 sq. miles
Population of contiguous counties for year of construction	17,700
Estimated income of the contiguous counties for year of construction (000)	$10,125
Estimated agricultural income of the contiguous counties for year of construction (000)	$6,347
Distance from the nearest population center over 25,000	45 miles
Number of reservoirs in contiguous counties	1
Year construction began	1946
Year construction ended	1949
Yearly construction expenditures (000)	
Year 1	$672
Year 2	$1,271
Year 3	$265
Estimated average yearly expenditure for operations and maintenance (000)	$124
Population of counties within 100-mile radius beginning of last decennial census	463,030
Population of counties within 100-mile radius ending of last decennial census	474,976
Number of cities within 100-mile radius of reservoir (over 10,000)	3
Population of cities within 100-mile radius of reservoir	
City 1	20,000
City 2	31,000
City 3	29,500
Distance from the reservoir of cities within 100-mile radius (miles)	
City 1	38
City 2	45
City 3	60
Per Capita income of counties within 100-mile radius of reservoir	$681
Surface area of reservoir	510 acres

TABLE 6b (cont.)

Type	Input
Shoreline of reservoir	11 miles
Total area of all lakes* within 100-mile radius of reservoir	42,010 acres
Number of lakes* within 100-mile radius of reservoir	5

*Lakes are defined as bodies of water consisting of over 2,500 acres feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1945, Sales Management's, Survey of Buying Power, U.S. Census, 1940 and 1950.

Hords Creek Area

Hords Creek Dam and Reservoir, the oldest and smallest reservoir in the study, was constructed as a multiple purpose project. It provides relief from flood damage, a water supply, and facilities for public recreation and wildlife conservation.

The general overall economy of the Hords Creek Area prior to construction was in a decline. During and after construction there were periods that showed an increase, but impact provided by Hords Creek was not enough to offset the declining trend of the economy.

As previously mentioned, Hords Creek Dam and Reservoir is the smallest of the study group with a surface area of only 510 acres, a shoreline of a mere 11 miles, and a low income base. There are only three cities in the 100-mile radius demand area that have a population of 10,000 or more. The closest city with a 25,000 population is 45 miles from the dam.

TABLE 7b

BASIC MODEL INPUT DATA
LEWISVILLE DAM

Type	Input
Name of project	Lewisville Dam
Total land area of contiguous counties	942 sq. miles
Population of contiguous counties for year of construction	36,900
Estimated income of the contiguous counties for year of construction (000)	$33,833
Estimated agricultural income of the contiguous counties for year of construction (000)	$7,987
Distance from the nearest population center over 25,000	22 miles
Number of reservoirs in the contiguous counties	2
Year construction began	1948
Year construction ended	1955
Yearly construction expenditures (000)	
Year 1	$120
Year 2	$2,445
Year 3	$3,743
Year 4	$5,189
Year 5	$3,905
Year 6	$2,245
Year 7	$3,375
Year 8	$4,979
Estimated average yearly expenditure for operations and maintenance (000)	$343
Population of counties within 100-mile radius beginning of last decennial census	1,634,254
Population of counties within 100-mile radius ending of last decennial census	1,837,171
Number of cities within 100-mile radius of reservoir (over 10,000)	6
Population of cities within 100-mile radius of reservoir	
City 1	370,000
City 2	21,000
City 3	38,000
City 4	24,000
City 5	247,000
City 6	20,200

TABLE 7b (cont.)

Type	Input
Distance from the reservoir of cities within 100-mile radius (miles)	
City 1	22
City 2	22
City 3	59
City 4	97
City 5	32
City 6	80
Per Capita income of counties within 100-mile radius of reservoir	$1,250
Surface area of reservoir	23,280 acres
Shoreline of reservoir	183 miles
Total area of all lakes* within 100-mile radius of reservoir	206,708 acres
Number of lakes* within 100-mile radius of reservoir	13

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1945, Sales Management's, Survey of Buying Power, U.S. Census, 1940 and 1950.

Garza-Little Elm Area

Garza-Little Elm Dam and Reservoir, which incorporated old Lake Dallas, is located 22 miles northwest of Dallas, Texas. Flood control and conservation are the main functions provided by the dam for the area.

The economy of the area when construction started in 1948, was rather inactive. However, since that time the reservoir has had a net beneficial impact and soon after fill-up the trend became one of steady growth.

Garza-Little Elm is in a demand area which has thirteen other reservoirs, one of which is located in the same county. Two of the competing reservoirs are about the same distance, as Garza-Little Elm, from the two major metropolitan areas, Dallas and Fort Worth. Dallas is the closest city and is one of six in the area with populations of 10,000 or more.

TABLE 8b

BASIC MODEL INPUT DATA
NAVARRO MILLS DAM

Type	Input
Name of project	Navarro Mills Dam
Total land area of contiguous counties	2,104 sq. miles
Population of contiguous counties for year of construction	58,073
Estimated income of the contiguous counties for year of construction (000)	$76,802
Estimated agricultural income of the contiguous counties for year of construction (000)	$19,722
Distance from the nearest population center over 25,000	40 miles
Number of reservoirs in the contiguous counties	1
Year construction began	1959
Year construction ended	1963
Yearly construction expenditures (000)	
Year 1	$1,264
Year 2	$2,730
Year 3	$3,050
Year 4	$1,816
Estimated average yearly expenditure for operations and maintenance (000)	$167
Population of counties within 100-mile radius beginning of last decennial census	2,049,011
Population of counties within 100-mile radius ending of last decennial census	2,564,576
Number of cities within 100-mile radius of reservoir (over 10,000)	6
Population of cities within 100-mile radius of reservoir	
City 1	30,000
City 2	827,000
City 3	110,000
City 4	23,500
City 5	68,000
City 6	532,000
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	104
City 2	71
City 3	40

TABLE 8b (cont.)

Type	Input
City 4	18
City 5	93
City 6	89
Per Capita income of counties within 100-mile radius of reservoir	$1,748
Surface area of reservoir	5,070 acres
Shoreline of reservoir	38 miles
Total area of all lakes* within 100-mile radius of reservoir	95,770 acres
Number of lakes* within 100-mile radius of reservoir	12

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1954, Sales Management's, Survey of Buying Power, U.S. Census, 1950 and 1960.

