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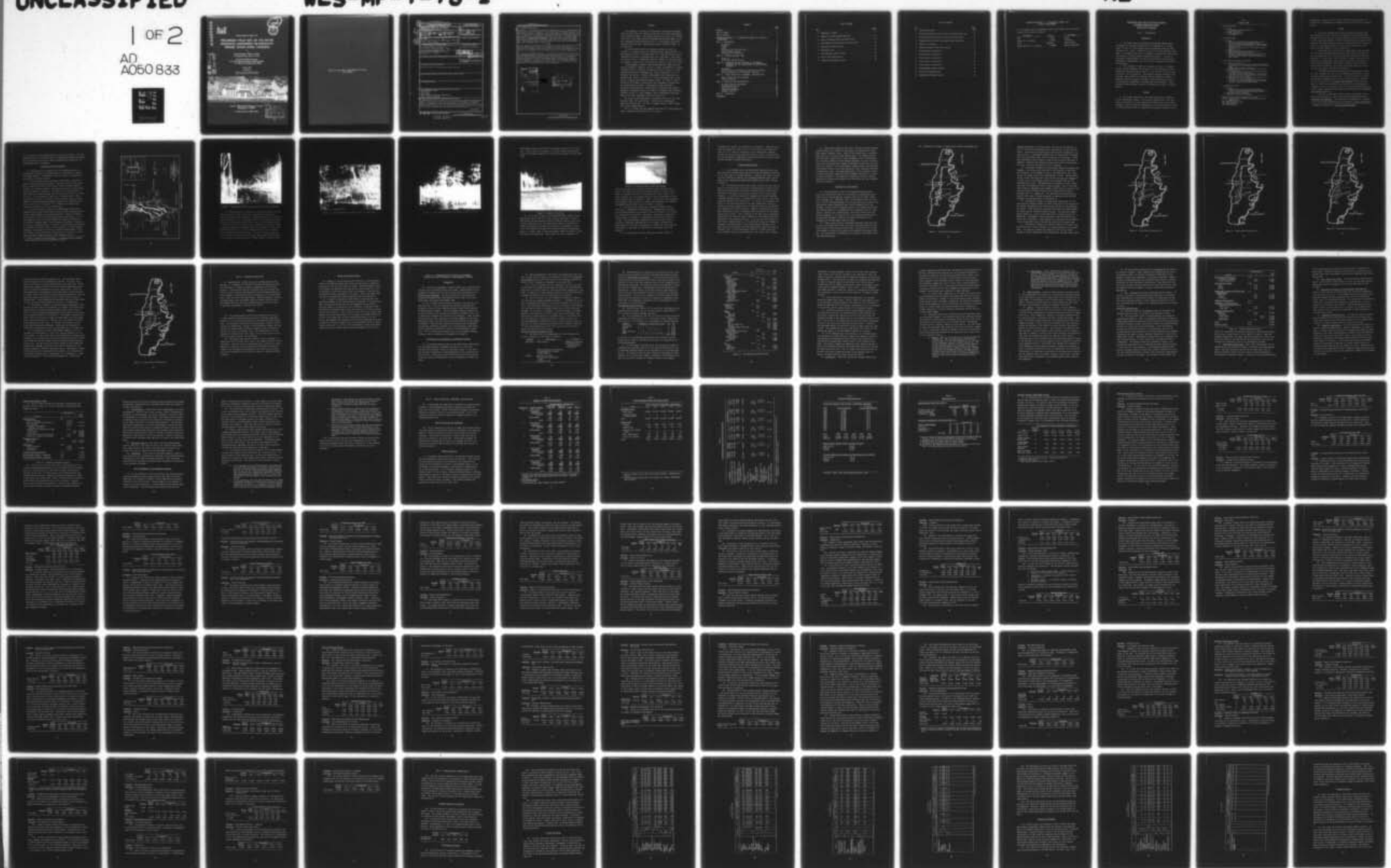

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PRELIMINARY FIELD TEST OF THE WATER RESOURCES ASSESSMENT METHODOLOGY (WRAM); TENSAS RIVER, LOUISIANA

by

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Final Report

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A preliminary field test was made of the Water Resources Assessment Methodology (WRAM). Intended for use by an interdisciplinary team, WRAM is a systematic approach to assessment of impacts and evaluation of alternatives for water resource programs and projects. This pilot field application of WRAM to the Tensas River Project in eastern Louisiana primarily used existing data.

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20. ABSTRACT (Continued).

Background of the Tensas River Project is presented as well as a description of the study area and the flood-control alternatives under consideration by the U. S. Army Engineer District, Vicksburg. An interdisciplinary team was formed to conduct the field test. Assessment variables were selected and weighted relative to their importance in assessment and evaluation within each of the four accounts delineated by Principles and Standards: national economic development (NED), environmental quality (EQ), social well-being (SWB), and regional development (RD). The projected effects on each variable were then scaled across alternatives and the without-project condition.

After the weights and scales were multiplied for each variable within an account and then added to each alternative, a search for the best alternative was carried out. Although no best alternative was selected, the strengths and weaknesses of each alternative were revealed to allow for trade-offs among them.

The conclusions include two points. First, those who participated in the field test unanimously support the interdisciplinary team approach. Second, the use of the weighted rankings technique by the interdisciplinary team provided an effective procedure for selecting assessment impact variables and focusing detailed analysis on the most critical variables. Both advantages and limitations of WRAM will be examined more closely in future field applications, and improvements in the methodology are under consideration.

PREFACE

This research, Evaluation of Environmental Assessment Techniques, Work Unit CWIS 31443, was conducted under the Civil Works Environmental Impact Research Program. This report presents the results of a limited field test of the Water Resources Assessment Methodology (WRAM), an impact assessment method prepared by the U. S. Army Engineer Waterways Experiment Station (WES), Environmental Effects Laboratory (EEL), in February 1977.

The work reported herein was conducted during the period of 25 April to 10 August 1977 by an interdisciplinary team from the U. S. Army Engineer District, Vicksburg; EEL; U. S. Fish and Wildlife Service Vicksburg Field Office; and Mississippi State University. The report was written by Sue E. Richardson, William J. Hansen, R. Charles Solomon, and Jeanne C. Jones and was reviewed by Dr. Stanley A. West, all of EEL.

Acknowledgement is made to the interdisciplinary study team composed of Raymond R. Henderson, Calvin R. Ashley, and Charles E. Crowther, Vicksburg District; Steven W. Forsythe and Lloyd E. Inmon, U. S. Fish and Wildlife Service (Vicksburg); Drs. John H. Peterson, Jr., Erve J. Chambers, and Charles A. Clinton, Mississippi State University; and especially Mr. Billy K. Colbert, U. S. Fish and Wildlife Service (Fort Worth), formerly team leader and member of EEL. Dr. Larry W. Canter, University of Oklahoma, assisted with the development of predictions for water-quality variables. Appreciation is also extended to COL Gerald R. Gallaway, CE, and COL John H. Moellering, CE, District Engineers, Vicksburg District, Mr. Robert P. Flanagan, Chief, Planning Division, and Mr. St. Clair Thompson, Chief, Environmental Resources Branch, for their cooperation during the field test.

The study was performed under the general direction of Drs. John Harrison, Chief, EEL, and Conrad J. Kirby, Chief, Environmental Resources Division, EEL. Mr. John B. Bushman, Office, Chief of Engineers, was technical monitor.

COL J. L. Cannon, CE, was Commander and Director of WES during the study. Technical Director was Mr. F. R. Brown.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
acres	4046.856	square metres
square miles (U. S. statute)	2.589988	square kilometres

PRELIMINARY FIELD TEST OF THE WATER RESOURCES ASSESSMENT METHODOLOGY (WRAM) TENSAS RIVER, LOUISIANA

PART I: INTRODUCTION

Background

1. The "Water Resources Assessment Methodology (WRAM)--Impact Assessment and Alternative Evaluation" was published as an interim report by the U. S. Army Engineer Waterways Experiment Station (WES), (Solomon et al., 1977). Intended for use by an interdisciplinary team, WRAM is a systematic approach to assessment of impacts and evaluation of alternatives for water resource programs and projects. In order to determine the methodology's utility and flexibility in actual project assessments, implementation of a test case on a proposed water project was necessary.

2. The components of WRAM are presented in Table 1. The WRAM process includes weighting (an estimation of each variable's relative importance) and scaling (an estimation of the relative effects of each alternative on each variable). The weighted rankings technique is the procedure used in WRAM for assigning relative importance; weighted rankings, functional graphs, and linear proportioning may be used for scaling impacts, depending on available data and technology. These techniques were explained in detail in Solomon (1977) and are reviewed herein.

Purpose

3. The primary objective of this field application of WRAM was initial methodology testing. This involved determination of the type, quality, and quantity of data required for effective use of the methodology; it also involved the determination of the practicality of using an interdisciplinary team for weighting and scaling as proposed in the

Table 1

Components of WRAM

I. INTERDISCIPLINARY TEAM

A. Selection
1. Select members of interdisciplinary team.
2. Designate team leader.

B. Review and Familiarization
1. Review study area history.
2. Visit study area.

II. ASSESSMENT VARIABLES

A. Selection.
1. Assemble list of mandatory* or critical** variables for each of the four national accounts (EQ, NED, SWB, and RD).†
2. Use criteria questions or weighting portion of weighted rankings technique, along with professional judgment, to select additional relevant variables.
3. Identify any resulting interactive or cross-impact variables or categories.

B. Environmental Inventory
1. Assemble extant baseline data for selected variables.
2. Identify variables with data deficiencies.
3. Use weighted rankings technique and other criteria to allocate manpower and funding resources to data-collection effort.
4. Conduct field studies or assemble information on data-deficient input variables.

III. IMPACT PREDICTION, ASSESSMENT, AND EVALUATION

A. Prediction and Delineation
1. Predict changes in each variable for each alternative plan and the no-action alternative using available techniques and/or professional judgment.
2. Delineate potential impacts of alternatives.
3. Highlight significant impacts and "red flag" any critical issues.

B. Weighting and Scaling
1. Use weighted rankings technique to determine relative importance coefficients (RIC) for each variable.
2. Scale predicted impacts through development of alternative choice coefficients (ACC) or use of function graphs or linear scaling.

C. Evaluation and Interpretation of Results
1. Multiply RIC's by ACC's to obtain final coefficient matrix. Sum coefficient values for each alternative.
2. Use values in final coefficient matrix as basis for description of impacts of alternatives and trade-offs between alternatives.
3. Discuss any critical issues and predicted impacts.

IV. DOCUMENTATION OF RESULTS

A. Rationale
1. Describe rationale for selection of decision variables.
2. Describe procedure for impact identification and prediction, and rationale for weighting, scaling, and interpreting results.

B. Referencing of Sources of Information

C. Decision on Environmental Impact Statement

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* Mandatory = variables required by legislation or regulations.
** Critical = variables that are not mandatory but usually impacted by water resources projects.
† EQ = Environmental Quality
NED = National Economic Development
SWB = Social Well-Being
RD = Regional Development

methodology. Another objective of the field test was to assess the potential for implementation of WRAM in Corps field offices on a routine basis.

Scope

4. Of several proposed water resource projects that might have been acceptable for the initial field testing of the WRAM procedures, the Tensas River project was selected primarily because of its proximity to WES, under whose auspices the field testing effort was planned. This proximity permitted continual access to the study area and to persons in the U. S. Army Engineer District, Vicksburg, who had worked on the project and were familiar with the study area.

5. The primary data sources for the Tensas River field test were the Gulf South Research Institute report (GSRI, 1974), Vicksburg District personnel and files, and public meeting participation and documentation. The GSRI report, which provides a general overview of the Tensas River, encompasses archaeological, historical, and cultural sites; general demographic and economic characteristics; water and related land-use patterns; hydrologic and geologic features; and terrestrial and aquatic wildlife and vegetation.

6. Some additional data were acquired from other sources during the test, although the focus of this application of WRAM was on methodology testing using available data. It should be noted that GSRI's Environmental Assessment for the Tensas River project was conducted prior to the adoption of Principles and Standards (Water Resources Council, 1973)* and that neither the authorized plan (authorized by Congress in 1965) nor additional alternative plans being considered in current Phase I general design studies were formulated under Principles and Standards guidelines.

7. The above constraints explain several shortcomings of this report when evaluated in terms of current Corps guidelines based on Principles and Standards. This application of WRAM was not a rigorous test of the overall methodology, but was rather an initial examination

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* Hereafter referred to as Principles and Standards.

of its potential routine applicability in Corps field offices. The data presented herein are only those used for methodology testing; this report is not intended to provide the complete documentation required for an environmental effect assessment.

Description of the Study Area

8. The study area is located west of the Mississippi River in northeastern Louisiana and includes portions of East Carroll, Madison, and Tensas parishes. The immediate study area (Figure 1) encompasses approximately 910 square miles.*

9. In its present state, the Tensas River meanders through the three northeastern Louisiana parishes. The upper portion of the study area, primarily that part located in East Carroll and upper Madison parishes, is currently devoted to agricultural activities, with soybean and cotton farming in dominance. The lower portion is contained in lower Madison and Tensas parishes and has been in agriculture on a similar scale. It also contains a large area of forested lands. These forests, most of which are privately owned, constitute one of the most extensive, self-maintaining bottomland hardwood areas remaining in the state of Louisiana. See Figure 2 for an example of a typical area along the forested section of the Tensas River.

10. The study area is typical of the Mississippi River Delta, exhibiting flat, nearly level lands with local relief formed by natural levees, channel meanders, and alluvial deposits. Seasonal flooding has played a critical role in maintaining the wetland habitat. Due to the adaptation of the bottomland hardwood and wetland ecosystems to the historic flooding regime, cyclic flooding is necessary to maintain the current ecological balance. Reduction in the frequency and duration of inundation cycles will result in the alteration of wetland habitat, leading to the disruption of biotic associations and movement of fish and wildlife, and placing severe limitations on the survival of native flora and fauna (Bragg and Tatschi, 1977) (Figures 3 and 4).

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 5.

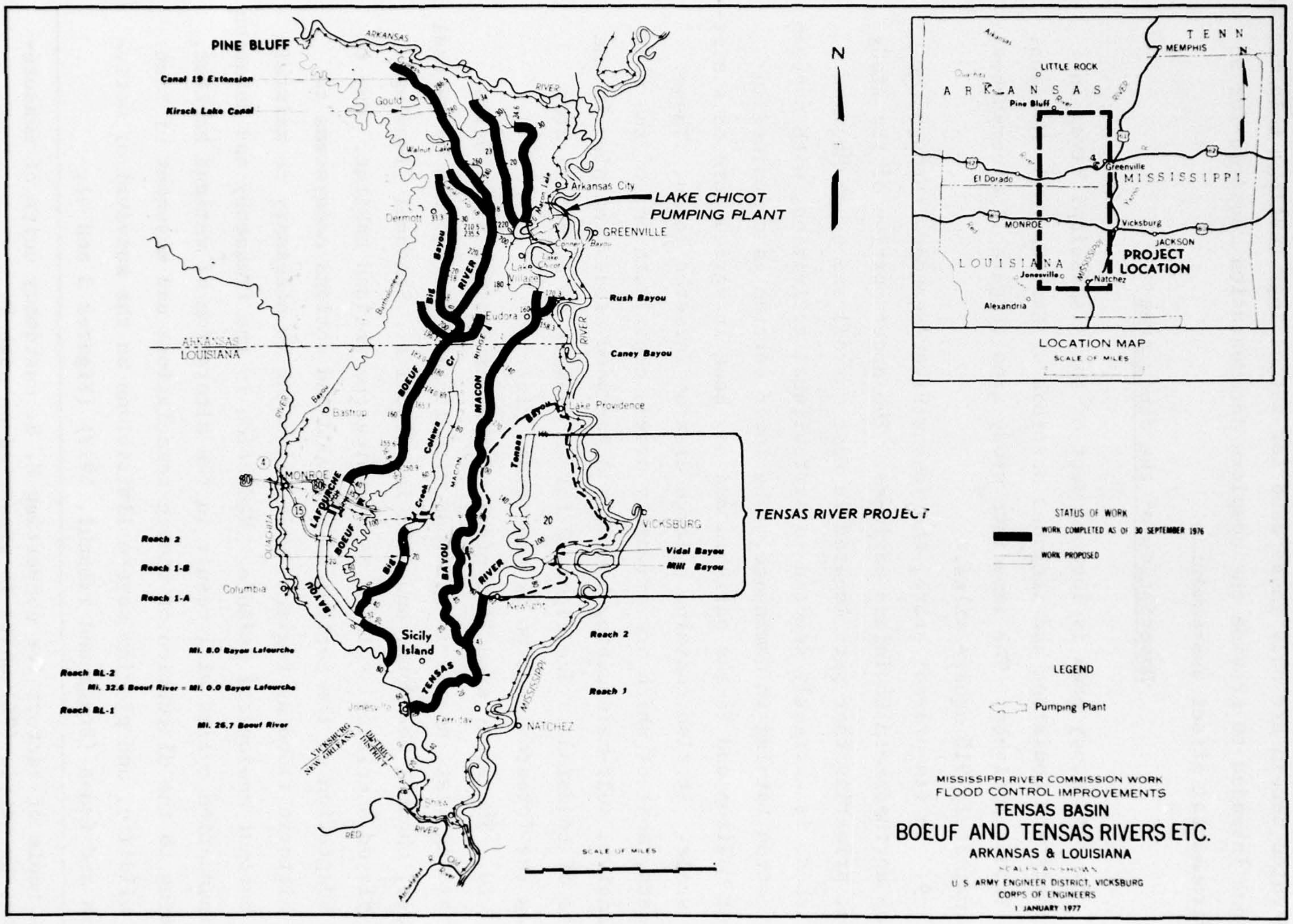

Figure 1. Tensas River Basin

Figure 2. Bottomland hardwood forest typical of Tensas River area

11. Fertile alluvial soil deposits, rich forest stands, and abundant water supplies have led to man's utilization of the area for lumbering and agricultural purposes. Lumbering operations in the basin became profitable in the closing decades of the 19th century and numerous short railroads were built into the forest for log transportation in the early years of the 20th century. Clearing of forests for lumber encouraged agricultural development and the development of large-scale mechanized farming. As a result, substantial tracts of forests have been converted to agricultural areas. The forest-clearing trend and the construction of flood-control projects have changed large portions of the original wetland system into a highly managed, energy-intensive

Figure 3. Typical wetland area within study area (Judd Brake)

Figure 4. Vegetational diversity in wetlands within study area

agricultural system, especially in the northern portions of the study area. Future land use is expected to continue toward increased agricultural development regardless of Corps action (Figures 5 and 6) (GSRI, 1974).

