REND LAKE RESERVOIR, ILLINOIS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED JULY 6, 1962, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON AN INTERIM REPORT ON THE REND LAKE RESERVOIR, ILLINOIS, REQUESTED BY A RESOLUTION OF THE COMMITTEE ON PUBLIC WORKS, HOUSE OF REPRESENTATIVES, ADOPTED JULY 6, 1949

SEPTEMBER 12, 1962.—Referred to the Committee on Public Works and ordered to be printed with two illustrations

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1962

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(Only Plate 1 printed)

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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.

IN REPLY REFER TO:

Honorable John W. McCormack

August 23, 1962

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 6 July 1962, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on an interim report on the Rend Lake Reservoir, Illinois, requested by a resolution of the Committee on Public Works, House of Representatives, adopted 6 July 1949.

In accordance with Section 1 of Public Law 534, 78th Congress, and Public Law 85-624, the views of the Governor of Illinois and the Department of the Interior are set forth in the inclosed communications. The views of the Departments of Agriculture and Commerce, the Public Health Service and the Federal Power Commission are inclosed also.

The Bureau of the Budget advises that there is no objection to the submission of the report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

Cyrus Vance

Cyrus R. Vance
Secretary of the Army

1 Incl (dup)
Rept w/accompg
papers & illus

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON 25, D. C.

August 15, 1962

Honorable Cyrus R. Vance
Secretary of the Army
Washington 25, D. C.

Dear Mr. Secretary:

Assistant Secretary Schaub's letter of July 17, 1962, submits the proposed report of the Chief of Engineers on Rend Lake Reservoir on the Big Muddy River in Illinois, in partial response to a resolution adopted July 6, 1949, by the Committee on Public Works of the House of Representatives of the United States.

The Chief of Engineers recommends construction of the Rend Lake Dam and Reservoir on Big Muddy River, Illinois, for flood control, water supply, recreation, and fish and wildlife, and as a stimulus for economic redevelopment of the area, at an estimated first cost of $35,500,000. Local interests will reimburse the United States for costs allocated to water supply, currently estimated at $6,031,000, in accordance with the terms of the Water Supply Act of 1958, as amended. The benefit-cost ratio is stated to be 1.4.

The proposed Rend Lake Reservoir is located in an area of substantial and chronic unemployment. The project has been coordinated with the Area Redevelopment Administration of the Department of Commerce, and benefits to area redevelopment have been credited to the project. We note, however, that the project is economically feasible without the consideration of such benefits.

The standards for evaluation of water resources projects adopted by this administration recognize area redevelopment as a legitimate purpose of these works. Precise methods for determining the amount of such benefits have not, however, been developed or approved. Although it is apparent that Rend Lake promises a significant contribution to the improvement of economic conditions in southwestern Illinois, the measure of such benefits contained in the report has been determined somewhat arbitrarily. We would expect that with more experience and study of area redevelopment benefits as they relate to water resources projects, improved methods for measuring these values will be developed.

You are advised that there would be no objection to the submission of the report to the Congress. No commitment, however, can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Sincerely yours,

Acting Director

COMMENTS OF THE GOVERNOR OF ILLINOIS

OFFICE OF THE GOVERNOR

SPRINGFIELD

OTTO KERNER
GOVERNOR

May 31, 1962

Lt. General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Room 1230 P-7
Washington, D. C.

Dear General Wilson:

Your letter and the accompanying report entitled, "Abstract of Federal Report Rend Lake Reservoir", has been received and considered by this office. The recommendations for the construction of the Rend Lake Reservoir on Big Muddy River, Illinois, for flood control, water supply and other purposes are approved by this office and I urge that the Corps of Engineers expedite these proposals in every possible way. This approval is subject to the condition that I do not hereby and cannot, commit the State of Illinois to participation in construction of the projects or to future expenditures of State funds.

The Board of Economic Development of the State of Illinois is the official State agency for continued consideration of these proposals. They will provide such further State consideration, comment and cooperation as shall be required from time to time.

Sincerely,

Governor

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON 25, D. C.

6 July 1962

Dear General Wilson:

This is in reply to your letter of May 1, 1962, requesting our comments on reports on Rend Lake Reservoir, Illinois. The recommended construction consists of a dam and reservoir for flood control, domestic and industrial water supply, pollution abatement, fish and wildlife conservation, recreation development and as a means for regaining economic prosperity in southern Illinois.

During the final planning stages of the District and Division Engineer's reports and during the time the Board of Engineers for Rivers and Harbors studied the proposed project, staff of the Bureau of Mines provided information and consulting service on possible effects on mineral reserves. We note that estimated construction costs have been increased to provide for possible additional adverse effects on the future recovery of coal and oil from under the proposed reservoir.

Plans for land acquisition provide for acquisition in fee of approximately 32,400 acres to elevation 415, which is five feet above the flood control pool; 1400 acres for development of public recreational facilities at selected sites; 120 acres for hunting and fishing access in the proposed waterfowl area in the upper arms of the reservoir; 750 acres at the damsite; and 230 acres for roadway relocations and access roads to the dam. The sum of proposed acquisitions for all purposes amounts to about 34,900 acres. In addition to this acreage, the Rend Lake Conservancy District plans to acquire lands located within a quarter-mile outside the recommended acquisition line at elevation 415. The National Park Service advises that the 1400 acres proposed for acquisition for development for public recreation use are inadequate, particularly in the light of the large size of the impoundment and the importance of recreation.

It might be said that of the 32,400 acres to be acquired for the reservoir itself, the lands lying above the normal pool elevation, totalling 13,500 acres, would be available for recreation use. It is true that shoreline protection and access to the water surface afforded by these lands are important recreationally. Unfortunately, however, the bulk of this acreage will be located in the upper reaches of the impoundment where the topography is least desirable for recreation use. Also, some 7,600 acres of this land would be subject to frequent flooding and practically all of it would be inundated less frequently for short periods.

It would appear that a more logical distribution of lands acquired could be reached than by arbitrarily establishing an elevation below which all lands will be scheduled for acquisition. Following this procedure, the distance from the fee taking line to the shoreline of the normal pool will be long in the flat, least desirable recreational areas of the impoundment while the distance will be relatively short in the more desirable areas. It is believed that due to the character of the terrain and the distribution of existing cultural improvements in the area, this disproportionate distribution of publicly owned lands will be further exaggerated by any ensuing blocking-out by land purchasing activities.

The Park Service further advises that less land is needed in public ownership in the upper reaches of the reservoir than is presently designated for acquisition for shoreline protection, and that considerable additional lands should be publicly owned and held open for public recreation use in the lower portion of the area. Acquisition in fee to the top of the flood pool should be sufficient in those areas not needed for recreational development. A reappraisal of the recreational potential is recommended with particular attention to providing adequate land for the immediate and foreseeable needs for public general recreation purposes.

For compliance with the Act of June 27, 1960, (47 Stat. 220), relating to historical and archeological data, the District Engineer should keep the Regional Director, National Park Service, currently advised as to the status of the project.

The Fish and Wildlife Service interpreted the District Engineer's statement concerning "acceptance of recommendations," page 38 of his report to mean that all of the Service's recommendations have been accepted with the exception of the proposal to acquire land at Gun Creek for a goose management area.

We appreciate the opportunity of presenting our views.

Sincerely yours,

Kent Ko

Assistant Secretary of the Interior

Lt. General Walter N. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D. C.

22 June 1962

Honorable Elvis J. Stahr, Jr.
Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Chief of Engineers' letter of May 1, 1962, transmitting for our review and comment his proposed interim review survey report of Rend Lake Reservoir on the Big Muddy River, Illinois.

The report was prepared at the request of the Area Redevelopment Administration pursuant to an application by the Rend Lake Conservancy District for assistance in the construction of a dam and reservoir on the Big Muddy River in the vicinity of Benton, Illinois. The report recommends the construction of the Rend Lake Reservoir for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, and area redevelopment.

According to the report, the total average annual net benefits are estimated to be $1,675,000, of which approximately 13 percent are attributed to flood control, 20 percent to water supply and pollution abatement, 17 percent to area redevelopment and about 50 percent to fish and wildlife conservation and recreation. The report indicates that some of the benefits from the flood control features of the project will result from the reduction of flood damages to rural improvements and to crop and pasture lands. The report also estimates that some flood control benefits will accrue from increased production on areas, now in woodland, which may be converted to crop and pasture use as the result of a reduction in flooding.

The report estimates that 34,900 acres of land will be acquired for the basic project. Some of the lands which will be used for the project are now in cultivation and are capable of producing fair yields of adapted crops. However, the report does not provide information which would permit us to estimate the relationship between the additional production on the agricultural lands to be afforded protection and the loss of production on the lands to be acquired for project purposes. Therefore, we are unable to appraise the net effects of the proposed project on agricultural resources and production.

The report estimates that the net increase in demand for municipal and industrial water use by the year 2010 within a 25-mile radius of the

proposed project will be approximately 40 million gallons per day. Accordingly, the report recommends the inclusion of storage in the proposed reservoir to satisfy this demand. Although the report does not provide information on specific amounts to be made available to different municipalities, the city of Mt. Vernon, Illinois, is within the 25-mile radius considered to be the service area for the water supply feature of the project and may have been included in the estimates for municipal and industrial water needs.

The Jefferson County Soil Conservation District and the city of Mt. Vernon, Illinois, have sponsored a watershed project for the Seven Mile Creek Watershed under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, as amended). This plan provides for land treatment and structural measures for upstream erosion and sediment control, flood prevention, and approximately 5,200 acre-feet of water supply storage for the city of Mt. Vernon.

The watershed project was approved on June 29, 1961, and Federal assistance has been authorized under the provisions of Public Law 566 for the installation of the proposed works of improvement. It is estimated that the municipal water supply which will be made available by this project will meet the immediate needs of the city of Mt. Vernon. It does not appear that this municipality would require additional water from the proposed Rend Lake Reservoir until some future time.

We appreciate the opportunity afforded us to review this report.

Sincerely yours,

Frank J. Welch
Assistant Secretary

COMMENTS OF THE DEPARTMENT OF COMMERCE

THE UNDER SECRETARY OF COMMERCE
FOR TRANSPORTATION
WASHINGTON 25, D.C.

May 31, 1962

Lieutenant General W. K. Wilson, Jr., USA
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

As requested in your letter of May 1, 1962, I am transmitting herein the comments of the interested Department of Commerce agencies on your proposed report on the Rend Lake Reservoir, Illinois.

The Coast and Geodetic Survey advises that the vertical and horizontal geodetic control in the project area are adequate. The vertical geodetic control monuments established along State Highway 37 in the vicinity of Gun Creek may be damaged by the proposed construction. The Coast and Geodetic Survey would appreciate being advised of the need for the relocation of these monuments well in advance of the construction.

The Area Redevelopment Administration advises that the proposed Rend Lake Reservoir is located in a redevelopment area (Public Law 87-27) that has been suffering from widespread and persistent unemployment for over 30 years. This is an area with immense natural resources, a fine transportation network, a strategic geographic location within the Midwest and other assets. The one vital need that could lead to a full development of these resources, new jobs for virtually all the unemployed, and much needed community improvements of various kinds is a large and stable water supply. The proposed Rend Lake, in the opinion of most authorities, would solve this water problem.

The Area Redevelopment Administration, over a period of many months, has been vitally concerned with the Rend Lake project. Field investigations in southern Illinois substantiated the Area Redevelopment Administration's initial feeling that this project has great merit. In order to explore this matter further, however, the Area Redevelopment Administration, in September 1961, asked the Corps of Engineers to make an economic feasibility study of the project. To finance this work, the Area Redevelopment Administration provided the Corps of Engineers with a $45,000 technical assistance grant.

The initial report of the Corps of Engineers and its subsequent revisions, prepared with the assistance of various Federal and State agencies, show that this multi-purpose water conservation project would aid southern Illinois in many ways. In addition to a much needed water supply for domestic use and industrial purposes, the area would profit greatly from flood control, recreation, and wildlife preservation. In view of these substantial benefits, the Corps of Engineers recommended that the development of the Rend Lake Reservoir move ahead at the earliest opportunity. The Area Redevelopment Administration concurs with this recommendation and strongly urges that work on the project begin without delay.

The Bureau of Public Roads notes that the construction of Rend Lake Reservoir will require the relocation of a number of primary and secondary highways and that the cost of reconstructing these highways ($6,278,000) has been included as a part of the project cost. The Bureau of Public Roads also understands that the additional cost of building Interstate Highway 57 through the area that will be inundated by the reservoir to the higher gradeline necessitated by the reservoir has also been included as a part of the project cost. It is assumed that the relocated highways will be rebuilt to the then current standards for the traffic existing at the time the highways are reconstructed.

Your courtesy in providing a copy of this report for our review is appreciated.

Sincerely yours,

Frank L. Barton

Frank L. Barton
Deputy Under Secretary
for Transportation

COMMENTS OF THE PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE — WASHINGTON 25, D. C.

BUREAU OF STATE SERVICES — Refer to:

June 13, 1962

Major General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

This is in reply to your letter of May 1, 1962, requesting comments on the Rend Lake Reservoir--Big Muddy River, Illinois.

The Public Health Service recommendations on water supply and water quality control are included in the report in Appendix D. We note that the recommended storage for both these purposes is provided in the proposed project.

It is recommended that vector control measures be incorporated into the plans for this project, and that, in this connection, coordination be maintained with the Illinois Department of Public Health.

The opportunity to review the report is appreciated. We stand ready to provide consultation concerning vector control, water supply and pollution control aspects of the project on your request.

Sincerely yours,

James B. Coulter

James B. Coulter
Acting Chief
Technical Services Branch
Division of Water Supply
and Pollution Control

COMMENTS OF THE FEDERAL POWER COMMISSION

FEDERAL POWER COMMISSION
WASHINGTON 25

14 June 1962

Lieutenant General W. K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Reference: ENGCW-PD

Dear General Wilson:

This is in reply to your letter of May 1, 1962, inviting comments by the Commission with regard to your proposed report and to the reports of the Board of Engineers for Rivers and Harbors and of the District and Division Engineers on Rend Lake Reservoir, Illinois.

The reports of your Department recommend construction of the Rend Lake reservoir on Big Muddy River for flood control, water supply, and other purposes. The reservoir would provide a total storage capacity of 302,500 acre-feet and control the runoff from a drainage area of 488 square miles. The estimated cost to the United States for project construction is $35,500,000, of which the net cost would be $29,469,000 after reimbursement by local interests for water supply.

Studies by the Commission staff show that use of the water supply storage for power purposes would make possible a continuous power output of about 130 kilowatts. With an installed capacity of 1,300 kilowatts at the project, the average annual generation would be approximately 4,250,000 kilowatt-hours. The studies show that the value of this power would be substantially less than the cost of the necessary power facilities.

Based on its consideration of the reports of your Department and the studies of its own staff, the Commission concludes that the development of hydroelectric power is not economically feasible at the proposed Rend Lake reservoir.

Sincerely yours,

Joseph C. Swidler

Joseph C. Swidler
Chairman

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REND LAKE RESERVOIR, ILLINOIS

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO

ENGCW-PD 6 July 1962

SUBJECT: Rend Lake Reservoir, Illinois

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the report of the Board of Engineers for Rivers and Harbors, accompanied by the reports of the District and Division Engineers, in partial response to a resolution adopted 6 July 1949 by the Committee on Public Works of the House of Representatives, United States, concerning the advisability of providing improvements in the interest of flood control, water conservation, and other purposes on Big Muddy River and its tributaries, Illinois. It is confined to consideration of the proposed Rend Lake Reservoir on Big Muddy River near Benton, Illinois.

2. The reporting officers recommend authorization of the Rend Lake Dam and Reservoir on Big Muddy River, Illinois, for flood control, water supply, and other purposes, at an estimated cost of $30,400,000 for construction and $88,000 annually for maintenance, operations, and major replacements, subject to certain requirements of local cooperation, including payment or reimbursement of certain costs allocated to water supply, fish and wildlife conservation, and general recreation.

3. The Board of Engineers for Rivers and Harbors, after full consideration of the reports of the District and Division Engineers and of the additional information received in response to the Division Engineer's public notice, concludes that the estimated construction costs should be increased to provide for possible adverse effects on the future recovery of mineral reserves and for increased highway construction costs in the reservoir area. It also concludes that acquisition of project lands, including the subordination of mineral and oil rights, should be undertaken by the Corps of Engineers in accordance with its normal procedures. In establishing the requirements of local cooperation, the Board considers that local interests should not be required to contribute to the costs allocated to fish and wildlife conservation. Accordingly, the Board recommends construction of the Rend Lake Reservoir on Big Muddy River, Illinois, for flood control, water supply, and other purposes, at an estimated

cost of $35,500,000 for construction of which $27,600,000 would be Federal cost after reimbursement of $7,900,000 by local interests for costs allocated to them for water supply and recreation, presently estimated at $6,031,000 and $1,869,000, respectively. Operation and maintenance costs, including major replacements, are estimated at $88,000 annually, of which $70,000 would be Federal and $18,000, non-Federal. The benefit-cost ratio is 1.4.

4. I concur generally in the findings of the Board. The proposed reservoir will provide a valuable fish and wildlife conservation and flood control service. The Area Redevelopment Administration has determined that the project also will provide for a basic need for permanent constructive reorientation of the depressed economy of the region through the provision of water supply and recreation potentials which will lead to relief from the substantial persistent unemployment causing hardship to thousands of individuals and their families, thus detracting from the national welfare. The plan has been formulated to obtain optimum utilization of the reservoir site and is economically justified by a substantial margin.

5. With respect to recreation the project plan provides for the balanced basic development necessary for fully effective public use and enjoyment of related potentials for recreation which will be created by the reservoir. In accordance with procedures in effect within the Corps of Engineers at the time of preparation of their reports the District and Division Engineers assigned to local interests portions of the reservoir costs allocated to recreation. The Board concurred.

6. The cost-sharing procedures followed by the reporting officers have been under review for some time in recognition of the principle that provision of adequate opportunities for outdoor recreation is among the basic requirements of a sound national conservation program, and of growing public demands on Federal land and water areas. These demands give indication of doubling the 1960 rate of use by 1970 and a several-fold increase by the end of the century. Both principle and demand have been confirmed by the recent report of the Outdoor Recreation Resources Review Commission to the President and Congress, and emphasized by the President in his recent conservation message to the Congress. The Commission's investigations disclosed the pivotal role of water in outdoor recreational activity and stressed the need for public action to assure that adequate opportunities for water-based outdoor recreation are

accessible to all Americans. I believe this objective will be fostered by Federal assumption of the separable cost of balanced basic recreational development, plus a portion of joint project costs allocated to this function in the order of 25 percent or less of total project costs. In the case of Rend Lake joint costs allocated to such development are well within this limit. I concur in the recommendations of the Board, with the exception of the requirement that local interests participate in the cost of the project in relation to the basic recreational services it will provide. Accordingly I recommend that local interests reimburse the United States for costs allocated to water supply alone, presently estimated at $6,031,000, as first cost and $9,000 for annual operation and maintenance. The first cost of construction to the Federal Government would be $35,500,000 with a net cost, after reimbursement for water supply, of $29,469,000; and $79,000 annually for operation and maintenance.

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

CORPS OF ENGINEERS, U. S. ARMY
BOARD OF ENGINEERS FOR RIVERS AND HARBORS
WASHINGTON 25, D.C.

ENGBR 26 February 1962

SUBJECT: Rend Lake Reservoir, Illinois

TO: Chief of Engineers
Department of the Army

1. Authority and scope.--This report is in partial response to the following resolution adopted 6 July 1949:

> Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River, printed in House Document Numbered 669, Seventy-sixth Congress, Third Session, with a view to determining the advisability of providing improvements in the interest of flood control, water conservation, and other purposes on Big Muddy River and its tributaries, Illinois.

The report considers the advisability of Federal construction of the proposed Rend Lake Reservoir on Big Muddy River near Benton, Illinois.

2. Basin description.--The Big Muddy River, draining 2,360 square miles in southern Illinois, rises in Jefferson County and flows 155 miles to empty into the Mississippi River 75.7 miles above the mouth of the Ohio River. The watershed of 488 square miles above the site of the proposed dam is hilly with broad, flat lowlands along the principal tributaries. The stream slope is about 1 foot per mile in the reach near Benton, and channel capacities range from 1,000 cubic feet per second at Benton to 5,000 cubic feet per second at Murphysboro.

3. Economic development.--Mining of bituminous coal, oil production, and farming are the principal industries within the area under consideration. Franklin and Jefferson Counties, within which the proposed Rend Lake Reservoir is located, ranked fourth and sixth, respectively, in coal production in Illinois in 1960. The economy of southern Illinois has been declining for over 30 years due largely to

the mechanization of coal-mining operations. Franklin and Jefferson Counties have 24.4 percent and 11.4 percent, respectively, of the labor force unemployed. The population of the two counties in 1960 was 71,600, of which 48 percent was urban.

4. Water-resource problems.--

a. Flooding.--Storms with heavy rainfall occur most frequently during spring and early summer. The flood of May 1961 was the largest of the six major floods which have occurred in the basin since 1915. Maximum discharge at Benton was 35,800 cubic feet per second. About 103,400 acres of bottom land along Big Muddy River below the proposed Rend Lake dam site, at mile 103.7, are subject to flooding. The average annual damage is estimated at about $157,000 of which $57,000 is crop damage and $100,000, property damage.

b. Water supply.--Municipal and industrial water is presently obtained from wells or surface impoundments. Seasonal fluctuations and extended drought periods seriously deplete water supplies. With allowances for existing water-supply facilities, it is estimated that the net increase in water demand by 2010 within 25 miles of Benton will be about 40 million gallons per day.

c. Stream pollution.--It is anticipated that, under state law, municipalities will take proper measures to correct the general pollution problem for normal stream-flow conditions. However, low-flow augmentation is desirable during drought periods when there may be little or no flow in the river.

5. Improvements desired.--Local interests desire construction of the Rend Lake Reservoir to provide water supply, recreation, and pollution abatement. They contend that the proposed project would aid substantially in reducing the unemployment and distressed economic conditions in the area. Downstream interests emphasize the need for flood control. Coal-mine owners in the area, while not opposed to the project, request that full consideration be given to any adverse effects the project might have on their continued operations. The District Engineer reports that the Rend Lake Conservancy District has expressed willingness and financial ability to meet the requirements of local cooperation.

6. Improvements considered.--The District Engineer finds that the most feasible plan of development would consist of a rolled-earth dam on Big Muddy River at mile 103.7. The dam would be 42 feet high

above the flood plain with a reinforced concrete spillway and an auxiliary earth spillway located in the east abutment. The combined length of dam and spillway would be 8,900 feet. Outlet works through the earth section of the dam would consist of two 6-foot by 6-foot sluices for regulation of the pool under normal operating conditions and drawdown of the pool. The reservoir would have a capacity of 302,500 acre-feet consisting of 111,500 for flood control, 109,000 for water supply, 57,000 for pollution abatement, and 25,000 for siltation. As an adjunct to the project, two small impoundments would be provided on two of the upper arms of the reservoir for wildlife conservation. The District Engineer estimates the construction cost, based on January 1962 prices, at $30,400,000, exclusive of $45,000 for preauthorization study costs. Under his plan, local interests would be required to reimburse the Federal Government for the cost assigned to them for water supply, fish and wildlife conservation, and general recreation, an amount estimated at $8,100,000. The annual charges are estimated at $1,075,300, of which $749,600 would be Federal and $325,700, non-Federal. These include operation, maintenance, and major replacement costs of $88,000 annually of which $66,600 would be Federal and $21,400, non-Federal. The net average annual benefits are estimated at $1,675,000, consisting of $216,000 for flood control, $301,000 for water supply, $61,000 for pollution abatement, $312,000 for fish and wildlife conservation, $536,000 for recreation, $285,000 for area redevelopment, and a deduction of $36,000 for added cost to overland transportation. The benefit-cost ratio is 1.6, based on a 100-year period of analysis. The District Engineer concludes that a multiple-purpose reservoir on Big Muddy River is economically justified and will contribute to the permanent constructive reorientation of the depressed economy of the region.

7. Local cooperation.--Under the District Engineer's plan, local interests would be required to repay the United States for all costs allocated to water supply in accordance with provisions of the Water Supply Act of 1958 as amended. They would also be required to pay their part of the costs for construction and subsequent operation, maintenance, and major replacements allocated to fish and wildlife conservation and general recreation.

8. Recommendations of reporting officers.--The District Engineer recommends authorization of Rend Lake Dam and Reservoir on Big Muddy River, Illinois, for flood control and other purposes, generally in accordance with his plan, subject to certain local cooperation. The Division Engineer concurs, and in addition recommends that the

Chief of Engineers be authorized to effect a formal agreement with the Rend Lake Conservancy District regarding proposed schedules of land acquisition and the advancing of Federal funds from annual project appropriations sufficient for land acquisition as scheduled. He further recommends that no construction be undertaken until valid title to the dam site and other construction areas have been obtained and delivered to the United States, and subordination of oil, gas, and mineral rights has been accomplished by the Conservancy District.

9. Public notice.--The Division Engineer issued a public notice informing interested parties of the recommendations of the reporting officers and affording them an opportunity to present additional information to the Board. Careful consideration has been given to the communications and information received.

Views and Recommendations of the Board of Engineers for Rivers and Harbors.

10. Views.--After careful consideration of the reports of the District and Division Engineers, and of the additional information received in response to the Division Engineer's public notice, the Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers except in the following respects:

a. The Board believes that the estimated project costs should be increased to provide for possible additional adverse effects on the future recovery of coal and oil from under the proposed reservoir area, and to include additional costs for raising Interstate Route 57 through the reservoir area;

b. The Board considers that the acquisition of project lands, including the subordination of mineral and oil rights, should be accomplished by the Corps of Engineers in accordance with its normal procedures; and

c. The Board concludes that because of the general nature of the fish and wildlife conservation benefits, local interests should not be required to contribute to this feature of the improvement.

As a result of the above, the Board estimates the total cost of the project at $35,500,000, of which $27,600,000 would be Federal

and $7,900,000, non-Federal. The non-Federal cost includes reimbursement for water supply amounting to 16.99 percent of the construction cost, currently estimated at $6,031,000, and a portion of the cost allocated to general recreation amounting to 5.26 percent of the construction cost, currently estimated at $1,869,000. Operation and maintenance costs, including major replacements, are estimated at $88,000 annually, of which $70,000 would be Federal and $18,000, non-Federal. The benefit-cost ratio is 1.4.

11. The Board also notes that the project has been coordinated with the Area Redevelopment Administration, United States Department of Commerce, and benefits have been credited to the proposed project for area redevelopment effects. These secondary benefits are not generally used for project justification, but because of the active participation of the Area Redevelopment Administration in the proposed project, the Board believes it appropriate to include such benefits in this instance. The estimated costs allocated to the area redevelopment feature are $7,166,000 for construction and $200 annually for operation and maintenance. These have been included in the net Federal costs.

12. Recommendations.--The Board accordingly recommends construction of the Rend Lake Reservoir on Big Muddy River, Illinois, for flood control, water supply, and other purposes, generally in accordance with the plan of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated total cost of $35,500,000 for construction and $88,000 annually for maintenance, operation, and major replacements: Provided that prior to construction local interests furnish assurances satisfactory to the Secretary of the Army that they will:

a. Hold and save the United States free from damages for any water-rights claims resulting from construction and operation of the project;

b. Reimburse the United States in accordance with the Water Supply Act of 1958, as amended, the first costs and the annual operation and maintenance costs allocated to municipal and industrial water-supply storage, tentatively estimated at $6,031,000 and $8,800, respectively, for the ultimate development; and

c. Pay that portion of the joint construction costs allocated to recreation which is in excess of 15 percent of the initial construction cost amounting to 5.26 percent of the initial construction cost, presently estimated at $1,869,000, plus interest during construction on this amount; and pay that assigned portion of the

maintenance, operation, and major replacements costs allocated to recreation, amounting to 10.45 percent of the total annual project costs for maintenance, operation, and major replacements, presently estimated at $9,200;

Provided further, that payments by local interests of the assigned portions of first costs of the project for which they are responsible may be made in a lump sum prior to commencement of construction, in installments prior to commencement of pertinent items, in accordance with construction schedules as required by the Chief of Engineers, or in equal annual payments beginning when the project is first available for these specific uses, and in any event within 50 years after the project is first available for such uses, and shall include interest on any unpaid balances.

13. Of the Federal construction cost of $35,500,000 for the recommended improvements, the net cost to the United States is estimated at $27,600,000 after payment by local interests of the costs assigned to them for water supply and general recreation.

FOR THE BOARD:

KEITH R. BARNEY
Major General, USA
Chairman

SYLLABUS

This is an interim report on the basin investigation of the Big Muddy River, authorized by House Public Works Committee Resolution dated 6 July 1949, and is made at the request of the Area Redevelopment Administration pursuant to application by the Rend Lake Conservancy District for assistance in construction of a dam and reservoir on the Big Muddy River in the vicinity of Benton, Illinois. The Rend Lake Reservoir, as outlined herein, would provide substantial flood reduction in the Big Muddy River valley with incidental reduction in Mississippi River flood flows; an assured source of water supply for present and future needs; low-flow augmentation in the interest of sanitation in the Big Muddy River; fish and wildlife conservation; and recreation. In addition to these primary benefits, the Rend Lake Reservoir would contribute to the reorientation of the depressed economy of the region. The total cost of the project is estimated at $30,400,000, of which $22,300,000 would be Federal and $8,100,000 non-Federal. The Federal cost includes $6,373,000 allocated to the Area Redevelopment Administration. The non-Federal cost includes repayment for water supply amounting to $4,990,000; a cash contribution of $1,583,000 for fish and wildlife benefits; and a contribution of $1,527,000 because of special local benefits for recreation. Average annual benefits are currently estimated at $1,675,000, and annual charges at $1,075,300, giving a benefit-cost ratio for the Rend Lake Reservoir of 1.6 to 1. The District Engineer recommends that the Rend Lake Reservoir be authorized as a multiple-purpose project for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, and area redevelopment, subject to specified requirements of local cooperation.

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
420 LOCUST STREET
ST. LOUIS 2, MISSOURI

ADDRESS REPLY TO
DISTRICT ENGINEER
REFER TO FILE LMLED-P

27 December 1961

SUBJECT: Interim Report, Rend Lake Reservoir, Illinois

THRU: Division Engineer
U. S. Army Engineer Division, Lower Mississippi Valley
Vicksburg, Mississippi

TO: Chief of Engineers
Department of the Army
Washington 25, D. C.

SECTION I - AUTHORIZATION, PURPOSE, AND SCOPE

1. AUTHORIZATION

This interim report is submitted in partial response to the following resolution adopted by the Committee on Public Works of the House of Representatives, 6 July 1949.

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River, printed in House Document Numbered 669, Seventy-sixth Congress, Third Session, with a view to determining the advisability of providing improvements in the interest of flood control, water conservation, and other purposes on Big Muddy River and its tributaries, Illinois."

Pursuant to application made by the Rend Lake Conservancy District for assistance in construction of a dam and reservoir on the Big Muddy River, the Area Redevelopment Administration, U. S. Department of

Commerce, made funds available to the Corps of Engineers requesting preparation of a survey report on the proposed Rend Lake project. Preparation of the report was assigned the U. S. Army Engineer District, St. Louis, Missouri, on 6 October 1961.

2. PURPOSE

This is an interim report on the basin investigation of the Big Muddy River authorized by the foregoing resolution. The purpose is twofold - to determine the engineering and economic feasibility of the proposed Rend Lake Reservoir to provide for multiple-purpose use, including flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, and area redevelopment; and to determine the extent of Federal interest in the proposed project.