Navarro Mills Area

Navarro Mills Dam and Reservoir is located 16 miles southwest of Corsicana, Texas. Construction was started in 1959 and deliberate fill-up was begun in 1963. The main purpose of the reservoir is that of flood control and water conservation.

Within the demand area there are 12 reservoirs, none of which are in contiguous counties. Only six cities in the area meet the 10,000 population criteria and the closest city with 25,000 is 40 miles from the reservoir.

Livestock is the main source of income into the economy, which had been exhibiting a slow steady growth prior to construction. Once construction was finalized, the economy continues to increase but at an increasing rate. This indicates that Navarro Mills Dam and Reservoir has had a favorable impact on the area's economy.

TABLE 9b

BASIC MODEL INPUT DATA
SAM RAYBURN DAM

Type	Input
Name of project	Sam Rayburn Dam
Total land area of contiguous counties	3,775 sq. miles
Population of contiguous counties for year of construction	103,700
Estimated income of the contiguous counties for year of construction (000)	$107,826
Estimated agricultural income of the contiguous counties for year of construction (000)	$13,351
Distance from the nearest population center over 25,000	84 miles
Number of reservoirs in the contiguous counties	2
Year construction began	1956
Year construction ended	1965
Yearly construction expenditures (000)	
Year 1	$648
Year 2	$2,295
Year 3	$4,257
Year 4	$6,591
Year 5	$5,800
Year 6	$6,550
Year 7	$8,896
Year 8	$10,407
Year 9	$5,574
Year 10	$3,748
Year 11	$2,095
Estimated average yearly expenditure for operations and maintenance (000)	$409
Population of counties within 100-mile radius beginning of last decennial census	1,239,900
Population of counties within 100-mile radius ending of last decennial census	1,386,500
Number of cities within 100-mile radius of reservoir (over 10,000)	8
Population of cities within 100-mile radius of reservoir	
City 1	50,000
City 2	26,327
City 3	106,000
City 4	62,900

Unlike Falcon and Amistad, Sam Rayburn is not an International Reservoir. The total monetary inputs were considered and no adjustments were necessary as was the case with Falcon and Amistad. Sam Rayburn is located in a populated area with a slowly growing economy. Since 1965, the year construction ended, the economy of the area has been rising and it is predicted that tourism will be a major monetary input into the area.

Within the 100-mile radius demand area there are eight cities with populations of 10,000 or more; however, the closest is 84 miles from the dam. There are nine other reservoirs in the area, only one of which is in the contiguous counties, and have a total surface area less than half that of Sam Rayburn.

TABLE 9b (cont.)

Type	Input
City 5	30,000
City 6	51,540
City 7	66,200
City 8	51,100
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	135
City 2	128
City 3	89
City 4	102
City 5	84
City 6	134
city 7	110
City 8	100
Per Capita income of counties within 100-mile radius of reservoir	$1,270
Surface area of reservoir	114,500 acres
Shoreline of reservoir	560 miles
Total area of all lakes* within 100-mile radius of reservoir	178,250
Number of lakes* within 100-mile radius of reservoir	9

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1954, Sales Management's, Survey of Buying Power, U.S. Census, 1950 and 1960.

Sam Rayburn Area

Sam Rayburn Dam and Reservoir, the largest water-impoundment project in the State, was constructed primarily to develop water resources in the area, such as controlling floods, generating hydroelectric power and conserving water for municipal, industrial, and agricultural uses.

TABLE 10b

BASIC MODEL INPUT DATA
SANFORD DAM

Type	Input
Name or project	Sanford Dam
Total land area of contiguous counties	3,596 sq. miles
Population of contiguous counties for year of construction	185,100
Estimated income of the contiguous counties for year of construction (000)	$378,197
Estimated agricultural income of the contiguous counties for year of construction (000)	$34,057
Distance from the nearest population center over 25,000	45 miles
Number of reservoirs in contiguous counties	1
Year construction began	1961
Year construction ended	1966
Yearly construction expenditures (000)	
Year 1	$4,245
Year 2	$10,695
Year 3	$17,008
Year 4	$19,417
Year 5	$21,871
Year 6	$7,037
Year 7	$1,144
Estimated average yearly expenditure for operations and maintenance (000)	$150
Population of counties within 100-mile radius beginning of last decennial census	287,712
Population of counties within 100-mile radius ending of last decennial census	364,138
Number of cities within 100-mile radius of reservoir (over 10,000)	3
Population of cities within 100-mile radius of reservoir	
City 1	24,664
City 2	20,911
City 3	137,969
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	41
City 2	12
City 3	45

TABLE 10b (cont.)

Type	Input
Per Capita income of counties within 100-mile radius of reservoir	$1,989
Surface area of reservoir	12,000 acres
Shoreline of reservoir	100 miles
Total area of all lakes* within 100-mile radius of reservoir	12,000 acres
Number of lakes* within 100-mile radius of reservoir	1

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1959, Sales Management's, Survey of Buying Power, U.S. Census, 1950 and 1960.

Lake Meredith Area

Sanford Dam and Reservoir is located in the Texas Panhandle about 40 miles northeast of Amarillo. The dam's main function is to supply water for both municipal and industrial use to the cities in the Panhandle. An aqueduct system is used in conjunction with the reservoir to meet these needs.

The economy of the area, before construction started in 1961, was one of stable growth. Since data for the years after construction is not sufficient, no reliable conclusion can be drawn about the projections. However, the projections show the same basic pattern that existed before construction started.

There are three cities in the 100-mile radius area that have population of over 10,000 with the largest having a population of 137,969.

This is the only reservoir within 100 miles of the dam and it is larger than average size. These combined facts tend to explain the relative popularity of Lake Meredith as a recreation center.

TABLE 11b

BASIC MODEL INPUT DATA
SOMERVILLE DAM

Type	Input
Name of project	Somerville Dam
Total land area of contiguous counties	1,934 sq. miles
Population of contiguous counties for year of construction	37,700
Estimated income of the contiguous counties for year of construction (000)	$46,319
Estimated agricultural income of the contiguous counties for year of construction (000)	$18,940
Distance from the nearest population center over 25,000	27 miles
Number of reservoirs in the contiguous counties	1
Year construction began	1962
Year construction ended	1967
Yearly construction expenditures (000)	
Year 1	$2,073
Year 2	$3,777
Year 3	$6,244
Year 4	$8,254
Year 5	$1,617
Estimated average yearly expenditure for operations and maintenance (000)	$150
Population of counties within 100-mile radius beginning of last decennial census	2,243,604
Population of counties within 100-mile radius ending of last decennial census	2,839,054
Number of cities within 100-mile radius of reservoir (over 10,000)	20
Population of cities within 100-mile radius of reservoir	
City 1	139,741
City 2	30,419
City 3	23,337
City 4	11,619
City 5	27,542
City 6	11,396
City 7	1,243,158
City 8	11,999
City 9	15,631
City 10	13,366

TABLE 11b (cont.)