Figure 5. Results of clearing

12. As is true for much of the Mississippi Delta region, fertile agricultural land is one of the most valuable resources of the area. The fertile soil and excellent climatic condition combine to help form a highly productive area. The agricultural industry, employing the latest technological developments and production techniques, is basically crop-production oriented with livestock production being supplementary. In 1969, lands in farms represented almost 63 percent of total land area in the study area. Major crops are cotton, soybeans, and

Figure 6. Contrast between forest and farmland

small grains, with cattle and hogs being the major livestock enterprises. The number of farms is declining (from 5412 in 1949 to 1347 in 1969), but average farm size is increasing (128 acres in 1949 to 511 acres in 1969), as is the average value of lands and buildings per farm (from $6,900 in 1949 to $158,800 in 1969). These trends toward changing farm structure have resulted in a significant displacement of unskilled and semiskilled farm labor, which is likely to continue.

13. The Tensas River study area is sparsely populated, with a 1970 total of approximately 38,000 persons. Outmigration, which has been occurring steadily in the region for several decades, has resulted in a substantial net decline in population. The present population of Tensas Parish, for example, is approximately one-half the population of 1910. This considerable outmigration can be attributed largely to the lack of employment opportunities in the region, contributed by mechanization of the area's farmlands and a tendency for prime agricultural lands to come under the ownership of increasingly fewer farm families.

14. The Tensas region and the study area contain a wealth of

archaeological remains, both prehistoric and historic. Numerous sites have been identified, with a total of 111 recorded in the study area. There is still a lack of information on site significance, however, because the sites have been identified only by surface collection without test excavation. Additional sites would probably be located by more detailed surveys or during construction.

Problem Identification

15. In its present state, the Tensas River does not provide adequate drainage to ensure flood control for crop and livestock production in the upper parts of the affected area. As more of the total land area has been converted to farming, the flooding problem has become increasingly severe, resulting in significant economic loss to local farming interests.

16. The authorized Tensas River project involved the area from the mouth of the Tensas River to mile 166, including about 16 miles of Mill and Vidal Bayous upstream from their confluence with the Tensas River. That part of the project on the lower 61 miles of the river has been completed. It involved clearing the snagging work that was expedited to ensure completion prior to inundation by the pool area of the Jonesville Lock and Dam on the Black River. As a result of this partial completion of the authorized project, the lower Tensas River region is actually receiving a higher degree of protection than will be afforded upon completion of the total project. However, flood protection in the upper Tensas River region is dependent upon construction of the remaining 105 miles of work. Thus, residents of the lower area are generally pleased with the situation, while residents in the northern area desire completion of the authorized project. It is the work on the upper 99 miles that is addressed herein. Five alternative plans for channel improvement are being studied. Each would facilitate drainage in the upper portions of the study area and significantly reduce the threat of flooding. Most of these improvements would be in Tensas Parish and part of Madison Parish, occurring mainly in the forest land or nearby.

17. These forest lands and their water resources currently provide essential habitat for wildlife of the region, including several endangered species (Spindler, 1977). Much of the forested area is presently under lease to local hunting and fishing clubs. The hardwood forests have been under a high level of forest management, and a sustained harvest of forest products provides limited employment for local residents. It has been anticipated that channel improvements through this area will result in a threat to the forest products industry and to fish and wildlife habitat through a more rapid conversion of the remaining forestland to agricultural uses. Increased introduction of toxic chemicals associated with increased farming activities throughout the basin is a threat to fish and wildlife. The threat will become more serious as greater quantities of agricultural chemicals and fertilizers are used following project construction.

Flood-Control Alternatives

18. The Tensas River project, including Mill Bayou and Bayou Vidal, was authorized in 1965 for the purposes of accomplishing flood control and to provide improved drainage outlets in the upper Tensas River drainage area. Presently, flood control measures would be necessary to provide optimum drainage for low-lying agricultural areas in the three-parish region comprised of East Carroll, Madison, and Tensas parishes. During advanced planning studies of the Tensas River project, the Vicksburg District is considering five alternative plans for flood control, including the authorized plan, that would either follow the present alignment of the Tensas River or would require construction of new auxiliary channels in addition to channel modification (i.e., deepening and straightening) along the river.

19. Flood control would be provided by improving flood flow capacities of the Tensas River above river mile 61 to Swan Lake and in the lower reaches of Mill Bayou and Bayou Vidal. The project alternatives are designed to provide flood reduction and improved agricultural drainage. The alternatives are designated as A through E, according to the following descriptions.

20. Alternative A (Figure 7) would require channel enlargement and

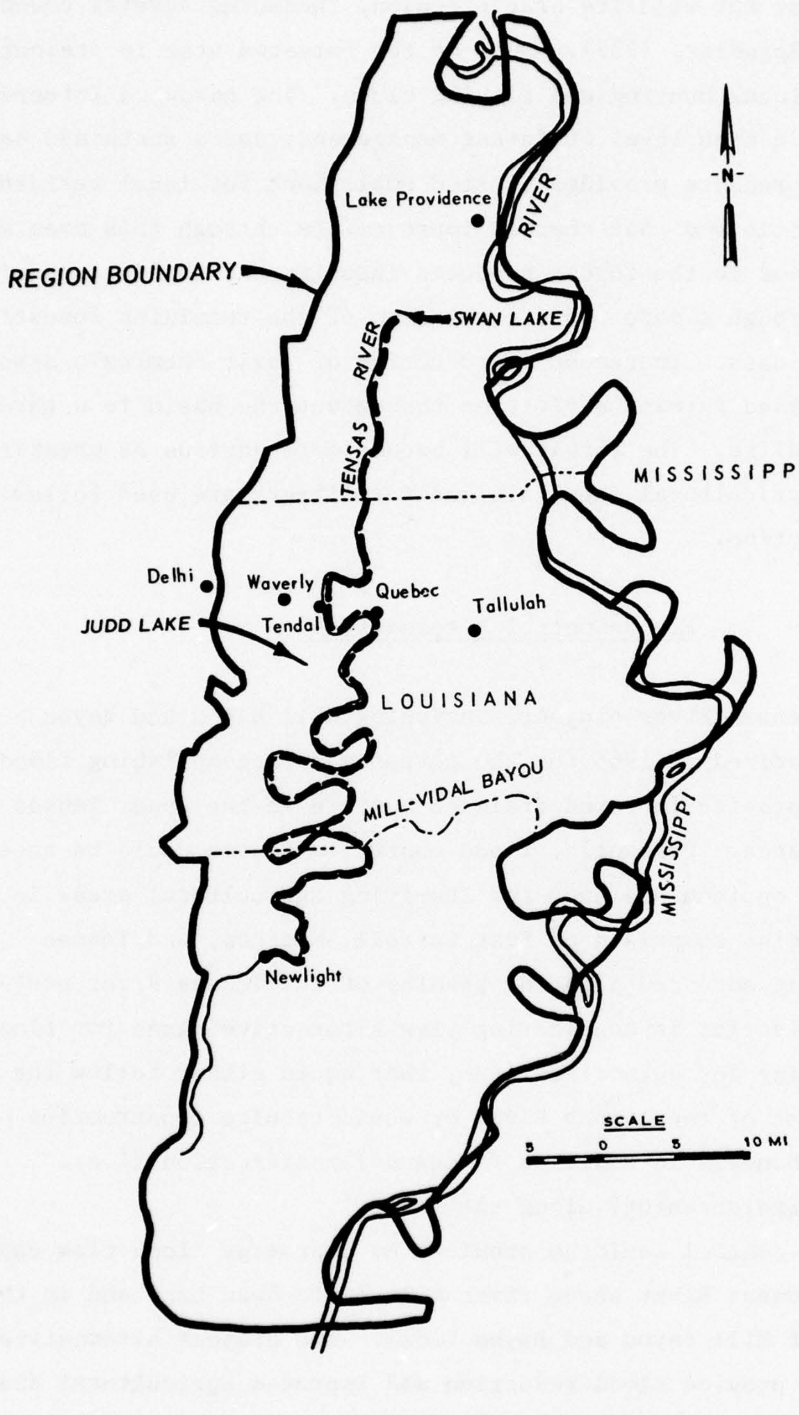

Figure 7. Flood-control Alternative A

snagging operations in the Tensas River from mile 61 near Newlight to mile 166 at Swan Lake including channel improvements in Vidal and Mill bayous. Construction would follow the existing river alignment for the entire project. Approximately 10,000 acres of rights-of-way, including 5300 acres above-bank lands, would be required in construction. Above-bank requirements would consist of 2000 cleared acres and 3300 acres of woodland. Rights-of-ways along Mill Bayou would utilize approximately 250 acres of cleared land and 450 acres of woodland.

21. Alternative B (Figure 8) would require channel enlargement and snagging in the Tensas River from mile 61 near Newlight to Swan Lake with formation of five bendway cutoffs in the Tensas River that would shorten the length of the river approximately 40 miles. Channel modifications in Mill and Vidal bayous would include clearing and snagging of a 6-mile reach of the bendway carrying this tributary back into the realigned Tensas River. Implementation of Alternative B would utilize 1700 acres of woodland and 1300 of cleared acreage. Four of the oxbow lakes formed by impounding three bendway cutoffs would be located in the southern portion of Madison Parish, with an additional lake being developed near U. S. Highway 80. The feasibility of developing these bendway cutoff lakes is being considered in ongoing Fish and Wildlife mitigation studies applicable to Alternative B.

22. Alternative C (Figure 9) requires the construction of a 30-mile auxiliary channel through the lowest lands east of the Tensas River and channel enlargement of the Tensas River from mile 61 near Newlight to mile 69. Above this point, watershed flows would be divided between the Tensas and the proposed auxiliary channel. The auxiliary channel would originate at a point on the Tensas River 2.5 miles north of U. S. Highway 80. Enlargement of the Tensas River would be necessary from this point to Swan Lake. Lands required for construction of Alternative C will include 2628 acres of forests and 1300 acres of cleared land.

23. Alternative D (Figure 10) requires flood-flow carriage by the Tensas River and a 27-mile channel to be constructed west of the Tensas River. The auxiliary channel would begin near mile 62, be routed through the lowest lands west of the Tensas River, and then would rejoin

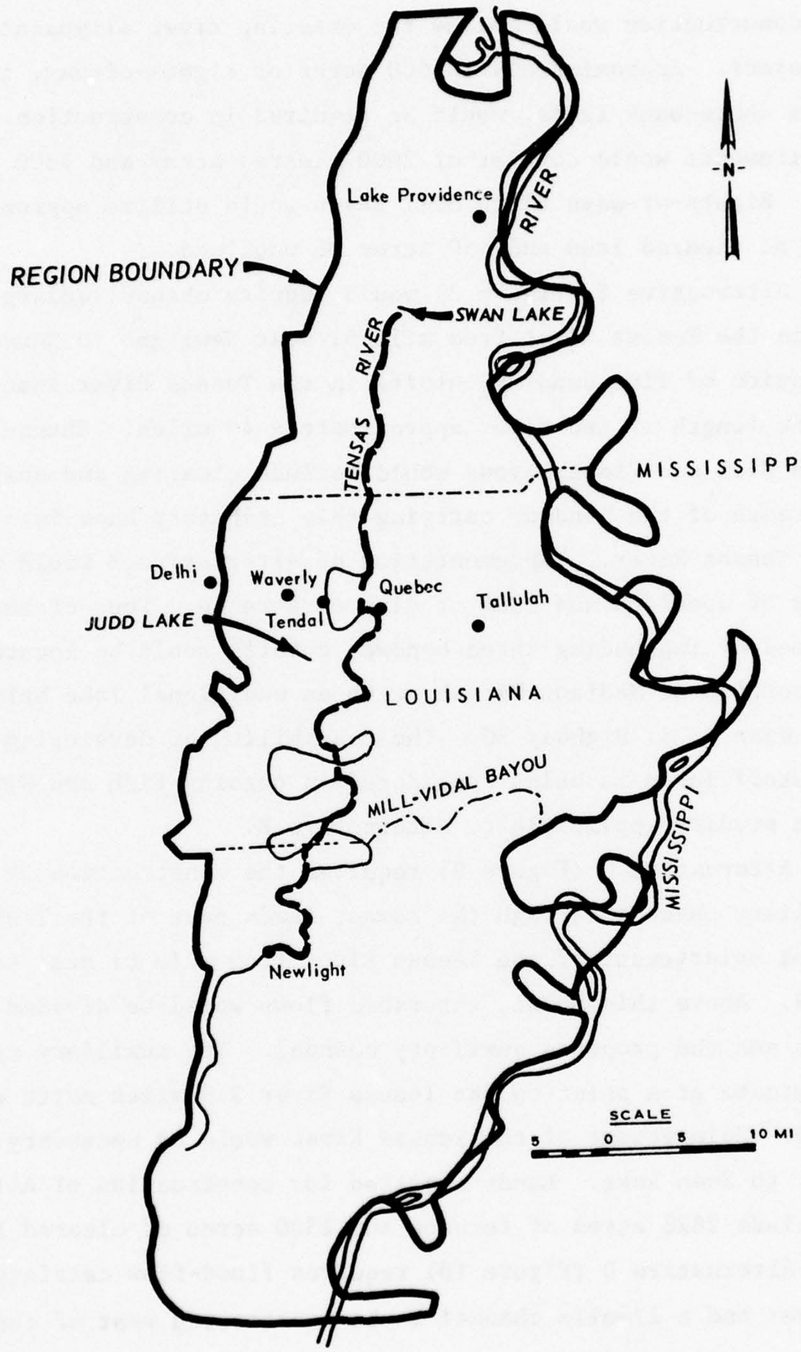

Figure 8. Flood-control Alternative B

Figure 9. Flood-control Alternative C

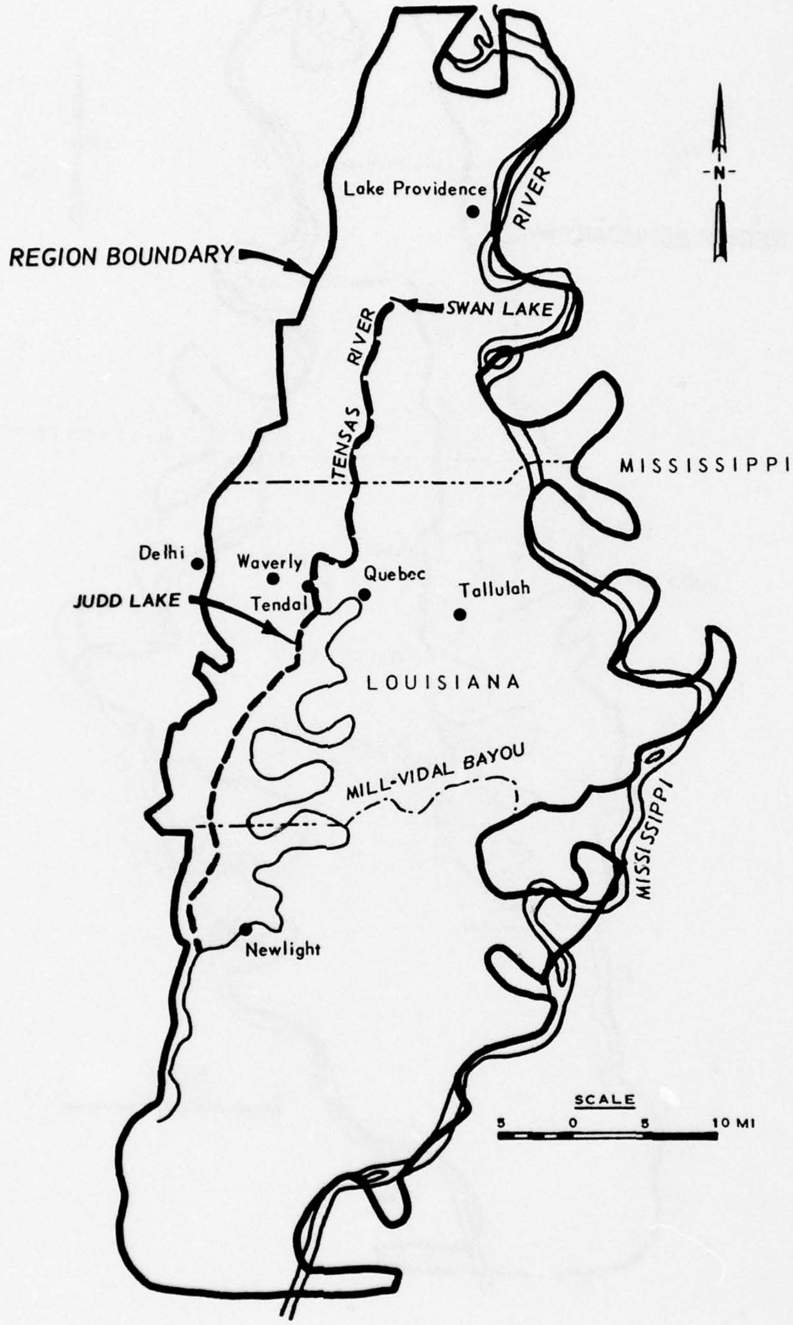

Figure 10. Flood-control Alternative D

the Tensas River due south of Interstate 20. This auxiliary channel would be aligned with the following water bodies: Fool Lake, Judd Brake, Africa Lake, Lich Bayou, Leading Bayou, and Indian Lake. Direct construction losses would be 2360 acres of forested wetlands and 1200 acres of cleared land required for project rights-of-way. Above top bank rights-of-way requirements for this alternative include 760 acres of cleared land and 240 acres of forests along the Tensas River with the auxiliary channel requiring 2210 acres of forests and 350 acres of cleared lands. Channel modifications along Mill Bayou-Bayou Vidal would utilize 450 acres of wooded lands and 250 acres of cleared lands.