3. SCOPE

The scope of this report is limited to a review of plans for the proposed Rend Lake Reservoir and a study to insure that the proposed reservoir will provide a practical and economic means of fulfilling existing and prospective needs. A report prepared by the Division of Waterways, Department of Public Works and Buildings, State of Illinois, in 1957, entitled "Report of Survey, Rend Lake Reservoir, Jefferson and Franklin Counties", is the basic document under review.

a. Field work undertaken for the investigation consisted of reconnaissance, foundation explorations, and flood damage surveys. A study of proposed land use and development, prepared by a planning and resource consultant for the Rend Lake Conservancy District, was utilized to the fullest extent.

b. During preparation of the report, all appropriate Federal and State agencies and local organizations were advised of the scope of the investigation and consulted as to their interest in the improvements under study. The District Engineer has made a reconnaissance of the area.

4. PRIOR REPORTS

The following is a list of prior reports dealing in whole or in part with the Big Muddy River.

a. Preliminary examination of the Big Muddy River, prepared by the U. S. Army Engineer District, St. Louis, dated 26 January 1926, concluded that flood control improvements were not feasible at that time.

b. Report, prepared under authority of the River and Harbor Act of 3 March 1925, by U. S. Army Engineer District, St. Louis, dated 10 May 1933, contained a study of navigation possibilities on the Big Muddy River. Recommendations contained in the report were unfavorable to improvements.

c. House Document No. 669, 76th Congress, third session, dated 20 March 1940, presented a general plan for improvement of the Mississippi River above the mouth of the Ohio River in the interest of flood control, navigation, and water power. A reservoir on the Big Muddy River at Murphysboro was considered as a possible means of flood control at some future time.

d. Preliminary examination of the Big Muddy River and Beaucoup Creek, prepared by the U. S. Army Engineer District, St. Louis, dated January 1957, concluded that it was technically feasible to provide improvements for modern barge transportation and recommended a survey report to determine definitely the economic feasibility of such improvements.

e. Report under review herein, prepared by the Division of Waterways, State of Illinois, dated 1957, in response to Illinois State Senate Bill No. 406, 69th General Assembly, determined the engineering feasibility of a dam and reservoir on the Big Muddy River near Benton to serve the purposes of municipal and industrial water supply, recreation, conservation, and other related uses.

SECTION III - DESCRIPTION

5. BASIN CHARACTERISTICS

a. Watershed. The Big Muddy River basin is located in Southern Illinois and drains all or parts of eight counties. This report is concerned specifically with that portion of the basin lying in the upper reaches of the Big Muddy River above Benton containing approximately 488 square miles or about one-fifth of the entire Big Muddy basin. See plate 1, Basin Map.

b. Main stem. The Big Muddy River rises in Jefferson County, flows in a generally southwesterly direction a distance of approximately 155 miles, and empties into the Mississippi River at mile 75.7 above the mouth of the Ohio River, near Grand Tower. Approximately 50 miles, one-third of its length, are located upstream of the proposed Rend Lake damsite.

c. Tributaries. The major tributaries to the proposed reservoir are listed in table 1.

Table 1
Streams and watershed areas tributary
to proposed Rend Lake Reservoir

Name	Drainage area (square miles)
Casey Fork	114
Rayse Creek	98
Atchison Creek	23
Gun Creek	45
Marcum Creek	7
Big Muddy	99
Area immediately tributary to reservoir	63
Reservoir area (elevation 410)	39
Total	488

d. Topography. The watershed of the area under consideration herein is characterized by hilly upland topography and broad, almost flat lowlands along the principal streams. Maximum topographic

relief varies from approximately elevation 620 feet m. s. l. near the headwaters to approximately elevation 380 feet m. s. l. at the site of the proposed Rend Lake Dam. Along the Big Muddy River and at the confluence of tributaries, the bottom lands are continuous, varying from approximately 1 to 2 miles in width.

6. GEOLOGY

Prior to the Illinoian Glacial Epoch, the Big Muddy River cut a broad valley through the Pennsylvanian shales and sandstones in the Rend Lake area. Following the withdrawal of the Illinoian ice sheet, large quantities of melt water caused the Mississippi River to carry such large quantities of sediments that the river's capacity to transport them was exceeded. The Mississippi River then began to aggrade its channel, and valley train deposits were built up across the mouths of some of its tributary streams. The Big Muddy River was one that was unable to cut through these deposits as fast as the Mississippi laid them, and thus became impounded. This lake characteristic was probably intermittent in character, but well defined terrace levels are evidence of at least two different periods of prolonged lake existence. When the Mississippi River was once more capable of transporting the sediment delivered to it, degrading of its channel occurred and the ponded Big Muddy River, now nearly full of sediment, began to drain. Typical of the lacustrine deposits, sediments of the Big Muddy valley consist of a series of clays and silts, laminated with small carbonaceous and calcareous concretions, with intermittent laminae of very fine sand. The clays and silt composing the lake fill are relatively impervious, although they have been found to be saturated; ground water moves along the thin irregular layers of fine sand previously mentioned. The deeper portions of valley fill consist of silts, sands, and fine gravels which probably are remnants of an early valley train deposit formed when the stream carried melt water from the ice margin. This lower portion varies in permeability with the degree of uniformity of sorting, but does not contain considerable ground water. Bedrock is 60 or more feet below the flood plain, with the deeper portion occurring on the west side of the valley in the Sesser area. Bedrock consists of sandstone underlain by shale and is of the McLeansboro group of the Pennsylvanian sediments.

7. STREAM CHARACTERISTICS

The total fall of the Big Muddy River is about 260 feet. Water surface slopes vary from about 10 feet per mile near the source to about 1 foot per mile in the area of Benton. Widths of the Big Muddy

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River channel in the area upstream of Benton vary from about 100 feet for low water conditions to an average of about 285 feet for high water conditions. Bank height averages approximately 20 feet. Channel capacity of the Big Muddy River ranges from approximately 1,000 c.f.s. at Benton to 5,000 c.f.s. at Murphysboro.

8. ECONOMIC DEVELOPMENT

a. Population. Based on the 1960 census, total population of Jefferson and Franklin Counties, in which the proposed Rend Lake Reservoir is located, is estimated at 71,600, of which approximately 48 percent is urban. Table 2 lists towns in Jefferson and Franklin Counties having a population of 500 or more.

Table 2
Population of principal towns

Town	Population
Benton	7,023
Buckner	610
Christopher	2,854
Mount Vernon	15,566
Orient	588
Royalton	1,225
Sesser	1,764
West City	814
West Frankfort	9,027
Valier	649
Zeigler	2,133

b. Employment. Southern Illinois for over 30 years has been an area of chronic unemployment and underemployment. This is attributed to the fact that its economy is based primarily on coal mining, and employment in that industry has fallen from about 25,000 workers in the late 1920's to around 4,000 at the present time. This decline is largely the result of mechanization. For the labor market area which embraces the territory surrounding the proposed Rend Lake Reservoir, current unemployment is estimated at approximately 20,000. Franklin and Jefferson Counties, in which the proposed reservoir is located, show 24.4 percent and 11.4 percent, respectively, of the labor force unemployed. Of the eight counties which lie in whole or in part in the Big Muddy River basin, seven are presently classified as areas of substantial and persistent unemployment.

c. Industry. Mining of bituminous coal, oil production, and farming are the principal industries within the area under consideration. As of 1960, Franklin and Jefferson Counties ranked fourth and sixth, respectively, in coal production in the State. Six mines in Franklin County produced approximately 4,129,000 tons of coal in 1960 and two mines in Jefferson County produced approximately 2,960,000 tons of coal. An important area of Illinois oil production is in Franklin County which produced approximately 39,600,000 barrels through 1954 for which latest figures are available. Accumulated production in Jefferson County reached 45,000,000 barrels by the end of 1954. The amount of new growth has been relatively small in recent years. Approximately 51 producing oil wells are located within the proposed Rend Lake Reservoir. In the Franklin-Jefferson County area, there are several small manufacturing plants, including food, apparel, lumber, printing, leather, metal, machinery, and miscellaneous items. Agricultural products include corn, forage, and orchard crops. Some livestock raising is carried on in the area.

d. Land usage. There is shown in table 3 a generalized land use description of the Big Muddy River watershed. In the proposed Rend Lake Reservoir area, the valley floor is heavily timbered and overgrown with brush. Some logging operations are currently active, but are limited to cutting out the relatively sparse merchantable timber. A few farms are operated in the cleared areas of the valley floor and along the fringes of the timbered areas, but these are subject to frequent overflow. In the upland areas surrounding the reservoir where soil and drainage conditions are more suitable and flooding is less frequent, there are profitable fruit, grain, agricultural, and dairy farmlands.

Table 3
Land use in the Big Muddy watershed

Use	Percent of watershed
Farmland	64
Forest	21
Wasteland	12
Urban	3

e. Natural resources. Commercially significant natural resources of the Rend Lake area consist of coal and oil.

f. Transportation facilities. The area under consideration is presently served by Federal and State highways, supplemented by a system of county and township roads. The State of Illinois presently has plans, and is in the process of obtaining right-of-way, for an interstate highway which will generally parallel the east side of the proposed reservoir. Rail transportation is furnished by six lines - the Missouri Pacific; Illinois Central; Southern; Chicago, Burlington and Quincy; Louisville and Nashville; and the Chicago and Eastern Illinois Railroads. A few municipalities within the general area are served by air transportation.

g. Navigation, water supply, and other water uses. Although the lower 37.5 miles of the Big Muddy are designated by law as navigable, the river is not regarded as a commercially navigable stream in its present state. Domestic and industrial water supplies within the basin are obtained from surface impoundments and from wells. There are no hydroelectric power developments within the basin. No commercial irrigation is practiced, and the need for major irrigation is not apparent since, under normal conditions, precipitation is adequate and well distributed.

9. CLIMATOLOGY

a. General. The area is characterized by hot summers and cool winters. The climatology of the area is presented in detail in appendix C.

b. Temperature. The climate of the basin is considered moderate, having a mean annual temperature of about 56 degrees and a recorded temperature range from -20 to 114 degrees. Weather changes and temperature fluctuations are frequent throughout the year.

c. Precipitation. Average annual rainfall is approximately 40.6 inches. Maximum rainfall of 4.70 inches in 24 hours was recorded at Benton on 27 December 1922. The area has experienced occasional droughts, the most severe extending from April 1952 to April 1955.

d. Storm characteristics. Most of the storms that cross the basin follow prevailing wind patterns, moving from the southwest to northeast during the spring and summer months and from the

northwest to the southeast during the winter. The area is subjected to intense local rainstorms of short duration, as well as to widespread storms of lesser intensity. The more notable storms of record are of the latter type and have been responsible for the major floods within the basin. Storms with heavy rainfall are more frequent during the spring and early summer months.

10. STREAM FLOW DATA

a. Discharge. Stream flow data on the Big Muddy River have been collected intermittently from 1908 to date at three gaging stations on the main stem. Maximum and minimum discharges recorded at the stations are shown in table 4.

Table 4
Mean, maximum, and minimum discharges

Gaging station	Location (river mile)	Drainage area (square mile)	Discharge c.f.s. Mean	Maximum*	Minimum
Benton	98.6	498	497	35,800	0
Plumfield	86.0	753	713	43,500	0
Murphysboro	35.9	2,170	1,845	32,000	0

* Flood of May 1961.

b. Stream flow characteristics. In the Big Muddy River basin, runoff is rapid in the area extending from the headwaters to Plumfield and sluggish from Plumfield to the mouth. Crests occur two to three days after beginning of rise at Benton and four to five days after beginning of rise at Plumfield. At Murphysboro, crests occur about seven days after beginning of a rise. Recession after crest is slow. The lowermost reaches are affected by backwater from the Mississippi River.

11. FLOODS

Detailed flood data were not available prior to 1913; however, newspaper accounts and records indicate that destructive floods occurred in 1875, 1908, and 1913. Principal floods during the period of record were those of 1915, 1943, 1944, 1946, 1950, and 1961. The flood of 7-25 May 1961 is the greatest flood of record. Storm runoff for this period was estimated at 10 inches. Maximum discharges of 35,800 c.f.s. with a crest stage of 24.94 feet were recorded at Benton and 43,500 c.f.s. with a crest stage of 29.67 feet were recorded at Plumfield.

SECTION IV - EXISTING PROJECTS

12. CORPS OF ENGINEERS' PROJECTS

The Degognia and Fountain Bluff Levee and Drainage District and the Grand Tower Drainage and Levee District are located in the Mississippi River bottoms adjacent to the Big Muddy River. Their levee systems provide protection against flooding from both the Mississippi and Big Muddy Rivers. Levee protection for the Degognia and Fountain Bluff and the Grand Tower Districts was authorized by the Flood Control Acts of 22 June 1936 and 28 June 1938, respectively. The projects were completed in 1959.

13. IMPROVEMENTS BY OTHER AGENCIES

a. U. S. Fish and Wildlife Service. The Crab Orchard project, located in the southern part of the Big Muddy watershed near Carbondale, consists of three dams and reservoirs - Crab Orchard Lake, Little Grassy Lake, and Devil's Kitchen Lake. The project affords a source of municipal and industrial water supply to neighboring towns, wildlife conservation areas, and recreational areas for the public. The project as a whole was initiated as a land utilization project of the Resettlement Administration in 1936. Authorized as a State-operated Works Project Administration development approved by the Soil Conservation Service, it subsequently has been transferred and placed under the jurisdiction of the U. S. Fish and Wildlife Service.

b. Local impoundments. Within the Big Muddy watershed there are a number of small surface impoundments built by local interests to provide sources for municipal water supplies. In addition, there are a few small impoundments scattered throughout the basin built solely for recreational purposes.

SECTION V - PROBLEMS UNDER INVESTIGATION

14. BIG MUDDY RIVER

a. Flood problem. The major portion of the developed areas in the Big Muddy basin is located at levels where flooding is infrequent. Damage from floods is confined generally to the bottom land areas along the Big Muddy River and its tributaries. With the exception of the major flood of record, that of May 1961, floods are not a serious hazard to urban areas. In the area between the mouth of the Big Muddy River and the site of the proposed Rend Lake Reservoir, mile 103.7, there are approximately 103,400 acres of bottom lands subject to flooding. The majority of this area is in timber. Most of the flooding occurs during the period January through May. Analysis of flood data covering the period 1940-1961 shows that there were 20 years in which the river was above flood stage. At Benton, the greatest flood discharge, 35,800 c.f.s., occurred during the period 7-25 May 1961. Flood damage surveys were made by the St. Louis District as part of an overall evaluation. The surveys included general information on farm practices, average yields, usual flood behavior, and data on rural and urban property damages. The flood plain below the proposed damsite was divided into a number of reaches and area-elevation curves constructed for each reach. Damage per acre for various crops and periods of time during planting, growing, and harvesting seasons was developed. Utilizing flood frequency profiles, the number of cultivable acres inundated on an average annual basis was determined. Damage values were then applied to the crop acres inundated to arrive at the average annual crop damage, currently estimated at $57,200. Urban and rural property damages were determined and evaluated on a frequency basis. Average annual urban and rural property damage was estimated at $78,100 and $21,800, respectively. Total average annual damage within the basin below the proposed Rend Lake Reservoir is estimated at $157,100. Data and procedures used in determining average annual damages are outlined in appendix A.

b. Water supply. Towns and communities within the basin presently obtain their water supply from wells or surface impoundments. Wells are subject to seasonal fluctuations, and during extended drought, ground waters have become critically low. Well water is a source of supply for small isolated communities and rural households. During drought periods, many rural homes purchase water delivered by tank truck. The capacities of some

surface impoundments have been seriously impaired by sedimentation. Several communities that are dependent upon surface impoundments as their main source of water supply have suffered loss of interested industry because of lack of adequate water supply.

c. Stream pollution. The State of Illinois has enacted water pollution legislation. Progress in water pollution control is reflected in construction of new sewage treatment plants and additions to existing facilities within the basin. It is anticipated that municipalities will undertake the necessary improvements to correct the general pollution problem under normal stream flow conditions. However, low-flow augmentation from the reservoir is deemed desirable during drought periods when zero flow is experienced under existing conditions.

d. Socio-economic problem. Unemployment and underemployment are the area's basic problems. Closely associated with this is the physical deterioration of many structures and community facilities. Evidence of stagnation is widespread with a profusion of neglected and vacated buildings in numerous towns, particularly those in the coal mining region. The agricultural industry is of a marginal nature and, contrary to the national trend of farms increasing in size with greater mechanization, the farms in the Big Muddy River basin have fallen behind in comparison. New construction is noticeably absent. There has been a loss of population in the basin, especially among the younger people. Many have left the area in search of new opportunities as indicated by the fact that between 1950 and 1960 the State, as a whole, showed an increase in population of 15.7 percent while both Franklin and Jefferson Counties, in which the Rend Lake Reservoir will be located, showed a loss of population of 19.3 percent and 10.0 percent, respectively. Complicating this problem is the unsatisfactory water supply and a lack of venture capital. Industrial expansion that might have provided many jobs has been lost because of the lack of adequate water supply. All of these factors combine to handicap the area in competing for new industry. Unemployment figures show that during the period 1955-1959, inclusive, approximately $20,000,000 was paid out for unemployment relief in eight counties in the basin. In addition, welfare payments amounting to approximately $4,500,000 a year are being made in area assistance and to dependent children.

e. Navigation. Preliminary investigation of the advisability of providing improvements for modern barge transportation on the Big Muddy River indicates that Federal participation to the extent of providing a lock and dam in the Rend Lake project might be justified.

Modification in the Rend Lake project to include allocation of water for augmenting low flows in the interest of navigation might also be justified. However, since the study has not progressed sufficiently to determine definitely a plan of improvement or its economic justification, the worth of Rend Lake Reservoir to the considered navigation improvements cannot be evaluated at this time.

15. IMPROVEMENTS DESIRED

The District Engineer held a public hearing at Benton, Illinois, on 7 December 1961. Approximately 500 people attended the hearing, including members and representatives of The Congress of the United States, the Governor of Illinois, various Federal and State agencies, State legislature, Mayors, Boards of County Supervisors, Chambers of Commerce, labor, trades, various civic organizations, industry, and local interests. The vast majority favored construction of the Rend Lake Reservoir to provide water supply, recreation, and pollution abatement. They were unanimous in their opinion that the lake would aid substantially in reducing the unemployment and distressed conditions in the area. Those in the area downstream of the proposed Rend Lake Dam emphasized the need for flood control. One group advocated the Rend Lake project as an initial step in the over-all development of the Big Muddy River basin with particular reference to future canalization. The only opposition expressed at the hearing was by a group of bottom land farmers who would be displaced by construction of the Rend Lake project. Coal mine owners in the area, while not opposed to the project, requested that full consideration be given to any adverse effects the project might have on their continued operations. A transcript of the public hearing is on file in the office of the District Engineer, U. S. Army Engineer District, St. Louis.

SECTION VI - SOLUTIONS CONSIDERED

16. GENERAL

Studies related to this survey report have been based on utilization of the plan of improvement proposed by the Division of Waterways, State of Illinois, in its report published in 1957. While none of the text and plates have been reproduced for purposes of this report, they are on file in the office of the District Engineer, U. S. Army Engineer District, St. Louis. The report contained herein is being made at the request of the Area Redevelopment Administration to determine the economic justification of the proposed Rend Lake Reservoir and to ascertain the extent of Federal interest in the project. The review of the State's report includes a determination of the engineering feasibility, the optimum water use, and the economic justification of the project.

17. PLANS CONSIDERED

The Illinois Division of Waterways investigated two dam heights. In both instances, the main dam consisted of a compacted, rolled-earth embankment extending across the main valley floor with a reinforced concrete spillway and an auxiliary earth spillway located in the east abutment. In one study, the main spillway was set at elevation 405.0, and in the other, at elevation 410.0. The purpose of this twofold study was to define the practical minimum and maximum acceptable spillway crest elevations. The State found that below elevation 405.0 the reservoir storage available decreased rapidly, and above elevation 410.0 the amount of freeboard required would call for construction of several saddle dams on the perimeter of the reservoir, plus additional road and railroad alterations which would materially increase the cost of the project. Consultation with the Rend Lake Conservancy District, State agencies, and other Federal agencies indicated that, for the purposes of this report, the plan of improvement with spillway crest at elevation 410 m. s. l. would provide a plan of improvement that would allow optimum development of all resources within the area. In the design of the dam, the State of Illinois included a spillway structure of sufficient capacity to pass the inflow from the design storm, as modified by reservoir storage, with an accompanying rise in reservoir level of not more than 5 feet above spillway crest. In this case, surcharge elevation of the design storm flood, having a frequency of occurrence of about once in 100 years, would be at elevation 415 m. s. l.

18. REND LAKE RESERVOIR

a. Multiple-purpose features. The following objectives were considered in developing an optimum plan of operation for the Rend Lake Reservoir.

(1) Provide flood control in the valley below the dam, either by reducing flood stages through a time-lag effect, in which case there would be no reservoir storage allocated specifically for flood control purposes, or by allocation of definite storage for flood waters.

(2) Provide an assured source of domestic and industrial water supply for towns and communities in the basin over the life of the project.

(3) Increase low water flows in the Big Muddy River in the interest of pollution abatement.

(4) Use of the stored waters in the reservoir for conservation of fish and wildlife.

(5) Recreation.

(6) Long-range redevelopment to alleviate depressed economy of the region.

b. Standard project flood. The standard project flood represents the most severe flood having a reasonable possibility of occurrence and was derived by the use of synthetic unit hydrographs whose characteristics were considered satisfactory for each of the major tributaries entering the reservoir. These synthetic unit graphs were determined in accordance with methods and procedures outlined in EM 1110-2-1405. A standard project storm with 14.7 inches of rainfall in 96 hours was developed using methods and procedures outlined in CW Bulletin 5-2-8. The storm was broken down into 6-hour increments and arranged in a storm pattern in accordance with the procedures outlined in the bulletin. Initial losses of 1.0 inch and incremental loss of 0.5 inch per 6 hours were then applied. The standard project storm rainfall excess values of 10.4 inches were applied in turn to the Benton unit hydrograph and the Rend Lake Reservoir inflow hydrograph. The peak flow under natural conditions resulting from the standard project storm is about 36,100 c.f.s. and occurs

126 hours after beginning of rainfall. Maximum reservoir inflow occurs about 66 hours after beginning of rainfall and is equal to 146,000 c.f.s. With initial water surface elevation 410, routing of inflow through reservoir storage indicated a surcharge elevation of 416 and outflow of 25,350 c.f.s.

c. Spillway design flood. Spillway design flood represents the theoretical maximum which would result under the most critical meteorological and ground conditions. The maximum possible precipitation characteristic of the Big Muddy River basin was derived from the Hydrometeorological Report No. 33 dated April 1956. This was then expanded into a 96-hour storm with 27.5 inches of rainfall and reduced 5 percent for basin shape factor. A storm pattern similar to that for the standard project storm was set up, and the same losses were applied with a resultant runoff of 21.5 inches. Peak flow under natural conditions was about 75,100 c.f.s. and occurs 126 hours after beginning of rainfall. Maximum reservoir inflow is 300,800 c.f.s. and occurs 66 hours from beginning of rainfall. With initial water surface at elevation 410, routing of inflow through reservoir storage produced a surcharge elevation of 420.0 and outflow of 74,260 c.f.s. Top of dam was established by the State at elevation 424 and provides 4 feet of freeboard which is deemed adequate.

d. Flood data comparison. For the purpose of comparison, there are listed in table 5 pertinent data concerning the maximum flood of record, the standard project flood, and the spillway design flood. Detailed data relative to the details of these and other floods and pertinent hydrologic information are contained in appendix C.

Table 5
Comparative flood hydrograph data, Benton - mile 98.6

Flood	Peak flow (c.f.s.)
Maximum flood of record (7-25 May 1961)	35,800
Standard project flood	36,100
Spillway design flood	75,100

SECTION VII - PLAN OF IMPROVEMENT

19. GENERAL

After consideration of the various solutions investigated, including use of only surcharge storage above the spillway crest for flood control, it was determined that the plan of improvement which would provide the greatest over-all benefit to the Big Muddy River basin would consist of the proposed Rend Lake Dam and Reservoir operated for positive flood control, water supply, pollution abatement, conservation of fish and wildlife, and recreation.

20. RESERVOIR FEATURES

a. Damsite. The proposed damsite is located on the Big Muddy River approximately 103.7 miles above its mouth, opposite Benton, Illinois. The watershed tributary to the dam represents about 20 percent of the total drainage area of the basin. A map showing the location of the damsite and an outline of the Rend Lake Reservoir is shown on plate 2, Reservoir Map.

b. Type of structure. The dam consists of a compacted earth embankment with an uncontrolled concrete spillway and outlet channel. The top of dam, elevation 424.0, is approximately 42 feet above the general valley floor. Total length of the dam and spillway is approximately 8,900 feet. The concrete spillway would consist of a broad-crested weir at elevation 410 m.s.l., 500 feet in length, converging to a 320-foot stilling basin and outlet channel. A bridge would cross the spillway channel. Outlet works for regulation of the pool under normal operating conditions and drawdown of pool would consist of two 6-foot by 6-foot concrete box sluices located in the earth section of the dam. In order to reduce the surcharge elevation on the concrete spillway, an auxiliary earth spillway consisting of an 800-foot, broad-crested weir would be located in the east abutment of the dam structure at elevation 415 m.s.l. The following principal modifications have been made in the design proposed by the State of Illinois to insure the stability of the main structure.

(1) A 40-foot downstream berm has been added to the dam section at an elevation 24 feet below top of dam.

(2) Downstream slope has been changed from 1 on 2-1/2 to 1 on 3.

(3) Internal drainage has been changed from a rock toe drain to a chimney drain.

In addition, mining within 800 feet of the centerline of the dam axis will be prohibited. Typical sections of the main dam and spillway are shown on plates 3 and 4, Plan, Elevation, and Section, and Spillway Plan and Section.

c. Storage requirements. The flood control pool is designed to provide storage equivalent to 4.3 inches of runoff. Based on these requirements, storage for flood control is estimated to be 111,500 acre-feet. Storage for water supply and pollution abatement is designed to assure adequate supply during the critical period, taking into account evaporation and other losses. Based on the period of record, the critical period for storage requirements extended from 1 June 1953 to 30 November 1954, or 548 days. Storage amounting to 109,000 acre-feet is reserved for domestic and industrial water supply. Storage amounting to 57,000 acre-feet is reserved for pollution abatement. Sediment storage based on 0.5 acre-foot per square mile per year over a 100-year life of the project is estimated at 25,000 acre-feet. Total water storage in the reservoir at spillway crest elevation at 410 m.s.l. is estimated to be 302,500 acre-feet.

d. Remedial measures. The Rend Lake Reservoir will require alterations and relocations to State highways and secondary and county roads; alteration to one railroad; and alterations to power, transmission, and telephone lines. Relocations and alterations are based on elevation 415.0, which is 5 feet above main spillway crest elevation. Elevation 415.0 m.s.l. provides protection against a flood having a frequency of occurrence of about once in 100 years. In 1957, the State of Illinois Highway Department approved the plans for relocations for the existing road net within the reservoir area to elevation 415.0. The State of Illinois Highway Department plans to build Interstate Highway 57 connecting Chicago and New Orleans along the east side of Rend Lake. Top of roadway will be at elevation 418.0.

e. Plan of operation. The Corps of Engineers will be responsible for the correlated operation of the reservoir for flood control, water supply, pollution abatement, and recreation. The proposed plan of operation is as follows:

(1) Inactive storage pool (elevation 380.0 to 390.5). This storage, amounting to 25,000 acre-feet, is allocated to provide for sedimentation over 100-year period.

(2) Pollution abatement (elevation 390.5 to 397.7). This storage will be used for low-flow augmentation in the Big Muddy River. It is proposed to provide a minimum daily release of approximately 30 c.f.s. through the dewatering conduits in the main dam. This flow was recommended by the Public Health Service for future needed improvement in water quality downstream of Benton.

(3) Water supply pool (elevation 397.7 to 405.0). Current water consumption for nine municipalities in the area under consideration averages 100 gallons per day per person. While this is measurably below the national average, it is estimated that the daily per capita of water consumption will increase to approximately 160 gallons, resulting in a total daily municipal demand of approximately 21,000,000 gallons per day. An estimated 24,000,000 gallons daily will be required for industrial purposes by large water-using firms not included in the estimate for municipalities. With proper allowance for existing impoundments, the net increase in water demand by the year 2010 is expected to reach approximately 40,000,000 gallons per day. Of this total, it is further estimated that within a 5-mile radius of Benton, the demand will be approximately 20 percent of the total, or 8,000,000 gallons; within 15-mile radius, 50 percent of the total, or 20,000,000 gallons; and within 25-mile radius, the demand will be equal to the total capacity of the proposed development. Average daily withdrawal rate, based on anticipated consumption of 40,000,000 gallons per day, is about 62 c.f.s.

(4) Flood control (elevation 405.0 to 410.0). To provide for maximum flood control benefits to the Big Muddy River basin, storage between elevations 405.0 and 410.0 is reserved for runoff during flood periods. This storage will effect reductions to the standard project flood stages at Benton, Plumfield, and Murphysboro approximately 6.8 feet, 3.8 feet, and 3.1 feet, respectively. Releases below reservoir will be limited to bankfull capacity or 1,000 c.f.s.

f. Fish and wildlife conservation. While no allocation of storage is made in the reservoir specifically for conservation of fish and wildlife, storage available for water supply and pollution abatement will afford full opportunity for improvement of fish and wildlife resources. The U. S. Fish and Wildlife Service recommends construction of small impoundments on the upper arms of the reservoir on Rayse Creek (Big Muddy River) and Casey Fork to be utilized as a

refuge for ducks. No additional lands would be acquired for these impoundments. The U. S. Fish and Wildlife Service further proposed establishment of a goose refuge on Gun Creek, which will require acquisition of approximately 5,700 acres of land outside the project area. All of these facilities were analyzed on an incremental basis, and it was found that the proposed goose refuge on Gun Creek could not be economically justified at this time. The cost of the impoundments on Big Muddy River and Casey Fork is estimated at $988,000. The two dams and subimpoundments will be designed and constructed with the assistance of the U. S. Fish and Wildlife Service. Operation and management of these units will be vested in the Illinois Department of Conservation in accordance with recommendations of the U. S. Fish and Wildlife Service.

g. Recreation. No allocation of storage was made in the reservoir solely for recreation. However, with approximately 18,900 surface acres available at normal pool elevation of 405.0 and under the plan of reservoir operation proposed, the project would be favorable for recreational development and use. The National Park Service estimates that the reservoir would experience approximately 1,670,000 annual visitor-days attendance by the third year of the project's operation and approximately 3,840,000 annual visitor-days attendance about the 50th year. The National Park Service recommends acquisition of approximately 16,800 acres of land for public access. Approximately 1,400 acres have been selected for the provision of public-use facilities in accordance with Section 4 of the Flood Control Act of 1944. An additional 120 acres will be provided for hunting and fishing access to fish and game management areas proposed by the U. S. Fish and Wildlife Service and which will be licensed to the Illinois Department of Conservation. The National Park Service estimates the cost of facilities to provide for anticipated annual visitation at approximately $5,592,000 initially and an additional $7,380,000 ultimately, a total of $12,972,000. These costs represent developments by Federal and non-Federal interests. Facilities to be provided by the Federal Government on the 1,400 acres will include boat launching ramps, picnic areas, tent camping areas, access and circulation roads, potable water, and sanitary facilities at an estimated cost of $1,829,000. These facilities will provide for approximately 536,100 annual visitors or approximately 32 percent of the total annual visitor-days estimated for the first three years of the reservoir's operation. It is anticipated that the facilities which will be required to accommodate the additional attendance initially and ultimately will be provided by State and local governments as well as private enterprises. The Illinois Department of Conservation proposes development of two areas totaling approximately 2,000 acres as a unit of the State park system.

h. Lands required. Lands required for the reservoir, approximately 32,400 acres, are based on acquisition in fee to elevation 415, which is 5 feet above the flood control pool. These lands, in addition to fulfilling the needs of reservoir operations, will provide and insure adequate public access around the reservoir area. Provisions are also included to purchase in fee 1,400 acres for development of public recreational facilities at selected sites; 120 acres for hunting and fishing access in the proposed waterfowl area in the upper arms of the reservoir; 750 acres at the damsite, including acreage for construction of the outlet channel; and 230 acres for roadway relocations and access roads to the dam. Total acquisition for the project is estimated at 34,900 acres. In addition to the foregoing, the Rend Lake Conservancy District plans to acquire lands located within a quarter mile strip outside the recommended acquisition line of 415. Ownership of this quarter mile strip will permit the Conservancy District to control the course of development of the reservoir area, such as parks, recreational and residential areas, business enterprises, and other related developments. The cost of the additional lands proposed by the Rend Lake Conservancy District has not been included in the project cost estimate.

i. Pertinent data. Pertinent data on the Rend Lake Reservoir are summarized below.