Type	Input
City 11	67,175
City 12	32,065
City 13	13,969
City 14	14,299
City 15	12,713
City 16	97,808
City 17	11,656
City 18	20,344
City 19	212,136
City 20	33,047
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	147
City 2	78
City 3	108
City 4	138
City 5	27
City 6	23
City 7	91
City 8	79
City 9	137
City 10	67
City 11	143
City 12	135
City 13	131
City 14	132
City 15	122
City 16	102
City 17	106
City 18	139
City 19	98
City 20	126
Per Capita income of counties within 100-mile radius of reservoir	$1,841
Surface area of reservoir	11,460 acres
Shoreline of reservoir	85 miles
Total area of all lakes* within 100-mile radius of reservoir	120,470 acres
Number of Lakes* within 100-mile radius of reservoir	11

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1959, Sales Management's, Survey of Buying Power, U.S. Census, 1950 and 1960.

Somerville Area

Somerville Dam, the primary study area, is located in the south central part of Texas and is about two miles southwest of Somerville, Texas. Construction was started in 1962 with fill-up beginning in 1967.

The economy of the study area prior to construction may be described as primarily agricultural, growing at a slow rate. The area had erratic population changes, relatively constant retail sales, and a slow growth in disposable income.

One characteristic that makes Somerville unique is the large number of cities with populations of 10,000 or more in the demand area. However, the closest city of 25,000 population is 25 miles from the Dam and there are 11 other reservoirs in the 100-mile area.

TABLE 12b

BASIC MODEL INPUT DATA
TWIN BUTTES DAM

Type	Input
Name of project	Twin Buttes Dam
Total land area of contiguous counties	1,534 sq. miles
Population of contiguous counties for year of construction	64,630
Estimated income of the contiguous counties for year of construction (000)	$119,371
Estimated agricultural income of the contiguous counties for year of construction (000)	$13,383
Distance from the nearest population center over 25,000	10 miles
Number of reservoirs in contiguous counties	2
Year construction began	1959
Year construction ended	1963
Yearly construction expenditures (000)	
Year 1	$2,319
Year 2	$10,982
Year 3	$8,335
Year 4	$2,464
Estimated average yearly expenditure for operations and maintenance (000)	$88
Population of counties within 100-mile radius beginning of last decennial census	373,186
Population of counties within 100-mile radius ending of last decennial census	445,460
Number of cities within 100-mile radius of reservoir (over 10,000)	4
Population of cities within 100-mile radius of reservoir	
City 1	26,500
City 2	50,600
City 3	68,000
City 4	73,300
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	111
City 2	137
City 3	10
City 4	116
Per Capita income of counties within 100-mile radius of reservoir	$1,827

TABLE 12b (cont.)

Type	Input
Surface area of reservoir	8,400 acres
Shoreline of reservoir	56 miles
Total area of all lakes* within 100-mile radius of reservoir	31,910 acres
Number of lakes* within 100-mile radius of reservoir	5

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1954, Sales Management's, Survey of Buying Power, U.S. Census, 1950 and 1960.

Twin Buttes Area

Twin Buttes Dam is located in West Texas approximately twelve miles west of San Angelo. Construction started in 1959 and the reservoir became operational in 1964. The reservoir serves two primary purposes, flood control and water supply.

In applying the model, a basic assumption is made that the reservoir will fill up at least to conservation level. Twin Buttes, however, did not meet this criteria and therefore the projections do not closely approximate the actual figures.

Compounding this problem is the fact that San Angelo Dam is also in Tom Green County and is only ten miles from Twin Buttes. This offers an element of competition to Twin Buttes for potential recreators.

Most economies are improved by the location of a reservoir in the area and the same held true for Twin Buttes. The economy was declining before construction, but reversed this trend after construction and exhibited a steady growth. This growth probably would have been greater if the reservoir had reached conservation level.

TABLE 13b

BASIC MODEL INPUT DATA
WHITNEY DAM

Type	Input
Name of project	Whitney Dam
Total land area of contiguous counties	2,023
Population of contiguous counties for year of construction	47,800
Estimated income of the contiguous counties for year of construction (000)	$32,000
Estimated agricultural income of the contiguous counties for year of construction (000)	$17,440
Distance from the nearest population center over 25,000	29 miles
Number of reservoirs in the contiguous counties	1
Year construction began	1947
Year construction ended	1951
Yearly construction expenditures (000)	
Year 1	$3,552
Year 2	$6,307
Year 3	$14,100
Year 4	$8,689
Year 5	$5,769
Year 6	$2,191
Estimated average yearly expenditure for operations and maintenance (000)	$150
Population of counties within 100-mile radius beginning of last decennial census	1,612,866
Population of counties within 100-mile radius ending of last decennial census	1,903,109
Number of cities within 100-mile radius of reservoir (over 10,000)	5
Population of cities within 100-mile radius of reservoir	
City 1	23,000
City 2	21,000
City 3	370,000
City 4	96,000
City 5	247,000
Distance from reservoir of cities within 100-mile radius (miles)	
City 1	80
City 2	108

TABLE 13b (cont.)

Type	Input
City 3	79
City 4	29
City 5	67
Per Capita income of counties within 100-mile radius of reservoir	$1,088
Surface area of reservoir	15,800 acres
Shoreline of reservoir	190 miles
Total area of all lakes* within 100-mile radius of reservoir	157,600 acres
Number of lakes* within 100-mile radius of reservoir	14

*Lakes are defined as bodies of water consisting of over 2,500 acre feet.

Source: Corps of Engineers statistics, Texas Almanac, Agricultural Census, 1945, Sales Management's, Survey of Buying Power, U.S. Census, 1940 and 1950.

Whitney Dam

Whitney Dam, the second of the two orginal comparative areas, is located 5.5 miles southwest of the small town of Whitney, Texas. Similar to Belton, the reservoir was started in 1947 and was to serve the area with hydroelectric power.