24. Alternative E (Figure 11) includes channel enlargement of the Tensas River from mile 61 near Newlight to the mouth of Mill Bayou and construction of an eastern auxiliary channel routed up Mill Bayou to mile 4.5, then north through predominantly cleared land and to the east of the auxiliary channel of Alternative C. The channel, including Mill Bayou, would be 25.6 miles in length and would connect with the Tensas River south of Interstate 20. From this point, the Tensas River would be enlarged north to Swan Lake. In addition, the remainder of Mill Bayou-Bayou Vidal would be modified. Construction of Alternative E would utilize 1500 acres of forest land and 3000 acres of cleared land.

25. It should be noted that the auxiliary channels to be constructed for Alternatives C, D, and E will function primarily as overflow channels. As water flows approach the agricultural discharge flood frequency of two to five years, excess flows would be bypassed or directed through the auxiliary channel thereby reducing flooding within the project area. Low and normal flows would continue to pass through the Tensas River, although a low water level would be maintained in the auxiliary channels to minimize vegetative growth. Additionally, rights-of-way required for the deposition of the material for construction of the auxiliary channels will be substantial (i.e., Alternative C - 2830 acres; Alternative D - 2570 acres; and Alternative E - 3700 acres).

Figure 11. Flood-control Alternative E

PART II: INTERDISCIPLINARY TEAM

26. Implementation of WRAM requires an interdisciplinary team approach. As a minimum, the team should include representatives from the disciplines of ecology, economics, engineering, and the social sciences. If specialists from each discipline are not available from District staffs, qualified representatives from coordinating agencies, local colleges or universities, private consultants, or the interested public could be used as team participants. Before weighting or scaling procedures begin, each team member should be familiar with the study area, WRAM procedures, and Corps planning regulations (Office, Chief of Engineers, Department of the Army, 1975, 1976).

Selection

27. The interdisciplinary team for the Tensas River field test included personnel from the Vicksburg District, Waterways Experiment Station, U. S. Fish and Wildlife Service, and Mississippi State University. The disciplines represented included biology, economics, social science, and engineering. Because of the methodology testing, the team consisted of eleven members, which was somewhat larger than might be expected for projects of similar scope. The representation of a preponderance of WES personnel (four people) on the team would not be expected once WRAM procedures are established.

28. Team members were selected because of their involvement or familiarity with the Tensas River study or with WRAM or because of their discipline. Personnel from the Vicksburg District included the project engineer, an important inclusion since this individual is usually in charge of the coordination and momentum of the entire project study. Actual team leadership for the field test, however, remained with WES personnel.

Review and Familiarization

29. Members of the interdisciplinary team were at least generally familiar with WRAM procedures and/or with pertinent Corps of Engineers regulations by the time the field test began. Individual members varied in the amount of familiarity they had with the actual study area. Most of the District staff had several years prior exposure to the area and considerable previous involvement in the study. Other team members had limited or no significant previous experience with the study area.

30. A number of procedures proved helpful in ensuring that less experienced members of the team developed an awareness of the study area. These included discussions with more knowledgeable WES and District staff and exposure to significant public documents, including the GSRI Environmental Assessment (GSRI, 1974) and transcripts of public meetings related to the project. Upon initiation of the field test, several team members visited the Tensas River area to conduct an informal "windshield survey" of the study area, and one overflight was made of the area. Several team members also attended a public meeting regarding the project in Rayville, Louisiana, 29 March 1977 to gain an appreciation for public opinion in the area. An effort by the team members to gain and maintain familiarity with the Tensas Basin continued throughout the field test.

PART III: DETERMINATION AND WEIGHTING OF ASSESSMENT VARIABLES AND DATA DEVELOPMENT FOR ENVIRONMENTAL INVENTORY

Background

31. Selection of assessment variables begins once a study has been initiated and an interdisciplinary team formed. WRAM provides for the grouping of variables into the four-account system established in the Principles and Standards. The four accounts are entitled National Economic Development (NED), Environmental Quality (EQ), Social Well-Being (SWB), and Regional Development (RD).

32. All critical variables must be included in the initial variable selection. These are variables specificially identified for coverage by law or by Corps regulations and/or those usually impacted by water-resource projects. Then the weighted rankings technique can be used to assist in the selection of additional variables from a list of noncritical variables for inclusion in the analysis. These decisions should be based on the collective professional judgement of the interdisciplinary team, with input from public participation and interagency coordination. When initial variable selection has been accomplished and baseline information compiled, the interdisciplinary team assigns relative importance coefficients (RIC's) to each assessment variable used. This is accomplished through the use of the weighted rankings technique, which is explained in paragraphs 40 through 42.

Determination and Weighting of Assessment Variables

33. The interdisciplinary team for the Tensas River Basin project met to discuss and select assessment variables on 25 April 1977. District staff provided a review of alternative plans. It was noted that the main consideration in developing each of the alternatives was flood control. Other water-related activities, such as water quality, recreation, power, and navigation, were not considered as project purposes.

34. After introduction of the team to the Tensas River area, the NED, EQ, SWB, and RD accounts were delineated in accord with Principles and Standards and the 1105-2-200 series of Corps Engineer Regulations (Office, Chief of Engineers, Department of the Army, 1975).

35. A list of potential critical variables for each account that was provided in the WRAM interim report was used by the interdisciplinary team as an initial guide for selecting variables significant to the study. A general set of SWB variables prepared by Texas A&M University (Guseman and Dietrich, 1977) provided additional variables.

36. After an initial list of assessment variables was compiled, the team used the weighted rankings technique (see paragraph 41) to conduct a preliminary assessment of the relative importance of each variable. This preliminary determination of RIC's was then refined throughout the field test process through further data collection and team meetings. At one point, for example, a decision was made to collapse several of the variables in the EQ account into one subcategory that would more accurately reflect the available data. In the SWB account, the team decided to collapse the variables originally selected to describe demographic characteristics into a single variable, since the data did not allow distinguishing between the two originally selected. The RIC's presented herein are the final results of this iterative process for the Tensas River project.

National Economic Development Account

37. The NED account was disaggregated into the following categories, subcategories, and specific variables.

Category	Subcategory	Variable
Beneficial	Flood control	Inundation reduction Intensification of of agricultural production
	Value of output from unemployed or underemployed resources (redevelopment)	
Adverse	Construction costs Operation and maintenance costs Mitigation costs	

38. The NED objective is enhanced by increasing the value of the nation's output of goods and services and improving national economic efficiency (Principles and Standards). Increased flood control is the primary purpose of the Tensas River Project; flood-control benefits are expected to accrue from both inundation reduction and intensification of agricultural production. NED benefits would also be expected to accrue from the use of unemployed or underemployed resources during project construction. Adverse impacts on the NED objective would result primarily from the costs associated with project construction, operation and maintenance. RIC's were not assigned to variables within the NED account since all benefits and costs are measured in comparable dollar terms that can be combined to determine the net contribution of each alternative to the NED objective.

Environmental Quality Account

39. The EQ account consists of the categories, subcategories, and variables shown in Figure 12; the interdisciplinary team derived the RIC's using the weighted rankings technique.

40. As an illustration, the RIC's are derived for the first level categories in the EQ account (i.e., terrestrial, aquatic, human interface, and air). The rationale for the assignment of these categories,

Category	Assignment of Importance Values										Sum	RIC
Terrestrial	1	1	1	1	-	-	-	-	-	-	4	0.40
Aquatic	0	-	-	-	1	0	1	-	-	-	2	0.20
Air	-	0	-	-	0	-	-	0	1	-	1	0.10
Human Interface	-	-	0	-	-	1	-	1	-	1	3	0.30
Dummy	-	-	-	0	-	-	0	-	0	0	0	0.00
											10	1.00

as well as for the remaining subcategories and variables of the EQ account and for those of the SWB and RD accounts, is discussed in the following paragraphs.

41. For the reasons discussed below, the terrestrial category is considered more important than any of the other EQ categories in terms of assessing potential impacts of the alternatives for the Tensas River project. In comparison with the other categories (including the dummy category that, as described in WRAM, is included in the weighting procedure only so that no category or variable receives a zero weight),

Variable	RIC Level 1	2	3	4	Final RIC
Terrestrial	0.40				
Habitat		0.30			
Forested Wetlands			0.67		0.0804
Cleared Land			0.33		0.0396
Land Quality		0.13			
Flood Frequency			0.25		0.0130
Toxic Materials			0.40		0.0208
Soil Nutrients			0.20		
Short Term				0.33	0.0034
Long Term				0.67	0.0070
Soil Texture			0.15		0.0078
Critical Community Relationships		0.30			
Species Diversity			0.50		
Short Term				0.33	0.0198
Long Term				0.67	0.0402
Species Number			0.50		
Short Term				0.33	0.0198
Long Term				0.67	0.0402
Threatened Species		0.20			0.0800
Pests		0.07			0.0280
Human Interface	0.30				
Esthetic		0.42			0.1260
Historical		0.16			0.0480
Archeological		0.42			0.1260
Aquatic	0.20				
Habitat		0.24			
Short Term			0.33		0.0158
Long Term			0.67		0.0322
Water Quality		0.19			
Physical			0.50		
Temperature				0.50	0.0095
Turbidity				0.50	0.0095
Chemical			0.50		
pH				0.20	0.0038
Dissolved Oxygen (DO)				0.20	0.0038
Nitrates				0.20	0.0038
Biochemical Oxygen Demand (BOD)				0.20	0.0038
Pesticides				0.20	0.0038
Water Quantity		0.10			0.0200
Critical Community Relationships		0.29			
Species Diversity					
Short Term			0.33		0.0191
Long Term			0.67		0.0389
Threatened Species		0.14			
Short Term			0.33		0.0092
Long Term			0.67		0.0188
Pests		0.04			0.0080
Air	0.10				
Quality		0.67			
Gases			0.33		0.0221
Particulates			0.67		0.0449
Climatology		0.33			0.0330

Figure 12. Environmental quality account

terrestrial is always assigned a value of one and the other category a value of zero (the first four columns of the tabulation). Next, the aquatic category is compared with the remaining categories (columns five through seven). Since the aquatic category is considered more important in terms of potential impacts in the Tensas River project than air (column five) and the dummy (column seven), aquatic is assigned a value of one and the compared category a value of zero. In the comparison with human interface (column six), aquatic is considered less important and is assigned a value of zero, with the value of 1 assigned to human interface.

42. After completion of the paired comparisons, the assigned values are summed (sum column). The RIC values are then simply the sum of an individual category divided by the total sum of all categories. Similar calculations have been used for deriving RIC's for all variables in the EQ, SWB, and RD accounts based on the following rationale.

43. In terms of potential impacts on environmental quality for the Tensas River project, the interdisciplinary team considered the terrestrial category more important than any of the other major EQ categories because of the significance of the bottomland forests in this area. This is one of the largest and one of the last major bottomland forests of this type in the southeastern United States. Presently, the forestland within the Tensas River Basin is being cleared for agriculture. Any proposed actions that would affect this trend will have significant impacts on the environmental quality of the Basin.

44. Of the remaining major EQ categories, the interdisciplinary team considered the human interface category most important because of the substantial archaeological resources that could potentially be affected and the significant esthetic values of the existing forestlands. The aquatic category was judged next most important because of value of the isolated wetlands in the Tensas Basin that provide habitat for native fauna and flora. The air category was considered least important of the major categories because of the generally good air quality currently within the study area and the Basin.

45. Terrestrial. Within the terrestrial category, habitat and

critical community relationships were considered of equal importance and both were considered more important than the remaining subcategories. The habitat provided by the existing bottomland forests regime is considered critical to the survival of native plant and animal species. These indigenous plant and animal species interact to form interdependent biological communities, which in turn assist in maintaining the terrestrial ecosystem. Due to the sensitive interrelationships between the physical habitat and the biotic communities, habitat and critical community relationships were considered of equal importance.

46. The native forest communities of the Tensas River area constitute self-perpetuating ecosystems exhibiting unique variety in species numbers and diversity. Changes in the species density and/or diversity would disrupt present food-chain, competition, and shelter relationships within these communities, possibly disrupting the established ecosystem. Therefore, species number and species diversity were considered as primary indicators of critical community relationship quality and were assigned equal weights.

47. Threatened species were considered next most important within the terrestrial category. Data indicate that several endangered species, including the Florida panther, Mississippi Valley red wolf, and several bird species are present in the area and that careful consideration should be given to potential impacts on these species. The subcategory of pests was considered least important within the terrestrial category because no current pest problems are known to exist in the Tensas River Basin and the proposed alternatives are expected to have little effect on the incidence of pests.

a. Habitat. Habitat was divided into forested wetlands and cleared land. The interdisciplinary team assessed forested land to be the most important to the viability of the indigenous plant and wildlife communities. The forested wetlands variable is utilized as an indicator for bottomland hardwoods and wetlands in the region; cleared acreage habitat includes agricultural cropland, pastureland, and residential areas. Although cleared acreage creates edge effects for wildlife foraging and migration routes, this habitat type was considered less important than forested land to indigenous wildlife species.

b. Land quality. Primary land-quality indicators were flood frequency, soil toxicity, soil nutrients, and soil texture. Of these variables the potential increase of toxic materials through increased agricultural activity was considered most important. Flood frequency was also determined important due to the dependence of the wetland forest ecosystems on periodic inundation cycles. Potential effects on soil nutrients were considered of more importance than impacts on soil texture, with potential long-term impacts considered more important than short-term effects.

48. Human interface. Within the human interface category, esthetic and archaeological variables were considered most important because of the high esthetic value of the region due to the forestlands and the large number of archaeological sites located within the study area. No known or recorded historical sites are located within the study area; therefore, the historical variable was weighted less heavily.

49. Aquatic. Within the aquatic category, critical community relationships were considered most important due to the high prevalence of unique biotic communities in isolated wetland areas within the Tensas River Basin. These communities constitute a balanced ecosystem formed by close interaction of organisms with their wetland environment. Even minor alterations in these ecosystems could possibly destroy the entire community complex. Aquatic habitat was considered next most important, because the wetlands of the Tensas River Basin provide a high quality habitat for native fauna and flora. Water quality was considered next most important. The water quality within the Basin is not considered high, but is adequate to support native flora and fauna, and channelization could have potentially significant impacts on water quality. Threatened species were considered next most important primarily because of the presence of the American alligator, which is presently classified as an endangered species. The aquatic pest variable was considered of least importance in the weighting procedures, because the incidence of pests is presently minimal and it was not considered to be an important characteristic in selecting an alternative in the Tensas River analysis. For all variables within the aquatic category in which short- and long-range impacts were considered, the long-range impacts were considered most important.

50. The water-quality subcategory was disaggregated into physical and chemical variables. These variables were weighted equally due to the composite effects of physical and chemical constituents on the balance of terrestrial, semiaquatic, and aquatic ecosystems. Physical variables include temperature and turbidity, while chemical variables include pH, DO, BOD, pesticides, and nitrates. These particular variables were utilized as primary indicators for water quality since they are among the major determinants of aquatic productivity and species composition.

51. Air. Subcategories include climatology and air quality. Of the two, air quality, including gases and particulates, was accorded more importance due to the potential impacts of construction activity such as the increased presence of motor vehicles and due to the fact that climatology was not expected to be impacted either with or without a project.

Social Well-Being Account

52. The SWB account was disaggregated into the categories and variables shown in Figure 13, and RIC's were assigned as shown.

53. The Tensas River Basin is characterized by low incomes and underemployed resources. There are substantial differences of opinion between agricultural interests who desire increased flood protection and continued clearing and those (particularly hunters and conservationists) who desire to retain the forested bottomland. Given the potential economic and social ramifications of increasing this conflict, the interdisciplinary team considered real income distribution and community organization as equally the most important categories in terms of the Tensas River project. Demographic characteristics were considered next most important because of local concern over the long-term trend of outmigration. The esthetic values and educational, cultural, and recreational opportunities were considered next most important because of the concern of local residents. The existing bottomland forests provide a valuable esthetic resource that could be affected by a project; the limited educational, cultural, and recreational opportunities are also of concern to residents. The category of life, health, and

Variable	RIC Level 1	2	3	Final RIC
Real Income Distribution	0.21			
Incidence of Benefits		0.67		0.1407
Income Expenditures		0.33		0.0693
Life, Health, Safety	0.08			
Life		0.33		0.0264
Health		0.33		0.0264
Safety		0.33		0.0264
Educational, Cultural, Recreational Opportunities	0.13			
Education		0.33		0.0429
Culture		0.33		0.0429
Recreation		0.33		0.0429
Emergency Preparedness	0.03			
Demographic Characteristics	0.17			
Population Change/Migration				
Short Term		0.33		0.0561
Long Term		0.67		0.1139
Community Organization	0.21			
Cohesion		0.50		0.1050
Employment		0.17		
Short Term			0.33	0.0118
Long Term			0.67	0.0239
Displacement		0.33		0.0693
Noise	0.06			0.0600
Esthetic Values	0.13			0.1300

Figure 13. Social well-being account

safety was considered next important because the existing flood hazard does not pose a major threat to life, health, or safety. Noise and emergency preparedness, the least important categories in terms of the social well-being of the residents of the Tensas River area, were not expected to be affected by any of the alternatives proposed.

54. Real income distribution. Real income distribution was disaggregated into the variables incidence of benefits and income expenditures. Since any alternative project on the Tensas River will be Federally financed, there will be no impact on income expenditures. The incidence of benefits, however, is critical to this analysis because

of the trends toward increasing farm size and value in the hands of fewer people. Therefore, incidence of benefits was considered to be of greater significance and weighted relatively more important than income expenditures.

55. Life, health, and safety. The existing flood hazard does not impose a major threat to life, health or safety, and the three subcategories were therefore considered to be of equal importance in this analysis.