General

All elevations are in feet above mean sea level, 1929 adjustment.

Dam

Location of dam, river miles above mouth	103.7
Drainage area above mouth of river, square mile	2,360
Drainage area above damsite, square mile	488

Stream flow data (c.f.s.)

Maximum discharge of record at damsite (flood of May 1961)	35,800
Minimum discharge at damsite	0
Average annual discharge at damsite	511
Bankfull flow at damsite	1,000

Elevations

Average flood plain elevation at damsite	382
Top of inactive storage pool	390.5

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Elevations (cont'd)

Top of pollution abatement pool	397.7
Top of water supply pool	405.0
Top of flood control pool	410.0
Taking line for land acquisition	415.0
Spillway design flood	420.0
Top of dam	424.0
Height of dam above flood plain (feet)	42

Storage (acre-feet)

Inactive storage pool	25,000
Pollution abatement pool	57,000
Water supply pool	109,000
Flood control pool	111,500
Total	302,500

Areas (acres)

Inactive pool	4,800
Pollution abatement pool	10,000
Water supply pool	18,900
Flood control pool	24,800

Land requirements (acres)

Dam and reservoir, including relocations	33,380
Recreational requirements	1,520

Miles of shoreline

At normal pool level 405	162

Dam and spillway

Type - Rolled filled earth embankment; uncontrolled concrete spillway and outlet channel.	
Total crest length (feet)	8,900
Crest width, embankment (feet)	30
Crest length, spillway (feet)	500
Elevation of spillway crest	410.0
Elevation of stilling basin floor	378.0

Outlet works

Sluices, number and size in feet	2 - 6 x 6
Maximum discharge through sluices with reservoir at elevation 410 c.f.s.	2,500

Gates on sluices

Type - vertical lift

Reservoir clearing (acres)

Reservoir area to be cleared below 415.0	15,900

SECTION VIII - ESTIMATES OF COSTS

21. ESTIMATES OF FIRST COSTS

Estimates of first costs are based on the assumption that the United States will construct the dam and appurtenant works, make such alterations and relocations of highways, railroads, and utilities, and undertake remedial measures as are necessary. The estimate also reflects subordination of mineral and oil rights within the project area. Acquisition of necessary lands and improvements would be undertaken by the Rend Lake Conservancy District. Unit costs are based on January 1962 prices and wherever possible upon information available for comparable types of work under construction within the general area. A contingency allowance is included in the direct costs. First costs are summarized below and are presented in detail in appendix B.

Classification No.	Item	Cost
01	Lands and damages	$ 6,300,000
02	Relocations	8,261,000
03	Reservoirs	2,743,000
04	Dams - main	6,715,000
	subimpoundments	865,000
08	Roads, railroads, and bridges	470,000
14	Recreation facilities	1,829,000
19	Buildings, grounds, and utilities	186,000
20	Permanent operating equipment	30,000
30	Engineering and design	1,690,000
31	Supervision and administration	1,311,000
	Total project cost	$30,400,000

Note: Preauthorization costs amounting to $45,000 are not included in the above estimate.

22. LOSS OF TAXES

Acquisition of those lands required for project purposes will result in some loss of taxes to local governments. Anticipated expansion of existing facilities upon which taxes will be collected, together with increased evaluation of real property adjacent to the reservoir area plus additional taxable improvements, will more than restore these tax losses.

SECTION IX - ESTIMATES OF BENEFITS

23. ESTIMATES OF BENEFITS

a. General. Principal benefits attributable to the reservoir include reduction of flood damages in the Big Muddy River valley below the dam, reduction of flood crests in the Mississippi River, domestic and industrial water supply, pollution abatement, fish and wildlife conservation, recreational development, and a means of regaining economic prosperity in Southern Illinois. Estimates have been made on a conservative basis that have a reasonably high degree of realization. Average annual benefits are based on January 1962 price levels and are summarized briefly in the following subparagraphs. Details of benefit analysis are contained in appendix A.

b. Flood control benefits - Big Muddy River. Based on crop practices and development in the area below Rend Lake Reservoir, it is estimated that floods cause an average annual damage amounting to $57,200 to crops and $99,900 to property, of which $21,800 is to rural property and $78,100 to urban property. Total average annual crop and property damage is estimated at $157,100. Operation of Rend Lake Reservoir under the plan outlined herein will provide substantial reduction in flood damages. The standard project flood would be reduced approximately 6.8 feet at Benton, immediately below the dam, 3.8 feet at Plumfield, and 3.1 feet at Murphysboro. Average annual crop and rural property damages would be reduced from $79,000 to $39,800 resulting in an average annual benefit of $39,200. Average annual damage to urban properties would be reduced from $78,100 to $36,400, resulting in an average annual benefit of $41,700. Total average annual damages eliminated in the Big Muddy River valley below the Rend Lake Dam are estimated at $80,900. With the elimination of frequent overflow, it is estimated some of the timberland, amounting to approximately 2,900 acres, would be converted to cropland use. In addition, more intensive cropping practice would become practical with some redistribution of acreages planted. These additional benefits, amounting to approximately $133,500 on an average annual basis, would be widespread accruing at varying amounts in the valley between Rend Lake Reservoir and Murphysboro. Total average annual benefits creditable to Rend Lake Reservoir for eliminating flood damages in the Big Muddy River basin are estimated at $214,400.

c. Flood control benefits - Mississippi River. In the Mississippi River Reservoir Benefit Study, the considered Murphysboro Reservoir on the Big Muddy River in the D group was credited with average annual flood prevention benefits amounting to $21,000. These benefits reflect damages eliminated by the reservoir in the unprotected area downstream of Cairo, Illinois. Based on the comparative flood control storage available at the Murphysboro Reservoir, it is estimated that approximately 10 percent of the total benefits, or $2,100, could be credited to the Rend Lake project.

d. Domestic and industrial water supply. While it is not possible to definitely establish all of the potential water users, the Public Health Service, in evaluating the water supply requirements over the life of the project, indicated that the ultimate demand from the Rend Lake Reservoir would be approximately 40,000,000 gallons per day, of which 20 percent would be in the area within 5 miles of the reservoir, 50 percent within 15 miles of the reservoir, the total within 25 miles of the reservoir. To assure adequate supply against the most severe drought conditions, water supply storage of 109,000 acre-feet is required. Benefits are determined as being equal to the alternative costs of obtaining the total water requirements adjusted to reflect, insofar as practicable, the physical convenience, i.e., difference in cost of transporting the water from the reservoir to the communities. Allowance has been made for the period of development by discounting future demands to reflect present worth. On this basis, average annual benefits to water supply are estimated at $300,700. A report by the Public Health Service concerning water supply aspects of the project is contained in appendix D.

e. Flow augmentation. During drought periods, zero flow has been experienced on the Big Muddy River. The Public Health Service, in studying the Rend Lake project, has indicated that the forecasted future population growth in the basin would contribute a large domestic and industrial waste load to the stream, even after such waste loads had been processed through a high degree of sewage treatment. Under the low flow conditions characteristic of the Big Muddy River, a severe degradation of the water quality will take place. Improvement of these conditions can be brought about by flow augmentation from Rend Lake Reservoir during periods of low stream flow in order to dilute the waste load. The Public Health Service recommends a minimum daily release of approximately 30 c.f.s. for which storage amounting to 57,000

acre-feet has been reserved in the reservoir. The monetary measure of the value of low-flow augmentation was obtained by comparing the average cost of obtaining equivalent waste reduction in a sanitary sewage treatment plant and is estimated at $60,600 annually. A report prepared by the Public Health Service is contained in appendix D.

f. Benefits to fish and wildlife. A detailed report prepared by the U. S. Fish and Wildlife Service, in cooperation with the Illinois Department of Conservation, indicates a substantial benefit to the fishery and wildlife resources would be realized by construction and operation of the Rend Lake Reservoir as proposed herein. The net annual fishery benefit attributable to the project is estimated at $254,000. Construction of two small impoundments in the upper arms of the reservoir on Rayse Creek and Casey Fork as a refuge for ducks is included in the over-all plan as recommended by the U. S. Fish and Wildlife Service. Benefits attributable to these additional facilities are estimated at $58,000. Total average annual benefits for fish and wildlife are estimated at $312,000. The report of the U. S. Fish and Wildlife Service is contained in appendix D.

g. Recreational benefits. A report on recreational use and development of Rend Lake Reservoir was prepared by the National Park Service and is included in appendix D. The National Park Service states that the primary value of the proposed impoundment from the recreational standpoint lies in its ability to provide recreation opportunities on a scale and sufficiently accessible to residents of metropolitan St. Louis to attract those people into this region for recreation activities. The influx of visitors will supplement other benefits derived from the reservoir, and expenditures by recreationists for services and commodities will strengthen the economy of the region. The National Park Service estimates that, based on an annual visitation initially of 1,670,000, annual benefits would amount to $2,672,000. The ultimate visitation anticipated 50 years after completion of the project is estimated by the National Park Service at 3,840,000, with annual benefits amounting to $6,144,000. Based solely on provisions of public use facilities to be provided in accordance with Section 4 of the Flood Control Act of 1944, annual visitor-day attendance at these facilities is estimated at 536,100, exclusive of hunter and fishermen days. Using a conservative value of $1.00 per visitor-day, average annual recreational benefits to be included in the project justification are estimated at $536,100.

h. Redevelopment benefits. A large portion of Southern Illinois is suffering substantial persistent unemployment causing hardship to thousands of individuals and their families, thus detracting from the national welfare. In addition to the primary benefits credited to the project, the proposed Rend Lake Reservoir will provide additional benefits based on its contribution to the permanent constructive reorientation of the depressed economy of the region. These latter benefits are of two basic types: redevelopment benefits derived from the relief of present and persistent unemployment starting during the construction period and continuing indefinitely; and redevelopment benefits derived from new economic activities and development from the broadened and reoriented economic base starting when the project becomes operational and also continuing indefinitely. These benefits are conservatively estimated at a total of $350,400 annually for both types. According to the Area Redevelopment Administration, the long-range redevelopment benefits will be substantially larger than the estimated values used herein and include an estimated 5,000 new jobs in the area with an estimated payroll of $29,000,000 annually, decrease in area relief costs estimated about $1,000,000 annually, and increase of about $3,000,000 annually in Federal income taxes. The assessment of the area redevelopment benefits includes $65,300 annually for permanent relief of unemployment based on the nature and extent of the present unemployment levels as explained in appendix A. In the allocations procedures used herein, $65,300 annually was treated as an economic saving. The redevelopment benefits from the broadened and reoriented economic base reflect industrial and commercial activities and investments of unknown magnitude and timing and those attributable to the Rend Lake project cannot be derived, at this time, by precise appraisals. For the purpose of this report, these benefits were estimated, as explained in appendix A, at $285,100 annually on the basis of the total primary benefits attributed to the project.

i. Negative benefits. Detriments or negative benefits to overland transportation resulting from costs of providing greater clearances for bridges to be modified or reconstructed as part of the project and increased operation costs of future vehicle operation have been estimated at $36,000 annually, based upon criteria developed by the Bureau of Public Roads. These increased costs will be deducted from the total benefits to obtain the net benefits for the considered improvement.

j. Recapitulation of benefits. Annual benefits attributable to the Rend Lake Reservoir are summarized as follows:

Flood control	$ 216,500
Water supply	300,700
Pollution abatement	60,600
Fish and wildlife	312,000
Recreation	536,100
Area redevelopment	285,100
Total	$1,711,000
Less negative benefits	36,000
Total net benefits	$1,675,000

SECTION X - ALLOCATION AND APPORTIONMENT OF COSTS

24. ALLOCATION AND APPORTIONMENT OF COSTS

a. Allocation of costs. Cost allocations are based on the separable costs-remaining benefits method which consists of determining the separable cost of including each function in the multiple-purpose project and determining an equitable distribution of joint costs incurred for several purposes in common. The application of the separable costs-remaining benefits method of cost allocation to the project is presented in appendix B. There is shown in table 6 allocation of first costs and annual operation and maintenance which includes major replacements.

Table 6
Allocations

Purpose	First costs	Annual operation and maintenance
Flood control	$ 4,574,000	$13,800
Water supply	4,990,000	8,800
Pollution abatement	1,041,000	3,200
Fish and wildlife conservation	4,912,000	14,100
Recreation	8,510,000	47,900
Area redevelopment	6,373,000	200
Total	$30,400,000	$88,000

b. Apportionment of costs. The costs of constructing, operating, and maintaining Rend Lake Reservoir have been apportioned between Federal and non-Federal interests on a functional basis. Because of the widespread distribution of flood control effects of the project, all costs allocated to this purpose have been assigned to the Federal Government in accordance with procedures established for similar projects in the Flood Control Act of 1936, as amended. The costs allocated to pollution abatement and Area Redevelopment have also been assigned to the Federal Government. The costs allocated to fish and wildlife conservation, excluding costs of subimpoundments proposed by the U. S. Fish and Wildlife Service, have been apportioned equally between Federal and non-Federal interests in recognition of the national aspects. Project costs allocated to recreation in the

amount of 15 percent of the total project costs, plus the cost of facilities and lands provided under Section 4, Flood Control Act of 1944, have been assigned to the Federal Government. The remainder of the costs allocated to fish and wildlife conservation and recreation has been assigned to non-Federal interests. Costs allocated to water supply have been assigned to non-Federal interests in accordance with current policy stated in the Water Supply Act of 1958. Apportionment of first costs and annual maintenance and operation, including major replacements, are shown in table 7.

Table 7
Apportionment of costs

Purpose	First costs		O&M, including major replacements	
	Federal	Non-Federal	Federal	Non-Federal
Flood control	$ 4,574,000	---	$13,800	---
Water supply	---	$4,990,000	---	$ 8,800
Pollution abatement	1,041,000	---	3,200	---
Fish and wildlife conservation	3,329,000	1,583,000	10,100	4,000
Recreation	6,983,000	1,527,000	39,300	8,600
Area redevelopment	6,373,000	0	200	0
Total	$22,300,000	$8,100,000	$66,600	$21,400

SECTION XI - ECONOMIC JUSTIFICATION

25. ANNUAL CHARGES AND BENEFIT-COST RATIO

a. Costs. A construction period of three years is assumed for the Rend Lake Reservoir. Amortization of Federal investment is computed on a sinking fund basis of 2-5/8 percent for an assumed life of 100 years. Non-Federal investment for water supply, fish and wildlife conservation, and recreation was amortized at the 2-5/8 percent rate on the assumption that local interests will elect to repay these costs on an annual installment basis. It was further assumed that the entire amount of non-Federal costs will be repaid within 50 years after the project is first placed in operation. Major replacements, such as sluice gates and electrical system, would require replacement approximately every 50 years. Certain recreational facilities provided under Section 4 of the Flood Control Act of 1944 would be replaced in their entirety at varying intervals from 10 to 25 years. Average annual charges based on economic costs are shown in table 8.

Table 8
Annual costs

	Federal	Non-Federal	Total
Interest	$639,500	$221,000	$ 860,500
Amortization	43,500	83,300	126,800
Major replacements	23,800	5,200	29,000
Operation and maintenance	42,800	16,200	59,000
Total	$749,600	$325,700	$1,075,300

b. Benefit-cost ratio. Based on average annual benefits outlined in paragraph 23 and average annual costs shown in table 8, the benefit-cost ratio for the Rend Lake Reservoir is computed to be 1.6 to 1.

SECTION XII - COORDINATION AND LOCAL COOPERATION

26. COORDINATION WITH OTHER AGENCIES

During preparation of the report, all appropriate Federal and State agencies and local organizations were advised of the scope of the investigation and consulted as to their interest in the proposed plan of improvement. A resume of the more important coordination effected with these agencies is outlined as follows.

a. Federal agencies.

(1) Public Health Service. The Public Health Service evaluated the water supply requirements as well as the need of, and advisability for, low-flow augmentation. The report is contained in appendix D. The Public Health Service concluded that:

"a. The probable future population and industry increase in the Jefferson-Franklin County area can beneficially use a daily average quantity of 40 million gallons for water supply in addition to that now developed and serving this area.

"b. Such supply can be developed in the proposed Rend Lake Reservoir. The raw water derived therefrom, with proper and continuous attention to treatment of it, would yield an acceptable potable public water supply.

"c. The alternate sources which should be considered on a comparative basis to that found in Rend Lake should consist of:

"1. Rend Lake developed to a single-purpose public water supply project, and

"2. A source of supply in the Mississippi River with the raw water piped to Benton, Illinois.

"d. Low flow augmentation releases from the reservoir in the amount of 30 c.f.s. will bring about a future needed improvement in water quality from Benton on downstream. The annual value of this improvement is computed as $60,600."

(2) U. S. Fish and Wildlife Service. A detailed report on fish and wildlife resources in relation to Rend Lake Reservoir is contained in appendix D and has been fully coordinated with the Illinois Department of Conservation. The report concludes that there will be a net gain in benefits to fish life of $254,000 and a net gain of $58,000 in waterfowl benefits. The U. S. Fish and Wildlife Service made the following recommendations.

"(a) A minimum release of 30 c.f.s. be maintained at all times to the Big Muddy River below the reservoir.

"(b) Minimum of 15 acres of land, with public access thereto, including 1,000 feet of stream bank frontage on each side of the Big Muddy River, immediately below the stilling basin, be acquired as an integral part of the project to provide for public use of the reservoir tailwater for fishery purposes.

"(c) The Gun Creek arm be developed for goose management purposes through the purchase of an additional 3,800 acres of land located approximately as outlined on the attached map. The operation, control, and management of this entire unit, which would total 5,700 acres, should be vested in the Illinois Department of Conservation.

"(d) The east and west arms of Rend Lake Reservoir be developed for waterfowl management purposes through the construction of subimpoundment dikes and the control works necessary to manipulate water levels between elevations 405 and 410 m.s.l. Operation, control, and management of these units should be vested in the Illinois Department of Conservation.

"(e) Every possible effort be made to acquire the lands within the east arm and west arm subimpoundment areas before the bottom land timber can be removed.

"(f) Appropriate consideration be given to the development of a reservoir zoning plan in connection with over-all recreational planning to insure that certain areas or periods will be available for fishing, hunting, and other wildlife purposes without conflicting use for general recreation.

"(g) Prior to establishment of clearing specifications and determination of plans for recreational development, a joint discussion be held between representatives of the Corps of Engineers, the Rend Lake Conservancy District, the Bureau of Sport Fisheries and Wildlife, and the Illinois Department of Conservation to formulate mutually acceptable plans for reservoir clearing, zoning, and provision of public access.

"(h) All project lands and waters within the established fee taking line, except for areas reserved for general recreation or other specific public purposes, be made available to the Illinois Department of Conservation for fish and wildlife management through the provisions of a General Plan in accordance with Section 3 of the Fish and Wildlife Coordination Act.

"(i) The following language be incorporated in the report of the District Engineer, Corps of Engineers:

> 'That all lands acquired in fee as a part of the project, together with project waters, be open to free public use for hunting and fishing in accordance with regulations prescribed by the Illinois Department of Conservation, except for sections reserved for safety, efficient operation, or protection of public property.'"

(3) National Park Service. A study of the recreational potential of the Rend Lake Reservoir has been prepared by the National Park Service and fully coordinated with the Illinois Department of Conservation. The report, as contained in appendix D, concludes that the reservoir is suitable for planned recreational development and will add significantly to the recreation and economic base of the area. Optimum development of the reservoir would result in an initial annual visitation estimated at 1,670,000 and an ultimate visitation of 3,840,000. The following recommendations were contained in the report of the National Park Service.

> "1. Approximately 16,800 acres of land should be acquired for public recreation development at the time of project construction. In addition, the shoreline should be further protected by acquiring in fee all the land lying within 500 feet horizontal distance from the fee taking line in those areas not already protected through the activities of some compatible organization.

"2. During pre-construction and construction periods, the Corps should maintain close liaison with public agencies, organizations and individuals interested in recreation development and coordinate such development in the best interest of the public.

"3. Shoreland use and reservoir zoning plans should be made to protect the recreation values of the project through cooperative efforts of interested agencies.

"4. Consideration should be given to the Illinois Department of Conservation as the administering agency for the recreation development and operation of the reservoir.

"5. Additional and more comprehensive field work should be accomplished with particular attention given to specific site locations.

"6. An archeological survey is necessary to locate archeological values deserving salvage."

(4) U. S. Department of Commerce, Area Redevelopment Administration. The Area Redevelopment Administration assisted in preparation of this interim report in furnishing information and data on short-range and long-range redevelopment benefits attributable to construction of the Rend Lake Reservoir. A report prepared by the Area Redevelopment Administration is contained in appendix D.

b. State of Illinois agencies.

(1) Department of Public Health. The State Department of Public Health has expressed a critical need for supplemental water supply as an aid in the development of numerous communities to be served by comprehensive water distribution system from Rend Lake.

(2) Illinois Department of Conservation. The Illinois Department of Conservation has expressed general concurrence with the U. S. Fish and Wildlife Service's report on the fish and wildlife potential of the Rend Lake Reservoir and the National Park Service's report on the recreational use of the reservoir. They further recommend acquisition of approximately 2,000 acres to be developed as a unit of the Illinois State park system.

c. Acceptance of recommendations. In general, the recommendations of the various Federal and State agencies are concurred in. With reference to the recommendation of the U. S. Fish and Wildlife Service for establishment of waterfowl refuges, the two subimpoundments have been included in the plan proposed herein. The proposal of a goose management area on Gun Creek has not been favorably considered because of lack of economic justification due primarily to cost of lands required outside of the project area.

d. Local agencies. Under provision of an act of the Illinois General Assembly, approved 11 June 1925, the Rend Lake Conservancy District was established on 17 January 1955. The Conservancy District covers all of Franklin County and six townships within Jefferson County. The Board of Trustees of the Conservancy District has been apprised of the plan of improvement outlined herein and the general terms of local cooperation. While the Board members concur in general with the plan, they are not in agreement with the operation as pertains to flood control. They pointed out that, under the proposed plan, the water surface area at normal pool would be approximately 19,000 acres, whereas, the water surface areas at normal pool elevation 410 would be approximately 25,000 acres. They allege that the lesser pool would not permit full development of their ultimate plans, particularly in the Jefferson County area, where a substantial lesser pool area would prevail than under a higher normal pool level. The Board has expressed its willingness and financial ability to meet the requirements of local cooperation.

27. LOCAL COOPERATION

Non-Federal interests will be required to assume the apportionment of first costs and annual maintenance and operation, including major replacements, in the amounts indicated in table 7, Apportionment of costs. In accordance with provisions of the Water Supply Act of 1958, the cost of storage allocated to water supply in the Rend Lake Reservoir would be reimbursed by the users. The estimated cost to local interests for water supply is $4,990,000 which represents 16.41 percent of the initial construction cost of the project. In addition, the annual cost of operation and maintenance, including major replacements allocated to water supply, would be borne by the water users. This annual cost, presently estimated at $8,800, is equivalent to 10.00 percent of the total annual cost of operation and maintenance, including replacements. The portion of the cost allocated to fish and wildlife conservation that is to be

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borne by non-Federal interests is presently estimated at $1,583,000, or 5.21 percent of the initial construction cost. The annual cost of operation and maintenance, including major replacements, assigned to non-Federal interests for fish and wildlife conservation is estimated at $4,000, or 4.55 percent of the total annual operation and maintenance cost, including major replacements, for the Rend Lake Reservoir. The portion of joint project costs allocated to recreation and which is to be borne by local interests is presently estimated at $1,527,000, or 5.02 percent of the initial construction cost. In addition, local interests would be required to pay a portion of the annual cost of operation and maintenance, including major replacements allocated to this purpose, presently estimated at $8,600, or 9.80 percent of the total annual cost of operation and maintenance, including replacements for the project. Under the plan outlined herein, it is proposed that acquisition of the project lands, including necessary subordination of mineral rights, will be accomplished by the Rend Lake Conservancy District. Of these lands, the Rend Lake Conservancy District will be required to convey to the Federal Government those portions required for the damsite and those access areas which will be developed by the Corps of Engineers. Operation and management of the subimpoundments for waterfowl will be vested in the Illinois Department of Conservation. The Conservancy District will be responsible for management of all remaining lands with the requirement that adequate access be provided along the perimeter of the reservoir at normal pool level for the general use of the public.

28. DISCUSSION

This is an interim report on the basin investigation of the Big Muddy River authorized by House Public Works Committee Resolution dated 6 July 1949, and is being made at the request of the Area Redevelopment Administration pursuant to application made by the Rend Lake Conservancy District for immediate assistance in construction of a dam and reservoir on the Big Muddy River in the vicinity of Benton, Illinois. Southern Illinois for over 30 years has been an area of chronic unemployment and underemployment. This is attributed to the fact that its economy is based primarily on coal mining. Employment in that industry has fallen substantially, largely as a result of mechanization. Evidence of stagnation is widespread with a profusion of neglected and vacated buildings in numerous towns, particularly those in the coal mining region. Agriculture has fallen behind national trends in production. There has been a substantial loss of population in the Big Muddy River basin, especially among the young people. Complicating this problem is the inadequate water supply and a lack of venture capital. Unemployment figures show that during the period 1955-1959, inclusive, approximately $20,000,000 was paid out for unemployment relief in eight counties in the basin, seven of which have been classed as distressed economic areas. This report is based on a review of the plan of improvement contained in a report on Rend Lake Reservoir prepared by the State of Illinois in 1957, and includes a determination of the engineering feasibility and economic justification of the project. The plan proposed herein would provide substantial flood reductions in the Big Muddy River valley with incidental reduction on flood flows in the Mississippi River; an assured source of water supply for an ultimate demand of 40,000,000 gallons per day, to the towns and communities, including future industry, within 25 miles of the reservoir; low-flow augmentation in the interest of sanitation in the Big Muddy River below the reservoir; fish and wildlife conservation; recreation; and, in addition to these primary benefits, contribute to the reorientation of the depressed economy of the region. Average annual benefits are estimated at $1,675,000. The estimated cost of the proposed improvements is $30,400,000, of which $29,535,000 is for the Rend Lake Reservoir and $865,000 for two auxiliary subimpoundments for waterfowl management purposes on the Big Muddy River and Casey Fork. Of the total first cost, $22,300,000 would be

Federal cost and $8,100,000 non-Federal cost. An allocated cost of $6,373,000 to the Area Redevelopment Administration is included in the net Federal cost. Average annual economic costs based on 100-year life of the project are estimated at $1,075,300. The benefit-cost ratio for this project is 1.6 to 1. Average annual operation and maintenance, including major replacement, is estimated at $88,000, of which $66,600 would be Federal cost and $21,400 non-Federal cost. The division of costs between Federal and non-Federal is based on current policies. Rend Lake Reservoir as proposed herein provides for an integrated and efficient utilization of the waters of the Big Muddy River, based upon comprehensive consideration of all practical uses. The Governor of Illinois has indicated strong support of the project and State participation. While the Board of Trustees of the Rend Lake Conservancy District has expressed the opinion that it is willing and able to furnish the necessary local cooperation, it objects to the inclusion of flood control storage in the reservoir, contending that the normal pool under the plan of operation proposed herein does not afford the same opportunity for development as would a normal pool at elevation 410, particularly in the Jefferson County area. This contention is not fully supported. The major reduction in reservoir area which would occur in Jefferson County is largely offset by the proposal of the U. S. Fish and Wildlife Service for the construction of two sub-impoundments as waterfowl management areas. Under the U. S. Fish and Wildlife Service plan, pool levels above the subimpoundments would vary from elevation 405 to 410. In Franklin County, there would be only a minor reduction in reservoir area. Because of these factors, it is believed that the plan as proposed herein will provide essentially the same development potential as the plan of operation originally advocated by the Rend Lake Conservancy District. Elimination of flood control as a primary purpose would be a serious omission since it would fail to meet the needs of the rural and urban areas downstream which are subject to substantial damage during major floods. Furthermore, it would seriously lessen the value of the reservoir as an element of the over-all plan of basin development and require that other, and possibly more costly, means be sought at a later time to accomplish the same degree of flood control, since favorable sites for reservoirs are extremely limited in the Big Muddy River basin. Additional information on the plan of improvement outlined herein, called for by Senate Resolution 148, 85th Congress, adopted 28 January 1958, is contained in attachment 1 to this report.

SECTION XIV - CONCLUSIONS

29. CONCLUSIONS

It is concluded that:

a. The Rend Lake Reservoir, operated for flood control, water supply, pollution abatement, fish and wildlife conservation, and recreation, would afford the optimum water use of the reservoir, and will function as a useful unit of an over-all basin development.

b. Under present conditions, benefits for project purposes other than recreation would justify 100 percent of the project's financial cost. The over-all benefit-cost ratio for the project is 1.6 to 1.

c. Local cooperation, as stated in paragraph 27, is warranted in view of the water supply, fish and wildlife, and recreational benefits the project would provide.

d. Local interests, although not fully in accord with the inclusion of flood control in the plan of operation, have demonstrated sufficient interest in the Rend Lake Reservoir to warrant the assumption at this time that necessary local cooperation would be forthcoming.

SECTION XV - RECOMMENDATIONS

30. RECOMMENDATIONS

The District Engineer recommends that:

a. Rend Lake Dam and Reservoir, Big Muddy River, Illinois, be authorized for the purposes of flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, and area redevelopment, generally in accordance with plans outlined herein. Of the estimated initial construction cost of $30,400,000, the net cost to the United States is $22,300,000 after reimbursement by local interests of costs assigned to them for water supply, fish and wildlife conservation, and recreation. The estimated cost to the United States for maintenance and operation, including major replacements, is expected to average about $66,600 annually.

b. Prior to construction, the Rend Lake Conservancy District, acting as local sponsor, will, in addition to other requirements outlined in paragraph 27:

(1) Furnish assurances satisfactory to the Secretary of the Army that it will enter into a contract or contracts with the United States for:

(a) Payment to the United States of that portion of the construction cost allocated to water supply amounting to 16.41 percent of the initial construction cost, or $4,990,000, based on current estimates, plus interest during the construction on this amount; no payment need be made in this amount or interest charged thereon until storage is first used for water supply purposes, but in no event shall the interest-free period exceed 10 years.