The surrounding area is sparsely populated and the population of the contiguous counties had been steadily declining in 1947. Waco, Texas, a city of 96,000 people, is the closest population center at 29 miles.

Despite the fact that 14 other reservoirs are within a 100-mile radius, Whitney has had a satisfactory recreation attendance. This has helped to boost the local economy to some degree above the slow economic growth of an agrarian economy. The presence of Whitney Dam appears to have a favorable impact effect on the economy because the rate of growth was increased.

APPENDIX C

TABLE 1c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, AMISTAD RESERVOIR, 1968-1976

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1968	96,000	29,000		
1969	97,000	4,131,000		
1970	98,000	6,280,000	30,000	
1971	100,000	7,425,000	356,000	
1972	101,000	8,063,000	541,000	
1973	102,000	8,444,000	639,000	
1974	104,000	8,696,000	694,000	
1975	105,000	8,883,000	727,000	
1976	106,000		749,000	

*No attendance figures available.

Source: Derived from population projections and attendance factors for Amistad Reservoir.

TABLE 2c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, BELTON RESERVOIR, 1954-1961

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1954	2,884,000	865,000	755,000	768,000
1955	2,924,000	1,221,000	1,089,000	1,190,000
1956	2,964,000	1,856,000	1,656,000	1,685,000
1957	3,004,000	2,195,000	1,958,000	2,214,000
1958	3,045,000	2,384,000	2,127,000	2,376,000
1959	3,087,000	2,498,000	2,228,000	2,407,000
1960	3,129,000	2,573,000	2,295,000	1,607,000
1961	3,172,000	2,628,000	2,344,000	2,214,000

*Figures furnished by U.S. Corps of Engineers, Fort Worth District.

Source: Derived from population projections and attendance factors for Belton Reservoir.

TABLE 3c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, CANYON RESERVOIR, 1964-1971

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1964	1,582,000		475,000	
1965	1,609,000	483,000	1,193,000	631,000
1966	1,638,000	239,000	1,821,000	956,000
1967	1,666,000	365,000	2,162,000	1,113,000
1968	1,695,000	433,000	2,357,000	1,427,000
1969	1,725,000	472,000	2,478,000	
1970	1,755,000	496,000	2,562,000	
1971	1,786,000	513,000	2,628,000	

*Figures furnished by U.S. Corps of Engineers, Fort Worth District.

Source: Derived from population projections and attendance factors for Canyon Reservoir.

TABLE 4c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, FALCON RESERVOIR, 1955-1961

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1955	352,000	106,000	106,000	
1956	365,000	6,426,000	1,048,000	
1957	379,000	9,995,000	1,630,000	
1958	393,000	12,091,000	1,972,000	
1959	407,000	13,432,000	2,191,000	
1960	422,000	14,392,000	2,347,000	
1961	438,000	15,164,000	2,473,000	

*No attendance figures available.

Source: Derived from population projections and attendance factors for Falcon Reservoir.

TABLE 5c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, FERRELLS BRIDGE RESERVOIR, 1959-1966

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1959	1,250,000	375,000	375,000	250,000
1960	1,248,000	4,258,000	2,205,000	1,300,000
1961	1,246,000	6,375,000	3,301,000	2,193,000
1962	1,244,000	7,423,000	3,844,000	3,106,000
1963	1,241,000	7,939,000	4,111,000	3,299,000
1964	1,239,000	8,188,000	4,241,000	4,277,000
1965	1,237,000	8,305,000	4,301,000	4,093,000
1966	1,234,000	8,356,000	4,327,000	4,336,000

*Figures furnished by U.S. Corps of Engineers, New Orleans District.

Source: Derived from population projections and attendance factors for Ferrells Bridge Reservoir.

TABLE 6c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, HORDS CREEK RESERVOIR, 1949-1956

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1949	474,000	142,000	142,000	61,000
1950	475,000	-335,000	91,000	84,000
1951	476,000	-504,000	136,000	127,000
1952	477,000	-589,000	159,000	144,000
1953	479,000	-633,000	171,000	161,000
1954	480,000	-655,000	177,000	161,000
1955	481,000	-668,000	181,000	144,000
1956	482,000	-675,000	182,000	163,000

*Figures furnished by U.S. Corps of Engineers, Fort Worth District.

Source: Derived from population projections and attendance factors for Hords Creek Reservoir.

TABLE 7c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, GARZA-LITTLE ELM RESERVOIR, 1955-1963

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1955	1,948,000		584,000	1,150,000
1956	1,971,000	591,000	1,932,000	1,776,000
1957	1,994,000	2,089,000	2,444,000	2,013,000
1958	2,017,000	3,171,000	2,596,000	2,112,000
1959	2,041,000	3,743,000	2,658,000	2,248,000
1960	2,065,000	4,058,000	2,697,000	2,283,000
1961	2,090,000	4,242,000	2,731,000	2,328,000
1962	2,114,000	4,361,000	2,764,000	2,387,000
1963	2,139,000	4,448,000		2,530,000

*Figures furnished by U.S. Corps of Engineers, Fort Worth District.

Source: Derived from population projections and attendance factors for Garza-Little Elm Reservoir.

TABLE 8c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, NAVARRO MILLS RESERVOIR, 1963-1970

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1963	2,743,000	823,000	823,000	262,000**
1964	2,805,000	-1,282,000	117,000	432,000
1965	2,869,000	-1,967,000	179,000	430,000
1966	2,934,000	-2,347,000	214,000	402,000
1967	3,001,000	-2,572,000	234,000	409,000
1968	3,069,000	-2,718,000	248,000	407,000
1969	3,139,000	-2,824,000	257,000	
1970	3,210,000	-2,911,000	265,000	

*Figures frunished by U.S. Corps of Engineers, Fort Worth District.

**Recorded for six months.

Source: Derived from population projections and attendance factors for Navarro Mills Reservoir.

TABLE 9c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, SAM RAYBURN RESERVOIR, 1966-1972

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1966	1,483,000	445,000	45,000	993,000
1967	1,499,000	16,404,000	2,361,000	2,172,000
1968	1,516,000	24,882,000	2,985,000	2,955,000
1969	1,533,000	29,355,000	3,169,000	
1970	1,550,000	31,805,000	3,243,000	
1971	1,568,000	33,235,000	3,289,000	
1972	1,585,000	34,150,000	3,328,000	

*Figures furnished by U.S. Corps of Engineers, Fort Worth District.