56. Educational, cultural, and recreational opportunities. Schools in this area are not over-crowded, but the general educational level achieved is very low. The bottomland forests and streams provide excellent hunting and fishing opportunities, but private ownership limits access for recreational purposes. The primary form of recreation in the area is through private hunting and fishing clubs. Cultural resources in the area are also limited. Because opportunities in all three of these areas are limited but of concern, the variables education, culture, and recreation were considered of equal importance in the Tensas River study.

57. Demographic characteristics. The long-term trends in population and migration were considered more important in the Tensas Basin by the team than the short-term trends because of the overriding implications for a stable economic and social system in the area.

58. Community organization. The team selected three variables in regard to community organization: cohesion, employment, and displacement. Of these, community cohesion was considered most important based primarily on the team's understanding of potential conflicts generated within the study area by the project itself. This conflict was seen basically as attitudinal differences between persons in the upper and lower regions of the Basin. As with most water resource development projects, displacement of families is of major concern and was considered next most important in the Tensas River study. Employment was considered least important in terms of community organization because of the fact that current trends are not expected to change, with or without a Corps project.

Regional Development Account

59. The RD account includes the categories, subcategories, and variables shown in Figure 14. Relative importance coefficients were assigned as shown.

Variable	RIC Level 1	RIC Level 2	RIC Level 3	Final RIC
Income Effects	0.24			
Value of Outputs		0.25		
Value of Underemployed Resources		0.14		0.1440
User Payments		0.21		
Increases from Induced or Stemming Activities		0.13		0.0312
Increases from Construction & O&M		0.13		
Short Term			0.33	0.0103
Long Term			0.67	0.0209
Losses from Displaced Activities		0.11		0.0264
Losses of Assistance and Welfare		0.04		0.0096
Employment Effects	0.19			
Short Term			0.33	0.0627
Long Term			0.67	0.1273
Population	0.05			
Total Population		0.50		
Composition		0.33		0.0500
Distribution		0.17		
Economic Base and Stability	0.29			0.2900
Environmental Effects - Regional	0.10			0.1000
Socio-Cultural Effects - Regional	0.14			0.1400

Figure 14. Regional development account

60. Given the fact that the study area is characterized by low incomes and underemployed resources, the long-range trend of out-migration is an obvious indicator of the lack of economic opportunities available in the area. For these reasons the interdisciplinary team considered those categories relating to economic development as being of most importance in this study: namely, economic base and stability, income effects, and employment effects (in that order). Regional socio-cultural effects were considered to be of the next greatest concern to local residents followed by regional environmental effects.

Population characteristics were considered least important since changes in population trends would not be expected unless there were changes in economic opportunities.

61. Income effects. Income effects were disaggregated into seven subcategories. Three of these values, outputs, value of underemployed resources, and user payments, are the most important in terms of regional development of the Tensas River Basin. Since these can be measured in monetary terms, their RIC's were combined to facilitate the scaling of the impacts (see Part IV for additional discussion). The next most significant subcategories for regional development in the Tensas River Basin are increases from induced or stemming activities (such as those from increased agricultural production) and increases from construction and operation and maintenance (such as increases in business activities generated by wages spent by out-of-area workers). Losses of assistance and welfare were considered least important in terms of the Tensas River study.

62. Employment effects. Both short- and long-term employment effects could occur. The long-term effects are considered more important, although short-term impacts from construction activities will probably be larger in terms of the absolute number of jobs.

63. Population. Of the potential population impacts, effects on total population were considered most important by the interdisciplinary team because of the long-term population decline. Given the sparse population within the Basin, distribution was considered least important of the population variables.

Data Development for Environmental Inventory

64. By the conclusion of the first meeting, the interdisciplinary team had developed at least a general idea of the types of data that would need to be compiled to conduct a final weighting and scaling of variables for the four accounts. Various members of the team were to compile and, in some instances, to collect additional data within their areas of expertise. Time and funding restrictions would limit the

amount of additional data collected. In this regard, the initial determination of assessment variables would serve as a guide to determining the critical areas where additional data could most usefully be added.

65. Three important considerations influence data collection. One factor, as mentioned above, is the value of any particular data relative to the project being considered (the RIC). Two other equally important factors are the accessibility of particular kinds of data and the costs. Much data related to waterways projects are easily available from secondary sources, including Federal census reports and records maintained by local agencies. Other data may not be so readily accessible, and some degree of field research might be indicated.

66. However, generating new data through field research is a time-consuming and expensive process. The limited resources and immediate need-to-know that will be experienced by most District offices utilizing WRAM procedures (or any other procedures) places constraints on the amount of data collection that can be undertaken. The WRAM procedures take this fact into account. The procedures are designed to help interdisciplinary teams make decisions as to where their necessarily limited data collection efforts might best be employed.

67. In working on the Tensas River project, the interdisciplinary team met twice during the data compilation and collection effort. The major purposes of these meetings were to provide each member with an update of the progress of other members and to share information sources relating to each account. Four aspects of the process merit special mention.

a. As the meetings of the interdisciplinary team progressed, the close interrelationship of the four accounts and the value of interaction among team members became apparent. Had data for the four accounts been developed separately, there would have been considerable duplication of effort. With team interaction, members were able to profit from the experience and developing of data resources by other members.

b. Equally important, the team approach permitted each member to maintain perspective on each account and each variable affected by the project. For example, the social impacts expected as a result of the alternatives could be evaluated in relation to the significant environmental effects concerning cleared agricultural lands and valuable bottomland forests. Had material for the social and environmental accounts been developed independently, it is unlikely that interaction would have been as clearly recognized.

c. WRAM procedures permitted variation in the development of documentation for each account. During the second and third meetings of the interdisciplinary team, it was clear that data collection for each of the accounts was progressing at different rates due to differences in data requirements, available data resources, and time available to different team members. These variations did not, however, affect the team's overall progress or limit its effectiveness for decisionmaking.

d. Importantly, the procedures helped the team avoid premature closure on determining the overall significance of any particular variable. In this sense, data collection and meetings of the interdisciplinary team were properly used to refine rather than defend the judgments made by the team during the initial assessment of variables discussed above.

68. In conclusion, the data-collection efforts and the decisionmaking process for the field test were complementary to each other. Initial and subsequent decisions about the importance of each variable vis-a-vis the project helped team members effectively use scarce resources.

PART IV: IMPACT PREDICTION, ASSESSMENT, AND EVALUATION

69. In using WRAM, two steps must be followed to accomplish impact evaluation. First, baseline data must be measured and changes predicted for each variable. Second, the predicted changes for each variable must be scaled in terms of each alternative plan. It is in the second step (scaling) that the evaluation of changes is made by the interdisciplinary team.

Impact Prediction and Assessment

70. For the Tensas River field test of WRAM, the interdisciplinary team relied mainly on projections previously developed by the Vicksburg District. This was particularly true for the economic and land-use variables. The District's projections in these areas were based on surveys of residents of the study area. Predictions of changes for water-quality variables and for some of the economic and social variables were developed by WES personnel from secondary data sources or contracted research.

Impact Evaluation

71. Using WRAM, impact evaluation is accomplished through scaling and the development of alternative choice coefficients. Given baseline data and impact prediction for each variable, the changes must be scaled for the alternatives in terms of environmental quality, social well-being, or regional development. Scaling can be accomplished by one of three approaches: use of weighted rankings technique as discussed in Part III; use of linear scaling and proportioning of resulting scaled impacts; and use of functional curves and proportioning of scaled impacts. Data used in the scaling of specific variables for the Tensas study are given in Tables 2 through 6. The scaling techniques are explained in detail when they are first used.

Table 2

Summary of Average Annual Benefits*

Alternative	Benefit Category	Annual Benefits, thousands $s: Current Year (1977)**	Base Year (1982)**	Future†	Total††
A	Flood control:				
	Inundation	709	765	160	925
	Intensification	2,816	3,097	815	3,912
	Subtotal	3,525	3,862	975	4,837
	Redevelopment	225	225	0	225
	Total	3,750	4,087	975	5,062
B	Flood control:				
	Inundation	708	764	159	923
	Intensification	2,815	3,136	814	3,950
	Subtotal	3,523	3,900	973	4,873
	Redevelopment	186	186	0	186
	Total	3,709	4,086	973	5,059
C	Flood control:				
	Inundation	678	731	152	583
	Intensification	2,757	3,032	798	3,830
	Subtotal	3,435	3,763	950	4,713
	Redevelopment	241	241	0	241
	Total	3,676	4,004	950	4,954
D	Flood control:				
	Inundation	666	718	149	867
	Intensification	2,639	2,902	764	3,666
	Subtotal	3,305	3,620	913	4,533
	Redevelopment	220	220	0	220
	Total	3,525	3,840	913	4,753
E	Flood control:				
	Inundation	666	718	149	867
	Intensification	2,639	2,902	764	3,666
	Subtotal	3,305	3,620	913	4,533
	Redevelopment	320	320	0	320
	Total	3,625	3,940	913	4,853

* Benefits were calculated using interest rate of 6-3/8%, a 50-yr project economic life, and a development period of 50 yr (Source: Vicksburg District).

** Undiscounted values.

† Discounted values.

†† Total of base year (1982) benefits and future benefits.

Table 3

Total Investment Costs and Annual Costs*

Item	A	B	C	D	E
	Costs for Each Alternative, thousand $s				
Investment costs:					
First costs	42,600	33,700	44,100	40,200	58,330
Interest during construction**	0	0	0	0	0
Total	42,600	33,700	44,100	40,200	58,330
Annual costs:					
Interest	2,716	2,148	2,811	2,563	3,718
Sinking fund	130	102	134	122	117
Operation and maintenance	57	41	41	41	49
Major replacements	104	91	140	119	195
Loss of net returns	134	76	79	80	110
Total	3,141	2,458	3,205	2,925	4,249

* Costs are based on July 1977 price levels (Source: Vicksburg District).

** Interest during construction not required for channel improvement type projects.

Table 4

Environmental Baseline Data and Projections

Variable	Baseline (1977)	Without Project	Alternatives A	B	C	D	E
Forested Acreage, Year 2032	142,600	29,700	21,319	22,864	21,338	22,294	22,154
Cleared Acreage, Year 2032	194,000	306,900	315,281	313,736	315,262	314,306	313,446
Induced Clearing		0	5,081	5,136	5,734	5,046	5,046
Forested Acreage Cleared for Construction		0	3,300	1,700	2,628	2,360	1,500
Average Annual Inundated Acreage	105,058	105,058	32,969	32,881	33,919	35,700	33,919
Water Quality:							
Temperature, °C							
Average	18.4	19.0	19.2	19.5	19.5	19.5	20
Range	3-30	4-31	4-31	4-31	4-31	4-32	5-32
Turbidity (Jackson Turbidity Unit)	95	112	120	131	133	135	135
pH	7.4	7.6	7.7	7.9	8.2	7.8	7.8
Dissolved oxygen, mg/ℓ	6.8	6.3	6.0	5.5	5.5	5.5	5.0
Nitrates, mg/ℓ	0.99	1.13	1.13	1.15	1.15	1.15	1.15
Biochemical oxygen demand, mg/ℓ	2.6	2.7	2.9	3.2	3.3	3.3	3.3
Archaeological Sites	111	111	8	30	55	75	74
Displacement, Households		-	43	28	22	20	20

Source: Baseline data - Vicksburg District and Louisiana Water Quality Office
Projections - Vicksburg District and WES

Table 5

Population Characteristics*

Population (Tensas, East Carroll, and Madison parishes):

Year	Total Population	Population Density (persons/mi^2)
1930	45,740	26.5
1940	53,406	31.0
1950	46,962	27.3
1960	42,673	24.8
1970	37,618	21.9
1975	37,600	21.8
1981	37,600	21.8
1991	36,300	21.1
2001	34,100	19.8
2011	32,200	18.7
2021	30,700	17.8
2031	29,500	17.1

Race:	1950	1960	1970	1975	1980
White	16,870	15,497	15,067	14,965	14,856
Nonwhite	30,092	27,176	22,614	21,724	20,894

Median Family Income (1970 in Current Dollars):

East Carroll	$3,612
Madison	$3,981
Tensas	$3,173

Percent Families with Income Less Than Poverty Level (1970):

East Carroll	50.4%
Madison	45.1%
Tensas	50.1%

* Source: GSRI, 1974, and Vicksburg District, 1975.

Table 6

Employment Data

Existing Labor Force (May 1977)*:

	Parish		
	East Carroll	Madison	Tensas
Civilian labor force	4675	4950	3000
Civilian employed	4275	4500	2800
Unemployed - number	400	450	200
- percent	8.6	9.1	6.9

Estimated Construction Job Requirements *,†

	Alternatives				
Labor Classification	A	B	C	D	E
Skilled ††	50	52	70	71	94
Semiskilled ††	46	41	54	57	72
Unskilled ≠	86	63	73	100	96
Total ≠≠	182	156	197	228	262

* Source: State of Louisiana Employment Service and Vicksburg District

† Individual job durations range from an estimated 60 to 440 days.

†† Estimated that 25 percent would be hired locally.

≠ Estimated that 80 percent would be hired locally.

≠≠ Supervisory and administrative personnel are estimated to be 20 percent of all other personnel with none hired locally.

National Economic Development Account

72. As previously noted, the NED objective is enhanced by increasing the value of the Nation's output of goods and services and improving economic efficiency. Net benefits, which can be estimated using Corps benefit-cost analysis procedures, provide a valid indicator of the contribution of alternative plans to the NED objective. Since all variables are measured in comparable dollar terms and net benefits can be directly estimated by combining these like measures, it is not necessary to scale individual variables within the NED account. The derivation of net benefits for the Tensas River alternatives, based on the data presented in Tables 2 and 3, is summarized in the following tabulation.

Item	Without Project	Net Benefits of Each Alternative, Thousand $s				
		A	B	C	D	E
First cost*	0	42,600	33,700	44,100	40,200	58,330
Annual costs	0	3,141	2,458	3,205	2,925	4,249
Annual primary benefits**	0	4,837	4,837	4,713	4,533	4,533
Redevelopment benefits**	0	225	186	241	220	320
Total annual benefits	0	5,062	5,059	4,954	4,753	4,853
Excess of benefits over costs†	0	1,696	2,415	1,508	1,608	284

* Based on July 1977 price levels. Obtained from Table 3.
** Obtained from Table 2.
† Total annual benefits less annual costs.

Environmental Quality Account

73. A general overview of the effects of the alternatives on each variable and the scaling technique used for derivation of the ACC follows.

Variable: Terrestrial/Habitat/Forested Wetlands

Indicator: Forested Acreage

74. Changes in forested acreage from project implementation would result from induced clearing for agricultural purposes and losses to construction. Estimates of the amount of clearing that would be expected without a project have been made by Vicksburg District personnel based on surveys of local landowners as well as estimates of the induced clearing that would result from project construction. Estimates have also been made of the amount of forested land that would need to be cleared for construction of each of the project alternatives. These estimates are presented in the following tabulation. The estimate of forested acreage currently within the study area as well as that expected for the year 2032 for the without-project condition and with each of the alternatives is presented in the first row of the following tabulation. The expected changes from the without-project condition resulting from induced clearing and losses to construction, respectively, are presented for each of the alternatives in the second and third rows. Net change is from existing conditions for the without-project condition, while for the alternatives it is changes from the without-project condition. Scale values (the alternative choice coefficients) derived from use of the linear proportioning technique are presented in the last row. The linear proportioning technique can be used for scaling when the variables are measured in quantitative terms, a functional curve is not available, and the quantitative measures are assumed to depict qualitative differences. The scale values are derived by summing the quantitative measures for the alternatives and without-project condition (this sum is the value 140,669 shown in the last column of the first row) and dividing this sum into each of the individual measures (for example 29,700 ÷ 140,669 equals 0.2111 for the without-project condition). Similar information is presented for each of the following variables for which ACC's were derived using linear scaling techniques.

	Existing	Without Project	Estimated Forested Average, Year 2032 Alternative A	B	C	D	E	Total
	142,600	29,700	21,319	22,864	21,338	22,294	23,154	140,669
Induced Clearing			5,081	5,136	5,734	5,046	5,046	
Losses to Construction			3,300	1,700	2,628	2,360	1,500	
Net Change		-112,900	-8,381	-6,836	-8,362	-7,406	-6,546	
Scale (ACC)		0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	

<u>Variable</u>: Terrestrial/Habitat/Cleared

<u>Indicator</u>: Cleared Acreage

75. Since habitat has only been disaggregated into forested and cleared types, losses of agricultural lands to construction would still be categorized as cleared. Therefore, net changes in cleared acreage from the without-project condition includes changes from induced clearing and losses of forested lands to construction.

	Existing	Without Project	Cleared Acreage, Year 2032 Alternative A	B	C	D	E	Total
	194,000	306,900	315,381	313,736	315,262	314,306	313,446	1,878,931
Induced Clearing			5,081	5,136	5,734	5,046	5,046	
Woodland Cleared for Construction			3,300	1,700	2,628	2,360	1,500	
Net Change		+112,900	+8,381	+6,836	+8,362	+7,406	+6,545	
Scale (ACC)		0.1633	0.1678	0.1670	0.1678	0.1673	0.1668	

<u>Variable</u>: Terrestrial/Land Quality/Flood Frequency

<u>Indicator</u>: Average Annual Inundated Acreage

76. Reduction in periodic flooding is considered to be detrimental to the existing ecosystem. The average inundated acreage is considered to be an appropriate indicator of the relative impact of the alternatives on periodic inundation.

		Average Annual Inundated Acreage, Year 2032						
		Without	Alternative					
	Existing	Project	A	B	C	D	E	Total
	105,058	105,058	32,969	32,881	33,919	35,700	33,919	274,446
Change			-72,089	-72,177	-71,139	-69,358	-71,139	
Scale (ACC)		0.3828	0.1201	0.1198	0.1236	0.1301	0.1236	

Variable: Terrestrial/Land Quality/Soil Nutrients/Short Term (1982-1992)

Indicator: Soil Fertility

77. Presently, the soils of the Tensas River region are high in nutrients exhibiting high fertility (GSRI, 1974). Project impacts on soil nutrient content would be negligible over the short term. ACC's are derived using the weighted rankings technique (see paragraphs 40-42).