(b) Payment to the United States of the costs for maintenance and operation of the project, including major replacements, allocated to water supply, after such water supply is first used, amounting to 10,00 percent of the total annual project costs for maintenance, operation, and major replacement, or $8,800 annually, based on current estimates.

(c) Payment to the United States of that assigned portion of the joint construction cost allocated to fish and wildlife

conservation amounting to 5.21 percent of the initial construction cost, or $1,583,000, based on current estimates, plus interest during construction on this amount.

(d) Payment to the United States of that assigned portion of the costs for maintenance and operation, including major replacement of the project allocated to fish and wildlife conservation, amounting to 4.55 percent of the total annual project cost for maintenance, operation, and major replacement, or $4,000 annually, based on current estimates.

(e) Payment to the United States of that portion of the joint construction costs allocated to recreation which is in excess of 15 percent of the initial construction cost amounting to 5.02 percent of the initial construction cost, or $1,527,000 based on current estimates, plus interest during construction on this amount.

(f) Payment to the United States of that assigned portion of the costs for maintenance and operation of the project, including major replacement allocated to recreation amounting to 9.80 percent of the total annual project costs for maintenance, operation, and major replacement, or $8,600 based on current estimates.

(2) Be given the option to reimburse the United States for the portions of first costs of the project for which they are responsible:

(a) In lump sum payable prior to commencement of construction,

(b) In annual amounts during the period of construction proportional to the estimated annual Federal construction costs, or

(c) In equal annual payments beginning when the project is first available for these specific uses, and in any event within 50 years after the project is first available for such uses, and shall include interest at 2-5/8 percent on any unpaid balances.

4 Incl
1. Appendix A, Estimates of Benefits
2. Appendix B, Estimates of Costs
3. Appendix C, Hydrology and Hydraulics
4. Appendix D, Reports from Other Agencies

ALFRED J. D'AREZZO
Colonel, CE
District Engineer

[First endorsement]

LMVGN (SLD rpt 27 Dec 61)
SUBJECT: Interim Report, Rend Lake Reservoir, Illinois

U. S. Army Engr Div, Lower Mississippi Valley, Vicksburg, Miss., 5 Jan 62

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.

1. I concur in the recommendation of the District Engineer that the Rend Lake Dam and Reservoir on Big Muddy River, Illinois be authorized at an estimated total cost of $30,400,000, of which 26.64 percent, amounting to $8,100,000 based on current estimates, plus 24.25 percent of the annual costs of operation, maintenance and major replacement, currently estimated at $21,400, will be repaid by local interests as defined in par 30b of the District Engineer's report.

2. Par 27 of the District Engineer's report, which is cited in par 30b as the basis for the recommended local cooperation, does not clearly and completely define the responsibility for acquisition of lands and rights-of-way and the means of payment for the interest to be delivered to the Federal Government for construction and operation of the reservoir. In addition to 34,900 acres required for the reservoir, dam site, and initial recreation development, the Rend Lake Conservancy District plans to acquire fee title to 18,800 acres of adjoining land required for control of recreational development of the entire shore line. The Conservancy District already has acquired interest in 5,000 acres in and adjoining the reservoir and further acquisition is in progress. It is clearly in the best interests of both the Federal Government and the local sponsor that all acquisition of land and rights-of-way be handled by a single agency. Since the Conservancy District exists as a competent agency already engaged in land acquisition, I concur in the recommendation of the District Engineer that the Conservancy District accomplish acquisition of all project lands. Accordingly, I recommend that the project, if authorized, provide authority for the Chief of Engineers to designate the Rend Lake Conservancy District as a cooperating agency for the purpose of acquiring and making available necessary lands for the project and specifically to include acquisition and conveyance to the United States of fee title to all lands required for the dam site and those determined necessary for initial Federal development of public access and recreational uses.

3. In furtherance of the above I recommend that the Chief of Engineers be authorized to effect a full and formal agreement with the Rend Lake Conservancy District regarding proposed schedules of land acquisition and the advancing of Federal funds from annual project appropriations sufficient for land acquisition as scheduled. I further recommend that no construction be undertaken until valid title to the dam site and other construction areas have been obtained and delivered to the United States, and subordination of oil, gas, and mineral rights has been accomplished by the Conservancy District.

T. A. LANE
Major General, USA
Division Engineer

4 Incl
Appendices A to D
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CORPS OF ENGINEERS

U.S. ARMY

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38°20' 38°10' 38°00' 37°50' 37°40'

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RICHVIEW
ASHLEY
WOODLAWN
MT VERNON
RADOM
WALTONVILLE
NASON
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TAMAROA
SESSER
FINCKNEYVILLE
UPPER LIMIT OF IMPROVEMENTS
DUQUOIN
VALIER
PROPOSED REND LAKE DAM
NORTH CITY
BENTON
CHRISTOPHER
ZEIGLER
MUDDY RIVER
THOMPSONVILLE
ELKVILLE
ROYALTON
WEST FRANKFORT
AVA
JOHNSTON CITY
DESOTO
BIG
HERRIN
PITTSBURG
MURPHYSBORO
CARTERVILLE
CRAINVILLE
CARBONDALE
GORHAM
MARION
MISSISSIPPI RIVER
MARION
GIANT CITY STATE PARK

VICINITY MAP
SCALE IN MILES

WIS
IOWA
CHICAGO
ILLINOIS
IND
ST LOUIS
MISSOURI
MT VERNON
OHIO
KY
ARKANSAS
TENN

INTERIM REPORT
REND LAKE RESERVOIR
BIG MUDDY RIVER, ILLINOIS
BASIN MAP

IN 1 SHEET SHEET NO. 1

SCALES AS SHOWN

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

SUBMITTED RECOMMENDED APPROVED

SCALE IN MILES

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R JAN 62 PLATE 1

APPENDIX A

ESTIMATES OF BENEFITS

APPENDIX A

ESTIMATES OF BENEFITS

SECTION I - INTRODUCTION

1. PURPOSE

The purpose of this appendix is to outline the derivation of benefits attributable to the proposed plans of improvement for Rend Lake Reservoir. All monetary estimates of benefits are based on January 1962 price levels.

2. TYPES OF BENEFITS

Tangible benefits consist of flood control, the sociological impact of the project as it concerns the alleviation of unemployment and economic development in the project area, water supply, pollution abatement, fish and wildlife conservation, and recreation.

3. SCOPE

Benefits have been prepared for a multiple-purpose reservoir near Benton, Illinois, based on two plans of operation. Under either plan, the Rend Lake Reservoir would be operated as a multiple-purpose project for the purposes listed above in paragraph 2. Under one plan, 111,500 acre-feet of storage were provided for flood control purposes. No definite allocation of storage was made for the purposes of recreation and the conservation of fish and wildlife. These benefits would accrue incidental to the project, based on the fact that storage provided for water supply and pollution abatement was computed on a critical period of approximately 1-1/2 years. This would be sufficient to assure that enough water is available so that the full recreational, as well as fish, wildlife, and waterfowl potential of the project may be developed. In the second plan considered, no storage was allocated to flood control, and the reductions in flood stages were attributable to spillway storage only. In this case, storage equal to 111,500 acre-feet was allocated to recreation and conservation of fish and wildlife.

SECTION II - FLOOD CONTROL BENEFITS

4. SCOPE

Procedures used in, and details pertaining to, the development of benefits creditable to the considered Rend Lake Reservoir project are contained herein. For project formulation purposes, benefits have been derived for two plans of reservoir operation, one with, and one without flood control storage. For purposes of ready comparison, data for existing conditions and for conditions as modified by the two plans of operation are presented simultaneously, where practicable, in the following paragraphs.

5. TYPES OF BENEFITS

Benefits are credited to the considered reservoir improvement for:

a. Reduction in flood damages.

b. Increase in net income from presently cropped acres resulting from more intensive cropping practices.

c. Increase in net income resulting from conversion of timberland to cropland.

The derivation of crop benefits creditable to the considered reservoir has been based upon the difference between average annual net incomes from the land with and without the improvement. Benefits effected by the reservoir to property development are entirely flood reduction benefits.

6. AREA SUBJECT TO FLOODING

Downstream from the Rend Lake dam site there are approximately 103,400 acres of land along the Big Muddy River and within the backwater reaches of its tributaries that are subject to flooding. Approximately 38,800 acres of the area are presently in crops. It is estimated that about 10 percent of the remaining 64,600 acres is in urban areas, farm sets, roads, stream beds, and lakes, and the residual 58,100 acres are in timber. Urban areas subject to inundation include portions of West Frankfort, Freeman Spur, Royalton, Herrin, Carbondale, Hurst, Blairsville, and Murphysboro, Illinois. These towns and villages have a population of about 45,000 (1960 census). The major portions of the developed areas, including urban and rural property as well as agricultural lands, are located at levels of less frequent flooding, with the areas of more frequent flooding being timbered lands. The frequency of acreage flooding was derived by use of 20-foot contour interval, U. S. Geological Survey quadrangle sheets, 5-foot contour strip maps along the Big Muddy River prepared in 1959 from 1959 aerial photographs flown for use in Big Muddy River canalization studies, aerial photographs taken on 10 May 1961 while a Big Muddy River flood was in progress, and frequency flood profiles. Shown in table A-1 are acreages subject to inundation under existing and improved conditions by various frequency floods.

Table A-1
Acres subject to inundation by various frequency floods

Frequency in years	Elev.ft(msl) Plumfield gage natural condition	Total acres flooded	Crop acres flooded		
			Present conditions	With improvement without flood control storage*	With improvement with flood control storage
Standard project flood	387.7	103,380	38,770	34,560	29,680
100	387.0	78,000	33,800	25,480	20,080
50	386.4	66,400	25,500	18,210	11,580
20	385.5	53,430	15,490	10,730	6,570
10	384.4	44,700	10,850	7,150	4,720
5	382.5	32,410	6,820	5,050	3,090
2	377.3	17,300	3,210	2,500	1,870

* Based on flood frequency reductions attributable to spillway storage only.

7. FLOOD DAMAGES

a. Cropping characteristics and net returns. Data on cropping characteristics of the farm acreages were obtained by a sampling survey of approximately 10 percent of the acreages subject to inundation. These data were supplemented and modified based on interviews with Soil Conservation Service field personnel and U. S. Department of Agriculture farm agents within the flood damage area. Additional information was obtained through interviews with professors studying the land use characteristics of the Big Muddy basin at Southern Illinois University in Carbondale, Illinois. Dr. Carl L. Swisher of the University's Department of Geography published a report in June 1961 entitled "Use of Rural Land in the Big Muddy Watershed of Southern Illinois", wherein he points out that the Big Muddy River overflow lands are of soil types having rather high inherent fertility with most of the area being capable of producing excellent crops, provided flood protection is afforded. Average yields and distributions, together with production costs and net returns per acre for existing conditions and for conditions defining the ultimate capabilities of the soils, are shown in table A-2, based on January 1962 price levels.

Table A-2
Crop characteristics for agricultural acreages

Existing conditions

Crop	Percent	Yield bu/ac	Unit price** $	Total return $/ac	Preharvest and harvest costs, $/ac	Net return $/ac	Weighted return $/ac
Corn	50	50	1.00	50.00	36.00	14.00	7.00
Soybeans	40	25	2.35	58.75	27.30	31.45	12.58
Hay	10	2.0*	19.00	38.00	24.60	13.40	1.34
						Average per acre	20.92

Ultimate conditions

Corn	50	75	1.00	75.00	40.80	34.20	17.10
Soybeans	40	30	2.35	70.50	28.30	42.20	16.88
Wheat	5	30	1.85	55.50	27.20	28.30	1.36
Hay	5	3.0*	19.00	57.00	29.10	27.90	1.40
						Average per acre	36.74

* Tons/acre.
** January 1962 price level.
Note: Average yields indicated for 1961 for the State of Illinois, as reported in the U. S. Department of Agriculture publication "Crop Production", released 10 October 1961, are 76 bushels of corn and 29 bushels of beans per acre. Preliminary 1961 yield estimates for wheat and hay are 36 bushels and 2.05 tons per acre, respectively.

b. Flood damage per cropland acre. The procedure for computing damages to crops is based upon the following definitions. The income received by the farmer from sale of crops represents the cost of production, harvesting, and marketing, and a charge for management and overhead which is included in the item of gross profit. The loss from a flood which causes total loss of crop or prevents use of cropland for a whole season is measured by the anticipated gross profit, plus the cost incurred up to the time of the flood. The loss from a flood involving a replant crop, planted after the original crop has been lost by flooding, is measured by the anticipated gross profit on the original crop, plus all costs incurred for the original and replant crops, minus the income from any partial crop harvested. Based upon these definitions, estimated crop damage per acre for the various crops grown was derived from a historical series of flood events. During the period 1940 through 1961, there were 20 flood occurrences, 12 of which were damaging under current cropping practices. All of the 20 floods, however, would have caused damage under

conditions of anticipated future cropping practices wherein it was assumed that, in addition to present crops, wheat would be planted. These floodings, weighted by the respective acreages inundated, resulted in average annual damages per acre of $11.63 under existing conditions and $17.26 under ultimate conditions.

c. Average annual acres subject to flooding. Area-elevation curves for cropland areas were derived for 23 reaches between the proposed Rend Lake dam site and the point where Big Muddy River enters the Mississippi River flood plain. The Big Muddy River crosses the Mississippi River flood plain between flank levees of adjacent drainage and levee districts. Average annual cropping acres subject to flooding were computed for each reach utilizing the aforementioned flood frequency profiles. The average annual crop acres subject to damage under present conditions were computed to be 4,920 acres. The relationship between the 4,920 average annual acres flooded and the 38,800 acres subject to flooding indicates that much of the crop acreage is flooded only by the less frequent floods. The average annual acres that would be flooded with the improvement constructed, without and with flood control storage, have been determined to be 3,630 and 2,500 acres, respectively.

d. Crop damage, present conditions. Average annual damages to cropland are 4,920 acres times $11.63 damages per acre, or $57,200. These damages would be reduced to 3,630 acres times $11.63, or $42,200 with construction of the Rend Lake project without flood control storage. With flood control storage provided, damages would be reduced to 2,500 acres times $11.63, or $29,100.

e. Rural property damage. Rural property damages include damage to roads, fences, drainage ditches, farm sets, and dwellings. Damages to roads have been estimated to average $125 per mile, based on previous survey data obtained from county highway engineers. Fence damage has been estimated at $25 and ditching plus erosion damage at $5 per road mile. The average value of farm sets and other rural dwellings has been obtained by a sampling field survey. The number of units in each type of development was established from county maps published by the Illinois Department of Public Works and Buildings, in cooperation with the U. S. Department of Commerce and Bureau of Public Roads. Average annual damage to rural property has been computed to be $21,800. With construction of Rend Lake Reservoir with no allocation for flood control storage, average annual damages would be reduced to $15,300. If the reservoir is provided with flood control storage, average annual damages would be reduced to $10,700.

f. Urban damages. Urban damages occur in the towns of West Frankfort, Freeman Spur, Royalton, Herrin, Carbondale, Hurst, Blairsville, and Murphysboro, as follows:

(1) Damage starts in West Frankfort at about the 5-year frequency flood level. Damages up to the standard project flood level would occur to

16 residences, 2 service stations, the sewage treatment plant, a laundromat, a lumber mill, a mine supply company, a restaurant, and streets and sewers.

(2) Six residences are subject to damage at Freeman Spur which begins at about the 20-year frequency flood level.

(3) A water purification plant and a residence are subject to damage beginning at the 15-year frequency flood level at Royalton.

(4) Damage would begin at Herrin at about the 100-year frequency flood level and would consist of backwater basement damage to approximately 70 residences. Included in the damage estimate for Herrin is damage to a meat packing plant located near Herrin. Damage to that plant starts at about the 35-year frequency flood level.

(5) Damage at Carbondale would occur to the sewage treatment plant starting at about the 55-year frequency flood level.

(6) Minor damage starts at Hurst at the 5-year frequency flood level. Subject to damage to standard project flood level are approximately 100 residences, 2 churches, the sewage treatment plant, and a service station.

(7) Damage at Blairsville, starting at the 5-year frequency flood level, would occur to 30 residences, a grocery store, and a tavern.

(8) Minor residential damage in Murphysboro starts at the 5-year frequency level with commercial and industrial damage occurring at about the 10-year flood level. Subject to damage are 457 homes, including 130 new subdivision dwellings valued at $13,000 each. Also subject to inundation are a grade school, 2 motels, and 4 small grocery stores. The municipal water and sewage plants and the Illinois Electric and Gas Company distributing plant would have been out of operation during the 1961 high water if the flooding had been one foot higher. Officials claim that there is not available source of auxiliary power supply. With cessation of power, it is estimated that operations would be stopped at the shoe factory, a label manufacturing company, a textile mill, an aluminum extruding company, and about 200 commercial enterprises employing about 800 people with resulting loss of wages and loss of business estimated at about 20 percent of gross income.

Elevation damage frequency relationships were derived for each residential, commercial, and business property. Resulting average annual damages under present conditions and conditions with improvements are given in table A-3.

Table A-3
Average annual urban property damage

Town	Present conditions	With improvement without flood control storage*	With improvement with flood control storage
West Frankfort	$3,580	$ 700	$ 90
Freeman Spur	150	40	0
Royalton	40	20	10
Herrin	50	0	0
Carbondale	2,960	2,830	1,450
Hurst	3,140	2,240	1,280
Blairsville	450	180	80
Murphysboro	67,760	51,840	33,500
Total	$78,130	$57,850	$36,410
Say	$78,100	$57,800	$36,400

* Based on flood frequency reductions attributable to spillway storage only.

8. FLOOD DAMAGES PREVENTED

a. Crop damages prevented. With construction of the proposed Rend Lake project with incidental flood control storage, average annual crop damages of $57,200 would be reduced to $42,200, resulting in an annual benefit of $15,000. Residual damages with the Rend Lake project constructed with flood control storage are $29,100, and the benefit creditable to that project is $28,100.

b. Rural property damage. The $21,800 annual damage to rural properties would be reduced to $15,300 and $10,700 with the considered reservoir improvement with no allocation and with allocation for flood control storage, respectively. Corresponding damages eliminated would thus be $6,500 and $11,100, respectively.

c. Urban areas. Average annual urban damages of $78,100 would be reduced to $57,800 and $36,400 if the Rend Lake project were constructed without and with flood control storage provided, respectively. Corresponding benefits would be $20,300 and $41,700, respectively.

d. Total reduction in damages. Total benefits due to reduction in damages would amount to $41,800 and $80,900 for project conditions without and with flood control storage provided, respectively.

9. INCREASED LAND USE BENEFITS

a. Benefits from intensive agronomic practices. A substantial portion of farming operations in the area now subject to flooding is

performed on small farm units. In the past, the farm operators of these small units obtained an adequate livelihood by working part-time in the coal mines. With the decline of mine employment in the area, some of these part-time farmers have found their income insufficient to support their economic needs and have sold their farms. As a result, there has been some increase in the average size of farm units. However, it is considered that the trend towards larger size farms will decrease for the following reasons:

In the past, farming in the area has been accomplished largely on a part-time basis, with the income of these farmers reduced substantially by layoffs from their mine occupations. Even though the occupations of these part-time farmers have recently been reduced to farming only, with a consequent decrease in income, most of them have refused to migrate to other regions. It is considered that they will grasp any opportunity for part-time employment in any line of work that should develop within the area. With local interest groups and State and Federal agencies actively planning for any development in the area, there appears to be a great possibility of part-time farming, and small farm units will continue and be revived. In view of these indicated trends, it is considered that increased return benefit estimates should be conservative. This has led to the following considerations:

(1) It has been assumed that increased cropping methods would not be practiced except where demonstrated flood reductions were significant; increased yield and land conversion benefits have been restricted to those areas where estimated stage reductions are three feet or more. For the plan of reservoir operation without flood control storage allotment this assumption restricts benefit considerations to the river reach between miles 90 and 104. For the plan of improvement with flood control storage allotment, three feet or more reduction would be effected throughout the range of frequency flows analyzed from Rend Lake Dam site to the mouth of Big Muddy River.

(2) It was assumed that about half of the area on which flood damage reduction would be effected would remain in farm units too small to be susceptible to increased cropping practices. Crop acreages resulting from the analysis outlined in subparagraph (1) above were therefore reduced 50 percent prior to consideration for increased yield benefits.

(3) Because of the moderate level of farming now practiced in the area and the questionable likelihood that farmers owning the larger farm units will fully modify their practices to those necessary to obtain the estimated yield capabilities of the soils, increased yield return benefits were based on an assumed future level of cropland development in which their increased returns would be 75 percent of the maximum possible for the soil types. Estimated net returns under future conditions on flood-free lands would thus amount to $32.79 per acre.

(4) Experience has shown that after construction of an improvement there is a reluctance on the part of some farmers in areas susceptible to increased cropping practice to change their existing ways of farming.

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Even in the most productive and progressive areas of the Midwest complete participation in changed cropping methods cannot be expected. Since the acreages upon which increased cropping practices would be effected can be considered to vary with the degree of flood damages alleviated, it has been assumed that a measure of the degree of farmers' participation is the amount of average annual flood damage reduction effected. The improvement without flood control storage allotment would reduce annual average crop damages between miles 90 and 104 about 42 percent, and the improvement with flood control storage provided would reduce average annual crop damages in the total reach of river under consideration about 49 percent. Areas considered for increased yield benefits in accordance with subparagraphs (1) and (2) above were reduced by these percentages of participation in the manner outlined in Tables A-4 and A-5.

Increased yield benefits on existing cropland based upon the above assumptions amount to $15,300 and $79,800 with and without flood control storage allotments, respectively.

Table A-4

Rend Lake improvement without flood control storage, increased net return benefits on presently cropped acreage*

WITHOUT IMPROVEMENT		
Expected income without flooding		
$20.92 x 8,700 acres (standard project flood)		$182,000
Less crop damages due to flooding		
$11.63 x 1,060 average annual acres		- 12,300
Net income received	Total	$169,700
WITH IMPROVEMENT		
Expected income without flooding		
8,700 x 50% = 4,350 acres x $32.79		$142,600
8,700 - 4,350 = 4,350 acres x $20.92		91,000
	Subtotal	$233,600
Less crop damage due to flooding		
600 x 50% = 300 average annual acres x $15.85		- 4,800
600 - 300 = 300 average annual acres x $11.63		- 3,500
Net income to be received	Total	$225,300
INCREASE IN NET INCOME		$ 55,600
Less crop damage prevented, miles 90 to 104		
$11.63 x 460 average annual acres		- 5,300
INCREASED NET RETURN BENEFITS AT 100 PERCENT PARTICIPATION		$ 50,300
INCREASED NET RETURN BENEFITS AT 42 PERCENT PARTICIPATION		21,100
INCREASED NET RETURN BENEFITS DISCOUNTED**		15,300
INCREASED NET RETURN BENEFITS ON PRESENTLY CROPPED ACREAGE	Total	$ 15,300

* Based on flood frequency reductions attributable to spillway storage only.

** Discounted to reflect 15 year lag in attainment at 5 percent over 100 years (72.4 percent).

Table A-5

Rend Lake improvement with flood control storage, increased net return benefits on presently cropped acreage

WITHOUT IMPROVEMENT		
Expected income without flooding		
$20.92 x 38,800 acres (standard project flood)		$811,700
Less crop damage due to flooding		
$11.63 x 4,920 average annual acres		- 57,200
Net income received	Total	$754,500
WITH IMPROVEMENT		
Expected income without flooding		
38,800 x 50% = 19,400 acres x $32.79		$636,100
38,800 - 19,400 = 19,400 acres x $20.92		405,800
	Subtotal	$1,041,900
Less crop damage due to flooding		
2,500 x 50% = 1,250 average annual acres x $15.85		- 19,800
2,500 - 1,250 = 1,250 average annual acres x $11.63		- 14,500
Net income to be received	Total	$1,007,600
INCREASE IN NET INCOME		$253,100
Less crop damage prevented		
$11.63 x 2,420 average annual acres		- 28,100
INCREASED NET RETURNS AT 100 PERCENT PARTICIPATION		$225,000
INCREASED NET RETURNS AT 49 PERCENT PARTICIPATION		110,200
INCREASED NET RETURNS DISCOUNTED*		79,800
INCREASED NET RETURN BENEFITS ON PRESENTLY CROPPED ACREAGE	Total	$ 79,800

* Discounted to reflect 15-year lag in attainment at 5 percent over 100 years (72.4 percent).

b. Benefits from converted land use. Previous reference was made to the fact that crop acreages are generally located at levels subject to inundation only by floods of infrequent occurrence. The areas subject to more frequent flooding are mostly in woodland. It can be anticipated that with reductions in the frequencies of flooding, timbered areas adjoining cropland will be converted to cropland. Farmers interviewed readily expressed their intent to convert timberland to cropland if substantial flood reduction were provided. Since the amount of timberland (58,100 acres) is substantially greater than the cropland (38,800 acres) subject to flooding, a rational estimate of timberland conversion during the economic life of the improvement is difficult to derive. In consideration of the facts that some timbered

areas are located on hillsides which would not be suitable for cultivation, and that there will be many low-lying timbered areas still flooded too frequently to be considered for conversion, together with the knowledge that all farmers will not participate in land conversion, it is conservatively estimated that about 5 percent of the presently timbered areas will be converted to cropland. As in the derivation of increased return benefits to cropland, consideration of increased returns resulting from the reservoir improvement without flood control storage has been restricted to the 13,000 timberland acres between miles 90 and 104 because substantial reduction is effected for only this acreage. The method of derivation of these benefits is shown in tables A-6 and A-7, amounting to $13,000 and $53,700 without and with flood control allocation, respectively.

Table A-6

Rend Lake improvement without flood control storage, increased net return benefits on presently timbered acreage*

WITHOUT IMPROVEMENT		
Expected income without flooding		
13,000 acres x $3.00		$ 39,000
Less flood damages (none on timberland)		0
Net income received	Total	$ 39,000
WITH IMPROVEMENT		
Expected income without flooding		
13,000 x 5% = 700 acres x $32.79		$ 23,000
13,000 - 700 = 12,300 acres x $3.00		36,900
	Subtotal	$ 59,900
Less cost of timber conversion		
700 acres x $3.15		- 2,200
	Subtotal	$ 57,700
Less flood damages		
50 average annual acres x $15.85 (plus none on timberland)		- 800
Net income to be received	Total	$ 56,900
INCREASE IN NET INCOME		$ 17,900
INCREASED NET RETURN BENEFITS DISCOUNTED**		13,000
INCREASED NET RETURN BENEFITS ON PRESENTLY TIMBERED ACREAGE	Total	$ 13,000

* Based on flood frequency reductions attributable to spillway storage only.

** Discounted to reflect 15-year lag in attainment at 5 percent over 100 years (72.4 percent).

Table A-7

Rend Lake improvement with flood control storage, increased net return benefits on presently timbered acreage

WITHOUT IMPROVEMENT		
Expected income without flooding		
58,100 acres x $3.00		$174,300
Less flood damages (none on timberland)		0
Net income received	Total	$174,300
WITH IMPROVEMENT		
Expected income without flooding		
58,100 x 5% = 2,900 acres x $32.79		$ 95,100
58,100 - 2,900 = 55,200 acres x $3.00		165,600
	Subtotal	$260,700
Less cost of timber conversion		
2,900 acres x $3.15		- 9,100
	Subtotal	$251,600
Less flood damages		
195 average annual acres x $15.85 (plus none on timberland)		- 3,100
Net income to be received	Total	$248,500
INCREASE IN NET INCOME		$ 74,200
INCREASED NET RETURN BENEFITS DISCOUNTED*		$ 53,700
INCREASED NET RETURN BENEFITS ON PRESENTLY TIMBERED ACREAGE	Total	$ 53,700

* Discounted to reflect 15-year lag in attainment at 5 percent over 100 years (72.4 percent).

10. TOTAL BENEFITS

Total crop and property damages prevented, plus increased net income benefits, amount to $70,100 for the proposed Rend Lake improvement without provision of flood control storage, and $214,400 for the improvement with flood control storage. Derivation of these benefits is outlined in table A-8.

Table A-8
Rend Lake improvement without and with flood control storage, total benefits

	Without flood control storage*	With flood control storage
BENEFITS		
Flood damages prevented		
Crop	$15,000	$ 28,100
Rural property	6,500	11,100
Urban property	20,300	41,700
Total flood damages prevented	$41,800	$ 80,900
Increased net return benefits		
From presently cropped acreage	$15,300	$ 79,800
From presently timbered acreage	13,000	53,700
Total increased net return benefits	$28,300	$133,500
TOTAL ALL BENEFITS	$70,100	$214,400

* Based on flood frequency reductions attributable to spillway storage only.

11. MISSISSIPPI RIVER FLOOD CONTROL BENEFITS

In the recent Mississippi River Reservoir Benefit study, the considered Murphysboro Reservoir on the Big Muddy River was credited with $21,000 average annual flood prevention benefits. These benefits were for flood control that the reservoir would effect in the unprotected area downstream from Cairo, Illinois. Based upon the comparative flood control storage capacities of Rend Lake Reservoir with flood control storage allocation (111,500 acre-feet) and Murphysboro Reservoir (1,160,000 acre-feet), it is estimated that approximately 10 percent of the $21,000 benefit or $2,100 should be credited to Rend Lake Reservoir. Total flood control benefits credited to the reservoir would thus be $214,400 plus $2,100, or $216,500. It is estimated that Mississippi River flow reductions effected by Rend Lake Reservoir without flood control storage would not be significant. Therefore, no Mississippi River benefits are credited to that plan.

SECTION III - AREA REDEVELOPMENT BENEFITS

12. NATURE OF REDEVELOPMENT BENEFITS

In addition to the primary benefits credited to the project for products and services normally derived from a development of this nature, the proposed Rend Lake project has been credited with additional benefits based on those

contributions to the reorientation of the depressed economy of the region. These benefits are of two basic types: redevelopment benefits derived from the relief of present and persistent unemployment starting during the construction period and continuing indefinitely; and redevelopment benefits derived from new economic activities and development from the broadened and reoriented economic base starting when the project becomes operational and also continuing indefinitely. The basis for the assessment of these benefits is reported in the paragraphs below.

13. ASSESSMENT OF REDEVELOPMENT BENEFITS

In assessing the redevelopment benefits for purposes of this report, the nature and extent of the project's impact on local unemployment and on new economic activities and development were considered as a basis for estimating the monetary value of this benefit. The immediate effects of the construction works were assumed to represent the long-range effects on persistent unemployment conditions. The estimated construction cost included in the total first cost of the project was determined, together with the total labor cost and the unskilled labor costs included therein. It was assumed that an estimated $3,780,000 in unskilled labor costs would be the primary means of providing work opportunities for those presently on the local relief rolls. The number of unskilled jobs to be created directly or indirectly by the construction work was compared with the number of persons presently on the area relief rolls with consideration given to the probable physical ability and willingness of those on the relief rolls to work in the heavy construction industry, the probable shifting of some of those presently employed in heavy construction to thus create other openings for the presently unemployed, and other pertinent factors. From these considerations, it was concluded that about $65,300 annually would represent the permanent relief of the area unemployment that can be conservatively credited to the Rend Lake project, per se.