Source: Derived from population projections and attendance factors for Sam Rayburn Reservoir.

TABLE 10c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, SANFORD RESERVOIR, 1966-1976

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1966	419,000		126,000	1,062,000
1967	429,000		1,170,000	
1968	440,000		1,796,000	
1969	450,000	135,000	2,146,000	
1970	461,000	3,558,000	2,354,000	
1971	472,000	5,465,000	2,490,000	
1972	483,000	6,528,000	2,591,000	
1973	495,000	7,161,000	2,673,000	
1974	506,000	7,576,000		
1975	518,000	7,881,000		
1976	531,000	8,133,000		

*Figures furnished by the U.S. Department of the Interior, Bureau of Reclamation, Region 5.

Source: Derived from population projections and attendance factors for Sanford Reservoir.

TABLE 11c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, SOMERVILLE RESERVOIR, 1967-1974

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1967	3,348,000	1,004,000	1,004,000	
1968	3,427,000	822,000	2,328,000	2,646,000
1969	3,509,000	1,262,000	3,575,000	
1970	3,593,000	1,507,000	4,270,000	
1971	3,678,000	1,654,000	4,684,000	
1972	3,766,000	1,749,000	4,956,000	
1973	3,855,000	1,820,000	5,156,000	
1974	3,947,000	1,878,000	5,320,000	

*Figures furnished by U.S. Corps of Engineers, Fort Worth District.

Source: Derived from population projections and attendance factors for Somerville Reservoir.

TABLE 12c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, TWIN BUTTES RESERVOIR, 1963-1970

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1963	470,000	141,000	141,000	28,000
1964	478,000	431,000	755,000	35,000
1965	487,000	657,000	961,000	27,000
1966	495,000	781,000	1,027,000	9,000
1967	504,000	851,000	1,058,000	3,000
1968	513,000	895,000	1,080,000	
1969	522,000	926,000	1,100,000	
1970	532,000	950,000	1,120,000	

*Figures furnished by the U.S. Department of the Interior, Bureau of Reclamation, Region 5.

Source: Derived from population projections and attendance factors for Twin Buttes Reservoir.

TABLE 13c

PROJECTED POPULATION, PROJECTED ATTENDANCE, AND RECORDED ATTENDANCE, WHITNEY RESERVOIR, 1952-1958

Year	Projected Population	Original Projected Attendance	Revised Projected Attendance	Recorded Attendance*
1952	1,967,000	590,000	590,000	549,000
1953	2,000,000	1,670,000	1,549,000	1,685,000
1954	2,033,000	2,547,000	2,363,000	2,479,000
1955	2,067,000	3,022,000	2,802,000	2,984,000
1956	2,102,000	3,291,000	3,053,000	2,900,000
1957	2,137,000	3,458,000	3,207,000	3,031,000
1958	2,172,000	3,572,000	3,313,000	3,232,000

*Figures furnished by U.S. Corps of Engineers, Fort Worth District.

Source: Derived from population projections and attendance factors for the Whitney Reservoir.

APPENDIX D

TABLE 1d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, AMISTAD RESERVOIR,
1969-1976

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
5										39	$234		
6	29	9	7	$ 28	2	$ 6		$ 0	$ 34	58	348	0	$ 0
7	356	110	84	344	23	73	3	5	422	87	522	1	31
8	541	166	128	523	34	112	5	8	643	131	786	1	31
9	639	197	151	618	41	132	5	9	759	78	468	0	0
10	694	214	164	671	44	143	6	10	824	47	282	0	0
11	727	224	172	702	46	150	6	11	863	28	168	0	0
12	749	231	177	723	47	155	6	11	889	17	102	0	0

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 2d

RECREATIONAL AND INVESTMENT PROJECTION,
BY YEAR AND TYPE, BELTON RESERVOIR,
1954-1961

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
5	755	541	320	$1,308	108	353	113	$198	$1,859	19	$114		
6	1,089	780	461	1,886	156	509	163	285	2,680	29	174	2	$ 62
7	1,656	1,186	701	2,868	237	773	248	434	4,075	44	264	4	124
8	1,958	1,403	829	3,392	281	915	293	513	4,820	66	396	2	62
9	2,217	1,524	901	3,684	305	993	318	557	5,234	39	234	1	31
10	2,228	1,596	943	3,859	319	1,041	333	584	5,484	24	144	1	31
11	2,295	1,644	972	3,975	329	1,072	343	601	5,648	14	84	1	31
12	2,344	1,680	993	4,061	336	1,095	351	614	5,770	8	48	0	0

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 3d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, CANYON RESERVOIR,
1964-1971

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
6	475	411	251	$1,028	82	$ 268	77	$134	$1,430	12	$ 72		
7	1,193	1,032	632	2,585	207	675	193	338	3,598	18	108	5	$155
8	1,821	1,576	965	3,945	316	1,030	295	516	5,491	27	162	9	279
9	2,162	1,870	1,145	4,683	375	1,223	350	613	6,519	40	240	5	155
10	2,357	2,039	1,248	5,106	409	1,333	382	668	7,106	24	144	3	93
11	2,478	2,144	1,313	5,368	430	1,402	401	702	7,472	15	90	2	62
12	2,562	2,217	1,357	5,550	445	1,449	415	726	7,725	9	54	1	31
13	2,628	2,273	1,392	5,692	456	1,487	426	745	7,924	5	30	1	31

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 4d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, FALCON RESERVOIR,
1954-1961

Year	TOTAL ATTENDANCE		RECREATIONAL EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
4										31	$186		
5	106	63	48	$ 196	13	$ 42	2	$ 3	$ 241	47	282	9	$279
6	1,048	622	476	1,945	128	417	19	33	2,395	70	420	19	589
7	1,630	968	740	3,025	199	648	29	51	3,724	105	630	11	341
8	1,972	1,170	895	3,660	241	784	35	61	4,505	63	378	7	217
9	2,191	1,300	994	4,066	267	871	39	68	5,005	28	228	4	124
10	2,347	1,393	1,065	4,356	286	934	42	73	5,363	23	138	2	62
11	2,473	1,468	1,122	4,590	302	984	44	77	5,651	14	84	1	31