		Soil Fertility, Year 1992					
		Without	Alternative				
	Existing	Project	A	B	C	D	E
	High	High	High	High	High	High	High
Change		None	None	None	None	None	None
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Terrestrial/Land Quality/Soil Nutrients/Long Term (1982-2032)

Indicator: Cleared Acreage - Agricultural Lands Lost to Construction

78. Construction of any of the alternatives would impact on soil nutrients in two ways. First, reduction of the frequency of flooding would reduce nutrient deposition. Second, increased agricultural activity would increase the rate of nutrient depletion. The former impact is addressed by the variable frequency of flooding. Cleared acreage less agricultural lands lost to construction is considered an appropriate indicator of the latter. However, since an increase in acreage is considered an adverse impact, the usual linear scaling

techniques must be modified so that an increase in cleared acreage results in a lower scale value. This can be accomplished by inverting the scale values derived using normal linear scaling techniques. Scale values typically derived are presented in the fifth row (inverted scale) of the following tabulation. Each of the inverted scales values is divided into 1.0 (row six) and summed (36.0009). The final scale values (ACC's) are then the columnar values from row five divided by this sum (for example 5.9952 ÷ 36.009 equals 0.1665 for Alternative A).

Cleared Acreage - Agricultural Lands Lost to Construction, Year 2032

	Existing	Without Project	Alternative A	B	C	D	E	Total
	194,000	306,900	309,981	310,736	311,324	310,716	308,946	1,858,603
Induced Clearing (+)			5,081	5,136	5,734	5,046	5,046	
Losses to Const. (-)			2,000	1,300	1,300	1,200	3,000	
Net Change		+112,900	+3,081	+3,836	+4,424	+3,816	+2,046	
Inverted Scale		0.1651	0.1668	0.1672	0.1675	0.1672	0.1662	
1.0 ÷ Inverted Scale (36.0009)		6.0569	5.9952	5.9809	5.9701	5.9809	6.0168	
Scale (ACC)		0.1682	0.1665	0.1661	0.1658	0.1661	0.1671	

Variable: Terrestrial/Land Quality/Soil Texture

Indicator: Cleared Acreage - Agricultural Land Lost to Construction

79. At present the major soil conditions can be characterized by low permeability, wetness, high shrink-swell ratio, and low bearing capacity. These soils are difficult to work and proper drainage is necessary to establish crops (GSRI, 1974). Additionally, intense farming further degrades the texture of the soil. Under the without-project condition, the soil texture-permeability is expected to remain low for the short term (10 yr). Over a long term (50 yr), the condition would become lower with expected increase in clearing and increased farming. With Alternative A, B, C, D, or E, the rate of clearing would be accelerated. Consequently, texture-permeability for the long term would be lower over the 50-yr period due to increased farming of the clay soils. As with soil nutrients, cleared acreage less agricultural land lost to construction is considered to be an appropriate indicator of the relative impact on soil permeability in the study area. Therefore, ACC's were assigned as follows:

	Without Project	Alternative A	B	C	D	E
Scale (ACC)	0.1682	0.1665	0.1661	0.1658	0.1661	0.1671

Variable: Terrestrial/Land Quality/Toxic Materials

Indicator: Toxic Materials

80. Short-term increases of toxic material in the soil are expected as a result of accelerated conversion of forestland to farmland. However, as a result of greater legislative restrictions on the use of persistent pesticides and herbicides, concentration of toxic materials in the soil are expected to decrease and later stabilize over a 50-yr period.

		Toxic Materials, Year 2032					
	Existing	Without Project	Alternative A	B	C	D	E
	Low	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Terrestrial/Critical Community Relationship/Species Diversity/ Short Term (1982-1992)

Indicator: Forested Acreage

81. Presently, the Tensas River region exhibits a high terrestrial species diversity. Terrestrial fauna inhabiting the area includes 18 species of amphibians, 32 species of reptiles, 77 fall and summer bird species, and 46 species of mammals (GSRI, 1974). The wetland forests-bottomland hardwoods, pastures, and agricultural fields provide a diversified habitat source capable of supporting a variety of species; however, the undeveloped woodlands constitute the most essential habitat for terrestrial wildlife (GSRI, 1974). Therefore, channel alignments that encompass or bisect large areas of forests will most adversely affect the overall species diversity. Due to the direct dependence of species diversity on the available forested habitat, the forested acreage immediately affected for each alternative by construction activities is considered to be an appropriate indicator of the short-term impacts on species diversity.

	Forested Acreage, Year 1992							
		Without	Alternative					
	Existing	Project	A	B	C	D	E	Total
	142,600	132,340*	129,040	130,640	129,712	129,980	130,840	782,552
Losses to Construction			3,300	1,700	2,628	2,360	1,500	
Net Change		-10,260	-3,300	-1,700	-2,628	-2,360	-1,500	
Scale (ACC)		0.1691	0.1649	0.1669	0.1658	0.1661	0.1672	

* Adapted from Vicksburg District projections assuming uniform annual rate of clearing.

Variable: Terrestrial/Critical Community Relationship/Species Diversity/ Long Term (1982-2032)

Indicator: Species Diversity

82. Over a 50-yr period, forest clearing for agricultural utilization will continue with or without flood-control projects (GSRI, 1974). With this continued destruction of habitat acreage, regional species diversity is expected to be lowered extensively over the long term, with or without a project.

	Species Diversity, Year 2032						
		Without	Alternative				
	Existing	Project	A	B	C	D	E
	High	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Terrestrial/Critical Community Relationship/Species Number/ Short Term (1982-1992)

Indicator: Forested Acreage

83. At present the Tensas River Basin supports large populations of deer, wild turkey, small forest game, and nongame wildlife species. The populations are dependent on the amount of forested habitat available. As with species diversity, short-term species number will be directly affected by losses of wetland forests. The number of species present is considered proportional to the acreage of habitat available; therefore, forest acreage is utilized as an indicator of the short-term impact of each alternative on species number.

	Forested Acreage, Year 1992					
	Without Project	Alternative				
		A	B	C	D	E
Scale (ACC)	0.1691	0.1649	0.1669	0.1658	0.1661	0.1672

Variable: Terrestrial/Critical Community Relationships/Species Number/ Long Term (1982-2032)

Indicator: Species Number

84. All project alternatives, as well as the without-project condition, are expected to result in lower species numbers over a 50-yr period due to increased agricultural utilization of once-forested habitat. However, without project protection, wetland drainage would be less extensive and agricultural clearing would occur less rapidly. Therefore, the without-project condition would be least detrimental to species number.

		Species Number, Year 2032					
		Without	Alternative				
	Existing	Project	A	B	C	D	E
	High	Moderate	Low	Low	Low	Low	Low
Scale (ACC)		0.3333	0.1333	0.1333	0.1333	0.1333	0.1333

Variable: Terrestrial/Threatened Species

Indicator: Threatened Species Habitat

85. The bottomland hardwoods and forested wetlands of the Tensas River region are considered sensitive habitat for several species of threatened and endangered wildlife. Federally protected mammals and birds that are classified as endangered species and that may reside in the project area include the Florida Panther, Mississippi Valley Red Wolf, Southern Bald Eagle, Arctic Peregrine Falcon, American Ivery-Billed Woodpecker, and Bachman's Warbler (Spindler, 1977). Presently, the "critical habitat" potential and number of protected species in the area are considered high. Due to the channel alignment included in Alternatives A, B, and E, terrestrial habitat will be reduced moderately. Alternatives C and D will require much forested acreage initially,

resulting in more adverse effects on sensitive terrestrial species. Alternative D will affect the largest number of threatened and endangered species due to the channel alignment through several isolated wetland and bottomland hardwood areas. Without any project, present clearing trends for agricultural purposes are expected to continue, decreasing the acreage to essential habitat for the indigenous threatened species.

Threatened Species Habitat, Year 2032

	Existing	Without Project	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Habitat	High	Moderate	Moderate	Moderate	Low	Lowest	Moderate
Scale (ACC)		0.2333	0.2333	0.2333	0.0667	0.0	0.2333

Variable: Terrestrial/Pests

Indicator: Pest Incidence

86. The incidence of pests in the Tensas River Basin is currently low. Previous drainage projects have aided in the reduction of mosquito-breeding areas. Only one case of encephalitis has been reported since 1970 and that was in Madison Parish in 1976. No incidence of malaria or Rocky Mountain Spotted Fever have been reported since 1970 (Communicable Disease Center, Atlanta, telephone contact, June 1977). Neither the action alternatives nor the without-project condition is expected to change the incidence of vector-borne diseases.

Incidence of Pests

	Existing	Without Project	Alternatives A	Alternatives B	Alternatives C	Alternatives D	Alternatives E
	Low	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Human Interface/Esthetics

Indicator: Natural Diversity

87. The Tensas River region in conjunction with the Mississippi River serves as primary visual relief from the monotonous delta topography. The primary features of esthetic importance in the area are the Mississippi and Tensas Rivers, the Tensas River tributaries, the

oxbow and natural lakes, the wetlands, and the croplands. The wetlands are interlaced throughout the study area and also serve as prime wildlife habitat. The esthetic integrity of the region and the study area is based on a diversity and balance among these features rather than dominance by any one feature.

88. Alternatives A and B will result in extensive removal of vegetation adjacent to the Tensas River and accelerate clearing of forestland for cropland. However, Alternative B will incorporate cutoffs, leaving accessible oxbow bendways and large woodland tracts undisturbed by initial project construction. In this respect Alternative B will be less detrimental.

89. Alternatives C and D will result in new channels cut through currently forested areas and accelerated conversion of forestland to cropland. Alternative D will result in destruction of several wetland areas and natural lakes. Alternative E will pass primarily through existing farmland but will also result in accelerated conversion of forestland to cropland. Without any project, land clearing will still occur but at a reduced rate.

	Natural Diversity						
			Alternatives				
	Existing	Without Project	A	B	C	D	E
	High	Moderate	Low	Moderate	Low	Lowest	Low
Scale (ACC)		0.3000	0.1333	0.3000	0.1333	0.0	0.1333

Variable: Human Interface/Archaeological

Indicator: Number of Archaeological Sites Lost to Project Construction

90. The Tensas region and the study area contain a wealth of archaeological remains, both prehistoric and historic. Numerous sites have been identified; a total of 111 are recorded in the study area. However, there is still a lack of information because the sites have been identified only by surface collection. Undoubtedly, additional sites will be located with more detailed surveys. One site of national interest, Poverty Point, is located within the project region. The

Poverty Point site is listed on the 1977 National Register of Historic Places. This site, however, will not be affected by any of the alternatives. Alterantive A would affect 103 sites; B would affect 81; C would affect 46; D would affect 36; and E would affect 37 sites. Even under the without-project condition, sites may be lost to increasing agricultural development, although there is no way to predict this.

Number of Sites Lost to Project Construction

	Existing	Without Project	Alternative A	B	C	D	E	Total
	111	111	8	30	55	75	74	353
Net change		0	-103	-81	-46	-36	-37	
Scale (ACC)		0.3144	0.0227	0.0850	0.1558	0.2125	0.2096	

Variable: Human Interface/Historical

Indicator: Historical Sites

91. Based on discussion with members of the Louisiana Department of Art, History, and Archaeological Preservation, no known historic sites of State significance will be affected by any alternative.

Historical Sites

	Existing	Without Project	Alternative A	B	C	D	E
	None	None	None	None	None	None	None
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Aquatic/Habitat/Short Term (1982-1992)

Indicator: Aquatic Habitat Quality

92. The aquatic habitat types include wetland backwaters, rivers, tributaries, lakes, bayous, and associated areas that are periodically inundated. The isolated backwaters, lakes, and bayous of the Tensas River Basin presently provide a high-quality habitat for native fauna and flora. The Tensas River and its tributaries are less desirable habitat area due to the high prevalence of agricultural activity and associated pesticide runoff in these water bodies. Without project action, expected increases in agricultural activity would increase water turbidity and pesticide levels over the short term, lowering the aquatic habitat quality. The effects of each project alternative would depend

on the degree of project-induced drainage and habitat loss due to initial project construction and project-induced clearing. All alternatives will enhance drainage of low-lying backwaters, in turn, lowering regional aquatic habitat quality.

93. Alternative B includes snagging and channelization in portions of the Tensas River; in addition, the proposed cutoffs of the river bendways would bisect large tracts of adjacent wetlands. Due to this initial disruption of habitat, habitat quality will be low over the short-term.

94. Alternatives C and E encompass no major wetland areas, but would enhance drainage of bottomlands and allow accelerated agricultural development and further reduction in water quality.

95. Alternatives A and D would have the most impact on existing aquatic ecosystems. Alternative A necessitates the channelization of the Tensas River, disrupting the established riverbed biota due to destruction of the limnetic zone and increased turbidity. In addition, extensive clearing of adjacent wetland forest will occur. The channel alignment of Alternative D would coincide directly with several isolated lake and backwater areas. Destruction of these areas would occur initially due to project construction, with induced drainage further depleting the adjacent backwaters.

	Aquatic Habitat Quality, 1992						
		Without	Alternative				
	Existing	Project	A	B	C	D	E
	High	Moderate	Lowest	Low	Low	Lowest	Low
Scale (ACC)		0.3333	0.0333	0.2000	0.2000	0.0333	0.2000

Variable: Aquatic/Habitat/Long Term (1982-2032)

Indicator: Aquatic Habitat Quality

96. Over the long term, aquatic habitat quality will be lowered with or without flood-control projects due to the agricultural encroachment on wetland forests. Turbidity and physical disruption of aquatic systems will increase proportionately with increases in agricultural activities.

	Existing	Without Project	Alternative A	B	C	D	E
Aquatic Habitat Quality	High	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Aquatic/Water Quality/Physical/Temperature

Indicator: Temperature

97. Changes in water temperature would result from clearing around streambanks and removal of adjacent vegetation, formation of pools, changes in turbidity, change in surface acreage, and changes in rates of flow.

98. Without any project, conditions will result in minimal changes in the average regional temperature of the Tensas River. Alternative E would not cause major temperature changes in the river channel; it will, however, result in higher water temperatures in the auxiliary channel due to extensive clearing and higher turbidity resulting from erosion.

99. Alternatives B, C, and D would have similar impacts on temperature: the hydraulic capacity of the river channel will be similar in each, and the effect of auxiliary channels for Alternatives C and D will be similar to that of the oxbow lakes in Alternative B, causing overall temperature increases. Channelization and cleared rights-of-ways required for Alternative A would result in increased temperatures, but the increased hydraulic capacity would modify this increase. Therefore, the overall temperature change would be less than those for B, C, D, and E, but more than the expected change without any project.

Water Temperature, °C

	Existing	Without Project	Alternative A	B	C	D	E	Total
Average	18.4	19.5	19.2	19.5	19.5	19.5	19.5	
Range	3-30	4-31	4-31	4-31	4-32	4-32	5-32	
Inverted Scale		0.1628	0.1645	0.1671	0.1671	0.1671	0.1714	
1 ÷ Inverted Scale		6.1425	6.0790	5.9844	5.9844	5.9844	4.8343	(36.0090)
Scale (ACC)		0.1706	0.1688	0.1662	0.1662	0.1662	0.1620	

Variable: Aquatic/Water Quality/Physical/Turbidity

Indicator: Turbidity

100. Overall turbidity in the Tensas River is high, with averages of 95 JTU's at Tendal for 1974-1976 and 99 at Clayton for 1975-1976, which are typical for rivers within the region (Louisiana Stream Control Commission, 1973).

101. Impacts of the alternatives on turbidity are expected to occur during construction and later during operation. Initial impacts will be due to stream bank and channel clearing operations, whereas long-term changes will result primarily from changes in land use patterns.

102. The without-project condition is expected to result in the smallest increase in turbidity. Alternatives C, D, and E would result in the greatest increases in turbidity since the auxiliary channels would cut through forested or agricultural lands and accelerate the conversion of forestland to agricultural lands with subsequent erosion.

	Turbidity, JTU							
		Without	Alternative					
	Existing	Project	A	B	C	D	E	Total
	95	112	120	131	133	135	135	766
Inverted Scale		0.1462	0.1567	0.1710	0.1736	0.1762	0.1762	
1 ÷ Inverted Scale		6.8399	6.3816	5.8480	5.7604	5.6754	5.6754	
Scale (ACC)		0.1890	0.1764	0.1616	0.1592	0.1569	0.1569	

Variable: Aquatic/Water Quality/Chemical/pH

Indicator: pH

103. The Louisiana State water-quality standard for pH in the Tensas River Basin is 6.0-8.5; only one sample taken at the Tendal station between 1955 and 1976 has exceeded this standard (i.e., 8.9 in November 1971). No samples taken at the Clayton station between 1958 and 1969 exceeded State standards. Samples taken during the growing season appear to be slightly lower than the remainder of the year (Louisiana Stream Control Commission, 1973).

104. The major soil associations in the study area are slightly

acidic to mildly alkaline although predominantly alkaline. Consequently, soil erosion is expected to increase pH slightly. In addition, pH will increase due to application of fertilizers and lime to newly cleared agricultural lands, and the resulting runoff from these areas.

	Average pH							
		Without	*Alternative*					
	Existing	Project	A	B	C	D	E	Total
	7.4	7.6	7.7	7.9	8.2	7.8	7.8	47.0
Inverted Scale		0.1617	0.1638	0.1681	0.1745	0.1660	0.1660	
1 ÷ Inverted Scale (36.0170)		6.1843	6.1050	5.9488	5.7307	6.0241	6.0241	
Scale (ACC)		0.1717	0.1695	0.1652	0.1591	0.1673	0.1673	

Variable: Aquatic/Water Quality/Chemical/DO

Indicator: Dissolved Oxygen (DO)

105. The DO concentration is a function of organic loading, water temperature, hydraulic characteristics related to reaeration, and plankton. The Louisiana State water-quality standard for DO in the Tensas River is 5.0 mg/ℓ (Louisiana Stream Control Commission, 1975).