14. REDEVELOPMENT BENEFITS

The primary benefits attributed to the Rend Lake project for flood control, water supply, low flow regulation, fish and wildlife propagation, and recreation are expected to act as attractions for inducing new economic activities to come into the area. These redevelopment benefits are in addition to the primary benefits and the minimal unemployment benefits referred to in the paragraph above, and, according to the Area Redevelopment Administration, will be evidenced during the life of the project by an estimated 5,000 new jobs in the area with estimated payroll of $29,000,000 annually, decrease in area relief costs estimated at about $1,000,000 annually, increase of about $3,000,000 annually in Federal income taxes, and an unestimated amount of saving in unemployment insurances benefit payments and additional factors. These values support the soundness of investments in the Rend Lake project for the purpose of reorientating the present depressed economy of the area. However, the indices reflect industrial investments of indefinite magnitude and timing. As a basis for

assessments of the improvement to the economy resulting from the expanded economic base the project will create, it was deemed prudent to resort to the monetary assessments of the total primary benefits ($1,425,900 annually) rather than the indices referred to above. In the use of primary benefits for such purposes, care was necessary to avoid duplication of other benefits. Also, it was apparent that some discounting of these benefits was indicated in order to account for a reasonable period for full development of the economic reorientation. From consideration of these factors, it was concluded that about 20 percent of the total primary benefits, or about $285,100 annually, represented a reasonable estimate of these benefits.

SECTION IV - WATER SUPPLY BENEFITS

15. PRESENT SOURCES

Towns and communities within the Rend Lake sub-basin obtain their water supply from either surface impoundments or wells. The wells are subject to seasonal fluctuations, and during the extended drought, ground waters have become critically low. Several communities that are dependent upon surface impoundment as their main source of water supply have reached the maximum capacity of their systems. The adequacy of some of these sources is being further impaired due to loss of storage capacity from silting. The Illinois Department of Public Health has stated that some of these reservoir sources located within 15 miles of the Rend Lake site became "critical" during a severe drought that occurred in the region in 1954 and 1955 and major restrictions on water consumption had to be enforced for each of these supplies. In addition to these communities that have existing water systems, there are a minimum of 15 to 20 smaller incorporated areas that could be served by a comprehensive water distribution system from Rend Lake. Most of these communities have done everything within their power to develop a water supply but have been unsuccessful because of the financial burden involved. From a public health standpoint alone, the water for these areas is sorely needed.

16. FIELD INVESTIGATIONS

U. S. Public Health Service undertook an investigation concerning the water quality and quantity in the area. The study concerned itself primarily with the needs for future municipal and industrial usage that the surrounding area would require in the event that the Rend Lake Reservoir is built. A copy of its report is contained in appendix D.

17. WATER SUPPLY DEMAND

The Public Health Service in forecasting the water supply needs for the surrounding area assumed that these future demands would have to be met from storage provided in the Rend Lake Reservoir. The evaluation required providing an initial net supply of 6,700,000 gallons per day. Water supply demand for the first 15 years of operation is anticipated to grow at a 2-3/4 percent yearly rate, compounded annually. From the 16th year water supply demands will increase at a 4-1/2 percent yearly rate, compounded annually. This growth will continue until the ultimate industrial and domestic water supply requirements are reached; now estimated to occur in the 47th year of effective operation. It is estimated that the ultimate water supply requirements would amount to approximately 40,000,000 gallons per day. The Public Health Service has estimated that the demand for water would be prorated in the following manner:

Area of demand	Amount of water required
Within 5 miles of Benton, Illinois	8,000,000 gallons per day
Within 15 miles of Benton, Illinois	20,000,000 gallons per day
Within 25 miles of Benton, Illinois	40,000,000 gallons per day

18. REQUIRED STORAGE

Routing of natural flows of the Big Muddy and tributaries through the reservoir during critical low flow period, 1 June 1953 to 30 November 1954, and assuming an average withdrawal rate of 62 c.f.s. for water supply, indicated storage of 67,300 acre-feet would be required. Evaporation losses during this period were estimated at approximately 41,700 acre-feet, requiring a total storage for the critical period of 548 days, of 109,000 acre-feet.

19. BENEFITS

In determining the benefits accruable to the reservoir water supply storage, certain basic assumptions were made. The prime problem in the project area is to make available treated water at an economical cost. This will allow sale of water to communities presently without water supply systems and supplement existing treated water supply systems, avoiding the need to fund new capital investments. The Rend Lake Conservancy District proposes to furnish treated water to communities within an economical delivery distance of the reservoir. Therefore, in evaluating benefits accruable to water supply, it was assumed that the Rend Lake Conservancy District would provide at its own cost the intake structure and the water treatment plant. In evaluating the benefits attributable to water supply, the amount of demand was determined for each year of operation until the time that the ultimate demand was met. Review of cost data for single-purpose municipal water supply reservoirs revealed that storage costs for raw water may vary on an average from $160 as a minimum to $265 as a maximum per acre-foot of capacity. Since these data reflect some measure of the value of storage

capacity for municipal and industrial purposes, a mean value of $210 per acre-foot of capacity was used as a measure of the gross worth of water. The cost of the basic water requirements of 6,700,000 gallons per day plus the incremental cost of the growth demand discounted to present-day value was determined. The gross benefit then equaled this total cost amortized over 100 years at 4 percent interest or $492,500 on an average annual basis. However, to be conservative, this gross worth was modified to reflect the cost of transporting the water to the various areas of demand. Pipe line distances for the circles of demand established by the U. S. Public Health Service were determined extending from the transposed center point, water intake, to the mid point of each circle. The total pipe line cost, when amortized over the 100-year life of the project at 4 percent interest, equaled $191,800 on an average annual basis. The resultant net average annual benefit for water supply is $300,700.

SECTION V - POLLUTION ABATEMENT BENEFITS

20. GENERAL

The U. S. Public Health Service in their analyses of the water problems in the Rend Lake area and Big Muddy River Basin, studied the need for low flow augmentation in the interest of pollution abatement. A copy of their report is contained in appendix D. There are three public water supply intakes below the proposed Rend Lake damsite at the present time. The forecasted future population growth in the basin is anticipated to contribute a large domestic and industrial waste load to the stream even if the waste loads have been processed through a high degree of sewage treatment. Assuming that the low flow conditions of the 1952 - 1955 drought could again take place, the waste load that could be discharged into the stream would result in a concentration of wastes beyond assimilative capacity of the Big Muddy River. Under these conditions, a septic condition would prevail throughout the length of the river between Benton and a point downstream of Murphysboro, Illinois.

21. INVESTIGATION

The U. S. Public Health Service studied possible improvement of these prospective conditions that could be brought about by low flow augmentation from the Rend Lake Reservoir in order to dilute the anticipated waste loads. Based upon the forecasted population of the industrial growth to the year 2010, waste loads from various communities on the Big Muddy River and its tributary streams were computed. The computation of waste loads was derived assuming secondary treatment and a reduction in BOD content of 75 percent. The study showed that releases for pollution abatement equal to 30 cubic feet per second during periods of low flow would be required. The total load of 11,960 pounds per day of BOD discharge would be reduced by 3,785 pounds and would provide a dissolved oxygen count equal to four parts per million throughout the stream to a point below Murphysboro.

22. BENEFITS

As a monetary measure of the value of this improved assimilation capacity of the stream, comparison was made with the average cost of obtaining equivalent waste reduction in a sanitary treatment plant. It was estimated that this reduction in BOD could be accomplished at a unit cost of $16.00 per pound. Based on a reduction of 3,785 pounds and a unit value of $16.00 per pound, the average annual benefit attributable to low flow augmentation is estimated at $60,600.

SECTION VI - FISH AND WILDLIFE BENEFITS

23. FISHERY BENEFITS

A detailed report covering the recreational aspects of fish and wildlife for Rend Lake Reservoir has been prepared by the U. S. Fish and Wildlife Service in cooperation with the Illinois Department of Conservation and is contained in appendix D. The report indicates that a substantial benefit to the fishery of the basin would be realized. Based on the recreational aspects of fishing, net average annual benefits attributable to Rend Lake Reservoir are estimated to be $254,000.

24. WILDLIFE BENEFITS

The U. S. Fish and Wildlife Service has stated that construction and operation of Rend Lake Reservoir would result in a net average annual wildlife benefit of $13,000. As enhancement to this project, the U. S. Fish and Wildlife Service recommended development of three areas as waterfowl refuges. Two would be located in the upper arms of the reservoir on Rayse Creek (Big Muddy River) and Casey Fork and would be managed as duck refuges. Establishment of these two refuges required construction of impounding structures so that during the hunting season part of the refuge area could be flooded. In each case, a dam consisting of a compacted earth embankment with an uncontrolled notched weir spillway, rip rapped on both sides, was provided. The sluices required for the dam were sized to drain the area between elevations 405 and 410 within 15 days so that the pin oaks found in the area and vital to the waterfowl management could be protected and not lost because of long periods of inundation. Gross benefits attributable to these impoundments were estimated at $58,000 on an average annual basis. Net benefits attributable to these impoundments are equal to $58,000 less $13,000 accruable to the reservoir without any improvement, or $45,000 on an average annual basis. A third area located on Gun Creek on the east side of the reservoir was recommended for development as a goose refuge. For management purposes, acquisition of approximately 5,700 acres outside the project area would be required. Net average annual benefits attributable to this goose refuge are estimated at $22,500.

25. TOTAL BENEFITS

All three of these facilities were analyzed on an incremental basis and only the two sub-impoundments in the upper arms of the reservoir were

found to be economically justified, having a benefit-cost ratio of 1.1 to 1. Based on these analyses, average annual benefits attributable to Rend Lake for fish and wildlife conservation are estimated to be equal to $254,000 and $45,000, respectively, or a total of $312,000.

SECTION VII - RECREATIONAL BENEFITS

26. POTENTIAL FOR RECREATIONAL DEVELOPMENT

The reservoir shoreline and the operational plans for the reservoir are favorable for the development of recreational facilities. The reservoir will provide a large impoundment in a region where bodies of water for recreation are not numerous.

27. NEED FOR RECREATIONAL DEVELOPMENT

A report on the recreational use and development of Rend Lake Reservoir was prepared by the Department of the Interior, National Park Service, and is included in appendix D. The report indicated that the lower portion of the reservoir extending from the damsite to the Franklin - Jefferson County line is most suitable for planned recreational development by virtue of its accessability, large areas of land suitable to recreational use, and water of sufficient depth to encourage water sports and associated activities. Adaptable uses of the water and adjacent land would consist of picnicking, camping, canoeing, nature study, pleasure boating, water skiing, swimming, organized camping, fishing, and hunting. The development of the reservoir for public recreation is expected to attract a substantial number of visitors, particularly residents of the St. Louis metropolitan area. Estimates prepared by the National Park Service indicate that the Rend Lake Reservoir would have an annual visitor-day attendance of 1,670,000 exclusive of fishermen and hunter days three to five years after completion of the project. Ultimate visitation is estimated at 3,840,000 visitor days, an incremental increase of 2,170,000, that is expected to be reached within 50 years after completion of the project.

28. ILLINOIS DEPARTMENT OF CONSERVATION, DIVISION OF PARKS AND MEMORIALS

The Illinois Department of Conservation has expressed general concurrence with the report of the National Park Service and in the proposed recreational developments planned by the Corps of Engineers. In addition, the Illinois Department of Conservation has recommended certain areas, totaling approximately 2,000 acres be acquired for recreational use by either the Rend Lake Conservancy District or the State of Illinois. It is also proposed that development of these acreages be undertaken as integral units of the Illinois State Park system. In the event that this is accomplished, the Department of Conservation has proposed to assume operation and maintenance of at least three Corps of Engineers sites.

29. SIGNIFICANCE OF PROSPECTIVE RECREATION FEATURES TO THE PROJECT AS A WHOLE

Desire of the public for reservoir recreation is indicated by the fact that visitor-day attendance at existing Corps of Engineers reservoirs has been increasing at the rate of 10,000,000 per year. As an indication of the importance of recreational expenditures to the economy of the area, it is conservatively estimated that approximately $9,000,000 would be spent annually by the recreationists as well as hunters and fishermen who would make up the 2,272,000 visitor-day attendance expected annually within the first three years of operation at the Rend Lake Reservoir. These expenditures of costs are for food, gasoline, refreshment, boat rentals, bait sales, guide services, tackle sales, and lodgings.

30. RECOMMENDED EXPENDITURES FOR RECREATIONAL DEVELOPMENT

It is planned to provide suitable areas for public access and facilities for recreational use, to insure minimum basic requirements essential to development of the recreational potential. Development by the Corps of Engineers at an estimated cost of approximately $2,134,000, including some $334,000 for lands, will provide public access including facilities for boat launching, picnicking, swimming, and family tent camping facilities together with related access and circulation roads, potable water, and sanitary facilities. These facilities will provide for approximately 536,100 annual visitors which represent approximately 32 percent of the total visitation estimated by the National Park Service to occur within three years after start of operation. Provisions of these minimum recreational facilities have been developed in cooperation with the National Park Service and the Illinois Department of Conservation. It is anticipated that the State, Rend Lake Conservancy District, recreational service concessionaires, and private enterprise will provide the facilities, services, and commodities required for ultimate recreational development of Rend Lake. This ultimate cost is estimated to be $12,972,000.

31. RECREATIONAL BENEFITS

The National Park Service, in accordance with its current methods, estimated an average annual recreational benefit of $2,672,000, based on 1,670,000 visitor-day attendance within the first three years of operation and at a factor of $1.60 per visitor-day items. Recreational benefits used in the economic evaluation of the project were based on the estimated 536,100 annual visitors expected to utilize the basic minimum facilities. Utilizing a more conservative factor of $1.00 per visitor day, the average annual benefits attributable to recreational benefits for Rend Lake is estimated at $536,100.

SECTION VIII - SUMMATION OF BENEFITS

32. NEGATIVE BENEFITS

Detriments or negative benefits to overland transporation resulting from costs of providing greater clearances for bridges to be modified or reconstructed as part of the project and increased operation costs of future vehicle operation have been estimated at $36,000 annually, based upon criteria developed by the Bureau of Public Roads. These increased costs will be deducted from the total benefits to obtain the net benefits for the considered improvement.

33. SUMMARY OF BENEFITS

A summary of average annual benefits which will be realized under the plan of reservoir operation is as follows:

Flood control	
Big Muddy River	$214,400
Mississippi River	2,100
Water supply	300,700
Pollution abatement	60,600
Fish and wildlife	312,000
Recreation	536,100
Area redevelopment	285,100
Subtotal	$1,711,000
Less negative benefits	36,000
Total net benefits	$1,675,000

APPENDIX B

ESTIMATES OF COSTS

APPENDIX B

ESTIMATES OF COSTS

SECTION I - INTRODUCTION

1. SCOPE

The cost estimates presented herein are based on the plans of improvement proposed and developed by the Division of Waterways, State of Illinois, in its report on Rend Lake Reservoir, published in 1957. Modifications to the basic designs have been made incorporating Corps of Engineers' criteria. All costs are based on January 1962 price levels.

SECTION II - BASIS OF EVALUATION

2. CONSTRUCTION SCHEDULE

The time required to complete the principal project items was based on accepted construction practices. For cost purposes, construction time is estimated at three years.

SECTION III - BASIS OF DESIGN, CONSTRUCTION METHODS, AND PROCEDURES

3. GENERAL

Problems and procedures that are anticipated in the construction of the project are outlined in the following paragraphs. These serve as the basis for cost computations and are presented in conjunction with a discussion of the main construction features and their designs.

4. MAIN DAM

a. Description. The dam consists of a compacted earth embankment with an uncontrolled concrete spillway and outlet channel. The top of dam, elevation 424, averages 42 feet above the valley floor. Total length of the dam and spillway is approximately 8,900 feet. The concrete spillway would consist of a broad-crested weir at elevation 410, 500 feet in width, converging to a 320-foot stilling basin and outlet channel. A reinforced concrete bridge would span the spillway approach channel. Outlet works for regulation of the pool level under normal operating conditions and drawdown of pool would consist of two 6-foot by 6-foot concrete box sluices located in the earth section of the dam. In order to reduce the surcharge elevation an auxiliary paved spillway located in the east abutment of the dam structure would be placed at elevation 415 m.s.l. and would consist of an 800-foot broad-crested weir. Typical sections of the main dam and spillway are shown on plates 3 and 4 of the main report. Side slopes for the earth embankment utilize a basic 1 on 3 slope with modifications on the upstream and

downstream sides to insure adequate stability. Riprap is provided between elevations 424 and 395 m.s.l. on the upstream side to insure the integrity of the earth embankment against drawdown and wave action. A minor amount of riprapping is provided at the downstream toe of the embankment berm to insure the integrity of the chimney drain provided to control through seepage.

b. Sluice gates. The double 6-foot by 6-foot concrete box sluices are designed to control discharge below the main dam and are equipped with gates and trash racks. Flow line elevation would be set at 375, and an approach channel 13 feet wide with 1 on 3 side slopes would connect the river channel to the conduit for discharge of normal flow during construction of the dam. Maximum releases with combined operation of both dewatering conduits equal 2,500 c.f.s. at elevation 410, 2,250 c.f.s. at elevation 405, and approximately 1,000 c.f.s. at elevation 383 m.s.l.

c. Seepage control. To control the seepage through the embankment, an internal "chimney drain" was provided. The drain would extend vertically from the horizontal drainage blanket to elevation 415 m.s.l. This design will allow placement of random and pervious materials downstream of the internal drainage zone and would aid in the economy of construction. No relief wells have been provided for underseepage control. However, two ranges of piezometer will be provided to monitor underseepage pressures.

5. RELOCATIONS

a. General. The required relocations and remedial measures necessitated by construction of the proposed project are detailed in the cost estimate. In all cases, the relocations were provided to existing standards based upon present classifications.

b. Road and railroad relocations. Costs for road and railroad relocations and alterations were based on providing a floor elevation of 415 m.s.l. (5 feet above spillway crest and representing a frequency of occurrence for flooding greater than once every hundred years). While some of the roads traversing the reservoir pool will be abandoned, the main facilities will be relocated or altered to permit service to the area. The alterations and relocations indicated by the State in its 1957 report have been duplicated in this report. At that time, concurrence was obtained from the Illinois Division of Highways. Subsequent conversations between the State of Illinois Division of Highways and the St. Louis District office indicated that the Division of Highways has no modifications or additional requirements for the proposed plan of road relocations. Since the 1957 report, the Chicago and Eastern Illinois Railroad has built a new spur line in the upper arm of the reservoir. Since construction was predicated on the Rend Lake Reservoir being in place no alterations or relocation work is required. However, based on testimony presented at the public hearing, provisions have been made to provide riprapping of the upstream and downstream sides of the earth embankment up to elevation 415.

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c. Utilities. Power and telephone line relocations have been planned so that the unaffected but isolated areas will continue to be served. Abandoned utility lines will be removed from the reservoir area. These lines will be evaluated and compensation will be paid the operating company in the amount equal to the fair value of the facilities.

6. GEOLOGY AND SOIL DATA

a. General. The report on Rend Lake, as prepared by the Illinois Division of Waterways in 1957, was reviewed for compliance with established Corps of Engineers' criteria as pertains to soils and geology. Because of the time limit for preparation of this report, alternate sites were not considered. Instead, studies were concentrated on determining the feasibility and stability of the dam structure at the recommended site. A surface reconnaissance and study of available reports indicated that the areal geologic aspects as pertain to the reservoir were accurately reported. Additional investigations were made regarding the engineering aspects of the mineral geology. This investigation is detailed in paragraph 7.

b. Construction materials. Several sources capable of producing acceptable concrete aggregates, riprap bedding, stone filter material, and road surfacing materials are present within 65 miles of the damsite. The acceptability of these sources was determined through reference to the previous Corps of Engineers use and testing. All sources considered have produced materials approved by the Illinois Division of Highways.

c. Soils. A soils exploratory program was undertaken by the State for the 1957 report. This program was supplemented by additional borings taken by the St. Louis District. These borings were obtained to confirm the soil conditions to allow correlation of classification, and to permit shear tests on undisturbed samples of the valley clays. The results of the initial and supplemental borings program on the axis of the dam are presented on plate 5 of the main report. Borings taken upstream and downstream of the axis can be found in the State's report. A suitable borrow source is located in the west terrace about one-half mile upstream from the dam. The soil is a sandy clay, CL, and had a natural moisture content of 3 to 6 wet percent of optimum when sampled. The surface of the area is adequately drained, and the water table is well below contemplated borrow depths. Shear testing at optimum +5 percent water content revealed the following strengths for borrow material:

"Q" -- $\phi = 0^{\circ}$, C = 0.35 TSF.
"R" -- $\phi = 18^{\circ}$, C = 0.25 TSF.
"S" -- $\phi = 33^{\circ}$, C = 0.0 TSF.

The foundation clays were retested using samples obtained with improved techniques. Shear strengths for the foundation materials are:

"Q" -- $\phi = 0^{\circ}$, C = 0.58 TSF.
"R" -- $\phi = 16^{\circ}$, C = 0.33 TSF.
"S" -- $\phi = 21^{\circ}$, C = 0.10 TSF.

Stability of the proposed embankment and foundation was assessed using the above shear strengths. Pore pressures were determined using "blanket" formulas as in EM 1110-2-1901 and flow nets. Both the method of finite slices and method of planes, as outlined in EM 1110-2-1902, were used in the analysis. The design of the earth embankment as contained in the State's report did not meet the Corps of Engineers' established safety requirements. Consequently, the design was revised until all stability factors equaled or exceeded those required in EM 1110-2-1902. Studies of the seepage through the basement sands of the valley section and of the stability of the downstream blanket against uplift were made as outlined in EM 1110-2-1901. Seepage was estimated at between 1 and 2 c.f.s. The factor of safety against uplift exceeded 1.67 for the downstream blanket. Future mining subsidence upstream and downstream of the dam was considered in assigning permeabilities to the blanket clays of the valley floor.

7. HARD MINERAL RESOURCES

a. General. The State's report published in 1957 did not consider the effects of Rend Lake Reservoir on the hard mineral resources in the area. Herrin No. 6 coal is present throughout the entire area. The coal stratum is about 600 feet below the valley floor in 6 to 10-foot seams. There is an abandoned mine beneath the west abutment. This mine extends about 2,000 feet parallel to the dam and 1,000 feet perpendicular to the axis, upstream and downstream. A new mine has recently started operations that will eventually extend beneath the proposed reservoir. This mine is located approximately 5 miles upstream of the dam near Jackie Branch, northeast of the town of Sesser. A new mine will be put into operation in the very near future with the main shaft located approximately one-half mile south of the east abutment near Sugar Creek and northwest of the town of Benton. Present plans for mining propose continuous operations to extend beneath the dam area into the reservoir proper. All of the No. 6 coal beneath the reservoir is mineable.

b. Investigations. The Bureau of Mines was contacted as to the possibility of furnishing information and a letter report concerning the effects of the reservoir on the mineral resources of the area. However, because of the limited time available and the effects of existing workloads, the Bureau of Mines was not able to furnish a report. Mr. G. W. Josephson, Chief, Division of Mineral Resources, Region V, indicated that, in his opinion, a determination would have to be made as to the effects that the reservoir would have on the feasibility and costs of future

mining operations. He further indicated that such a determination should basically be made by the mine operators and the operating agency for the reservoir. Modern mining practices allow 85 to 90 percent removal of the available coal in the stratum and allow complete collapse of the mined-out area. Opinion has been expressed that some interference with mining operations might be experienced. To offset this, mining operations could be undertaken on the "room and pillar" method which permits removal of only 50 to 60 percent of the available coal. Discussions were held with Mr. W. J. Orlandi of the Department of Mines and Minerals, State of Illinois, and Mr. D. Simons of the Illinois State Geological Survey. They indicated that modern mining methods are feasible under the reservoir. Their opinions are based on recent experience beneath small reservoirs. In addition, an official of one of the major mining operators in the area has verbally indicated that his company anticipates no particular trouble in its mining operations due to the location of the Rend Lake Reservoir.

c. Conclusions and recommendations. The coal stratum is overlain by at least three competent limestone beds and numerous sandstone shale zones. The surface soils are plastic, relatively impervious clays. Subsidence over presently operating mines occurs over periods of days or weeks. These physical factors and the opinions of the State agencies, as well as various consulting engineers, give assurance that modern mining methods beneath the operating reservoir can be accomplished without added costs or loss of available coal. All parties also agreed that the mining operations would not significantly affect the amount of leakage from the reservoir area. In assessing the stability of the dam structure, the abandoned mine was first studied. The "room and pillar" mining method was used during its operation. Surface and air photo examination of the area did not reveal any subsidence. Experience with other abandoned mines in the area of similar age and mining methods suggests that subsidence, if it is to occur, does so within 3 years of abandonment. Since the mine has been in existence for the past 35 years, and considering the flexibility of the earth embankment, no special provisions have been made for the prevention or control of subsidence of this mine. However, to be on the conservative side, no future mining will be allowed within 800 feet of the centerline of the dam and the east and west abutments. This will allow a 45° angle to draw from any collapse to the toe of the dam. As a result, costs have been included in the estimate to buy outright all the rights to the hard mineral resources beneath this area of the dam. In relation to the mining operations underneath the remainder of the reservoir, subordination of the hard mineral rights to the reservoir will be required. Nominal costs for subordination beneath the reservoir are included in this estimate on the assumption that creation and operation of the reservoir will have no effects on mining operations.

8. OIL RESOURCES

Proven oil resources are present in the Mississippian sandstone formations of the area. There are approximately 54 producing wells that

are presently being worked by secondary recovery water flooding methods. Exploration drilling of the Devonian formation in the reservoir area is expected in the future since present explorations in adjacent areas have encountered oil in the Devonian sandstones. No subsidence or leakage problems are expected from removal of oil beneath either the dam or the reservoir. However, for purposes of this report, costs for subordination of oil rights within the reservoir area (elevation 415) have been included, based on present analysis of potential oil reserves.

9. LANDS REQUIRED

a. Project requirements. Costs listed for lands and damages are for the basic project requirements. Included in these costs are all lands in the reservoir area below elevation 415, which amount to 32,400 acres. In addition, provisions have been made to purchase in fee 1,400 acres for recreational facilities, 120 acres for access areas in the upper arms of the reservoir, 750 acres at the damsite, including acreage for construction of the outlet channel, and 230 acres for roadway relocations and access road to the dam. Total land acquisition for the basic project is 34,900 acres.

b. Additional area desired. The Rend Lake Conservancy District has indicated that it plans to acquire all lands located within a quarter-mile strip outside the recommended acquisition line of 415. In the course of development of the reservoir area, ownership of this quarter-mile strip will permit the conservancy district to control such issues as location of bridges, parks, recreational areas and playgrounds, roads, residential and business leases, conservation and wildlife refuges, and other related improvements allied to the creation of the reservoir. Inasmuch as this land acquisition has no direct bearing on the basic project and is a matter of concern to the conservancy district alone, this incremental cost has not been included in the project cost and formulation.

10. RESERVOIR CLEARING

For cost purposes, the 15,900 acres of timber cover indicated in the State of Illinois' report have been used. The State indicated that these timberlands are subject to frequent inundation, and difficulty may be experienced in the use of the heavy equipment for removal of the timber. Acreage involved compared very closely to an approximation utilizing the percent of land in timber below the proposed damsite.

11. FISH AND WILDLIFE IMPROVEMENTS

In accordance with request from the U. S. Fish and Wildlife Service, a study was made concerning the feasibility of providing subimpoundments in the upper arms of the reservoir for enhancement of waterfowl. An economic analysis on an incremental basis was made of providing these subimpoundments on the Big Muddy River and Casey Fork near Nason. Based on the benefits accruable to these subimpoundments, the benefit-to-cost

ratio was 1.1 to 1. Consequently, the cost of construction of these subimpoundments has been included in the cost of the project. In each case, a dam consisting of a compacted earth embankment with an uncontrolled notched weir spillway riprap on both sides, and sluices was provided. The design features included top of dam at elevation 415; an 800-foot broad-crested weir at elevation 410; and sluices sized to drain the area between elevations 405 and 410 within 15 days. The U. S. Fish and Wildlife Service indicated that the plan of operation would be as follows: that between the period 1 October and 15 December, water would be impounded by the structures to flood the area behind these dams up to elevation 410; that for the rest of the year water surface elevation would be maintained at elevation 405 to preserve the pin oaks vital to these duck refuges, the main portions of which are located between these two elevations. Based on average annual runoff data published by the State of Illinois for the Big Muddy River, it is anticipated that some supplementary pumping may be required during the period 1 October through 15 December. This would be provided by the operating agency assumed to be the State Department of Conservation. At the request of the U. S. Fish and Wildlife Service, establishment of a goose refuge on Gun Creek was also investigated. Based on the number of acres required for establishment and management of this refuge, as a first cost, this enhancement feature did not prove economically feasible. Therefore, the acreage required and the costs thereof have not been included in the project cost and formulation.

12. RECREATIONAL DEVELOPMENT

The National Park Service, in its report, indicated that only the southern portion of the reservoir is suitable for planned recreational development. Accordingly, the basic facilities for recreational development that are provided in accordance with Section 4 of the Flood Control Act of 1944, were located in this part of the reservoir. Nine sites have been selected to provide for boating access, picnicking, swimming, and family tent-camping facilities. Together with related access and circulation roads, potable water and sanitary facilities, the estimated cost of the minimum basic facilities is approximately $1,800,000. This cost represents the Federal Government's share of the total ultimate cost of development, approximately $13,000,000, recommended for Rend Lake by the National Park Service. All additional facilities would be provided by the State of Illinois, Rend Lake Conservancy District, civic organizations, and private enterprise, and have not been included in the basic project costs and formulation.

13. PREAUTHORIZATION STUDIES

The cost of preauthorization studies is $45,000. Because this cost is not pertinent in requesting funds from Congress for preconstruction planning and construction, and to avoid meaningless rounding of this

figure to permit adjustment of Federal and non-Federal costs to three significant figures, this cost has not been included in the project cost and formulation.

14. ENGINEERING AND DESIGN COSTS

Due to the urgency of this project and based on an anticipated speed-up, over and above that normally required for preconstruction planning, engineering and design costs have been computed at 8 percent of the construction work. This will allow design of some of the project features by qualified agencies other than the St. Louis District, Corps of Engineers, and will facilitate condensing the preconstruction planning phase for this project.

SECTION IV - ALTERNATIVE PLANS CONSIDERED

15. PLANS CONSIDERED

In selecting the best suitable plan for Rend Lake, principal consideration was given to a multiple-purpose reservoir for water supply, pollution abatement, recreation, fish and wildlife conservation, sociological impact, as pertains to the alleviation of unemployment and economic development in the project area, and flood control. Two multiple-purpose reservoirs were considered for the foregoing purposes. In one, specific storage for flood control was provided. In the other, no storage was allocated for flood control; flood control being effected in the valley below by reductions of flood stages by a time-lag effect. Consideration was also given to alternative projects capable of serving individual and various combinations of the functions served by the principal plans. In all cases, except for water supply and a joint project for fish and wildlife conservation and recreation, the alternative projects were assumed at the proposed damsite. In the case of a single-purpose project for water supply, the cost for separate impoundments computed at a mean cost of $210 per acre-foot and reflecting the initial and increased water demand over the life of the project, discounted to present date, was used as the alternative cost. In the case of a joint project for fish and wildlife and recreation, the cost of five lakes totaling the equivalent surface area as provided in the recommended plan was used as the alternative cost.