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 5d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, FERRELLS BRIDGE RESERVOIR,
1959-1966

Year	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
4	375	193	117	$ 478	39	$ 126	38	$ 66	$ 670	21	$126		
5	2,205	1,136	686	2,808	228	742	222	389	3,939	31	186	5	$155
6	3,301	1,702	1,028	4,204	341	1,111	333	582	5,897	46	276	10	310
7	3,844	1,982	1,197	4,896	397	1,294	388	678	6,868	69	414	6	186
8	4,111	2,119	1,280	5,236	425	1,384	415	725	7,345	42	252	4	124
9	4,241	2,186	1,320	5,400	438	1,428	428	748	7,576	25	150	2	62
10	4,301	2,217	1,339	5,477	444	1,448	434	759	7,684	15	90	1	31
11	4,327	2,230	1,347	5,510	447	1,457	436	763	7,730	9	54	1	31

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 6d

RECREATIONAL AND INVESTMENT PROJECTION
BY YEAR AND TYPE, HORDS CREEK RESERVOIR,
1949-1956

Year	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
3	142	101	75	$307	21	$68	6	$10	$385	4	$24		
4	91	65	48	195	13	43	4	6	244	5	30	2	$62
5	136	97	72	294	20	65	5	9	368	8	48	3	93
6	159	114	84	344	23	76	6	11	431	12	72	2	62
7	171	122	90	369	25	81	7	12	462	7	42	1	31
8	177	126	94	382	26	84	7	12	478	4	24	1	31
9	181	129	95	390	26	86	7	12	488	3	18	0	0
10	182	130	96	394	27	87	7	13	492	2	12	0	0

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 7d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, LEWISVILLE RESERVOIR,
1955-1962

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
7	584	481	292	$1,193	96	$ 315	93	$163	$1,671	29	$174		
8	1,932	1,592	1,592	3,946	319	1,040	308	539	5,525	44	264	5	$155
9	2,444	2,014	1,220	4,991	404	1,316	390	682	6,989	66	396	9	279
10	2,596	2,139	1,296	5,302	429	1,398	414	725	7,425	99	594	6	186
11	2,658	2,190	1,327	5,428	439	1,431	424	742	7,601	60	360	3	93
12	2,697	2,222	1,347	5,508	445	1,452	430	753	7,713	36	216	2	62
13	2,731	2,250	1,364	5,577	451	1,470	436	762	7,809	21	126	1	31
14	2,764	2,277	1,380	5,644	456	1,488	441	771	7,903	13	78	1	31

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 8d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, NAVARRO MILLS RESERVOIR,
1963-1970

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
4	823	663	445	$1,818	134	$437	84	$147	$2,402	5	$30		
5	117	94	63	258	19	62	12	21	341	7	42		
6	179	144	97	396	29	95	18	32	523	11	66	1	$31
7	214	172	115	472	35	114	22	38	624	17	102	2	62
8	234	189	127	518	38	124	24	42	684	10	60	1	31
9	248	199	134	547	40	131	25	44	722	6	36	1	31
10	257	207	139	568	42	137	26	46	751	4	24	0	0
11	265	214	143	586	43	141	27	47	774	2	12	0	0

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 9d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, SAM RAYBURN RESERVOIR,
1965-1972

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
9										39	$234		
10	445	239	160	$ 656	48	$ 158	30	$ 53	$ 867	58	348	6	$186
11	2,361	1,268	852	3,484	257	837	160	280	4,601	88	528	13	403
12	2,985	1,603	1,077	4,404	324	1,057	202	354	5,815	131	786	8	248
13	3,169	1,702	1,143	4,676	344	1,123	215	376	6,175	79	474	5	155
14	3,243	1,742	1,170	4,785	352	1,149	220	384	6,318	47	282	3	93
15	3,289	1,767	1,186	4,853	357	1,165	223	390	6,408	28	168	2	62
16	3,328	1,788	1,201	4,911	362	1,179	225	394	6,484	17	102	1	31

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 10d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, SANFORD RESERVOIR,
1966-1973

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
5	126	31	17	$ 68	6	$ 20	8	$ 15	$ 103	13	$ 78		
6	1,170	291	155	636	58	188	78	136	960	19	114	3	$ 93
7	1,796	447	239	976	89	289	120	206	1,474	28	168	6	186
8	2,146	534	285	1,166	106	345	143	250	1,761	43	258	4	124
9	2,354	585	313	1,279	116	379	157	274	1,932	26	156	2	62
10	2,490	619	331	1,353	123	401	166	290	2,044	15	90	1	31
11	2,591	644	344	1,408	128	417	172	302	2,127	9	54	1	31
12	2,673	665	355	1,453	132	430	178	311	2,914	6	36	0	0

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 11d

RECREATIONAL AND INVESTMENT PROJECTIONS BY YEAR AND TYPE, SOMERVILLE RESERVOIR, 1967-1974

Year	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
5	1,004	886	632	$ 2,584	181	$ 588	74	$129	$ 3,301	12	$ 72		
6	2,328	2,055	1,465	5,991	418	1,364	172	300	7,655	18	108	6	$186
7	3,575	3,144	2,249	9,200	643	2,095	263	461	11,756	27	162	13	403
8	4,270	3,769	2,687	10,989	768	2,502	315	551	14,042	41	246	8	248
9	4,684	4,134	2,947	12,054	842	2,754	345	604	15,403	25	150	5	155
10	4,956	4,374	3,118	12,753	891	2,904	365	639	16,296	15	90	3	93
11	5,156	4,550	3,244	13,267	926	3,021	380	665	16,953	9	54	2	62
12	5,320	4,696	3,347	13,691	956	3,118	392	686	17,495	5	30	1	31

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 12d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, TWIN BUTTES RESERVOIR,
1963-1970

Year	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
4	141	56	33	$ 134	11	$ 36	12	$ 21	$ 191	11	$ 66		
5	1,337	527	310	1,269	105	343	111	195	1,807	16	96	2	$ 62
6	1,701	670	395	1,614	134	437	142	248	2,299	25	150	5	155
7	1,818	716	422	1,725	143	467	151	265	2,457	37	222	3	93
8	1,873	738	434	1,777	148	481	156	273	2,531	22	132	2	62
9	1,912	753	444	1,814	151	491	159	279	2,584	13	78	1	31
10	1,947	767	452	1,848	153	500	162	284	2,632	8	48	1	31
11	1,982	781	460	1,881	156	509	165	289	2,679	5	30	0	0