106. In order to project changes in DO, relative indicators were used for comparing each alternative. The indicators and the rationale used were as follows:

- a. Biochemical oxygen demand (BOD). As BOD increases as a result of soil erosion, DO will decrease.
- b. Temperature. Increases in temperature will result in decreases in DO.
- c. Hydraulic capacity. As hydraulic capacity increases, DO will increase.

Based on information presented for each alternative relative to these three indicators, scale values for each alternative were developed as follows.

	Dissolved Oxygen, mg/ℓ							
		Without	Alternative					
	Existing	Project	A	B	C	D	E	Total
	6.8	6.3	6.0	5.5	5.5	5.5	5.0	33.8
Scale (ACC)		0.1864	0.1775	0.1627	0.1627	0.1627	0.1479	

Variable: Aquatic/Water Quality/Chemical/Nitrates

Indicator: Nitrates

107. Nitrates have traditionally been used as an indicator of nutrient enrichment or potential for eutrophication. Nitrates are generally associated with industrial and municipal sewage and agricultural land runoff. Nitrates are usually found in much higher concentrations in soils from farmland than in forestland. Consequently, the amount of erosion anticipated to enter the Tensas River and auxiliary channels from farmland will increase the nitrate concentration to a greater degree than runoff from forestland. However, relative changes in nitrate concentrations for each alternative are minimal from the standpoint of their effect on biological productivity or nutrient enrichment; therefore, projected differences were considered insignificant based on erosion potential for each alternative.

	Nitrates, mg/ℓ						
		Without	Alternative				
	Existing	Project	A	B	C	D	E
	0.99	1.13	1.13	1.15	1.15	1.15	1.15
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Aquatic/Water Quality/Chemical/BOD

Indicator: BOD

108. Organic matter (including natural substances, insecticides, herbicides, and other agricultural chemicals) enters waterways in precipitation runoff. Domestic and industrial wastewaters also contribute organics in various amounts. Biochemical oxygen demand is an indicator of the organic matter in water and can be related to the overall quality of a water body. The quantity of organic matter introduced in the Tensas River and auxiliary channels is proportional to erosion.

	BOD, mg/ℓ							
		Without	Alternative					
	Existing	Project	A	B	C	D	E	Total
Inverted Scale	2.6	2.7	2.9	3.1	3.3	3.3	3.3	18.7
1 ÷ Inverted Scale (36.4833)		7.1942	6.4475	5.8445	5.6657	5.6657	5.6657	
Scale (ACC)		0.1972	0.1767	0.1602	0.1553	0.1553	0.1553	

Variable: Aquatic/Water Quality/Chemical Pesticides

Indicator: Pesticides

109. Decreases in water quality and associated aquatic ecosystem stability can be directly related to increases in pesticide-herbicide concentrations. Currently no State water-quality standards for pesticides are being exceeded, although increased concentration of toxic chemicals in the soil and water are expected with the conversion of forestland to farmland. A potential for exceeding State standards will exist. However, similar to the discussion of toxic materials in the Terrestrial category, legislative regulations restricting the use of pesticides-herbicides should result in a decrease of the concentrations of these chemicals in the soil and water over a 50-yr period.

	Existing	Without Project	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
	Low	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Aquatic/Water Quantity

Indicator: *Water Quantity*

110. Each of the alternatives would increase the hydraulic capacity and allow flood flows to pass through the study area with greater speed. In so doing, the quantity of standing water in the area during and after heavy precipitation will be substantially decreased. These decreases will allow greater agricultural productivity at the expense of decreased aquatic and terrestrial wildlife habitat. However, with Alternative B the elevation of the oxbow lakes would be raised 3 ft, which would result in an increased quantity of water throughout the year. The eastern auxiliary channel for Alternative D would cut through several small lakes, ponds, and backwater areas, resulting in increased drainage. Consequently, Alternative D will cause a greater overall reduction in the quantity of water available within the Basin.

	Existing	Without Project	Alternative A	B	C	D	E
Water Quantity	High	Moderate	Low	Moderate	Low	Lowest	Low
Scale (ACC)		0.3000	0.1333	0.3000	0.1333	0.0000	0.1333

Variable: Aquatic/Critical Community Relationship/Species Diversity/ Short Term (1982-1992)

Indicator: Species Diversity

111. The remaining wetlands of the Tensas River Basin support 14 species of amphibians, 24 species of reptiles, 12 mammalian species, 23 species of waterfowl, and 36 species of fish (GSRI, 1974). Without any project, species diversity would be reduced due to loss of habitat to agricultural clearing. However, since direct channelization of natural water bodies will not occur, habitat reduction will be moderate over a short term. With a project, detrimental effects to aquatic species diversity would be linked directly to the loss of wetland habitat due to project construction and drainage, by channelization, project-induced clearing, and a change in pesticide and nutrient levels (GSRI, 1974).

112. When considering species diversity, project impacts on isolated wetland ecosystems must be considered of major importance; therefore Alternative D would be most detrimental due to its alignment through the following backwater areas: Judd Lake, Judd Brake, Africa Lake, Lich Bayou, Indian Lake, Leading Bayou, and Fool Lake, all of which support a high species diversity (GSRI, 1974). Species diversity of these areas is considered exceptionally high because of their isolated locations. The construction of Alternatives A, B, C, and E will decrease species diversity to a low level due to initial impacts of project construction and reduction of water quality and quantity in associated wetland areas of the basin.

	Existing	Without Project	Alternative A	B	C	D	E
Species Diversity	High	Moderate	Low	Low	Low	Lowest	Low
Scale (ACC)		0.3333	0.1667	0.1667	0.1667	0.0000	0.1667

Variable: Aquatic/Critical Community Relationships/Species Diversity/ Long Term (1982-2032)

Indicator: Species Diversity

113. Without any project, species diversity is expected to be lowered because of the encroachment of agricultural development on habitat. Although all project alternatives would increase drainage and accelerate agricultural clearing, differences in long-term impacts on species diversity would not be significant, except for Alternative D. Alternative D, due to the destruction of the isolated lake communities, would be most detrimental to diversity.

	Existing	Without Project	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Species Diversity	High	Low	Low	Low	Low	Lowest	Low
Scale (ACC)		0.2000	0.2000	0.2000	0.2000	0.0000	0.2000

Variable: Aquatic/Threatened Species/Short Term (1982-1992)

Indicator: Threatened Species

114. The American alligator, an endangered species, is the only aquatic vertebrate protected by Federal statute known to be in the study area. With the onset of project construction, the American alligator will be affected to various degrees depending on the amount of habitat destruction and the specific habitat area disrupted. Alternatives A, B, C, and E would decrease population stability due to direct destruction of habitat, increased drainage of backwaters, lakes and bayous, and project-induced clearing, all of which will lower habitat quantity and quality over the short term. Alternative D would be most adverse due to direct channel alignment with several isolated lake communities, such as Judd Brake (GSRI, 1974). Without any project, populations will drop to moderate levels over a short term.

	Existing	Without Project	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Threatened Species	High	Moderate	Low	Low	Low	Lowest	Low
Scale (ACC)		0.3333	0.1667	0.1667	0.1667	0.0000	0.1667

Variable: Aquatic/Threatened Species/Long Term (1982-2032)

Indicator: Threatened Species

115. Over the long term, the habitat for threatened species will decrease proportionally with the loss of aquatic habitat. Long-term impacts of all alternatives on threatened species would be the same as those impacts for aquatic habitat.

	Existing	Without Project	Alternative A	B	C	D	E
Threatened Species	High	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Aquatic/Pests

Indicator: Incidence of Vector-Borne Diseases

116. For the overall Tensas River region, the incidence of vector-borne disease is low for the years 1970-1976 with one case of encephalitis being recorded in Madison Parish in 1976 (Communicable Disease Center, Atlanta, telephone contact, June 1977). Incidence of pest-related diseases is expected to remain low with or without flood-control projects.

	Existing	Without Project	Alternative A	B	C	D	E
Incidence of Pests	Low	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Air/Quality/Gases

Indicator: Gases

117. Due to the relatively low concentrations of population and industry, the presence of gases such as sulfur oxides, carbon monoxide, hydrocarbons, and nitrogen oxides in the Tensas region are relatively low. Neither the without-project condition nor any of the action alternatives are expected to result in any significant changes of noxious gases in the study area or the region. Some minor localized increases of short-term nature will occur during construction due to increased presence of motor vehicles, but these are not anticipated to be of any significance.

	Existing	Without Project	Alternative A	B	C	D	E
Gases	Low	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Air/Quality/Particulates

Indicator: Forested acreage cleared (project construction + project-induced clearing)

118. Particulates are generally categorized into suspended and settleable solids. These categories refer to size and filtration characteristics. The particulates present within the Tensas region and study area include primarily dust and smoke; neither exist in high or harmful quantities (Louisiana Air Control Commission, 1974, 1977). The greater the number of acres cleared and burned the greater the quantity of particulates generated. Forested acreage cleared due to initial project construction and project-induced clearing is considered an appropriate indicator of particulate matter increases for each project alternative.

	Cleared Acreage							
	Existing	Without Project	Alternative A	B	C	D	E	Total
	142,600	29,700	21,319	22,864	21,338	22,294	23,154	140,669
Induced Clearing			5,081	5,136	5,734	5,046	5,046	
Losses to Construction			3,300	1,700	2,628	2,360	1,500	
Net Change		-112,900	-8,381	-6,836	-8,362	-7,406	-6,546	
Scale (ACC)		0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	

Variable: Air/Climatology

Indicator: Climatology

119. Climatological features such as air dispersion, precipitation, temperature, wind speed and directions, solar radiation, and relative humidity are not expected to be affected by any of the alternatives.

	Existing	Without Project	Alternative A	B	C	D	E
Changes in Climatology	Stable	Stable	Stable	Stable	Stable	Stable	Stable
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Social Well-Being Account

120. A general overview of the effects of the alternatives on each variable and the scaling used for derivation of the ACC follows. Scale values in this account are based on work done under contract for WES by Dr. John Peterson, et al., Mississippi State University.

Variable: Real Income Distribution/Incidence of Benefits

Indicator: Average Annual Inundated Acreage

121. Currently, that part of the area's population that is engaged in agricultural activity in the northern areas of the Tensas Basin would enjoy the greatest economic benefit from additional flood control. Each of the action alternatives will contribute to the prosperity of the Basin to the extent that flooding is actually controlled and available agricultural lands can be made more productive.

122. There is no direct quantitative measure of the numbers of individuals whose income will be directly affected by the implementation of any of the alternatives or of the degree of income change for these individuals. Since income enhancement will primarily be derived from lands increasing in value and productivity through flood protection, the average annual inundated acreage is considered to be an appropriate indicator of the relative impact of the alternatives on incidence of benefits.

	Average Annual Inundated Acreage							
		Without	Alternative					
	Existing	Project	A	B	C	D	E	Total
	105,058	105,058	32,969	32,881	33,919	35,700	33,919	274,446
Change			-72,089	-72,177	-71,139	-69,358	-71,139	
Inverted Scale		0.3828	0.1201	0.1198	0.1236	0.1301	0.1236	
1 ÷ Inverted Scale (43.1535)		2.6123	8.3264	8.3472	8.0906	7.6864	8.0906	
Scale (ACC)		0.0605	0.1929	0.1934	0.1875	0.1781	0.1875	

Variable: Real-Income Distribution/Income Expenditures

Indicator: Local Expenditures for Project

123. There are no plans for the local population to contribute financially to any portion of the Tensas River project. None of the alternative plans would result in noticeable increases in local income expenditures beyond those voluntary investments related to increased

agricultural development in the basin.

	Existing	Without Project	Alternative A	B	C	D	E
Local Expenditures, $	0	0	0	0	0	0	0
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Life, Health, and Safety/Life

Indicator: Loss of Life Directly or Indirectly Related to Periodic Flooding

124. The incidence of flooding is not sufficient to endanger the lives of the residents of the area under existing conditions. Therefore, there is no difference in the impact of any of the alternatives on this variable.

	Existing	Without Project	Alternative A	B	C	D	E
Loss of Life	0	0	0	0	0	0	0
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Life, Health, and Safety/Health

Indicator: Toxic Substances

125. In the long term, the overall concentrations of toxic substances in the soil and water are expected to decrease and stabilize as discussed in toxic substances in the EQ terrestrial category.

	Existing	Without Project	Alternative A	B	C	D	E
Toxic Substances	Low	Low	Low	Low	Low	Low	Low
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Life, Health, and Safety/Safety

Indicator: Incidence of Accidents

126. The incidence of flooding is not sufficient to affect the safety of the residents of the area under existing conditions. Neither construction- nor maintenance-related accidents are expected to have significant impacts for any project alternatives. Therefore, there is

no difference in the impact of any of the alternatives on this variable.

	Existing	Without Project	Alternative A	B	C	D	E
Accidents	0	0	0	0	0	0	0
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Educational, Cultural, and Recreational Opportunities/Education

Indicator: Educational Opportunities

127. Presently, primary and secondary school facilities in the area appear adequate and uncrowded, although the formal education level of the populace is low compared to the national average. Neither the without-project condition nor any of the alternatives are expected to affect significantly the educational opportunities in the project area or the Tensas River Basin.

	Existing	Without Project	Alternative A	B	C	D	E
Educational Opportunities	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Educational, Cultural, and Recreational Opportunities/Cultural

Indicator: Cultural Opportunities

128. Presently, cultural opportunities are limited in the Tensas River Basin; neither the without-project condition nor any of the alternatives are expected to significantly affect this variable.

	Existing	Without Project	Alternative A	B	C	D	E
Cultural Opportunities	Limited	Limited	Limited	Limited	Limited	Limited	Limited
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Educational, Cultural, and Recreational Opportunities/ Recreation

Indicator: Recreational Opportunities

129. Public access to the forested areas in the Tensas Basin is presently limited. There are no public recreational areas because most of the privately owned forestland is presently under lease to private sportsman's clubs. The without-project condition would have no effect on existing recreational opportunities. Some adverse effects can be anticipated, however, to the extent that fish and wildlife are threatened by habitat loss from the short-term increase of toxic substances in the region due to increased farming under Alternatives A, C, D, and E. Similarly, the likelihood that deforestation will continue under these alternatives may decrease existing recreational lands.

130. Although each of the alternatives calls for easements to be acquired by the Corps, it is only under Alternative B that these easements could be used to provide recreational areas for public use. Thus, Alternative B offers the slight benefit of increasing public utilization of the forested areas, and the other alternatives can be judged to have no significant effect on public access to existing forestlands.

		Without	Alternative				
	Existing	Project	A	B	C	D	E
Recreational Opportunities	Moderate	Moderate	Low	Moderate	Low	Low	Low
Scale (ACC)		0.3000	0.1000	0.3000	0.1000	0.1000	0.1000

Variable: Emergency Preparedness (All Variables)

131. There is no indication that any of the alternatives will have any impact on emergency preparedness.

	Without	Alternative				
	Project	A	B	C	D	E
Scale (For All Emergency-Preparedness Variables) (ACC)	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Demographic Characteristics/Short and Long Term

Indicator: Population Change

132. At the present, the most striking demographic feature of the Tensas River Basin has been its steady decline in population as a result of outmigration. The area experienced approximately a 20-percent decrease in population between 1960 and 1970. Most of this decrease occurred among small farmers and farm laborers. The primary change in population composition through outmigration has been a more equal racial proportion resulting from the heavier outmigration of blacks. Most town areas within the three parishes have experienced less population decline and in some cases slight growth. It is not likely that either the without-project condition or any of the alternatives will show a change in the present tendency for outmigration. Of any possible changes, the greatest likelihood would be for a slight increase in the rate of outmigration under any of the alternatives (A through E).

133. In the past, small-scale farmers have been displaced as extensive areas of the three parishes became more attractive for large-scale agricultural operations.

134. With abatement of the flooding problem, realized through any of the alternatives, it can be anticipated that the tendency for the conversion to larger scale machinery-intensive agriculture will be slightly accelerated. Further, while the implementation of the alternatives might slightly accelerate the outmigration, such an increase would be insignificant in comparison with the already existing high rate of outmigration. For this reason, although attempts were made in data analysis to distinguish between two demographic variables, population change and migration, in terms of both long- and short-term change, data did not support any distinction or any difference in impacts among the alternatives.

	Without Project	Alternative				
		A	B	C	D	E
Scale (For all Population Change) (ACC)	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Community Organization/Community Cohesion

Indicator: Existing Community Boundaries

135. Community cohesion is a difficult variable to measure and the one most subject to changes in measurement, depending on how the concept is used. One of the better established definitions of community cohesion is as identified geographic areas locally viewed as separate communities or rural neighborhoods. Alternatives that divide an established community geographically or have differential impacts on communities would be viewed as adverse. Since all alternatives bypass existing communities in this very rural region, there is no anticipated impact on community cohesion at this level.

136. Community cohesion can also be approached at a regional level and at the level of community interest. These two approaches overlap to a degree in this project. In the case of the Tensas River, there does appear to be a division of opinion as to the desirability of any further channel improvement. This can be partially attributed to regional factors. People in the northern part of the three-parish area tend to see direct economic benefit deriving from completion of the authorized project and are generally in favor of the action alternatives. Many people in the southern part of the region who once favored the project are aware that partial completion of the authroized project in their area has provided them greater protection than the total project was designed to provide upon completion. Therefore, they are generally less supportive of the action alternatives. They see little further economic benefit to them, and some fear that further upstream flood-control efforts will increase the volume of runoff water, potentially adversely affecting them.

137. Beyond these regional characteristics, residents primarily interested in the recreational potential of the forested areas generally oppose any of the action alternatives, while those with a primary interest in the area's agricultural development tend to favor them. Since those interested in forest recreation include individuals from outside the three-parish area at this level, there is incomplete fit between the community in regional terms and in terms of interests.

138. While these differences do exist, there is not sufficient evidence to determine reactions of the public to each of the alternative plans. Public opinion has usually not been so discriminating, but rather has taken a "for" or "against" position in relation to all the action alternatives.