16. COMPARISON OF PLANS

Summary comparison of the plans considered for development of the Rend Lake Reservoir site and possible alternatives thereto is given in table B-2. This summary is based on Federal financing except in the case of alternative water supply and joint project for fish and wildlife conservation and recreation, in order to compare the relative economic merits of these plans. **The multiple-purpose plan for water supply, pollution abatement, fish and wildlife conservation, recreation, sociological impact, with flood control storage, provides for a balanced development and would produce the greatest excess of benefits over costs than any other plan considered.**

Table B-1
Cost estimate
Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

Classification No.	Item	Cost
01	Lands and damages	6,300,000.00
02	Relocations	8,261,000.00
03	Reservoirs	2,743,000.00
04	Dams - main	6,715,000.00
	- sub-impoundments	865,000.00
08	Roads, railroads, and bridges	470,000.00
14	Recreation facilities	1,829,000.00
19	Buildings, grounds, and utilities	186,000.00
20	Permanent operating equipment	30,000.00
30	Engineering and design	1,690,000.00
31	Supervision and administration	1,311,000.00
	Total project cost (January 1962)	$30,400,000.00

Table B-1
Cost estimate
Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
.01	LANDS AND DAMAGES				(6,300,000.00)
	Lands and damages (including subordination of mineral rights and contingencies)	sum	job		6,300,000.00
	Total lands and damages				6,300,000.00
.02	RELOCATIONS				(8,261,000.00)
.1	Roads				
*No.1.	Road embankment	49,800	cu.yd.	0.75	37,350.00
	Riprap	6,265	ton	5.50	34,457.50
	Bedding stone	3,615	ton	5.50	19,882.50
	Roadway, 12' Oil	1,550	lin.ft.	1.50	2,325.00
	Bridge, treated timber	-	-	sum	9,000.00
	Culvert, 48" CMP	112	lin.ft.	24.00	2,688.00
	Guard Rail	3,100	lin.ft.	3.50	10,850.00
	Culvert and br. removal	-	-	sum	300.00
	Subtotal				$116,853.00
*2.	Road embankment	106,050	cu.yd.	0.75	79,537.50
	Riprap	12,250	ton	5.50	67,375.00
	Bedding stone	7,065	ton	5.50	38,857.50
	Roadway, 18' gravel	3,210	lin.ft.	1.50	4,815.00
	Bridge, conc. 1-105'span	-	-	sum	150,000.00
	Guard rail	6,420	lin.ft.	3.50	22,470.00
	Culvert and br. removal	-	-	sum	2,000.00
	Subtotal				$365,055.00
*3.	Road embankment	400	cu.yd.	0.75	300.00
	Riprap	350	ton	5.50	1,925.00
	Bedding stone	200	ton	5.50	1,100.00
	Roadway, 12' gravel	325	lin.ft.	1.00	325.00
	Subtotal				$ 3,650.00

*For identification, numbers correspond to relocation numbers shown on Plate 2, Main Report and those used by the State of Illinois in its 1957 report on Rend Lake Reservoir

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
*4.	Road embankment	6,955	cu.yd.	0.75	5,216.25
	Riprap	655	ton	5.50	3,602.50
	Bedding stone	380	ton	5.50	2,090.00
	Roadway, 18' gravel	945	lin.ft.	1.50	1,417.50
	Culvert, multi-plate pipe Archs(2) 13'-5" span 8'-5" rise 2@ 114 =	228	lin.ft.	108.00	24,624.00
	Guard rail	1,890	lin.ft.	3.50	6,615.00
	Culvert and br. removal	-	-	sum	900.00
	Subtotal				$ 44,465.25
5.	Road embankment	32,700	cu.yd.	0.75	24,525.00
	Riprap	2,690	ton	5.50	14,795.00
	Bedding stone	1,550	ton	5.50	8,525.00
	Roadway, 18' gravel	2,300	lin.ft.	1.50	3,450.00
	Culvert, multi-plate arch 10'-11" span, 7'-1" rise	123	lin.ft.	81.00	9,963.00
	Guard rail	4,600	lin.ft.	3.50	16,100.00
	Culvert and br. removal	-	-	sum	1,800.00
	Bridge, conc. 1-38' span	-	-	sum	26,000.00
	Subtotal				$105,158.00
7.	Road embankment	990	cu.yd.	0.75	742.50
	Riprap	275	ton	5.50	1,512.50
	Bedding stone	160	ton	5.50	880.00
	Roadway, 12' gravel	350	lin.ft.	1.00	350.00
	Culvert, 42"Ø pipe	87	lin.ft.	16.00	1,392.00
	Guard rail	700	lin.ft.	3.50	2,450.00
	Subtotal				$ 7,327.00
10.	Road embankment	60,000	cu.yd.	0.75	45,000.00
	Riprap	5,065	ton	5.50	27,857.50
	Bedding stone	2,925	ton	5.50	16,087.50
	Roadway, 22' concrete	770	lin.ft.	21.00	16,170.00
	Bridge, conc. 2-75' & 1-105' spans, 28' wide	-	-	sum	280,000.00
	Box culvert (raise)	-	-	sum	4,000.00
	Guard rail	1,540	lin.ft.	3.50	5,390.00
	Culvert and br. removal	-	-	sum	24,000.00
	Subtotal				$418,505.00

*For identification, numbers correspond to relocation numbers shown on Plate 2, Main Report and those used by the State of Illinois in its 1957 report on Rend Lake Reservoir

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
11.	Roadway, 12' gravel	800	lin.ft.	1.00	800.00
15.	Road embankment	2,200	cu.yd.	0.75	1,650.00
	Riprap	630	ton	5.50	3,465.00
	Bedding stone	365	ton	5.50	2,007.50
	Roadway, 12' gravel	685	lin.ft.	1.00	685.00
	Culvert, multi-plate arch 16'-7" span, 10'-1" rise	70	lin.ft.	165.00	11,550.00
	Guard rail	1,370	lin.ft.	3.50	4,795.00
	Culvert and br. removal	-	-	sum	200.00
	Subtotal				$ 24,352.50
16.	Road embankment	1,600	cu.yd.	0.75	1,200.00
	Riprap	460	ton	5.50	2,530.00
	Bedding stone	270	ton	5.50	1,485.00
	Roadway, 12' gravel	480	lin.ft.	1.00	480.00
	Culvert, 30" C.M.P.	71	lin.ft.	9.00	639.00
	Guard rail	960	lin.ft.	3.50	3,360.00
	Subtotal				$ 9,694.00
17.	Road embankment	39.735	cu.yd.	0.75	29,801.25
	Riprap	7,450	ton	5.50	40,975.00
	Bedding stone	4,470	ton	5.50	24,585.00
	Roadway, 18' gravel	6,700	lin.ft.	1.50	10,050.00
	Bridge, conc. 2-45.5' spans	-	-	sum	65,000.00
	Bridge, conc. 1-50' span	-	-	sum	36,000.00
	Culvert, conc. box	116	lin.ft.	350.00	40,600.00
	Guard rail	1,340	lin.ft.	3.50	4,690.00
	Culvert and br. removal	-	-	sum	2,500.00
	Subtotal				$254,201.25
19.	Road embankment	28,910	cu.yd.	0.75	21,682.50
	Riprap	3,645	ton	5.50	20,047.50
	Bedding stone	2,100	ton	5.50	11,550.00
	Roadway, 24' concrete	4,930	lin.ft.	24.00	118,320.00
	Conc. br.(raise 3') 3-43' spans	-	-	sum	70,000.00
	Culvert, multi-plate arch 12'-8" span, 8'-1" rise	124	lin.ft.	91.00	11,284.00
	Guard rail	9,860	lin.ft.	3.50	34,510.00
	Culvert and br. removal	-	-	sum	5,000.00
	Subtotal				$292,394.00

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
21.	Roadway, 12' gravel	500	lin.ft.	1.00	500.00
	Guard rail	1,000	lin.ft.	3.50	3,500.00
	Subtotal				$ 4,000.00
24.	Road embankment	1,100	cu.yd.	0.75	825.00
	Riprap	140	ton	5.50	770.00
	Bedding stone	80	ton	5.50	440.00
	Roadway, 18' gravel	960	lin.ft.	1.50	1,440.00
	Culvert, multi-plate arch(2) 2@ 82' each		lin.ft.	120.00	19,680.00
	Guard rail	1,920	lin.ft.	3.50	6,720.00
	Culvert removal	-	-	sum	300.00
	Subtotal				$ 30,175.00
27.	Road embankment	136,900	cu.yd.	0.75	102,675.00
	Riprap	22,650	ton	5.50	124,575.00
	Bedding stone	13,070	ton	5.50	71,885.00
	Roadway. 24' concrete	5,600	lin.ft.	24.00	134,400.00
	Bridge, conc.1-90' span	-	-	sum	80,000.00
	Bridge, conc.1-150'span	-	-	sum	110,000.00
	Bridge, conc.1-40' span	-	-	sum	48,000.00
	Guard rail	11,200	lin.ft.	3.50	39,200.00
	Culvert and br. removal	-	-	sum	8,000.00
	Subtotal				$718,735.00
29.	Road embankment	1,325,000	cu.yd.	0.75	993,750.00
	Riprap	109,000	ton	5.50	599,500.00
	Bedding stone	63,000	ton	5.50	346,500.00
	Roadway, 24' concrete	18,850	lin.ft.	24.00	452,400.00
	Bridge, conc.2-35',1-105'spans	-	-	sum	250,000.00
	Bridge, conc.1-114' span	-	-	sum	160,000.00
	Bridge, conc.1-17' span	-	-	sum	33,000.00
	Guard rail	37,700	lin.ft.	3.50	131,950.00
	Culvert and br. removal	-	-	sum	27,000.00
	Subtotal				$2,994,100.00
	Maintenance during Construction				$ 50,000.00
	Right-of-Way for Construction				$ 20,000.00
	Subtotal				$5,459,465.00
	Contingencies				818,535.00
	Total for Roads				$6,278,000.00

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
.2	Railroads				
20.	Embankment	32,800	cu.yd.	0.75	24,600.00
	Riprap	5,200	ton	5.50	28,600.00
	Bedding stone	3,900	ton	5.50	21,450.00
	Trackwork	2,690	lin.ft.	20.00	53,800.00
	Bridge, timber trestle, 10-14' spans	-	-	sum	24,000.00
	Culvert and br. removal	-	-	sum	900.00
	Subtotal				$153,350.00
26.	Embankment	334,700	cu.yd.	0.75	251,025.00
	Riprap	32,000	ton	5.50	176,000.00
	Bedding stone	19,000	ton	5.50	104,500.00
	Trackwork	8,860	ton	20.00	177,200.00
	Bridge, timber trestle, 4-14' spans	-	-	sum	11,000.00
	Bridge, timber trestle, 4-14' spans	-	-	sum	11,000.00
	Bridge, timber trestle, 10-14' spans	-	-	sum	24,000.00
	Bridge, timber trestle, 4-14' spans	-	-	sum	11,000.00
	Culvert, multi-plate arch 9'-4" span, 6'-3" rise	112	lin.ft.	85.00	9,520.00
	Culvert, 48" CMP	100	lin.ft.	24.00	2,400.00
	Culvert and br. removal	-	-	sum	3,000.00
	Subtotal				$780,645.00
	C.E.&I. Railroad Riprap of Fill				
	Riprap	30,000	ton	5.50	165,000.00
	Bedding stone	15,000	ton	5.50	82,500.00
	Subtotal				$247,500.00
	Right-of-Way for Construction	sum	job		10,000.00
	Subtotal for Railroads				$1,191,495.00
	Contingencies, 15%±				178,505.00
	Total for Railroads				$1,370,000.00

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
.3	Utilities				
	Transmission Lines				
	Power line (138 KV)	17	mile	19,000.00	323,000.00
	Power line (34.5 KV)	12	mile	8,700.00	104,400.00
	Power lines below 34.5 KV	17	mile	1,500.00	25,500.00
	Telephone lines	34	mile	2,000.00	68,000.00
	Right-of-Way for Construction	sum	job		12,000.00
	Subtotal				532,900.00
	Contingencies				80,100.00
	Total for Transmission Lines				$ 613,000.00
	TOTAL FOR RELOCATIONS				$8,261,000.00
.03	RESERVOIRS				(2,743,000.00)
	Clearing	15,900	acre	150.00	2,385,000.00
	Subtotal for reservoirs				$2,385,000.00
	Contingencies				358,000.00
	TOTAL RESERVOIRS				$2,743,000.00
.04	DAMS				(7,580,000.00)
	Main dam				
	Earth Dam				
	Clearing	10.7	acre	60.00	642.00
	Grubbing	10.7	acre	150.00	1,605.00
	Stripping foundation, 2'	170,000	cu.yd.	0.40	68,000.00
	Embankment from excavation includes 10% for settlement	1,334,000	cu.yd.	0.35	466,900.00
	Embankment from borrow includes 10% for settlement	264,000	cu.yd.	0.65	171,600.00
	Upstream Slope Protecting				
	Riprap, 18"-300#	52,000	ton	5.50	286,000.00
	Bedding stone, 6"	18,500	ton	5.50	101,750.00
	Downstream Slope Protecting				
	Riprap, 12"-150#	15,700	ton	5.50	86,350.00
	Bedding stone, 6"	9,100	ton	5.50	50,050.00
	Chimney drains, 4'	183,000	ton	5.00	915,000.00
	Roadway across dam, double bit. 22' width	20,000	sq.yd.	2.75	55,000.00

Table B-1 (Cont'd)

Classification No.	Item	Unit	Unit price	Total estimated cost	
	Roadway guard rail	16,300	lin.ft.	3.50	57,050.00
	Old channel fill	125,900	cu.yd.	0.35	44,065.00
	Turn Around & Parking Area				
	Excavation, Common				
	Retaining wall footings	1,160	cu.yd.	0.75	870.00
	Excavation, Structural				
	Retaining wall footings	25	cu.yd.	2.50	62.50
	Backfill, retaining wall	57,400	cu.yd.	1.50	86,100.00
	Fill, retaining wall	9,300	cu.yd.	3.50	32,550.00
	Concrete				
	Retaining wall	1,500	cu.yd.	40.00	60,000.00
	Retaining wall footings	1,670	cu.yd.	40.00	66,800.00
	Steel, Reinforcing				
	Retaining wall	164,000	lb.	0.13	21,320.00
	Retaining wall footings	183,000	lb.	0.12	21,960.00
	Surfacing, double bit.	14,200	sq.yd.	2.50	35,500.00
	Handrail	100,000	lb.	0.18	18,000.00
	Access road turnaround	770	sq.yd.	2.75	2,117.50
	Piezometers	6	each	500.00	3,000.00
	Bridge spanning spillway	-	-	sum	450,000.00
	Seeding and mulching	26	acre	225.00	5,850.00
	Subtotal, Earth Dam				$3,108,142.00
	Dewatering Structure				
	Excavation, Common				
	Channel, inlet & outlet	66,300	cu.yd.	0.40	26,520.00
	Conduit " "	1,200	cu.yd.	0.65	780.00
	Conduit	800	cu.yd.	0.65	520.00
	Control tower footings	600	cu.yd.	0.65	390.00
	Excavation, Structural				
	Conduit, inlet & outlet	20	cu.yd.	1.85	37.00
	Conduit	100	cu.yd.	1.85	185.00
	Conduit footings	120	cu.yd.	1.85	222.00
	Conduit cutoff walls	30	cu.yd.	2.00	60.00
	Tower footings	60	cu.yd.	1.85	111.00
	Concrete				
	Control tower	325	cu.yd.	70.00	22,750.00
	Footings, supports, & tower walk	165	cu.yd.	40.00	6,600.00
	Conduit	430	cu.yd.	60.00	25,800.00
	Conduit cutoff walls	50	cu.yd.	40.00	2,000.00
	Conduit footings	125	cu.yd.	40.00	5,000.00
	Inlet slab & wall, & outlet walls	300	cu.yd.	40.00	12,000.00
	Stilling basin slab	100	cu.yd.	30.00	3,000.00

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
	Reinforcing steel				
	Control tower	31,000	lb.	0.18	5,580.00
	Footings & tower walk	26,500	lb.	0.14	3,710.00
	Supports	1,300	lb.	0.15	195.00
	Conduit	109,500	lb.	0.13	14,235.00
	Cutoff walls, inlet & outlet walls	41,200	lb.	0.13	5,356.00
	Footings	12,500	lb.	0.12	1,500.00
	Inlet & outlet slabs	20,000	lb.	0.12	2,400.00
	Structural steel				
	Trash racks	2,200	lb.	0.50	1,100.00
	Service gates & accessories	12,000	lb.	0.75	9,000.00
	Machinery for service gates	2	each	9,000.00	18,000.00
	Emergency gate	5,000	lb.	0.75	3,750.00
	Dewatering structure				
	Machinery for emergency gate	1	each	12,000.00	12,000.00
	Installation of machinery	-	-	sum	6,000.00
	Power line, source to control str.	-	-	sum	6,300.00
	Electrical system (incl. standby equip.)	-	-	sum	5,200.00
	Sheet piling				
	Stilling basin	800	sq.ft.	5.00	4,000.00
	Pipe handrail	310	lin.ft.	10.00	3,100.00
	Drain pipe				
	Along outlet structure walls	130	lin.ft.	2.00	260.00
	Riprap				
	Inlet & outlet	110	ton	5.50	605.00
	Subtotal, Dewatering Structure				$208,266.00
	Main spillway				
	Excavation, common				
	Approach	370,400	cu.yd.	0.40	148,160.00
	Spillway & stilling basin	281,000	cu.yd.	0.65	182,650.00
	Outlet channel	496,300	cu.yd.	0.35	173,705.00
	Excavation, structural				
	Spillway & stilling basin	1,360	cu.yd.	1.85	2,516.00
	Backfill				
	Spillway & stilling basin walls	7,600	cu.yd.	3.50	26,600.00
	Concrete				
	Spillway floor	16,000	cu.yd.	30.00	480,000.00
	Spillway walls	2,500	cu.yd.	40.00	100,000.00
	Stilling basin floor	5,600	cu.yd.	30.00	168,000.00
	Stilling basin end sill	310	cu.yd.	40.00	12,400.00
	Stilling basin walls	510	cu.yd.	40.00	20,400.00
	Stilling basin wing walls	100	cu.yd.	40.00	4,000.00

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
	Reinforcing steel				
	Spillway	2,080,000	lb.	0.14	291,200.00
	Stilling basin	561,000	lb.	0.14	78,540.00
	Drain pipe				
	10" spillway & stilling basin	1,800	lin.ft	2.50	4,500.00
	6" spillway & stilling basin	4,450	lin.ft.	2.00	8,900.00
	Riprap, upstream & downstream	13,130	ton	5.50	72,215.00
	Bedding, material, upstream & downstream	4,050	ton	5.50	22,275.00
	Gravel, spillway & stilling basin	27,720	ton	5.50	152,460.00
	Sand, spillway & stilling basin	13,050	ton	5.00	65,250.00
	Steel sheet piling	20,700	sq.ft.	5.00	103,500.00
	Subtotal, Main Spillway				$2,117,271.00
	Auxiliary spillway				
	Excavation, common				
	Spillway	335,000	cu.yd.	0.40	134,000.00
	Slab	1,250	cu.yd.	0.65	812.50
	Cutoff walls	760	cu.yd.	0.65	494.00
	Cut for riprap	6,800	cu.yd.	0.65	4,420.00
	Excavation, structural				
	Slab	420	cu.yd.	1.80	756.00
	Cutoff walls	250	cu.yd.	2.50	625.00
	Concrete				
	Slab	1,660	cu.yd.	30.00	49,800.00
	Upstream cutoff wall	220	cu.yd.	40.00	8,800.00
	Downstream cutoff wall	450	cu.yd.	40.00	18,000.00
	Reinforcing steel				
	Slab	100,000	lb.	0.12	12,000.00
	Cutoff walls	64,300	lb.	0.13	8,359.00
	Riprap				
	Upstream & downstream	7,400	ton	5.50	40,700.00
	Crushed stone				
	Downstream section	1,155	ton	5.50	6,352.50
	Filter base course				
	Downstream section	1,080	ton	5.50	5,940.00
	Seeding	663,000	sq.ft.	0.006	3,978.00
	Subtotal, Auxiliary Spillway				$295,037.00

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Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
	Maintenance during construction				$110,000.00
	Subtotal, main dam				$5,838,716.00
	Contingencies				876,284.00
	Total, main dam				$6,715,000.00
	Auxiliary Dams (Subimpoundments)				
	Big Muddy				
	Embankment	89,000	cu.yd.	0.65	57,850.00
	Riprap, 18"-300#	15,700	ton	5.50	86,350.00
	Bedding stone	6,150	ton	5.50	33,825.00
	Roadway surfacing,6"cr.stn.	2,700	cu.yd.	0.75	2,025.00
	Concrete(incl.reinf.mesh)	400	cu.yd.	35.00	14,000.00
	Access road, 12' gravel	5,500	lin.ft.	1.50	8,250.00
	Foundation stripping (2' thick)	28,930	cu.yd.	0.40	11,572.00
	Outlet works				
	Inlet & gatewell	sum	job		30,000.00
	Sluice gate, 96"	sum	job		12,000.00
	Pipe, concrete, 96"	200	lin.ft.	80.00	16,000.00
	Headwall	sum	job		15,000.00
	Subtotal, Big Muddy				$286,872.00
	Casey Fork				
	Embankment	134,400	cu.yd.	0.65	87,360.00
	Riprap	31,500	ton	5.50	173,250.00
	Bedding stone	12,150	ton	5.50	66,825.00
	Roadway surfacing,6"cr.stn.	6,600	sq.yd.	0.75	4,950.00
	Concrete(incl.reinf.mesh)	400	cu.yd.	35.00	14,000.00
	Access road, 12' gravel	3,000	lin.ft	1.50	4,500.00
	Foundation stripping(2'thick)	6,500	cu.yd.	0.40	24,600.00
	Outlet works				
	Inlet & gatewell	sum	job		35,000.00
	Sluice gate,108"	sum	job		15,000.00
	Pipe, concrete,108"	200	lin.ft.	110.00	22,000.00
	Headwall	sum	job		18,000.00
	Subtotal Casey Fork				$465,485.00
	Subtotal auxiliary dams(subimpoundments)				752,357.00
	Contingencies				112,643.00
	Total auxiliary dams (subimpoundments)				$865,000.00
	TOTAL DAMS				$7,580,000.00

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
.08	ROADS, RAILROADS, & BRIDGES				(470,000.00)
	Access road, main dam				
	Double bit. surfacing,22'	103,250	sq.yd.	2.75	283,937.50
	Maintenance during construction	sum	job		125,000.00
	Subtotal				$408,937.50
	Contingencies				61,062.50
	TOTAL ROADS, RAILROADS AND BRIDGES				$470,000.00
14.	RECREATION FACILITIES				(1,829,000.00)
	Boat launching ramps	8	each	14,000.00	112,000.00
	Picnic tables	300	each	85.00	25,500.00
	Picnic tables with shelter	190	each	200.00	38,000.00
	Barbecue braziers	490	each	65.00	31,850.00
	Refuse container(SR-1)	120	each	45.00	5,400.00
	Incinerators(SI-2)	46	each	275.00	12,650.00
	Comfort stations				
	Type SC-2	17	each	8,500.00	144,500.00
	Type SC-1	12	each	13,500.00	162,000.00
	Fountains (WD-1)	27	each	900.00	24,300.00
	Fountains (bubbler)	38	each	150.00	5,700.00
	Fountain shelters (WS-3)	38	each	150.00	5,700.00
	Water supply system	sum	job		84,000.00
	Sewage treatment plant	sum	job		63,000.00
	Sewage system	sum	job		31,000.00
	Central wash house & shower	sum	job		75,000.00
	Park areas	11	acre	15,000.00	165,000.00
	Access road	8	mile	12,000.00	96,000.00
	Gravel paths	4.5	mile	8,000.00	36,000.00
	Reforesting	sum	job		20,000.00
	Picnic shelter (PS-1)	6	each	3,000.00	18,000.00
	Overlook shelter building (OS-3)	sum	job		30,000.00
	Tent camp sites	190	each	200.00	38,000.00
	Seeding, mulching & fertilizing	960	acre	160.00	153,600.00
	General area grading	sum	job		100,000.00
	Electrical supply	sum	job		88,000.00
	Maintenance during construction	sum	job		25,000.00
	Subtotal				$1,590,200.00
	Contingencies				238,800.00
	TOTAL RECREATIONAL FACILITIES				$1,829,000.00

Table B-1 (Cont'd)

Classification No.	Item	Quantity	Unit	Unit price	Total estimated cost
19.	BUILDING, GROUNDS, AND UTILITIES				(186,000.00)
	Warehouse (30'x50'x12')	sum	job		25,000.00
	Building with sanitary facilities (20'x20'x10')	sum	job		10,000.00
	Fencing (150'x150')	sum	job		5,000.00
	Parking area with entrance roads	sum	job		2,000.00
	Water supply (2-1/2 miles)	sum	job		45,000.00
	Maintenance during construction	sum	job		75,000.00
	Subtotal				$162,000.00
	Contingencies				24,000.00
	TOTAL FOR BUILDINGS, GROUNDS, AND UTILITIES				$186,000.00
20.	PERMANENT OPERATING EQUIPMENT				(30,000.00)
	Truck (1-1/2 tons)	1	each	3,000.00	3,000.00
	Tractors with accessories	2	each	3,000.00	6,000.00
	Boat	1	each	4,000.00	4,000.00
	Mosquito control equipment	sum	job		9,000.00
	Miscellaneous tools	sum	job		1,000.00
	Office equipment	sum	job		1,000.00
	Communication facilities (telephone)	sum	job		2,000.00
	Subtotal				$ 26,000.00
	Contingencies				4,000.00
	TOTAL FOR PERMANENT OPERATING EQUIPMENT				$ 30,000.00
30.	ENGINEERING AND DESIGN				$1,690,000.00
31.	SUPERVISION AND ADMINISTRATION				$1,311,000.00
	TOTAL PROJECT COST (January 1962)				$30,400,000.00

Table B-2

Summary of construction expenditures (100-year life basis)

Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

	Multiple-purpose project								Alternate single-purpose projects				Alternate multiple-purpose projects		
	Specific costs						Remaining joint costs	Total costs	Flood control	Water supply	Pollution abatement	Fish, wildlife and recreation	Flood control and (1) water supply	Flood control and (1) pollution abatement	Water supply and (1) pollution abatement
	Flood control	Water supply	Pollution abatement	Fish and wildlife	Recreation	Area redevelopment									
01 Lands and damages	---	---	---	---	$334,400	---	$5,965,600	$6,300,000							
02 Relocations	---	---	---	---	---	---	9,435,900	9,435,900							
03 Reservoir clearing	---	---	---	---	---	---	3,133,100	3,133,100							
04 Dam															
Main dam	---	---	---	---	---	---	7,670,200	7,670,200							
Sub-impoundments	---	---	---	$988,000	---	---	---	988,000							
08 Roads, railroads and bridges	---	---	---		---	---	536,900	536,900							
14 Recreation facilities	---	---	---	---	2,089,200	---	---	2,089,200							
19 Building, grounds, and utilities	---	---	---	---	---	---	212,400	212,400							
20 Permanent operating equipment	---	---	---	---	---	---	34,300	34,300							
Total for project	---	---	---	$988,000	$2,423,600	---	$26,988,400	$30,400,000	$25,800,000	$12,100,000 (2)	$20,000,000	$22,265,000	$28,600,000	$27,200,000	$27,000,000
Operation and maintenance															
Annual operation	---	---	---	$8,000	$14,400	---	$15,600	$38,000	$15,600	$12,600	$11,600		$27,600	$22,200	$27,000
Annual maintenance	---	---	---	4,000	5,000	---	6,000	15,000	6,000	5,400	5,400	$14,000	10,000	8,000	14,000
Annual major replacement	---	---	---	---	28,300	---	700	29,000	700	700	700	30,000	24,200	19,700	29,000
Annual supervision and administration	---	---	---	2,000	---	---	4,000	6,000	1,000	1,000	1,000	1,000	3,000	4,000	1,000
Total operation and maintenance	---	---	---	$14,000	$47,700	---	$26,300	$88,000	$23,300	$19,700 (2)	$18,700	$45,000	$64,800	$53,900	$71,000
Construction period								3 years	3 years	7 years	2 years	2 years	3 years	3 years	3 years

(1) Includes fish and wildlife conservation, recreation and area redevelopment
(2) Costs of separate impoundments discounted to present date and reflecting growth

Table B-2 (cont'd)

Summary of investments and annual charges (100-year life basis)

Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

	Multiple-purpose project									Alternate single-purpose projects					Alternate multiple-purpose projects		
	Specific costs						Remaining joint costs	Total costs		Flood control	Water supply	Pollution abatement	Fish, wildlife and recreation		Flood control and (1) water supply	Flood control and (1) pollution abatement	Water supply and pollution abatement
	Flood control	Water supply	Pollution abatement	Fish and wildlife	Recreation	Area redevelopment											
Investment																	
Construction expenditures	---	---	---	$988,000	$2,423,600	---	$26,988,400	$30,400,000		$25,800,000	$12,100,000	$20,000,000	$22,265,000		$28,600,000	$27,200,000	$27,000,000
Interest during construction	---	---	---	38,900	95,400	---	1,062,700	1,197,000		1,015,900	423,500	525,000	779,300		1,126,100	1,071,000	1,063,100
Total investment	---	---	---	$1,026,900	$2,519,000	---	$28,051,100	$31,597,000		$26,815,900	$12,523,500	$20,525,000	$23,044,300		$29,726,100	$28,271,000	$28,063,100
Annual charges																	
Interest	---	---	---	$27,000	$66,100	---	$736,300	$829,400		$703,900	$438,300	$538,800	$806,600		$780,300	$742,100	$736,700
Amortization	---	---	---	2,200	5,400	---	59,700	67,300		57,100	14,500	43,700	26,700		63,300	60,200	59,800
Operation and maintenance	---	---	---	14,300	19,400	---	25,600	59,300		22,600	19,000	18,300	15,000		40,600	34,200	42,000
Water replacement	---	---	---	---	28,300	---	700	29,300		700	700	700	30,000		24,200	19,700	29,300

Table B-2 (cont'd)

Summary of costs, charges, and benefits (100-year life basis)

Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

	Multiple-purpose project		Alternate single-purpose project					Alternate multiple-purpose project		
	Total cost		Flood control	Water supply	Pollution abatement	Fish, wildlife and recreation		Flood control and (1) water supply	Flood control and (1) pollution abatement	Water supply and pollution abatement
Construction expenditures	$31,400,000		$25,800,000	$12,100,000	$20,000,000	$22,265,000		$28,600,000	$27,200,000	$27,000,000
Interest during construction										
Specific flood control	---		$1,015,900							
Specific water supply	---			$423,500						
Specific pollution abatement	---				$525,000					
Specific fish and wildlife	35,000					$779,300				
Specific recreation	35,400									
Specific area redevelopment	---									
Joint use	1,062,700									
Total interest during construction	1,197,000		1,015,900	423,500	525,000	779,300		1,126,100	1,071,000	1,063,100
Project investment	$31,597,000		$26,815,900	$12,523,500	$20,525,000	$23,044,300		$29,726,100	$28,271,000	$28,063,100
Annual charges										
Interest on investment	$929,400		$793,900	$438,300	$538,800	$806,600		$780,300	$742,100	$736,700
Amortization of investment	67,300		57,100	36,500	43,700	26,700		63,300	60,200	59,800
Operation and maintenance	59,000		22,600	19,000	18,000	15,000		40,600	34,200	42,000
Major replacement	29,000		700	700	700	30,000		24,200	19,700	29,000
Taxes	---		---	---	---	---		---	---	---
Total annual charges	$984,700		$734,300	$472,500	$601,200	$878,300		$908,400	$856,200	$867,500
Annual benefits										
Flood control	$216,500		$216,500					$216,500	$216,500	---
Water supply	300,700			$300,700				300,700	---	$300,700
Pollution abatement	60,600				$60,600			---	60,600	60,600
Fish and wildlife	312,000					$312,000		211,000	149,500	312,000
Recreation	536,100					536,100		423,500	300,200	536,100
Area redevelopment	285,100							230,900	145,400	242,300
Total annual benefits	$1,711,000		$216,500	$300,700	$60,600	$848,100		$1,382,600	$872,200	$1,451,700
Benefit-cost ratio	1.74		0.28	0.64	0.10	0.96		1.52	1.02	1.67