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

TABLE 13d

RECREATIONAL AND INVESTMENT PROJECTIONS
BY YEAR AND TYPE, WHITNEY RESERVOIR,
1951-1958

	TOTAL ATTENDANCE		RECREATION EXPENDITURES							INVESTMENT			
			CAMP		BOAT & FISH		SWIM, PICNIC SKI, & SIGHTSEE			RESIDENTIAL		COMMERCIAL	
Year	Projected*	Outside*	Number*	Amount**	Number*	Amount**	Number*	Amount**	Total**	Number*	Amount**	Number*	Amount**
4										30	$180		
5	590	462	320	$1,307	94	$ 306	49	$ 85	$1,698	45	270	5	$155
6	1,549	1,213	839	3,432	246	802	128	223	4,457	67	402	10	310
7	2,363	1,849	1,280	5,234	375	1,224	194	340	6,798	100	600	6	186
8	2,802	2,194	1,518	6,208	445	1,452	231	404	8,064	60	360	3	93
9	3,053	2,390	1,653	6,762	485	1,581	251	440	8,783	36	216	2	62
10	3,207	2,510	1,737	7,104	510	1,661	264	462	9,227	22	132	1	31
11	3,313	2,594	1,795	7,339	526	1,716	273	477	9,532	13	78	1	31

*In thousands of people.

**In thousands of dollars.

Source: Projections generated by comparative-projection model.

APPENDIX E

TABLE 1e

ECONOMIC MEASUREMENTS FOR
AMISTAD AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 5,504		.0766	.0766	.0829	.0829
2	13,126		.0446	.1213	.0497	.1327
3	4,673		.0905	.2117	.0871	.2198
4	7,037		.1083	.3200	.0730	.2928
5	5,213		.1089	.4289	.0789	.3717
6	5,711		.1307	.5596	.0641	.4358
7	3,715		.1647	.7243	.0799	.5157
8	1,609		.1887	.9130	.0823	.5980
9	1,378		.2059	1.1189	.0782	.6762
10	1,257		.2191	1.3380	.0716	.7479
11	1,182				.0654	.8132
12	1,141				.0596	.8728

*Base year 1965.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 2e

ECONOMIC MEASUREMENTS FOR
BELTON AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$1,835	.145	.0855	.0855	.0785	.0785
2	1,690	.416	.1310	.2165	.1205	.1990
3	1,913	.532	.1568	.3732	.1413	.3404
4	4,419	.388	.1200	.4932	.1052	.4456
5	5,034	.658	.0940	.5871	.0871	.5327
6	3,066	.706	.0508	.6380	.0510	.5837
7	4,613	.450	.0480	.6860	.0378	.6214
8	5,428	.598	.0472	.7331	.0327	.6542
9	5,649	.735	.0402	.7734	.0265	.6806
10	5,808	.629	.0336	.8070	.0204	.7011
11	5,912	.752	.0283	.8352	.0152	.7163
12	5,968	.733	.0242	.8595	.0109	.7272

*Base year 1949.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 3e

ECONOMIC MEASUREMENTS FOR
CANYON AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 710	-.038	.0155	.0155	.0112	.0112
2	2,246	-.065	.0089	.0244	.0110	.0222
3	2,600	-.027	.0134	.0378	.0127	.0349
4	2,275	-.021	.0213	.0591	.0144	.0493
5	3,520	-.101	.0161	.0753	.0102	.0595
6	4,411	.073	.0259	.1011	.0093	.0688
7	5,064	.103	-.0113	.0898	.0102	.0790
8	7,356		.0326	.1224	.0066	.0856
9	7,073		.0207	.1432	.0136	.0991
10	7,503		.0476	.1908	.0379	.1370
11	7,783		.0537	.2445	.0424	.1795
12	7,970		.0601	.3046	.0467	.2262
13	8,143		.0662	.3709	.0506	.2768

*Base year 1958.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 4e

ECONOMIC MEASUREMENTS FOR
FALCON AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 1,138	.162	.0731	.0731	.0232	.0232
2	1,622	.203	.0440	.1171	.0491	.0724
3	3,496	.170	.0322	.1493	.0525	.1249
4	13,419	.119	-.1333	.0160	.1144	.2393
5	13,830	.168	-.3825	-.3665	.1369	.3762
6	6,663	.196	.0457	-.3208	.0927	.4690
7	4,955	.250	-.0744	-.3952	.0434	.5124
8	5,360	.317	.3908	-.0044	.0491	.5615
9	5,616	.301	.5464	.5419	.0363	.5977
10	5,822	.358	.6974	1.2390	.0273	.6251
11	6,025	.319	.8461	2.0850	.0207	.6457

*Base year 1950.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 5e

ECONOMIC MEASUREMENTS FOR
FERRELLS BRIDGE AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 646	-.005	.0042	.0042	.0052	.0052
2	2,595	.065	.0024	.0065	.0058	.0110
3	4,506	.101	.0018	.0084	.0056	.0165
4	4,121	.085	.0060	.0144	.0061	.0227
5	4,725	.073	.0059	.0202	.0060	.0287
6	6,929	.105	.0039	.0241	.0047	.0334
7	7,913	.101	.0105	.0346	.0061	.0395
8	8,166	.097	.0189	.0535	.0186	.0581
9	8,233	.286	.0261	.0797	.0206	.0787
10	8,250	.305	.0323	.1119	.0221	.1007
11	8,260		.0377	.1496	.0232	.1239

*Base year 1955.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 6e

ECONOMIC MEASUREMENTS FOR
HORDS CREEK AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 672	.009	.0447	.0447	.0094	.0094
2	1,271	.032	.0266	.0713	.0076	.0170
3	798	.018	.0403	.1116	.0086	.0256
4	461	.070	.0902	.2017	.0092	.0348
5	633	.035	.0842	.2859	.0085	.0433
6	689	-.025	-.0096	.2763	.0085	.0518
7	660	.006	-.0649	.2114	.0102	.0620
8	658	.021	-.0989	.1125	.0102	.0722
9	630	-.055	-.1196	-.0072	.0102	.0824
10	629	-.109	-.1325	-.1396	.0101	.0926