139. Looking at the region as a whole, it is apparent that division of opinion concerning the project is an extension of the existing conflict between individuals and interest groups who favor the preservation of forestlands and those who support further agricultural development. However, it is doubtful that the adoption of any of the action alternatives would significantly lower the existing community cohesion.

	Existing	Without Project	Alternative A	B	C	D	E
Existing Community Boundaries	Numerous Small Rural Communities	No Change	No Change	No Change	No Change	No Change	No Change
Scale (ACC)		0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Community Organization/Employment/Short-Term

Indicator: Civilian Employment

140. The short-term impacts of the alternatives from the without-project condition will be the result of construction jobs filled by local unemployed people. Estimates by the Vicksburg District indicate locally filled construction jobs would range from 60 to 400 days in duration and that the total of local job requirements ranges from 7 to 11 percent of the current unemployed labor force.

	Existing	Without Project*	Alternative A	B	C	D	E
Civilian Labor Force	12,625	12,625	-	-	-	-	-
Civilian Employment	11,575	11,575	11,670	11,650	11,665	11,689	11,693
Local Construction Jobs		0	95	75	90	114	118
Scale (ACC)		0.1655	0.1669	0.1667	0.1668	0.1671	0.1672

* Assumes no short-term changes in unemployment rate and short-term projected declines in population offset by projected increases in labor force participation rates.

Variable: Employment/Long Term

Indicator: Civilian Employment

141. An insignificant number of operation and maintenance jobs are anticipated with all alternative plans. Therefore, no significant impact is anticipated for this variable.

	Without Project	Alternative A	B	C	D	E
Scale (ACC)	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Community Organization/Displacement

Indicator: Individual Households Displaced

142. Corps data indicate that displacement of individual households would be significantly greater with Alternative A (43 households). Alternative B would result in the displacement of 28 households; Alternative C in the displacement of 22 households; and Alternative D and E will result in displacement of no more than 20 households.

	Existing	Without Project	Alternative A	B	C	D	E
Individual Households Displaced	0	0	43	28	22	20	20
Scale (ACC)		0.3440	0.0000	0.1200	0.1680	0.1840	0.1840

Variable: Noise

Indicator: Noise

143. There will be a temporary local increase in noise level during the construction phase for the action alternatives. Since this construction will be outside existing communities, this noise will not be significant in terms of the human population.

	Existing	Without Project	Alternative A	B	C	D	E
Scale (ACC)	-	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

<u>Variable</u>: Esthetic Values

<u>Indicator</u>: Net Changes in Forested Acreage

144. A number of local citizens' objections to the action alternatives suggest a concern over possible losses of the natural scenic beauty of the area. The southern part of the Tensas River Basin contains one of the last remaining large stands of bottomland hardwood forest in Louisiana and one of the few large tracts remaining in the lower Mississippi alluvial valley. As such, the region provides a place of esthetic value that has been recognized by both residents and visitors to the area.

145. It is clear that the without-project condition will result in the greatest preservation of these forestlands in their present state, at least for the time being. It should be noted, however, that since most of the forestlands remain under private ownership, long-range preservation of the area will be difficult or impossible. All the action plans will accelerate the threat to the present character of this region, particularly to the extent that the trend for converting additional forestland to agricultural uses is encouraged.

146. Since the esthetic value of the region is directly related to the diversity provided by the remaining forests, the best quantitative measure of the impact of alternatives is in the net changes in forested acreage.

	Forested Acreage							
		Without	Alternative					
	Existing	Project	A	B	C	D	E	Total
	142,600	29,700	21,319	22,864	21,338	22,294	23,154	140,669
Induced Clearing			5,081	5,136	5,734	5,046	5,046	
Losses of Construction			3,300	1,700	2,628	2,360	1,500	
Net Change		-112,900	-8,381	-6,836	-8,362	-7,406	-6,546	
Scale (ACC)		0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	

Regional Development Account

147. The purpose of the RD account is to identify and display significant impacts of alternative plans on relevant planning regions. For the Tensas River study, impacts are described for the three-parish region of East Carroll, Madison, and Tensas parishes. This region encompasses all areas that would be physically affected by an alternative plan and includes all areas that will incur significant social and economic effects. It is recognized that some of the impacts described for this region would result from transfers from the rest of the nation; however, in no instances would these transfers be expected to significantly affect any other area.

Variables: Income Effects/Value of Outputs + Value of Unemployed or Underemployed Resources + User Payments

Indicators: Flood-Control Benefits + Area Redevelopment Act (ARA) Benefits + Local Payments for Construction and O&M

148. The following income variable/indicators are measured in dollars and therefore are combined for scaling: value of outputs/flood-control benefits; value of unemployed resources/ARA benefits; user payments/local participation for construction costs and operation and maintenance costs. (Note: Sum of individual RIC's is to be used in final coefficient matrix.)

	Thousand $s					
	Without	Alternative				
	Project	A	B	C	D	E
Flood Control	0	4837	4837	4713	4533	4533
ARA	0	225	186	241	220	320
User Payments	0	0	0	0	0	0
Net Change (24,681)	0	+5062	+5059	+4954	+4753	+4853
Scale (ACC)	0	0.2051	0.2050	0.2007	0.1926	0.1966

Variable: Increased Induced or Stemming Activities

Indicator: Cleared Acreage

149. Induced or stemming activities would result from increased activities in the agricultural sector. Differences in cleared acreage is considered an appropriate indicator of the relative magnitude of induced or stemming activities.

	Existing	Without Project	Cleared Acreage Alternative A	B	C	D	E	Total
	194,000	306,900	309,981	310,736	311,324	310,716	308,946	1,858,603
Induced Clearing			+5,081	+5,136	+5,734	+5,046	+5,046	
Loss to Construction			-2,000	-1,300	-1,300	-1,200	-3,000	
Net Change		+112,900	+3,081	+3,836	+4,442	+3,816	+2,046	
Scale (ACC)		0.1651	0.1668	0.1672	0.1675	0.1672	0.1662	

Variable: Losses from Displaced Activities

Indicator: Forested Acreage

150. Forestry is the primary activity that would be displaced by induced clearing activities. Therefore, differences in forested acreage is considered an appropriate indicator of displaced activities.

	Existing	Without Project	Forested Acreage Alternative A	B	C	D	E	Total
	142,600	29,700	21,319	22,864	21,338	22,294	23,154	140,669
Induced Clearing			-5,081	-5,136	-5,734	-5,046	-5,046	
Loss to Construction			-3,300	-1,700	-2,628	-2,360	-1,500	
Net Change			-8,381	-6,836	-8,362	-7,406	-6,546	
Scale (ACC)		0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	

Variable: Increases from Construction and O&M Activities/Short Term

Indicator: Local Civilian Employment + Out-of-Town Workers

151. Regional development benefits from construction activities would result from local expenditures of wages paid to out-of-area workers. It is recognized that all wages to out-of-area workers would probably not be spent locally and individual wages will differ greatly between labor categories (i.e., skilled, semiskilled, and unskilled). However, because of the inability to estimate such factors precisely and the minor impact anticipated for this variable, the existing civilian labor force plus out-of-area workers is considered an appropriate indicator.

	Existing	Without Project*	Alternative A	B	C	D	E
Local Civilian Labor Force	12,625	12,625	-	-	-	-	-
Local Civilian Employment (69,983)	11,575	11,575	11,662	11,656	11,682	11,689	11,719
Out-Of-Area Jobs	-	0	+87	+81	+107	+114	+144
Scale (ACC)		0.1654	0.1666	0.1666	0.1669	0.1670	0.1675

* Assumes no short-term changes in unemployment rate and short-term projected declines in population offset by projected increases in labor force participation rates.

Variable: Increases from Construction and O&M Activities/Long Term

Indicator: Local Civilian Employment + Out-of-Area Workers

152. Operation and maintenance activities are not expected to result in the creation of any significant number of jobs; therefore, no significant impacts are expected for this variable.

	Existing	Without Project	Alternative A	B	C	D	E
Scale (ACC)	-	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Losses of Assistance and Welfare

Indicator: ARA Benefits as Inverse Measure

153. Losses of Federal and/or State monies for assistance and welfare could result from the employment of locally unemployed or underemployed persons during project construction. ARA benefits are considered an appropriate inverse indicator of the regional loss of such funds.

154. In order to derive ACC's using linear proportioning techniques, however, all measures must be positive. It is therefore necessary to add the absolute value of the smallest number of each of the measures before proportioning. In the following tabulation, Alternative E has the smallest value (-320), the absolute value of which is added to each of the measures (row 2) before proportioning (row 3).

	Without Project	Alternative A	B	C	D	E
Net Change	0	-225	-186	-241	-220	-320
Adjustment + 320 (728)	320	95	134	79	100	0
Scale (ACC)	0.4396	0.1305	0.1841	0.1085	0.1374	0

Variable: Employment/Short Term

Indicator: Civilian Employment

155. Short-term employment impacts would result from construction jobs filled by locally unemployed. Estimates by the Vicksburg District indicate locally filled construction jobs would range from 60 to 400 days in duration. The total of local job requirements ranges from 7 to 11 percent of the current local unemployed force.

	Existing	Without Project	Alternative A	B	C	D	E
Civilian Labor Force	12,625	12,625	-	-	-	-	-
Civilian Employment	11,575	11,575	11,670	11,650	11,665	11,689	11,693
Local Construction Jobs		0	+95	+75	+90	+114	+118
Scale (ACC)		0.1655	0.1669	0.1666	0.1668	0.1671	0.1672

Variable: Employment/Long Term

Indicator: Civilian Employment

156. An insignificant number of operation and maintenance jobs are anticipated with all alternative plans. Therefore, no significant impact is anticipated for this variable.

	Without Project	Alternative A	B	C	D	E
Scale (ACC)	0.1667	0.1667	0.1667	0.1677	0.1667	0.1667

Variable: Population

Indicator: Total Population, Density, and Composition

157. None of the action plans would be expected to significantly affect regional population, density, or distribution. No significant

impacts are therefore anticipated for any of the population variables.

	Without Project	Alternative A	B	C	D	E
Scale (for all Population Indicators (ACC)	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

Variable: Economic Base and Stability

Indicator: Cleared Acreage - Agricultural Lands Lost to Project Construction

158. Increased regional economic stability is anticipated from conversion from forestry to agricultural activities. An appropriate indicator of agricultural activity is cleared acreage less agricultural lands lost to project construction.

		Cleared Acreage Lost to Project Construction						
	Existing	Without Project	Alternative A	B	C	D	E	Total
	194,000	306,900	309,961	310,736	311,324	310,716	308,946	1,858,603
Induced Clearing	-	-	+5,081	+5,136	+5,734	+5,046	+5,046	
Losses to Construction	-	-	-2,000	-1,300	-1,300	-1,200	-3,000	
Net Changes		+112,900	+3,081	+3,836	+4,424	+3,816	+2,046	
Scale (ACC)		0.1651	0.1668	0.1672	0.1675	0.1672	0.1662	

Variable: Environmental Effects - Regional

Indicator: EQ Final Coefficient Matrix

159. It was the consensus of the interdisciplinary team that the best indication of environmental effects of regional significance would be the final ACC's from the EQ account. This allows for a consideration of all environmental characteristics of the area to be compared consistently throughout the analysis.

	Without Project	Alternative A	B	C	D	E
Scale (ACC)	0.2360	0.1458	0.1817	0.1514	0.1131	0.1731

Variable: Socio-Cultural Effects - Regional

Indicator: SWB Final Coefficient Matrix

160. For reasons similar to those stated above for regional environmental effects, the indicator for socio-cultural effects of regional significance is the final coefficient matrix for the SWB account.

	Without Project	Alternative A	B	C	D	E
Scale (ACC)	0.1967	0.1510	0.1700	0.1665	0.1665	0.1694

PART V: EVALUATION AND INTERPRETATION

161. Once the relative importance of the variables has been established (RIC's) and the impacts of alternatives on these variables scaled (ACC's), the two factors are combined by multiplication and the results are displayed in a final coefficient matrix for each account. The sum of these products for each alternative from the final coefficient matrices of the individual accounts indicates the relative desirability of the alternatives in terms of EQ, SWB, or RD. The NED account does not require this procedure since it is evaluated solely in monetary terms. The results of these procedures for the Tensas River project are presented here.

National Economic Development

162. The NED objective is enhanced by increasing the value of the Nation's output of goods and services and improving national economic efficiency. Net economic benefits are used to measure the contributions of alternative water resource development plans to this objective.

163. As indicated below, Alternative B is the most desirable alternative from the NED perspective, since it has the greatest net benefits. Alternatives A, C, and D are closely grouped below B in net benefits, while Alternative E and the without-project condition contribute least to the NED objective.

	Without	Alternative				
	Project	A	B	C	D	E
Net Benefits, Thousand $s	0	1696	2415	1508	1608	284

Environmental Quality

164. The EQ objective is enhanced through the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

165. The EQ account was evaluated in terms of four major categories: terrestrial, human interface, aquatic, and air. Each of the main categories was then disaggregated into the major components shown in Table 7. From an EQ perspective, it was determined that the without-project condition (0.2360) is most desirable followed by Alternative B (0.1817), and then by Alternatives E, C, A, and D (0.1731, 0.1514, 0.1458, and 0.1131, respectively). A Friedman's two-way nonparametric analysis of variance by ranks (Siegel, 1956) was performed on the final coefficient matrix of the EQ account. This distribution-free testing procedure indicated that a statistically significant difference was present at the 95-percent confidence level ($\alpha = 0.05$) among the alternatives.

166. The Tensas River area, as has been mentioned throughout the report, is a highly productive ecological system, containing prime bottomland hardwood forest that provide excellent wildlife habitat. Each of the alternatives action will result in accelerated conversion of forestland to farmland, with subsequent losses in wildlife habitat, increased erosion, and initial increases in the concentration of toxic chemicals in both the terrestrial and aquatic system. It should be noted, however, that even without the project, conversion of forestland to farmland will occur. Without some form of local, State, or Federal land acquisition program, it appears that a prime bottomland hardwood area and its associated wildlife habitat will be irretrievably lost to future generations.

Social Well-Being

167. The SWB account was evaluated in terms of income distribution; life, health, and safety; educational, cultural, and recreational opportunities; emergency preparedness; demographic characteristics; community cohesion; noise; and esthetics. As may be noted from Table 8, the without-project condition (0.1967) is considered most desirable and Alternative A (0.1560) is least desirable from the SWB perspective. The totals of the remaining alternatives are closely grouped between these two.

Table 7

Environmental Quality Account

Variable	RIC Level				Final RIC	Alternative Choice Coefficients						Final Choice Matrix					
						Without Project	Alternative					Without Project	Alternative				
	1	2	3	4			A	B	C	D	E		A	B	C	D	E
Terrestrial	0.40																
Habitat		0.30															
Forested Wetlands			0.67		0.0804	0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	0.0170	0.0122	0.0131	0.0122	0.0127	0.0132
Cleared Land			0.33		0.0396	0.1633	0.1678	0.1670	0.1678	0.1673	0.1668	0.0065	0.0066	0.0066	0.0066	0.0066	0.0066
Land Quality		0.13															
Flood Frequency			0.25		0.0130	0.3828	0.1201	0.1198	0.1236	0.1301	0.1236	0.0050	0.0016	0.0016	0.0016	0.0017	0.0016
Toxic Materials			0.40		0.0208	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
Soil Nutrients			0.20														
Short Term				0.33	0.0034	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Long Term				0.67	0.0070	0.1682	0.1665	0.1661	0.1658	0.1661	0.1671	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
Soil Texture			0.15		0.0078	0.1682	0.1665	0.1661	0.1658	0.1661	0.1671	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
Critical Community Relationships		0.30															
Species Diversity			0.50														
Short Term				0.33	0.0198	0.1691	0.1649	0.1669	0.1658	0.1661	0.1672	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033
Long Term				0.67	0.0402	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067
Species Number			0.50														
Short Term				0.33	0.0198	0.1691	0.1649	0.1669	0.1658	0.1661	0.1672	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033
Long Term				0.67	0.0402	0.3333	0.1333	0.1333	0.1333	0.1333	0.1333	0.0134	0.0054	0.0054	0.0054	0.0054	0.0054
Threatened Species		0.20			0.0800	0.2333	0.2333	0.2333	0.0667	0.0000	0.2333	0.0187	0.0187	0.0187	0.0053	0.0000	0.0187
Pests		0.07			0.0280	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0047	0.0047	0.0047	0.0047	0.0047	0.0047
Human Interface	0.30																
Esthetic		0.42			0.1260	0.3000	0.1333	0.3000	0.1333	0.0000	0.1333	0.0378	0.0168	0.0378	0.0168	0.0000	0.0168
Historical		0.16			0.0480	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080
Archeological		0.42			0.1260	0.3144	0.0227	0.0850	0.1558	0.2125	0.2096	0.0396	0.0029	0.0107	0.0196	0.0268	0.0264
Aquatic	0.20																
Habitat		0.24															
Short Term			0.33		0.0158	0.3333	0.0333	0.2000	0.2000	0.0333	0.2000	0.0053	0.0005	0.0032	0.0032	0.0005	0.0032
Long Term			0.67		0.0322	0.2000	0.2000	0.2000	0.2000	0.0000	0.2000	0.0064	0.0064	0.0064	0.0064	0.0000	0.0064

Table 7 (Concluded)