Table B-2 (cont'd)

Allocation by separable costs - remaining benefits methods

Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

	Flood control	Water supply	Pollution abatement	Fish, wildlife & recreation	Fish and wildlife	Recreation	Area redevelopment	Total
Allocation of annual charges								
Benefits	$216,500	$300,700	$60,600	$848,100	$312,000	$536,100	$285,100	$1,711,000
Alternate costs	784,300	472,500	601,200	878,300			285,100	3,021,400
Benefits limited by alternate costs	216,500	300,700	60,600	848,100	312,000	536,100	285,100	1,711,000
Separable costs	97,300	46,300	13,700	162,400	43,200	119,200	---	319,700
Remaining benefits	119,200	254,400	46,900	685,700	268,800	416,900	285,100	1,391,300
Allocated joint costs	51,400	109,700	20,200	295,500	115,800	179,700	122,900	599,700
Total allocation, economic costs	$148,700	$156,000	$33,900	$457,900	$159,000	$298,900	$122,900	$919,400
Savings in unemployment compensation	---	---	---	---			65,300	65,300
Total allocation, project costs	$148,700	$156,000	$33,900	$457,900	$159,000	$298,900	$188,200	$984,700
Benefit-cost ratio	1.46	1.93	1.79	1.85	1.96	1.79	1.51	1.74
Allocation of O & M costs								
Separable costs	$13,700	$8,700	$3,200	$33,400	$14,000	$19,400	---	$59,000
Allocated joint costs	---	---	---	---			---	---
Total allocation, O & M costs	$13,700	$8,700	$3,200	$33,400	$14,000	$19,400	---	$59,000
Allocation of major replacement								
Separable costs	---	---	---	$28,300	---	$28,300	---	$28,300
Allocated joint costs	$100	$100	---	300	$100	200	$200	$700
Total allocation, major replacement costs	$100	$100	---	$28,600	$100	$28,500	$200	$29,000
Allocation of investment								
Annual investment	$134,900	$147,200	$30,700	$395,900	$144,900	$251,000	$188,000	$896,700
Allocated investment	$4,753,500	$5,186,900	$1,081,800	$13,950,300	$5,105,800	$8,844,500	$6,624,500	$31,597,000
Allocation of construction expenditures								
Specific investment	---	---	---	$3,545,900	$1,026,900	$2,519,000	---	$2,545,900
Investment in joint-use facilities	$4,753,500	$5,186,900	$1,081,800	10,404,400	4,078,900	6,325,500	$6,624,500	28,051,100
Investment during construction on joint-use facilities	180,000	196,500	41,000	394,200	154,500	239,700	251,000	1,062,700
Construction expenditures in joint-use facilities	4,573,500	4,990,400	1,040,800	10,010,200	3,924,400	6,085,800	6,373,500	26,988,400
Percent of construction expenditures in joint-use facilities	16.94	18.49	3.86	37.09	14.54	22.55	23.62	100.00
Construction expenditures in specific facilities	---	---	---	3,411,600	988,000	2,423,600	---	3,411,600
Total construction expenditures	$4,573,500	$4,990,400	$1,040,800	$13,421,800	$4,912,400	$8,509,400	$6,373,500	$30,400,000

Table B-3
Summary of project costs, investment costs, and annual costs
(100-year life basis)

SUMMARY OF PROJECT COSTS

Item	Financial costs	Economic costs
a. Federal project costs:		
(1) Project costs - Corps of Engineers:		
(a) Total project construction costs	$24,027,000	$24,027,000
(b) Estimated market value of lands, easements, and rights-of-way not to be provided by others (exclusive of acquisition costs)	--	5,637,500
(c) Corps of Engineers project construction costs, excluding market value of land	--	18,389,500
(d) Non-Federal cash contribution	8,100,000	8,100,000
(e) Project net costs, Corps of Engineers	15,927,000	15,927,000
(f) Present worth of future additions for project purposes	--	0
(g) Total Corps of Engineers project net costs for economic evaluation	$15,927,000	$15,927,000
(2) Project costs - Area Redevelopment Administration:		
(a) Total project construction costs	$ 6,373,000	$ 6,373,000
(b) Estimated market value of lands, easements, and rights-of-way not to be provided by others	--	0
(c) Estimated market value of Federal lands not previously sold, enhanced, or used commercially for project use	0	0

Table B-3 (cont'd)

Item	Financial costs	Economic costs
(d) Other Federal project construction costs, excluding market value of land	--	$ 6,373,000
(e) Net financial cost, excluding lands transferred without financial obligations	$ 6,373,000	--
(f) Present worth of future additions for project purposes	--	0
(g) Total Area Redevelopment Administration project net costs for economic evaluation	--	$ 6,373,000
(3) Total Federal project costs:		
(a) Total financial costs of construction	$22,300,000	--
(b) Total economic costs of construction	--	$22,300,000
Non-Federal project costs:		
(1) Total project construction costs	$ 0	$ 0
(2) Estimated market value of lands, easements, and rights-of-way to be furnished by non-Federal interests (excludes acquisition costs)	--	0
(3) Non-Federal project construction costs, excluding market value of land	--	0
(4) Cash contribution	8,100,000	8,100,000
(5) Non-Federal project net costs	8,100,000	8,100,000
(6) Present worth of future additions	--	0
(7) Total non-Federal project net costs for economic evaluation	--	$ 8,100,000

Table B-3 (cont'd)

Item	Financial costs	Economic costs
c. Total project first costs:		
(1) Financial net first costs	$30,400,000	--
(2) Economic net first costs	--	$30,400,000
INVESTMENT COSTS		
a. Federal investment:		
(1) Recapitulation of project costs:		
(a) Total Federal project net costs	$22,300,000	$22,300,000
(b) Market value of Federally provided lands (exclusive of acquisition costs)	--	5,637,500
(c) Present worth of future additions	--	0
(2) Interest during construction:		
(a) Interest on total Federal project net costs ($22,300,000) @2-5/8% for 1/2 of 3-year construction period	878,100	878,100
(b) Adjustment for any net loss in productivity of lands during construction	--	44,900
(c) Total interest (and productivity lost) during construction	--	$ 923,000
(3) Total Federal gross investment	$23,178,100 Use $23,178,000	$23,223,000 $23,223,000
(4) Net salvage value of Federally owned portion of the project	--	2,822,000
(5) Total Federal net investment	$23,178,000	$20,401,000

Table B-3 (cont'd)

Item	Financial costs	Economic costs
b. Non-Federal investment:		
(1) Recapitulation of project costs:		
(a) Total non-Federal project net costs	$ 8,100,000	$ 8,100,000
(b) Estimated market value of lands provided by non-Federal interests (excludes acquisition costs)	--	0
(c) Present worth of future additions	--	0
(2) Interest during construction:		
(a) Interest on total non-Federal project net costs ($8,100,000) @2-5/8% for 1/2 of 3-year construction period	318,900	318,900
(b) Adjustment for any net loss in productivity for lands during construction	--	0
(c) Total interest (and productivity lost) during construction	--	$ 318,900
(3) Total non-Federal gross investment	$ 8,418,900 Use $ 8,419,000	$ 8,418,900 $ 8,419,000
~~(4)~~ Net salvage value of non-Federally owned portion of the project	--	0
(5) Total non-Federal net investment	$ 8,419,000	$ 8,419,000
c. Total net investment costs:		
(1) Total net financial investment	$31,597,000	--
(2) Total net economic investment	--	$28,820,000

Table B-3 (cont'd)

ANNUAL COSTS

Item	Financial costs	Economic costs
a. Federal annual costs:		
(1) Interest on gross investment:		
(a) Financial: ($23,178,000) @2-5/8%	$ 608,400	--
(b) Economic: ($23,223,000) @2-5/8%	--	$ 609,600
(c) Economic: Adjustment for net loss of productivity on land	--	29,900
(d) Total economic interest and productivity loss on gross Federal investment	--	$ 639,500
(2) Amortization of net investment:		
(a) Financial: ($23,178,000) @2-5/8% for 100 years (.00213)	49,400	--
(b) Economic: ($20,401,000) @2-5/8% for 100 years (.00213)	--	43,500
(3) Maintenance and operation	42,800	42,800
(4) Allowance for major replacements	23,800	23,800
(5) Total Federal annual costs:		
(a) Financial	$ 724,400	--
(b) Economic	--	$ 749,600
b. Non-Federal annual costs:		
(1) Interest on gross investment:		
(a) Financial: ($8,419,000) @2-5/8%	221,000	--
(b) Economic: ($8,419,000) @2-5/8%	--	221,000

Table B-3 (cont'd)

Item	Financial costs	Economic costs
(c) Economic: Adjustment for net loss of productivity on land	--	$ 0
(d) Total economic interest and productivity loss on gross non-Federal investment	--	221,000
(2) Amortization of net investment:		
(a) Financial: ($8,419,000) @2-5/8% for 50 years (.00989)	$ 83,300	--
(b) Economic: ($8,419,000) @2-5/8% for 50 years (.00989)	--	83,300
(3) Maintenance and operation	16,200	16,200
(4) Allowance for major replacements	5,200	5,200
(5) Loss of taxes. Allowance for net loss of taxes on lands and property transferred to Federal ownership	--	0
(6) Taxes foregone on power installation	--	0
(7) Total non-Federal annual costs:		
(a) Financial	$ 325,700	--
(b) Economic	--	$ 325,700
c. Total Federal and non-Federal annual costs:		
(1) Financial	$ 1,050,100	--
(2) Economic	--	$ 1,075,300

APPENDIX C

HYDROLOGY AND HYDRAULICS

APPENDIX C

HYDROLOGY AND HYDRAULICS

1. GENERAL

The proposed Rend Lake Dam and Reservoir is located on the Big Muddy River in Franklin and Jefferson Counties, Illinois, just upstream of the town of Benton, Illinois.

2. PURPOSE

The purpose of this study is to review the design of Rend Lake Reservoir with main structure spillway set at elevation 410.0,* auxiliary spillway set at elevation 415.0, and top of dam at elevation 424.0. Pertinent details on this structure are contained in "Report of Survey, Rend Lake Reservoir, Jefferson and Franklin Counties, 1957" by Division of Waterways, Department of Public Works and Buildings, Illinois. This appendix presents additional studies as supporting data on the adequacy of design.

3. SCOPE

The scope of this appendix involves making sufficient hydrologic and hydraulic investigations to insure project safety, operation, and adequacy.

4. DESCRIPTION

The Big Muddy River which lies wholly within the State of Illinois, rises in Jefferson County and flows in a general southwesterly direction through Jefferson, Franklin, Williamson, Jackson, and Union Counties for a distance of approximately 155 miles, and empties into the Mississippi River at mile 75.7 near Grand Tower, about 104 miles below St. Louis. The drainage basin has an area of 2,360 square miles, a median length of 72 miles, an extreme width of 53 miles, and an average width of about 33 miles. The rim elevation of the basin varies in width from about one-fourth to one-half mile from the Mississippi River bluff line to Murphysboro, and is generally from 1 to 2 miles wide above that point. In the vicinity of wide, sweeping horseshoe bends and at the confluence of creeks, the flood plain becomes very broad and reaches widths of about 0.7 mile. The river banks are fairly uniform. Their average height above low water varies from 25 feet near the mouth of the river to about 21 feet in the middle reaches and diminishes to approximately 15 feet in the upper reaches. Low-water widths of the Big Muddy River vary from 40 to 200 feet and average about 100 feet. High bank widths vary from 50 to a maximum of 600 feet and average about 285 feet. The total fall of the Big Muddy River is about 260 feet. Water surface slopes vary from about 10 feet per mile near the source to about 0.2 foot per mile near the mouth

* All elevations cited herein are in feet above mean sea level, 1929 adjustment.

5. AREA OF INTEREST

The area of primary interest herein is the area above Benton, Illinois, or the upper 488 square miles above the proposed damsite. Maximum length of this portion of the basin is 32.4 miles, and maximum width is 17.75 miles. River bed elevation near the damsite is about elevation 372 and overflow bottom at about elevation 382.

6. CLIMATE

The mean annual temperature for the area is 56 degrees. January, the coldest month, has a mean temperature of 32.8 degrees, and July, the warmest month, has a mean temperature of 78.7 degrees. The extremes from these mean temperatures have been recorded as minus 20 degrees and plus 114 degrees. The average date of the last killing frost is April 16, and the average date of the first frost is October 22. Prevailing winds are from the west.

7. PRECIPITATION

The normal precipitation is 40.63 inches per year. Precipitation is usually well distributed throughout the year with the greater portion in the warmer half-year. Winter precipitation usually occurs as rain rather than snow. Snowfall in light amounts is recorded, however, from October through May. The highest observed monthly total of precipitation occurred in August 1946 when 14.37 inches was recorded at Mt. Vernon. The lowest monthly total ever recorded at Mt. Vernon was in October 1908, when no more than a trace of precipitation was observed.

8. EVAPORATION

The evaporation rates to be expected for the Rend Lake Reservoir were estimated from the standard Weather Bureau Class A pan at Carbondale which yields rates of evaporation for the warmer months, and evaporimeters which record losses during the colder months. Average yearly measured amount of evaporation is 49.6 inches. June and July with 7.05 and 7.11 inches, respectively, are the months of highest evaporation. Pan coefficient is 0.7.

9. SEDIMENTATION

Expected sedimentation rates were based in part on a 7 month sampling program at the Benton gage. The adopted sedimentation rate by the State is 1.8 acre-feet per square mile annually. This estimate is considered to be ultra conservative, relative to storage loss estimate. Long-term rates for other reservoirs in the State indicate a rate of 0.5 acre feet per square mile as appropriate.

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10. ICE

Freezing temperatures rarely last long enough to cause extensive ice formation.

11. STREAM FLOW CHARACTERISTICS

In the Big Muddy basin runoff is rapid from Plumfield upstream and sluggish from Plumfield downstream. Crests occur 2 to 3 days after beginning of rise at Benton and 4 to 5 days after beginning of rise at Plumfield. At Benton the hydrograph width above 7500 c.f.s. is about 4 days, while at Plumfield it is about 5 or 6 days. At Murphysboro, crests occur about 7 days after beginning of rise; however, the hydrograph width above 7500 c.f.s. is about 17 to 22 days. Recession after crest is slow. The lower reaches are affected by backwater from the Mississippi River.

12. STREAM FLOW RECORDS

Stream flow data on the Big Muddy River have been collected intermittently from 1908 to date. There are four U. S. Geological Survey gaging stations in the basin. Three stations, Murphysboro, Plumfield, and Benton, are on the main stem and one station, Matthews, is on the tributary Beaucoup Creek. In addition, there are six stations maintained by the Corps of Engineers for obtaining stage data only. Three are on the main stem and three are on Beaucoup Creek. These stations were established in connection with the Big Muddy River and Beaucoup Creek canalization investigation. Stream flow data pertinent to the area are cited for Benton, Plumfield, and Murphysboro, and are presented in table C-1.

TABLE C-1
Stage and discharge data

Station	Drainage area	River mile	Maximum Stage	Maximum Disch.	Maximum Date	Minimum Stage	Minimum Disch.	Minimum Date	Mean
Benton	(1) 498	98.6	24.94	35,800	5/9/61	3.18	0.2	7/2-4/54 & 7/7-9/54	497
Plumfield	(2) 753	86.0	29.67	43,500	5/10/61	0.96	0	*8/2/36	713
Murphysboro	(3) 2170	35.9	37.98	32,000	5/12/61	0.79	0	8/13/36 to 9/1/36	1845

(1) Gage zero 365.51 1946-59 used for mean flow
(2) Gage zero 358.24 1908-9, 1911,12, 1914-59 used for mean flow
(3) Gage zero 335.5 1930-1959 used for mean flow

* No flow at various times 1908-9, 1914, 1936, 1940-41

13. FLOODS

Notable floods on the Big Muddy River occurred in 1913, 1915, 1943, 1944, 1946, 1950, and 1961. For description see pages 23 to 26 of the 1957 State Report.

14. FLOOD FREQUENCIES

Estimated flood discharge frequencies for Benton, Plumfield, and Murphysboro, computed by the extreme value method, are shown in table C-2. Both long term and short term values corresponding to short term length of record at Benton are shown.

Table C-2
Maximum annual flood discharge frequencies

Exceedance	Benton		Plumfield		Murphysboro	
Frequency	1946-1961	1909-1961	1946-1961	1909-1961	1946-1961	1916-1961
Percent						
50	9,300	7,800	9,500	7,900	13,700	11,800
20	17,800	13,100	18,900	13,900	21,300	19,200
10	23,300	16,800	25,100	17,800	26,400	24,100
5	28,700	20,000	31,100	21,600	31,300	28,800
2	35,600	24,200	38,800	26,500	37,600	34,800
1	40,800	27,500	44,600	30,200	42,400	39,400

15. DROUGHT

Beginning in April 1952, drought conditions were experienced by a large part of central and southern Illinois. There was a 3-year period from April 1952 to April 1955 when the runoff in a large part of the area was less than 30 percent of normal. For a 12-month period that ended in December 1954, runoff in this area averaged 10 percent and dropped to about 1 percent of normal for a 6-month period that ended in January 1954.

16. UNIT HYDROGRAPHS

The review of Rend Lake Reservoir Report made use of unit hydrographs developed for Plumfield and Benton, Illinois, on the Big Muddy River. In addition, synthetic unit hydrographs were developed for each major tributary entering the reservoir. The unit hydrograph developed for Benton was acceptable when compared with the Plumfield unit hydrograph which is published in "Unit Hydrographs in Illinois" dated 1948 and prepared by the Division of Waterways of the State of Illinois. The Plumfield unit hydrograph had been previously accepted and used by this office. The synthetic unit hydrographs were acceptable when characteristics were compared with those for other unit

hydrographs developed in the same general section of the State of Illinois. However, the synthetic unit hydrographs developed by the State of Illinois for Gun Creek and Atchison Creek were not considered to be satisfactory because, in each case, individual arms of the reservoir surface extended well up into the area for which hydrographs were developed. Therefore, new synthetic unit graphs were determined for these two creeks using characteristics suitable to the area and methods and procedures outlined in EM 1110-2-1405. Characteristics of unit hydrographs finally adopted are tabulated in table C-3.

Table C-3
Unit hydrograph characteristics

Location	L (mi.)	Lea (mi.)	tp (hrs)	q_p (cfs/sq.mi.)	C_t	C_p640	Drainage area (sq. mi.)
Benton	57.76	33.06	65	7.29	6.743	474	498
Gun Creek	9.75	5.00	4.9	97.53	1.84	487	24.52
Atchison Creek	8.82	4.26	4.4	110.45	1.76	495	20.87
Casey Fork	29.94	13.86	17.0	22.44	2.79	381	114.26
Big Muddy Arm	29.04	17.40	16.0	24.47	2.47	392	98.92
Royce Creek	23.60	12.70	15.0	24.69	2.71	370	97.50

17. STANDARD PROJECT STORM RAINFALL

A standard project storm of 96-hour duration was developed, using methods and procedures outlined in CW Bulletin 52-8. The storm was broken down into 6-hour increments and arranged into storm pattern as indicated in the above-mentioned bulletin. Initial losses of 1.00 inch and incremental losses of 0.50 inch per 6 hours were then applied. Rainfall, loss and excess are shown in table C-4.

18. MAXIMUM POSSIBLE PRECIPITATION

Maximum possible precipitation values were taken from Hydrometeorological Report No. 33 dated April 1956. This was then expanded into a 96-hour storm and reduced 5% for basin shape factor. A storm pattern similar to that for the standard project storm was set up and the same losses were applied. Rainfall, loss, and excess are indicated in table C-4.

19. STANDARD PROJECT FLOOD

Standard project storm rainfall excess values were applied, in turn, to the Benton, Illinois, unit hydrograph and the Rend Lake Reservoir inflow unit hydrograph. The results are as follows:

a. The peak flow under natural conditions resulting from the standard project storm is about 36,100 c.f.s. This peak occurs 126 hours after beginning of rainfall.

b. The maximum reservoir inflow from the standard project storm occurs about 66 hours after beginning of rainfall. This maximum inflow is 146,600 c.f.s.

20. SPILLWAY DESIGN FLOOD

The same procedure was followed using the maximum possible precipitation, as adjusted, with the following results:

a. Peak flow under natural conditions was about 75,100 c.f.s. and occurs 126 hours after beginning of rainfall.

b. The maximum reservoir inflow is 300,800 c.f.s. at 66 hours from beginning of rainfall.

21. SYNTHETIC FLOODS

In addition to the standard project flood and the spillway design flood, two additional synthetic floods of lesser magnitude were developed. These two floods were computed by taking, in turn, 50% and then 25% of the 6-hour increments of rainfall from the standard project storm and then applying the same losses as those for the standard project storm. Rainfall, loss, and excess for these storms are indicated in table C-4. Peak discharge under natural conditions was about 14,100 c.f.s. and 5,500 c.f.s., respectively, while the maximum reservoir inflow was 65,200 c.f.s. and 27,100 c.f.s.

Table C-4
Distribution of rainfall, loss and excess (inches)

Storm	Time in hours 6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96
M.P.P.																
Rainfall	0.18	0.20	0.24	0.20	0.49	0.75	0.95	0.53	1.24	3.90	15.86	1.65	0.29	0.36	0.37	0.31
Loss	0.18	0.20	0.24	0.20	0.36	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.29	0.36	0.37	0.31
Excess					.13	.25	.45	.03	.74	3.40	15.36	1.15				
S.P.S.																
Rainfall	.02	.06	.28	.04	.11	.27	1.25	.17	.71	1.74	8.14	1.10	.05	.12	.56	.08
Loss	.02	.06	.28	.04	.11	.27	.64	.17	.50	.50	.50	.50	.05	.12	.50	.08
Excess							.61		.21	1.24	7.64	.60			.06	
50% S.P.S.																
Rainfall	.01	.03	.14	.02	.05	.14	.62	.09	.35	.87	4.07	.55	.03	.06	.28	.04
Loss	.01	.03	.14	.02	.05	.14	.62	.09	.35	.50	.50	.50	.03	.06	.28	.04
Excess										.37	3.57	.05				
25% S.P.S.																
Rainfall	.00	.02	.07	.01	.03	.07	.31	.04	.18	.44	2.04	.28	.01	.03	.14	.02
Loss	.00	.02	.07	.01	.03	.07	.31	.04	.18	.44	.50	.28	.01	.03	.14	.02
Excess											1.54					

22. RESERVOIR ELEVATION STORAGE

Determination of the amount of storage available for a given elevation of the reservoir pool was made by planimetering contours upstream of the damsite. Storage between contours was then computed and accumulated to develop a curve of elevation versus storage. Storage values are tabulated in table C-5.

Table C-5
Elevation-storage table - Rend Lake Reservoir

Elevation in feet	Storage capacity in acre-feet
380	0
385	4,000
390	22,100
395	55,500
400	111,500
405	191,000
410	302,500
415	445,000
420	633,000

23. MAIN AND AUXILIARY SPILLWAY

The proposed project anticipates use of a main spillway 500 feet in length with a crest elevation of 410.0 and an 800-foot auxiliary spillway with crest elevation of 415.0. Capacity of these spillways is shown in table C-6.

Table C-6
Spillway rating tables - Rend Lake Reservoir

Elevation - feet	Main spillway c.f.s.	Auxiliary spillway c.f.s.	Combined c.f.s.
410	0	-	0
412	3,950	-	3,950
414	11,900	-	11,900
415	17,100	0	17,100
416	22,400	2,000	24,400
418	34,400	11,200	45,600
420	49,400	25,200	74,600
422	64,800	41,300	106,100

24. RESULTS OF ROUTING

A comparison of results of inflow hydrograph routings versus natural conditions at Benton is given in the following table C-7.

Table C-7*
Hydrograph comparisons

	Reservoir		Benton (natural)	
	Outflow Max Q	Surcharge elevation	Max Q	Elevation
	c.f.s.	-	c.f.s.	
M.P.P.	74,260	420.0	75,081	397.51
S.P.S.	25,350	416.1	36,068	390.51
75%	15,105	414.6	24,567	387.91
50%	7,110	412.8	14,131	385.01
25%	2,130	411.2	5,462	381.51

* Reservoir routings based on a pool elevation of 410.0 at beginning of floods.

25. FLOOD ROUTING WITH SURCHARGE STORAGE ONLY

For the purpose of downstream flood routing, the Big Muddy River floods of 1946 and 1961 were studied to determine constants to be used in average-lag method of routing. By the use of these constants, reservoir hold-outs were routed downstream to determine the effective flood decapitation at Plumfield and Murphysboro, Illinois. Due to the fact that time of flow varies under different flood conditions, downstream decapitation was taken as a 72-hour average decapitation corresponding to the peak time of downstream flows. Tabulation of downstream decapitation is shown in table C-8.

Table C-8
Flood decapitation, Rend Lake Reservoir

Storm	Benton	Plumfield	Murphysboro
	c.f.s.	c.f.s.	c.f.s.
S.P.S.	10,718	5,791	3,641
50%	7,021	4,361	2,958
25%	3,332	1,763	1,203

26. STAGE REDUCTIONS WITH SURCHARGE STORAGE ONLY

Comparison of peak discharges under natural conditions, and as modified by Rend Lake outflows, indicates that Benton stages would be reduced about 2-1/2 feet for the higher flows and about 2 feet for the lower flows; Plumfield stages would be reduced about 1 foot for the higher flow and 2 3/4 to 3 feet for the lesser flows; Murphysboro stages would be reduced 1/2 foot for the higher flows and 1 to 1 1/2 feet for the lesser flows. These stage reductions are applicable to floods of standard project flood magnitude and percentages thereof.

27. PROJECT ADEQUACY

For the State plan, with normal pool and main spillway crest at elevation 410, flood control storage is not a specific allocation; however, flood flow reductions will be obtained through use of the surcharge storage. In order to determine if the storage available will meet the requirements for sedimentation, water supply, downstream releases for pollution abatement, and other uses, the flow deficiency period was studied. The flow deficiency period was determined to be from 1 June 1953 to 1 April 1957 with the critical period being from 1 June 1953 to 30 November 1954 or 548 days. Sedimentation rate was taken as 0.5 acre-foot per square mile, which amounted to about 25,000 acre-feet for 100 years. Water supply withdrawal was determined to be ultimately 40 million gallons per day or about 62 cubic feet a second. Water releases for downstream pollution abatement was determined to be about 32 cubic feet a second. Water uses during this period amounted to 67,300 acre-feet for water supply, 35,000 acre-feet for pollution abatement, and 112,100 acre-feet for evaporation. Inflow during this period amounted to 41,900 acre-feet. Thus the storage required is the sum of the uses or 214,400 acre-feet less the inflow of 41,900 acre-feet, which gives 172,500 acre-feet of storage. Total reservoir storage below elevation 410 is 302,500 acre-feet. There is ample runoff and storage to sustain the reservoir for water needs in the critical period of record.

28. FLOOD CONTROL RESERVOIR

An investigation was made utilizing the same physical structure, but allocating the storage zone between elevations 410 and 405 for control of floods. There are 111,500 acre-feet of storage in this zone, and it is equivalent to 4.3 inches of runoff from the area above the proposed damsite. Utilization of this storage would result in major flood stage reductions at Benton, with appreciable amounts at Plumfield and Murphysboro. Inflows of the standard project flood and 75, 50 and 25 percent were routed through the reservoirs with releases limited to 1,000 cubic feet a second between pool elevations 405 and 410; thereafter spillway discharges controlled. Downstream effects were determined from the lag-average method, using differences between the natural and modified discharge hydrograph. An average of 72 hours was taken as a measure of effectiveness, corresponding to peak time of downstream station. At Benton, stage reduction for standard project flood, 75 and 50 percent, amounted to 6 to 7 feet and for 25 percent about 3 feet. At Plumfield, standard project flood reduction amounted to 2 feet; 75 percent about 4 feet; 50 percent about 7 feet; and 25 percent about 3 feet. At Murphysboro, standard project flood reduction amounted to 2 feet; 75 and 50 percent 3 to 5 feet; and 25 percent about 1 foot.

29. OTHER STORAGE ALLOCATIONS

Under the flood control plan, storage for other water uses, such as water supply, pollution abatement, and sedimentation would remain the same except for evaporation. With the lower pool elevation and lesser surface area, the amount for evaporation would be reduced to about 85,000

acre-feet. Storage requirements would amount to the following: Flood control - 111,500 acre-feet; inactive or sedimentation pool - 25,000 acre-feet; pollution abatement - 57,000 acre-feet; and water supply - 109,000 acre-feet. Both water supply and pollution abatement contain the required allowance for evaporation of about 85,000 acre-feet.

30. COMMENT AND DISCUSSION

Although studies have been as thorough as practicable within limits of time, personnel, and basic data available, further refinement and investigations would add to reliability of results. However, it is believed that the studies presented, and previous investigations, fully substantiate the adequacy of the project considered in this study. Hydrologic and hydraulic computations are on file in St. Louis District Office.

31. CONCLUSIONS

The dimensions and elevations of physical features of the proposed dam are considered adequate for the following reasons:

a. Top of dam elevation 424 will provide 4 feet of freeboard above maximum surcharge elevation of the inflow flood derived from maximum possible precipitation.

b. Auxiliary spillway at elevation 415 will limit its use and provide necessary auxiliary release to insure safety of structure.

c. Main spillway at elevation 410 allows sufficient capacity to take care of all inflows up to about 100-year frequency with 5-foot surcharge. Standard project flood rises to elevation 416.

d. Stilling basin elevation and length are adequate for hydraulic jump performance and dissipation of energy.

e. Dewatering conduits are sufficient in size for purposes intended.

APPENDIX D

REPORTS FROM OTHER AGENCIES

REPORT FROM

AREA REDEVELOPMENT ADMINISTRATION

Exhibit 1

ESTIMATES OF CERTAIN REDEVELOPMENT BENEFITS ATTRIBUTABLE TO THE PROPOSED REND LAKE PROJECT IN SOUTHERN ILLINOIS*

Southern Illinois should enjoy substantial industrial and commercial expansion with the development of Rend Lake. In addition to the large and steady water supply that it could provide domestic users, as well as industry, Rend Lake should make the territory a more attractive area in which to live -- a factor of growing importance in influencing industrial locations. Expansion of residential as well as working areas could be guided by a regional land use plan which is now being prepared. This improvement in water supply and regional amenities plus the area's tremendous coal reserves, petroleum and gas resources, mine head power potential, excellent transportation to major markets, favorable year-round climate, and other assets favor industrial growth.

In view of the long period of construction required to build Rend Lake -- estimated to require at least four years -- no industry at this early stage can be expected to commit itself to a future Rend Lake location; however, some good estimates of what we might call "Area Development Benefits" can be made. These predictions are based primarily on data provided by officials of the Rend Lake Conservancy District, by other community leaders in Southern Illinois, by the U. S. Department of Labor, the Bureau of Reclamation, the Bureau of Sport Fisheries and Wildlife and the Illinois Department of Labor.

Projected trends in the national economy might have constituted a basis for estimating future growth of the Rend Lake Area. Population forecasts for Southern Illinois also could be used as a starting point in predicting the area's economic future. Of course, without Rend Lake the future population growth of this southern district would not be very bright. National and State trends have not been overlooked. They are of great importance, but we decided to base our estimates primarily on the interest that nationally known industrial firms have shown in the six to eight counties comprising the Rend Lake territory.