*Base year 1946.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 7e

ECONOMIC MEASUREMENTS FOR
LEWISVILLE AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 120	.036	.0096	.0096	.0029	.0029
2	2,445	.120	.0061	.0157	.0775	.0804
3	3,743	.112	.0004	.0161	.1489	.2292
4	5,190	.087	-.0059	.0102	.1282	.3574
5	3,906	.185	-.0151	-.0049	.0890	.4464
6	2,245	.319	-.0068	-.0116	.0611	.5075
7	2,526	.373	-.0022	-.0095	.0487	.5524
8	6,288	.355	-.0122	-.0217	.0480	.6004
9	8,006	.439	-.0678	-.0895	.0306	.6310
10	8,547	.468	-.1060	-.1954	.0300	.6609
11	8,397	.487	-.1196	-.3150	.0274	.6883
12	8,334	.591	-.1152	-.4302	.0228	.7111
13	8,310	.660	-.1106	-.5408	.0178	.7289
14	8,355	.807	-.1072	-.6480	.0129	.7418

*Base year 1948.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 8e

ECONOMIC MEASUREMENTS FOR NAVARRO MILLS AREA AS PRODUCED BY SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$1,264	.021	.0109	.0109	.0125	.0125
2	2,730	.080	.0065	.0175	.0105	.0231
3	3,050	.052	.0081	.0256	.0106	.0337
4	4,415	-.014	.0045	.0300	.0082	.0419
5	581	.082	.0389	.0689	.0146	.0564
6	818	.094	.0414	.1103	.0114	.0678
7	924		.0246	.1349	.0093	.0771
8	942		.0111	.1460	.0094	.0865
9	925		-.0008	.1451	.0083	.0949
10	942		-.0114	.1337	.0075	.1023
11	953		-.0210	.1127	.0069	.1092

*Base year 1959.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 9e

ECONOMIC MEASUREMENTS FOR
SAM RAYBURN AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 648	.092	.0038	.0038	.0064	.0064
2	2,295	.125	.0021	.0059	.0322	.0386
3	4,257	.160	.0015	.0074	.0685	.1071
4	6,591	.194	.0001	.0075	.0632	.1703
5	5,800	.215	.0053	.0128	.0541	.2244
6	6,550	.250	.0062	.0190	.0492	.2735
7	8,896	.241	.0033	.0223	.0402	.3138
8	10,406	.422	.0027	.0250	.0393	.3531
9	6,217	.473	.0153	.0402	.0315	.3846
10	5,558		-.0069	.0333	.0241	.4087
11	8,035		-.0306	.0027	.0115	.4202
12	7,258		-.0811	-.0784	-.0069	.4132
13	7,212		-.0215	-.0998	.0074	.4207
14	7,102		-.0101	-.1100	.0054	.4260
15	7,047		.0010	-.1089	.0036	.4296
16	7,026		.0118	-.0971	.0020	.4317

*Base year 1956.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 10e

ECONOMIC MEASUREMENTS FOR
SANFORD AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 4,245	.018	.0005	.0005	.0120	.0120
2	10,695	.005	.0003	.0008	.0108	.0228
3	17,008	.097	-.0013	-.0004	.0099	.0327
4	19,417	.063	-.0026	-.0030	.0086	.0413
5	22,202		-.0017	-.0047	.0060	.0473
6	8,354		-.0012	-.0059	.0126	.0598
7	3,122		.0106	.0048	.0122	.0720
8	2,293		.0146	.0193	.0095	.0815
9	2,299		.0128	.0321	.0802	.0895
10	2,315		.0105	.0426	.0063	.0958
11	2,361		.0115	.0541	.0050	.1008
12	2,380		.0123	.0666	.0041	.1049

*Base year 1961.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 11e

ECONOMIC MEASUREMENTS FOR
SOMERVILLE AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$ 2,073		.0338	.0338	.0368	.0368
2	3,777		.0203	.0541	.0288	.0656
3	6,244		.0143	.0684	.0249	.0904
4	8,254		.0071	.0755	.0183	.1087
5	5,141		.0215	.0969	.0240	.1327
6	8,099		.0257	.1226	.0108	.1436
7	12,471		.0113	.1339	-.0011	.1424
8	14,686		.0070	.1410	-.0015	.1409
9	15,858		.0078	.1488	.0450	.1859
10	16,629		.0083	.1571	.0513	.2371
11	17,219		.0085	.1656	.0567	.2939
12	17,708		.0084	.1740	.0613	.3552

*Base year 1962.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 12e

ECONOMIC MEASUREMENTS FOR
TWIN BUTTES AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$2,319	.030	.0184	.0184	.0378	.0378
2	10,982	.032	.0163	.0347	.2438	.2816
3	8,335	.051	.0158	.0505	.1287	.4103
4	2,808	.031	.0171	.0676	.0575	.4678
5	2,053	.130	.0134	.0809	.0274	.4951
6	2,692	.156	.0075	.0885	.0145	.5096
7	2,860		.0043	.0927	.0098	.5194
8	2,813		.0029	.0956	.0070	.5264
9	2,781		.0020	.0976	.0051	.5315
10	2,799		.0014	.0990	.0036	.5351
11	2,797		.0009	.0999	.0025	.5376

*Base year 1959.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.

TABLE 13e

ECONOMIC MEASUREMENTS FOR
WHITNEY AREA AS PRODUCED BY
SYNTHETIC INDEX AND PROJECTION MODEL*

Year	Reservoir Generated Input**	Synthetic Index***	Original Model Projection		Modified Model Projection	
			Yearly	Total	Yearly	Total
1	$3,552	.181	.0976	.0976	.0703	.0703
2	6,307	.193	.0593	.1569	.0428	.1131
3	14,100	.280	.0236	.1805	.0170	.1300
4	9,019	.212	.0436	.2242	.3062	.1607
5	8,042	.247	-.0117	.2125	.0137	.1743
6	7,511	.238	.0223	.2347	.0213	.1956
7	7,734	.176	-.0446	.1901	.0032	.1988
8	8,666	.179	.0094	.1995	.0087	.2074
9	9,211	.152	.0099	.2094	.0062	.2136
10	9,540	.172	.0112	.2206	.0056	.2193
11	9,792	.245	.0126	.2332	.0057	.2250

*Base year 1947.

**In thousands of dollars.

***Index figures are net after normal growth has been removed.

Source: Data generated by synthetic index and the comparative-projection model.