Environmental Quality Account

Variable	RIC Level 1	RIC Level 2	RIC Level 3	RIC Level 4	Final RIC	Alternative Choice Coefficients: Without Project	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Final Choice Matrix: Without Project	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Water Quality		0.19															
Physical			0.5														
Temperature				0.5	0.0095	0.1706	0.1688	0.1662	0.1662	0.1662	0.1620	0.0016	0.0016	0.0016	0.0016	0.0016	0.0015
Turbidity				0.5	0.0095	0.1890	0.1764	0.1616	0.1592	0.1569	0.1569	0.0018	0.0017	0.0015	0.0015	0.0015	0.0015
Chemical			0.5														
pH				0.2	0.0038	0.1717	0.1695	0.1652	0.1591	0.1673	0.1673	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006
DO				0.2	0.0038	0.1864	0.1775	0.1627	0.1627	0.1627	0.1479	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006
Nitrates				0.2	0.0038	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
BOD				0.2	0.0038	0.1972	0.1767	0.1602	0.1553	0.1553	0.1553	0.0013	0.0007	0.0007	0.0006	0.0006	0.0006
Pesticides				0.2	0.0038	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Water Quantity		0.10			0.0200	0.3000	0.1333	0.3000	0.1333	0.0000	0.1333	0.0060	0.0027	0.0060	0.0027	0.0000	0.0027
Critical Community Relationships		0.29															
Species Diversity																	
Short Term			0.33		0.0191	0.3333	0.1667	0.1667	0.1667	0.0000	0.1667	0.0064	0.0032	0.0032	0.0032	0.0000	0.0032
Long Term			0.67		0.0389	0.2000	0.2000	0.2000	0.2000	0.0000	0.2000	0.0078	0.0078	0.0078	0.0078	0.0000	0.0078
Threatened Species		0.14															
Short Term			0.33		0.0092	0.3333	0.1667	0.1667	0.1667	0.0000	0.1667	0.0031	0.0015	0.0015	0.0015	0.0000	0.0015
Long Term			0.67		0.0188	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
Pests		0.04			0.0080	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
<u>Air</u>	0.10																
Quality		0.67															
Gases			0.33		0.0221	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037
Particulates			0.67		0.0449	0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	0.0095	0.0068	0.0073	0.0068	0.0071	0.0074
Climatology		0.33			0.0330	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0055	0.0055	0.0055	0.0055	0.0055	0.0055
											TOTAL	0.2360	0.1458	0.1817	0.1514	0.1131	0.1731

Table 8

Social Well-Being Account

Variable	RIC Level 1	RIC Level 2	RIC Level 3	RIC Level 4	Final RIC	Alternative Choice Coefficients: Without Project	Alternative Choice Coefficients: Alternatives A	B	C	D	E	Final Choice Matrix: Without Project	Final Choice Matrix: Alternatives A	B	C	D	E
Real Income Distribution	0.21																
Incidence of Benefits		0.67			0.1407	0.0605	0.1929	0.1934	0.1875	0.1781	0.1875	0.0085	0.0271	0.0272	0.0264	0.0257	0.0264
Income Expenditures		0.33			0.0693	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0115	0.0115	0.0115	0.0115	0.0115	0.0115
Life, Health, and Safety	0.08																
Life		0.33			0.0264	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044
Health		0.33			0.0264	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044
Safety		0.33			0.0264	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044
Educational, Cultural, and Recreational Opportunities	0.13																
Educational		0.33			0.0429	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072
Cultural		0.33			0.0429	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072
Recreational		0.33			0.0429	0.3000	0.1000	0.3000	0.1000	0.1000	0.1000	0.0129	0.0043	0.0129	0.0043	0.0043	0.0043
Emergency Preparedness	0.03				0.0300	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Demographic Characteristics	0.17																
Population Change/Migration																	
Short Term		0.33			0.0561	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094
Long Term		0.67			0.1139	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0190	0.0190	0.0190	0.0190	0.0190	0.0190

Table 8 (Concluded)

Social Well-Being Account

Variable	RIC Level				Final RIC	Alternative Choice Coefficients						Final Choice Matrix					
						Without Project	Alternatives					Without Project	Alternatives				
	1	2	3	4			A	B	C	D	E		A	B	C	D	E
Community Organization	0.21																
Cohesion		0.50			0.1050	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0175	0.0175	0.0175	0.0175	0.0175	0.0175
Employment		0.17															
Short Term			0.33		0.0118	0.1655	0.1669	0.1666	0.1668	0.1671	0.1672	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Long Term			0.67		0.0239	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040
Displacement		0.33			0.0693	0.3440	0.0000	0.1200	0.1680	0.1840	0.1840	0.0238	0.0000	0.0083	0.0116	0.0128	0.0128
Noise	0.06				0.0600	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Esthetic Values	0.13				0.1300	0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	0.0274	0.0197	0.0211	0.0197	0.0206	0.0206
											TOTAL	0.1967	0.1510	0.1700	0.1665	0.1655	0.1694

168. The differences in all of the totals in the SWB account are not great; the distribution-free testing procedure indicated that a statistically significant difference was not present at the 95-percent level among the alternatives. Although professional judgment is required in interpreting the results, they do support two observations made by the interdisciplinary team during the analysis. The first is that existing trends of conversion from forestry to agricultural activities and the associated impacts on income distribution, community organization, etcs., are going to continue with or without action by the Corps. This conversion is having and will continue to have the greatest impact on incomes and life styles of the residents of the study area. Implementation of a project alternative by the Corps will hasten some conversion, but it will not significantly affect the anticipated long-range impacts.

169. The second observation is that the alternatives being considered are all basically channelization projects differing primarily in alignments. Therefore, except for certain direct impacts such as dislocations, differences between alternatives in the anticipated impacts on the social well-being of residents of the Tensas River area are minor.

Regional Development

170. The RD account was evaluated in terms of income and employment effects, population, economic base and stability, environmental effects of regional significance, and socio-cultural effects of regional significance. As may be noted in Table 9, from the RD perspective Alternative B (0.1764) would be considered most desirable and the without-project condition (0.1591) least desirable. Again, as with the SWB account, there is little variation between any of the totals. No statistically significant difference was present at the 95-percent confidence level between the rankings of the alternatives.

171. The results for the RD account are not surprising considering the previous analysis of the SWB account. As noted, none of the

Table 9

Regional Development Account

Variable	RIC Level				Final RIC	Alternative Choice Coefficients						Final Choice Matrix					
						Without Project	Alternative					Without Project	Alternative				
	1	2	3	4			A	B	C	D	E		A	B	C	D	E
Income Effects	0.24																
Value of Outputs		0.25															
Value of Underemployed Resources		0.14			0.1440	0.0000	0.2050	0.2050	0.2007	0.1926	0.1966	0.0000	0.0295	0.0295	0.0289	0.0277	0.0283
User Payments		0.21															
Increases from Induced or Stemming		0.13			0.0312	0.1651	0.1668	0.1672	0.1675	0.1672	0.1662	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Increases in Construction and Operation and Maintenance		0.13															
Short Term			0.33		0.0103	0.1654	0.1666	0.1666	0.1669	0.1670	0.1675	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
Long Term			0.67		0.0209	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0035	0.0034	0.0035	0.0035	0.0035	0.0035
Losses from Displaced Activities		0.11			0.0264	0.2111	0.1516	0.1625	0.1517	0.1585	0.1646	0.0056	0.0040	0.0043	0.0040	0.0042	0.0043
Losses of Assistance and Welfare		0.04			0.0096	0.4396	0.1305	0.1841	0.1085	0.1374	0.0000	0.0042	0.0013	0.0018	0.0010	0.0013	0.0000
Employment Effects	0.19																
Short Term		0.33			0.0627	0.1655	0.1669	0.1666	0.1668	0.1671	0.1672	0.0104	0.0105	0.0104	0.0105	0.0105	0.0105
Long Term		0.67			0.1273	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0212	0.0212	0.0212	0.0212	0.0212	0.0212
Population	0.05																
Total Population		0.50															
Composition		0.33			0.0500	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083
Distribution		0.17															
Economic Base and Stability	0.29				0.2900	0.1651	0.1668	0.1672	0.1675	0.1672	0.1662	0.0479	0.0484	0.0485	0.0486	0.0485	0.0482

Table 9 (Concluded)

Variable	RIC Level				Final RIC	Alternative Choice Coefficients						Final Choice Matrix					
						Without Project	Alternative					Without Project	Alternative				
	1	2	3	4			A	B	C	D	E		A	B	C	D	E
Environmental Effects-Regional	0.10				0.1000	0.2360	0.1458	0.1817	0.1514	0.1131	0.1731	0.0236	0.0146	0.0182	0.0151	0.0113	0.0173
Socio-Cultural Effects - Regional	0.14				0.1400	0.1967	0.1510	0.1700	0.1665	0.1665	0.1694	0.0275	0.0211	0.0238	0.0233	0.0232	0.0237
											TOTAL	0.1591	0.1692	0.1764	0.1713	0.1666	0.1722

alternatives plans are expected to have a major effect on existing trends of conversion from forestry to farming activities. Thus, from the regional development perspective, the major project-induced impacts accrue from the influx of Federal monies for project construction and operation and maintenance activities and from the locally retained project benefits. Since the proposed alternatives would be totally Federally financed, local user payments would be minimal. For the Tensas River study, the RD evaluation is, therefore, largely influenced by the income effect categories.

Tradeoff Analysis

172. Once the evaluation of individual accounts has been completed, tradeoff analysis between alternatives within and between accounts can be considered. For the NED account, tradeoffs between alternatives are straightforward since it is simply the differences in net benefits between alternatives. For example, in the Tensas River study, the tradeoff between Alternative B and Alternative A within the NED account is $2,415,000 less $1,696,000 or $719,000. A decision to implement Alternative A over Alternative B would therefore yield $719,000 less in terms of enhancing national economic development. The difference of $719,000 in NED benefits would need to be offset by advantages of Alternative A over Alternative B in one or more of the other accounts for the decision-makers to decide in favor of Alternative A.

173. The totals of the final coefficient matrices (Tables 7, 8, and 9) give an indication of the overall differences between alternatives for the EQ, SWB, and RD accounts. Through a careful analysis of each final coefficient matrix, the factors that are the major causes of differences between alternatives can be determined. Analysis of these factors can yield subsequent modifications of present plans, new alternative plans, or enhancement or mitigation features designed to minimize adverse effects or maximize desirable plan features. For example, Alternative D will result in major adverse effects on EQ for both the

AD-A050 833 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 13/2
PRELIMINARY FIELD TEST OF THE WATER RESOURCES ASSESSMENT METHOD--ETC(U)
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short- and long-term aquatic species diversity and for short-term threatened aquatic species. A modified alignment of the proposed auxiliary channel could bypass several critical small lakes and backwater areas that would be adversely affected by the alignment now proposed. However, while realignment might minimize these adverse impacts, the hydraulic capacity might be decreased or more archeological sites might be damaged. The result of any such changes or tradeoffs should be enhancement of the acceptability of a plan. Similar modifications to enhance plan acceptability could also be attempted within SWB or RD and between accounts.

174. Although all of the action alternatives under consideration in the Tensas study are expected to accelerate the conversion of bottomland forests to agricultural activities, similar land-use conversions are anticipated even in the absence of a Corps project. The consensus of the interdisciplinary team, based on an overall analysis of project objectives, is that as much as possible of the remaining bottomland forest acreage should be retained in its existing state, because this is essential for preservation of the unique local environment. The Tensas River study was conducted prior to enactment of Principles and Standards. Therefore, an environmental quality plan that included provisions for habitat preservation was not formulated. Such a plan, however, is under consideration by the Vicksburg District.

175. In terms of the EQ account, the without-project condition is most desirable. This results primarily from the without project's higher rankings for the variables: forested wetlands, land quality/flood frequency, esthetic, archeological, aquatic habitat and species diversity/short-term, BOD, threatened aquatic species/short-term, and particulates. Of the action alternatives, Alternative B is the most acceptable in terms of EQ. An examination of Table 7 reveals the sources of the differences between Alternative B and the other alternatives: minimal impacts on forested wetlands, greater esthetic appeal, and a larger quantity of water retained in the forested wetland areas. Further tradeoff analysis within the EQ account might lead to identification of modifications in Alternative B that would lessen its more

adverse effects and incorporate some of the features that enhance the without-project condition. A yet more detailed examination of the effects of Alternatives A, C, D, and E could form the bases for further tradeoff analysis, although improvement in one component can adversely affect other, possibly more important, components.

176. The display of impacts for the SWB and RD accounts revealed no statistically significant differences between alternatives. Within SWB, without project is most desirable due to its preservation of recreational opportunities, lack of displacement of residents, and esthetic benefits. Of the action alternatives, B and E are the most acceptable due primarily to the incidence of economic benefits, recreational opportunities, minimal displacement, and esthetic benefits, although, again, these differences are not significant. Within the RD account, Alternative B is again superior to the other action alternatives, in addition to being more desirable than the without-project condition. The differences between these alternatives, however, are not significant and are smaller than the differences between alternatives within the SWB account. Therefore, further tradeoff analysis should focus primarily on the NED and EQ objectives.

177. Because the without-project condition is the most desirable in terms of EQ and the least desirable in terms of NED, and Alternative B is the most desirable in terms of NED and second most desirable in terms of EQ, the tradeoff analysis should primarily be an attempt to lessen the differences between the without-project condition and Alternative B. The goal is to incorporate as many as possible of the without project's environmental quality advantages into a modified Alternative B. This brings the focus to the EQ areas of changes in forested wetlands, land quality due to flood frequency, number of affected archeological sites, short-term impacts on aquatic habitat and species diversity, erosion-related water quality, short-term impacts on threatened aquatic species, and particulate air pollution. Tradeoff analysis needs to be extended to determine how many and/or what kinds of modifications could be made to Alternative B to lessen its adverse effects on these environmental quality variables while maintaining its NED benefits.

178. No best alternative for the Tensas River was selected for several reasons. First, the purpose of the field test was not to make recommendations. Second, the best alternative may not yet have emerged. Third, although the interdisciplinary team attempted to be familiar with the study area including needs, problems, and opportunities, the team's participation in public involvement and the District's formal decisionmaking were not part of the field test.

PART VI: CONCLUSIONS

179. It was the general consensus of the interdisciplinary team participating in the field test that WRAM is implementable at the District level and provides a systematic approach to impact assessment and alternative evaluation. Specific comments concerning strengths and weeknesses of WRAM that surfaced during this interim field test are discussed below.

180. Those who participated in the field test were in unanimous support of the interdisciplinary team approach. It is recognized that such an approach is not unique to WRAM and is a fundamental precept of both the Principles and Standards and associated Corps regulations. The value of WRAM is that it provides a vehicle for the interdisciplinary approach to become a practical reality rather than an idealistic concept. The use of team meetings to determine the relative importance of variables and to implement the scaling techniques ensures interdisciplinary interaction rather than multidisciplinary analyses. During the Tensas River field test, the specific benefits resulting directly from the interdisciplinary approach were the interchange of ideas, perspectives, and expertise concerning a range of problem areas and variables; effective allocation of individual team members' efforts with overall checks and balances provided by team interactions; effective interagency input and cooperation; and minimization of duplication in data collecti[illegible]mpilation.

181. Utilization of an interdisciplinary team does not require full-time participation by members. Sufficient organizational support of the interdisciplinary approach, however, is required so that the study manager can convene the members as needed for team decisions or interactions. Since use of an interdisciplinary approach requires individuals from many different organizational elements within a Corps District, the team leader must have sufficient authority and the support of all supervisors involved to ensure the timely completion of individual tasks. It may be noted again, however, that these requirements are not unique to WRAM but are necessary wherever the interdisciplinary team approach is used.

182. Use of the weighted rankings technique by the interdisciplinary team provided an effective procedure for screening potential impact variables and focusing on the most critical variables for more detailed analysis. Although some variables identified by the interdisciplinary team as not particularly significant to the Tensas River study were retained in the field application for the purpose of testing alternative scaling methods, the usefulness of WRAM procedures for identifying critical variables or categories was shown. These uses of the WRAM procedures were identified by team members from the Vicksburg District as being particularly useful because of limited resources generally available to them for impact assessment and evaluation. It was felt that an interdisciplinary team utilizing WRAM procedures was not only useful but necessary to eliminate less significant variables and rapidly assess others in a qualitative fashion.

183. The team concluded that there are no inherent conflicts between WRAM and the Habitat Evaluation Procedures (HEP) of the U. S. Fish and Wildlife Service or the Habitat Evaluation System (HES) developed by the Lower Mississippi Valley Division of the Corps. In fact, data obtained by using either HEP or HES can be used directly in the scaling portion of WRAM.

184. One limitation in the present application of WRAM identified by the field test, but which also may affect any analytical approach, is limited availability of acceptable functional curves for scaling. Weighted rankings and linear proportioning provide optional techniques for scaling, but they both have limitations that affect the quality of the final decision. Linear proportioning is a useful scaling technique whenever changes in quantity are anticipated to yield proportional changes in quality. However, when the quality relationship is discontinuous, threshold, or nonlinear, use of linear proportioning does not adequately depict quality differences between variables. The weighted rankings technique can also be used for scaling, especially when impacts are measured in qualitative terms. Differences in the resulting scaled values, however, may exaggerate perceived quality differences.

185. The above comments do not invalidate WRAM or its usefulness.

If a decision has to be made with limited data, WRAM can still assist in the decision process. With WRAM, as with any other analytical procedure, the more refined the measurement techniques and data available the more definitive the final result will be.

186. It is recognized that there is a minimum amount of data required for WRAM or any other methodology to function adequately. As the stage of planning progresses, it is critical that a major portion of the variables be quantified to allow greater precision and accuracy in the scaling process and to minimize the use of more subjective paired comparisons. With the use of more quantitive data and predictive techniques, WRAM becomes more sensitive and reliable and provides more technically adequate evaluations. Minimum data requirements, however, cannot be arbitrarily established, even for categories or specific types of projects, since environmental, economic, and social characteristics, as well as project objectives vary both among geographical regions and with time.

187. Although the consensus as to the usefulness of WRAM was favorable, it was also recognized that WRAM is not a panacea for the problems of impact assessment and evaluation. One fear expressed by several team participants is that WRAM will be misused, primarily by assuming that the numerical analysis is a replacement of the planning process rather than a tool to be used within the process. It is imperative that potential users understand what WRAM can and cannot do for them:

- WRAM will not formulate plans; it will, however, assist planners in identifying critical concerns within an area that should guide effective plan formulation.
- WRAM will not collect data; however, it will help in the identification of critical areas needed to be addressed in data collection and can assist in the allocation of limited planning resources to data collection.
- WRAM should not be used as the exclusive plan-selection criterion; rather it should be used to assist decision-making through systematic data collection, analysis, documentation of the decision process, and testing of critical decision factors.

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