Area Benefits During Construction Period - The region will benefit economically during the construction period. The Rend Lake Conservancy District estimates that 530 persons will be employed on the project. The U. S. Bureau of Reclamation has indicated that construction work in Southern Illinois would be limited to about 40 weeks a year. The Bureau also stated that approximately 50 per cent of the employees could be classed as skilled operators of large machines (bulldozers, etc.) getting about $4.10 an hour and 30 per cent, semi-skilled workers at $3.50 an hour.** A rough average of $3.75 an hour was suggested by the Bureau as being reasonable for the

*As previously agreed upon, no expansion based on the lake's recreational values has been included in these calculations, nor have we included any benefits derived from flood control or the provision of a reliable domestic water supply.

**Current union scale wages in Illinois are $4.12 an hour for bulldozer operators and $3.40 an hour for truck drivers.

construction of this project. By using this figure and a 40-hour work week, we get an average annual income per employee of $6,000 or total yearly wages of $3,180,000. Some of the materials used in construction may be purchased from local manufacturers and wholesalers but, since this figure is virtually impossible to estimate, no monetary gain for the local area is here assigned to this ancillary business. It is not expected that many new service jobs will be created during the construction period because there is presently considerable slack in the use of existing stores and facilities and services. There should be large local purchases of gasoline and oil and several hundred workers might move into the area, rent rooms and secure most of their meals locally. Home building and other construction also may be accelerated. This will have some impact on the area. It will help to stabilize trade and reduce the number of business failures. But since it is extremely difficult to set any value on this business it is not assigned as a benefit.

Anticipated Industrial Expansion - Should the construction of Rend Lake commence in 1962, and should the project be completed by 1966, there is an excellent chance that new industrial employment in the area will amount to about 5,000 jobs by 1972. This is the opinion of Rend Lake officials and other community leaders of Southern Illinois, who base their estimate on (1) anticipated future growth of the nation and of Illinois, (2) recent interest in a Southern Illinois location shown by a number of major industrial firms, (3) the influence of Crab Orchard Lake on industrial expansion in Southern Illinois, and (4) financial assistance of the Area Redevelopment Administration.

(1) National and Regional Expansion - According to most authorities, the nation as well as Illinois will experience substantial expansion over the next 15 years. This upward trend should be an important factor in evaluating possible economic growth of Southern Illinois.

The Committee for Economic Development feels that the gross national product will increase by about 3 per cent and output per man hour by about 2 per cent annually.* The Committee considers this a conservative estimate. These figures, of course, imply a steady and very substantial growth in the nation's manufacturing facilities.

Research and development programs also will have an impact on industrial expansion and location. Research has been described as "an infant with a fabulous future". In the United States there has been an investment of $10,500,000,000 in this "infant" during 1961. This figure is up 7 per cent from the investment in research during 1960. As new products are developed, the old plants must be enlarged or modernized and new plants built. In other words, there will be increasing obsolescence of existing plants and rebuilding in old or new locations will be in order. And as new

*"Economic Growth in the United States - Its Past and Future", Committee for Economic Development, 711 Fifth Avenue, New York 22, New York, Feb. 1958.

locations are investigated, the Rend Lake region, as well as many other areas, will be considered from time to time as a possible location for new plants. The addition of water to its other resources will place Southern Illinois in a better competitive position to attract this industry.

What are the growth prospects for Illinois? The National Planning Association in a report prepared for the Outdoor Recreation Resources Review Commission (but not yet published) observes that by 1976, Illinois will have retained its present share (6.4 per cent) of the nation's industry. It will also hold its share (26.5 per cent) of regional industry. It is anticipated that total civilian employment in the State which was 4,200,000 in 1957 will rise to 5,121,000 by 1976, an advance of 921,000 workers. The State's population which reached 10,081,000 in 1960 is expected to reach approximately 12,900,000 by 1976.

Illinois, especially the northern half, is an old and stable industrial area. Southern Illinois, on the other hand, is a somewhat virgin territory. In view of these differences the southern counties may enjoy an expansion greater than the State as a whole.

Considering future growth prospects for the nation and for Illinois, as noted above, and considering its position astride the increasingly busy north-south commercial routes of the Mississippi Valley it is reasonable to expect Southern Illinois to at least share in this advance if a large and reliable water supply can be added to its other assets that favor industrial expansion.

(2) Recent Interest of Major Industries in Southern Illinois

As an indication of what might be anticipated, it is interesting to note that in the 7-year period between 1953 and 1960, a number of major industrial firms, including Olin Mathieson, Alcoa and B. T. Goodrich, seriously considered the Rend Lake area as a possible site for plants that in the aggregate would have employed 6,300 persons. Since all of these concerns use large quantities of water, they were obliged to locate elsewhere. With an excellent water supply provided by Rend Lake, with coal and petroleum resources, and with the development of mine-head power facilities added to a good natural location between the populous northern markets and southern raw materials, the estimate of 5,000 new workers by 1972 appears reasonable.

(3) Influence of Crab Orchard Lake on Industrial Expansion

The effect of Crab Orchard Lake on regional industrialization points

up the value of a large body of water. Employment by industries located near Crab Orchard has ranged from 1,700 to a high of 2,600. On September 1 1961 it totaled 1,900 (See Attached Table). Numerous buildings vacated by the Federal Government after a World War II ordnance plant was closed, have been a special attraction. The availability of a limited quantity of water for industry plus recreational opportunities also played a part in attracting industry. But since Crab Orchard Lake is operated primarily as a wildlife refuge with industrial activities of secondary importance, since it is less than one-third the size of the proposed Rend Lake and, since it is not as centrally located in the coal mining district as Rend Lake, it is assumed that the latter very likely would attract several times the industrial employment found near Crab Orchard Lake.

(4) Financial Assistance of the Area Redevelopment Administration

Aid programs of the Area Redevelopment Administration, as exemplified by its recent industrial loan of $500,000 to the City of Carbondale for the enlarging and remodeling of a city owned industrial building, will be a factor in aiding the development of Southern Illinois. The new manufacturing facility in Carbondale will employ up to 500 persons the first year after it is enlarged and possibly 1000 by the end of three years. Without ARA's long-term loan, this industry may have been lost to the area. Thus, Southern Illinois, like other Redevelopment Areas participating in the ARA program, will have ARA financial assistance - loans and grants - as a special regional asset favoring economic growth. It is very doubtful, however, that a series of small ARA loans and grants would bring about significant economic recovery in Southern Illinois. The area needs a large and stable water supply, such as Rend Lake, as a basis for major industrial expansion.

New Regional Income From Industrial Employment - Per capita yearly income for those persons employed by new plants in the Rend Lake area should run around $5,800 or a total yearly payroll of $29,000,000. This figure is based on the assumption that the new plants will be primarily "heavy" industries. The U. S. Department of Labor reports that workers in the aluminum industry are paid, on the average, about $5,800 a year and in the chemical industry, around $5,700 a year. These figures are based on hourly wages in October 1961. Since wages are likely to increase rather than decrease, the $5,800 figure, as an average for the new industries, appears to be reasonable.

Possible Research Center - In view of the generally favorable year-round climate of Southern Illinois, the development of Rend Lake and its abutting area according to a master land use plan, the attraction of Crab Orchard Lake, the rapid growth of Southern Illinois University which presently has 10,000 students (but anticipates 18,000 by 1970), and the tremendous expansion of research and development activities on a national basis, this part of Illinois, once a few major industries are established, might

conceivably attract research laboratories as well as electronic-type industries employing a considerable number of people and paying a yearly wage much higher than the $5,800 figure noted above. No benefit is assigned to this possibility.

Service Jobs Based on Industrial Expansion - There is great difference of opinion on the number of service jobs created by each industrial job. There is also a difference of opinion on what the word "service" covers. As a general rule, it would be limited to new employment in retail and wholesale activities and personal and professional services. Some authorities, rather than limit service, or secondary employment, to the functions noted above, include all additional employment that can be based on the major industrial development. It is evident that additional families to feed and clothe, houses to build, schools to erect, children to teach, new factories to service, existing industries to enlarge, and other expansion will have a considerable impact on job opportunities. Our estimates assume a broad approach and include under "service" or ancillary development, all additional employment that might be anticipated.

Some researchers say that the ratio of industrial workers to other employment that this industry creates should be 1:1.5. A ratio of 1:1 most commonly is used, however, even this factor is too high for estimating expansion at Rend Lake.

The Area Development Division of the Office of Technical Services, U. S. Department of Commerce, studied this matter in 1955, when it published a report entitled, "What Will New Industry Mean to My Town?" Part of this study examines the impact of a large industry on the small town of Front Royal, Virginia, and comes up with the rather startling fact that 2,626 new industrial jobs resulted in the addition of only 795 other jobs. Front Royal, which was geared to handle peak tourist trade in summer, made only partial use of its retail and service facilities during nine months of the year; hence, existing enterprise could handle much of the new business created by industrialization. Moreover, since Front Royal was virtually a one-industry town, it does not necessarily give a true picture of what might happen in an area with diversified activities. Nevertheless, the existence of unused capacity in trade and service facilities is a factor of importance in weighing economic prospects.

Since existing commercial and service facilities in the Rend Lake area include some slack that is not fully utilized and since new retail outlets will be modern units requiring fewer workers to handle a given volume of trade than old establishments, a ratio of one industrial job to 0.8 ancillary jobs has been used in these estimates. This ratio may not hold for the initial period of industrialization but it should materialize within a matter of four or five years. Using this ratio, then, the 5,000 new industrial jobs should be the basis for approximately 4,000 other jobs. This "other" figure, of course, includes all anticipated employment. This appears to be a very conservative approach. By assigning a yearly income of

$3,900 for each of these additional workers -- a figure suggested by the Department of Labor -- the regional payrolls would be raised by about $15,600,000 each year.*

Total New Employment and Payrolls - Anticipated new employment and payrolls would be as follows:

Type of Work	No. of Employees	Total Yearly Payroll
Rend Lake Construction	530	$ 3,180,000 (will run for four years only)
New (permanent Industrial)	5,000	29,000,000 (by 1972)
Ancillary Employment Based on Industrial Expansion	4,000	15,600,000 (by 1972)

Payroll figures indicate a four-year construction period total of about $12,720,000 in wages; the end product being a yearly payroll of approximately $45,000,000 in new industries and other activities by 1972.

Unemployment in the Rend Lake territory, according to local officials, has been running around 15,000. The development outlined above may provide 9,000 new jobs within five to six years after the completion of Rend Lake. New development associated with recreational opportunities should reduce unemployment still further. If it is reasonable to anticipate 5,000 new industrial jobs in the Rend Lake area by 1972, it is not reasonable to assume that new development will automatically stop at that point. On the contrary, considering the range of local assets (partly created by the Lake) and the growing complex of local industries, the Rend Lake area should become more and more attractive for industry probably attracting several thousand additional jobs by 1975 and, consequently, reducing unemployment to a figure that would be considered normal for the area. But in view of the fact that older persons may find adjustment to new jobs difficult and the further fact that some of the new jobs will be filled by persons from outside the area, the rate of unemployment may continue to be above normal for at least four or five years but greatly below what the area has experienced since 1930.

* The average wage in wholesale establishments throughout the nation is about $95.00 per week and for retail firms, $70.00. Such service establishments as hotels, motels and laundries pay on the average about $50.00 per week. In view of the wide range of income in service and professional activities, the Labor Department suggested that an average weekly figure of $75.00 per person was reasonable.

Impact of New Employment on Unemployment Benefit Payments and Social Welfare Costs - New job opportunities in the Rend Lake area should reduce some of the relief expenditure in that area; accordingly, it seems desirable to note the impact of unemployment, in a group of eight southern Illinois counties, on the States unemployment insurance fund and social welfare assistance programs.*

It is quite apparent that major areas of persistent unemployment are a burden on the economy. When the labor force is mostly employed on a full-time basis, the cost of unemployment insurance, but in particular other welfare programs, may be materially reduced. The following information on unemployment compensation payments by county, compiled by the Research and Statistical Section of the Illinois Division of Unemployment Insurance, provides part of the picture:

County	5 Year Total** 1955 - 1959
Franklin	4,882,950
Hamilton	655,555
Jackson	2,747,605
Jefferson	2,992,275
Johnson	456,105
Perry	1,325,560
Saline	2,213,030
Williamson	5,004,980
	$20,278,060

This large sum comes from the State's unemployment insurance fund that is built up year by year through a payroll tax on all Illinois industries.*** Although this money is held by the U. S. Treasury Department, no Federal funds are included in this total.

It is difficult to show how the reduction or elimination of this large out-payment from the State unemployment insurance fund aids the Rend Lake area but on the basis of conversation with an official of the U. S. Bureau of Employment Security the following two benefits are noted: (1) As the unemployment insurance fund is built up, due to higher employment and a broadening of the tax base, the payroll tax paid by all Illinois industries can be slightly reduced. In a great industrial State such as Illinois this may amount to only a fraction of one percent; and there is always

*These counties -- Franklin, Hamilton, Jackson, Jefferson, Johnson, Perry, Saline, and Williamson pretty well comprise what might be called the "Rend Lake Territory".

**Data supplied by Elizabeth J. Slotkin, Chief, Research and Statistics Section, Division of Unemployment Compensation, Illinois State Employment Service, Chicago, Illinois.

***Benefit payments in September 1961 were running at an annual rate of approximately $6,200,000 for the eight counties.

some resistance to reducing a tax. Nevertheless, the possibility of a tax reduction, will tend to make the State more attractive to new industry. Then too, other things being equal, a State with a large unemployment insurance fund will be more attractive to new industry than a State whose fund is largely depleted. The latter State has gotten itself into a situation where a sharp increase in the unemployment tax paid by industry may be necessary in order to build up its insurance fund. (2) As increased employment in the Rend Lake area becomes stabilized over an extended time, larger numbers of workers will build up rights to future payments from the State's unemployment insurance fund. Should economic sluggishness occur later, these payments will tide workers over a considerable period of unemployment thus alleviating the drain that otherwise would be made on social welfare assistance funds (Federal, State and local) which normally fulfill an important aid function after insurance benefit payments are exhausted.

As stated above, these benefits cannot be measured in a limited study of this nature, but in evaluating the Rend Lake project they should be noted as a benefit factor of some importance, although we have not added them to the asset ledger.

A reduction of social welfare payments will benefit the Rend Lake area more directly than a cutback on unemployment insurance expenditures.

Social welfare costs always are lower in an economically healthy area than in an area of large and persistent unemployment. But certain phases of public assistance are not closely tied to unemployment. Old age assistance, aid to the blind, and aid to the permanently and totally disabled may be just as high in a wealthy area as in a poor area.

Authorities in the field of welfare assistance have suggested that two phases of social welfare -- aid to dependent children and general assistance -- are associated rather closely with the unemployment problem. The eight Illinois counties noted above received around $5,600,000 during 1960 for aid to dependent children and general assistance with almost 14,000 persons involved. In 1955 this payment was about $4,100,000 and in 1950 around $4,000,000. Money spent on this assistance comes from Federal, State and local governments. Without considerable research it is not possible to break down the above figures by source of funds. A reduction in this expenditure is surely desirable from every point of view. If we consider average yearly welfare payments, since 1950, as around $4,500,000 for the eight counties comprising the Rend Lake area, it seems extremely conservative to assume that area growth stemming from Rend Lake, by 1972, if not before, would eliminate at least $1,000,000 of this expense every year. A greater reduction in welfare payments has not been made because even prosperous areas will have children as well as older persons eligible for assistance.

Effect of New Employment on Income Tax Payments - How much income tax would the Federal Government collect from a new payroll of $45,000,000 in the Rend Lake territory?

Internal Revenue statistics show that a family of four persons with a net income of $5,000 per year pays around 10 per cent of this sum as Federal income tax. This 10 per cent figure is rather widely used in making estimates on tax return and it is considered very conservative, but we propose to use a slightly lower rate in making the following estimates.

Not counting wages paid to construction workers we have estimated the new permanent employment in the Rend Lake area by 1972 as 9,000 with a total yearly payroll of $45,000,000. This is an average of $5,000 per family with a net of roughly $4,500 per year. A four person family with this income would pay out about 7 per cent in Federal income tax. On this basis, then, a $40,500,000 net yearly income would yield $2,800,000 in Federal income tax.*

It may be noted, too, that new factories, wholesale houses, stores, homes and public facilities built in the Rend Lake territory will broaden the tax base resulting in greatly increased revenues for both local and State governments.

Conclusions - Would benefits from industrial and other economic expansion pay for all or at least a very large part of the average annual charges for the money invested in the Rend Lake project? Yearly requirements to amortize an investment of $25,000,000 at 3 3/8 per cent (current rate on ARA public facility loans) would be $1,140,000; or at 4 per cent, $1,254,000. Merely a casual look at economic benefits derived from industrial expansion and ancillary growth based on this new industry appears to justify an investment that would cover the entire project cost, even when 4 1/2 per cent money is used and the yearly amortization charges are $1,350,000.

The economic benefits created by Rend Lake, aside from benefits based on an expansion of recreational activities, flood control and improved domestic water supply, would be as follows:

(1) 530 construction jobs for 4 years with a total payroll of $12,720,000.

(2) At least 5,000 new industrial jobs by 1972 and a yearly payroll of $29,000,000.

(3) At least 4,000 ancillary jobs by 1972 based on industrial expansion with a yearly payroll of $15,600,000, thus making the total new yearly payroll about $45,000,000.

(4) Approximately $1,000,000 annual savings in social welfare costs which would benefit local, State and Federal governments.

* Construction workers for each of the four years required to complete the project would pay about $265,000 in Federal income tax.

(5) Increased yearly payment of about $2,800,000 in Federal income tax.

By adding this new income tax return to a possible saving of $1,000,000 on social welfare costs a total yearly benefit of $3,800,000 is derived.

These figures, of course, are rough estimates; they are also very much on the conservative side. With the addition of economic gain derived from recreational growth, flood control, and other area improvements, such as securing a reliable domestic water supply, there would appear to be more than enough return to pay for the entire project investment of $25,000,000.

Robert L. Wrigley, Jr.
Office of Planning and Research
Area Redevelopment Administration
U. S. Department of Commerce
Washington 25, D. C.
December 18, 1961

TABLE NO. IV. - INDUSTRIAL LEASING, REVENUE & EMPLOYMENT

Industry	Lease Footage				Monetary Return					Total No. Employed	
	May	June	July	Aug.	Rent	Wat. & Sew.	Steam	Switching	Total	4-30-61	8-31-61
Allen Industries	42,000	42,000	42,000	42,000	$ 2 373.36	$ 16.00		$ 150.00	$ 2 539.36	4	4
Aronson, Knute	2,021	2,021	2,021	2,021	101.04	--		--	101.04	1	1
Fern, Don	1,000	1,000	1,000	1,000	66.68	--		--	66.68	2	2
Diagraph Bradley	75,410	75,410	75,410	75,410	4 688.12	247.14		75.00	5 010.26	92	87
E. Side Lumberyard	16,195	16,195	16,195	16,195	1 079.64	24.00		225.00	1 328.64	3	3
Explosives, Inc.	2,138	2,138	2,138	2,138	71.28	--		--	71.28	2	2
General Services	63,294	63,294	63,294	63,294	3 539.72	16.00		--	3 555.72	12	13
Good Luck Glove	24,141	24,141	24,141	24,141	1 207.04	--		--	1 207.04	2	2
Great Lakes T. & T.	42,290	42,290	42,290	42,290	2 370.04	16.00		135.00	2 521.04	3	3
Grinnell	35,517	35,517	35,517	35,517	1 832.56	40.68		1 395.00	3 268.24	56	60
Hanley Ind.	1,069	1,069	1,069	1,069	35.64	--		15.00	50.64	--	--
Mass. Elec.	4,685	4,685	4,685	4,685	299.27	--		--	299.27	--	--
Monsanto	43,500	43,500	43,500	33,250	2 151.76	--		1 995.00	4 146.76	7	9
Nat'l. Reprod'ns	3,891	3,891	3,891	3,891	259.40	24.00		--	283.40	2	2
Norge	76,850	76,850	76,850	76,850	4 610.88	--		--	4 610.88	25	25
Olin Mathieson	442,306	443,913	441,545	453,402	19 825.07	10 298.96		3 780.00	33 904.03	273	289
Permanent Homes	20,500	20,500	20,500	20,500	1 161.68	16.00		--	1 177.68	--	--
Propellex Chem.	1,069	1,069	1,069	1,069	35.64	--		--	35.64	--	--
Sangamo Electric	207,418	207,418	207,418	207,418	10,431.40	6 351.70	$ 20 571.61	--	37 354.71	660	790
Schilli Trans.	3,324	3,324	3,324	3,324	221.60	16.00		--	237.60	6	6
Schilli Warehouse	10,250	10,250	10,250	10,250	512.52	--		165.00	677.52	2	--
Southern Homes	82,520	82,520	82,520	82,520	4 240.12	24.00		645.00	4 909.12	15	20
So. Metal Art	4,685	4,685	4,685	4,685	312.36	16.00		--	328.36	--	--
Oxford Electric	33,214	33,214	33,214	33,214	1 906.80	634.81		--	2 541.61	100	175
Triangle Const.	20,500	20,500	20,500	20,500	1 025.00	--		--	1 025.00	--	--
Universal Match	129,303	129,303	129,303	129,303	5 025.76	2 420.06		--	7 445.82	285	250
SIU-VTI	220,693	220,693	220,693	220,693	1.00	875.98		--	876.98	140	140
SIU-ETP	20,702	20,702	20,702	20,702	1 380.16	102.00		--	1 482.16	8	8
Simonds Const. Co.	--	--	--	--	100.00	--		--	100.00	--	--
COFT CLUB	--	--	--	--	--	40.00		--	40.00	--	--
COSA	--	--	--	--	25.00	30.69		--	55.69	--	--
Winger Const.	--	--	4,224	4,224	132.00	--		--	132.00	--	--
Blount Bros.	--	--	--	--	--	128.16		--	128.16	--	--
Am. Dist. Teleg.	--	--	--	--	5.00	--		--	5.00	--	--
Totals-May/Aug. 1961	1,630,485	1,632,092	1,633,948	1,635,555	$71 027.54	$21 338.18	$ 20 571.61	$ 8 580.00	$121 517.33		1893
Totals-April, 1961				1,677,054	$74 994.26	$17 243.88	$ 40 461.75	$ 7 050.00	$139 749.89	1700	

REPORT FROM

NATIONAL PARK SERVICE

EXHIBIT 2

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

Region Five
143 South Third Street
Philadelphia 6, Pa.

IN REPLY REFER TO:
L7423

November 14, 1961

District Engineer
U.S. Army Engineer District, St. Louis
Corps of Engineers
420 Locust Street
St. Louis 2, Missouri

Dear Sir:

In accordance with a request by phone from Mr. Johanboeke on October 13 and your confirming letter (LMLED-PR) of October 17, we are forwarding herewith a preliminary report covering the evaluation of the recreation potential and the resulting cost and benefits of recreation development for the proposed Rend Lake Project. Also enclosed is a map showing land recommended for acquisition for specific recreation development and use.

We appreciate the opportunity to evaluate the recreation potential of this project and if we can be of further assistance, please let us know.

Sincerely yours,

Ronald F. Lee
Regional Director

Enclosures

Copy to: William E. Smith, Superintendent
Division of Parks and Memorials
Department of Conservation
State Office Building
Springfield, Illinois

Exhibit 2

Region Five Office
November 14, 1961

PRELIMINARY REPORT

Recreation Potential, Rend Lake Project, Illinois

This report has been prepared under the authorization of the Park, Parkway and Recreation Area Study Act of June 23, 1936 and in accordance with request of October 17, 1961 from the District Engineer, St. Louis District, Corps of Engineers.

The report's purpose is to present a preliminary evaluation of the recreation aspects of the proposed Rend Lake project including its impact upon recreation resources, estimated measurable recreation benefits and development costs and other material useful to the District Engineer in further planning for wise use of the recreation values of the project area.

Rend Lake Reservoir is being surveyed as a single unit in a planned commercial navigation project on the Big Muddy River, Illinois. The proposed reservoir will also serve flood control, low flow augmentation, and water supply purposes. Field investigation of the site was conducted on October 24-25, 1961 by James L. Isenogle, Landscape Architect, Region Five, National Park Service, in company with representatives of the St. Louis District of the Corps of Engineers and Illinois Division of State Parks.

The dam site is in Franklin County on Big Muddy River, three miles northwest of Benton, Illinois. The earth fill dam will be 44' high and 8,230' long. The normal pool elevation will be 410' with a water surface area of 24,800 acres and a maximum depth of 28 feet. The flood surge pool elevation will be 415' with a water surface area of 33,060 acres. The operation plan for the reservoir has not yet been fully determined.

It is known that the water surface will be subject to 5' rise in elevation with the equivalent of the maximum storm of record, which is the design storm and can be expected once every 100 years. Drops in water level have not yet been accurately determined quantitatively. The topography of the site is such that any appreciable drop of water level will greatly depreciate the recreation value of the reservoir. For purposes of this report it will be assumed that drawdown of the water level during the recreation season will be minimal.

Topographically the reservoir site is flat, particularly in the upper half of the area. In the lower half there are a few low rolling hills and river and tributary bluffs. There are no outstanding topographic features in the area. The gradient of the proposed impoundments' shoreline will range from extremely flat up to 15% slope in a few cases. The majority of the shoreline of the lower portion will approximate a 5 to 8 percent slope.

The only important forested area on the site occurs in the river bottom. This timber will be removed with the construction of the reservoir. A large portion of the flood zone and almost all of the adjacent area is open farmland.

The climate is characterized by hot summers and cool winters. The mean annual temperature is 56 degrees ranging from a low average of 32.8 degrees to a high average of 78.7 degrees. The recreation season can be expected to begin in the latter part of April and extend through mid-October. The annual average rainfall is 40.63 inches.

Access to the impoundment by local users can be gained via existing State Routes 148, 37 and 14 which parallel the site on the west, east, and south, respectively. U.S. Routes 460 and 51 will provide access into the area from longer distances, particularly from St. Louis via U.S. Route 460. Interstate Route 57 will roughly parallel the eastern side of the impoundment replacing the existing State Route 37.

Census figures for 1960 indicate that there are about 400,700 people within fifty miles of the reservoir site and 128,200 within twenty-five miles. The St. Louis Metropolitan Area is seventy-five miles from the site with 2,060,000 people residing there. The population within fifty miles of the site is approximately 80 percent rural. Within twenty-five the rural population constitutes only about 35 percent of the total. The composite of people presently residing in the recreation service area of the proposed reservoir totals 2,460,800 including St. Louis. Approximately 90 percent of this total are living in an urban environment. It is estimated that this population will increase to 4,200,000 in fifty years. The majority of the increase should logically occur in the urban areas. The area within fifty miles has been losing population since 1930. The economy of the region in the vicinity of the reservoir site has been chronically depressed for many years. This condition is the largest single contributing factor to the past population loss.

Crab Orchard National Wildlife Refuge with Crab Orchard, Little Grassy and Devil's Kitchen Lakes is located 30 miles south and Lake Murphysboro State Park is 30 miles southwest of the project area. These areas provide considerable opportunity for recreation primarily to local people but they are limited by difficulty of access for people from longer distances, particularly from St. Louis. Conversely, the Rend Lake Reservoir, because of its accessibility from St. Louis, will attract visitors in quantity from outside the immediate vicinity and would consequently help bolster the local economy.

Losses to existing scenic or recreation values would be slight. The scenic qualities of the area to be inundated are not outstanding. The only loss of any consequence will be the removal of the existing timber in the river bottom. The Big Muddy River and its tributaries that will be affected by the Rend Lake project are shallow, slow moving streams with muddy banks and very little recreation value.

The primary value of the proposed impoundment from the recreation point of view lies in its ability to provide recreation opportunities on a scale and sufficiently accessible to residents of St. Louis to attract those people into this region for recreation activities. It can be expected that this influx of visitors will supplement other benefits derived from the reservoir in strengthening the economy of the region.

Rend Lake Reservoir is located within that portion of the Mississippi-Ohio River drainage known to represent one of the major concentrations of prehistoric occupation by the American aborigines. Intensive reconnaissance of the Big Muddy River area within the prospective reservoir will be justified to establish the location of archeological values to be salvaged. It is therefore recommended that at the time of project authorization an archeological survey be contracted for, logically with Southern Illinois University, which is currently one of the cooperating institutions participating in the National Park Service River Basin Program.

The southern portion of the reservoir is suitable for planned recreation development by virtue of its accessibility to St. Louis and large areas of land suitable to recreation use as well as the large water body impounded in a region of few natural lakes. These factors indicate that the proposed reservoir should logically be expected to receive moderate day use and heavy week-end and vacation use. Facilities provided should accommodate boat launching and storage, picnicking, swimming and associated activities with rather extensive camping areas.

In order to provide for public use and reasonable access to appropriate sites, it is necessary to acquire, in fee, selected areas outside the flood surge pool. The accompanying drawing indicates those lands that would be acquired in fee, at the time of construction, for recreation purposes. The land designated as "Recommended Acquisition for Recreation" totals approximately 16,800 acres.

An estimate of annual visitation is set forth in the following table and includes all types of recreation pursuits except hunting and fishing. Initial visitation is the estimated use 3 to 5 years after the completion of the project and ultimate visitation is the anticipated use 50 years after completion of the project. It should be noted that these estimates are optimum use figures based on the carrying capacity of shorelands and water surface acreage of the reservoir. It is possible that the total recreation demand could exceed the carrying capacity of the reservoir thereby resulting in overuse. This overuse would be detrimental to the recreation resource created and cannot be classified as project benefits. Present recreation use of the reservoir site other than hunting and fishing is negligible and is not considered in benefit calculations. The estimates assume that adequate basic facilities will be provided and properly maintained, and that the newly created recreation area will be administered in such a way that recreation values will not be destroyed through improper shoreline uses or unrestricted conflicting uses of the water surface.

Exhibit 2

RECREATION VISITATION, DEVELOPMENT COSTS AND BENEFITS

Proposed Rend Lake Reservoir

	Initial	Ultimate (Increment)	Total
Annual Visitation	1,670,000	2,170,000	3,840,000
Design Load	31,730	41,230	72,960
Cost of facilities, less land	$5,592,400	$7,380,300	$12,972,700
Annual Equivalent of Const. Costs	307,900	406,300	714,200
Annual Operation and Maintenance	334,800	438,400	773,200
Total Annual Costs	642,700	844,700	1,487,400
Total Annual Benefits	$2,672,000	$3,472,000	$6,144,000

The above table enumerates costs involved to provide adequate facilities for the anticipated annual visitation and to utilize the recreation potential inherent in the project. The annual equivalent of construction costs is amortized at 2 5/8% over a 25 year period, the estimated life of recreation facilities. The cost of land acquisition has not been included in these estimates. Some of these costs should logically be shared by other activities.

In order to arrive at a monetary figure which may serve to indicate possible annual recreation benefits, the estimated net annual recreation attendance is multiplied by $1.60, a derived market value for a day of reservoir recreation.

Summary of Findings, Conclusions and Recommendations

Findings and Conclusions

1. South Central Illinois and the St. Louis Metropolitan Area have a shortage of water based recreation resources.

2. The economy of the area adjacent to the proposed reservoir has been chronically depressed.

3. Population has been decreasing within fifty miles of the project while in St. Louis it has been increasing and is presently about 2,060,000 and is expected to increase to 3,800,000 in fifty years.

4. No existing recreation facilities will be affected by the proposed impoundment.

5. There may be some archeologically important sites in the flooded area.

6. The reservoir is suitable for planned recreation development and will add significantly to the recreation and economic base of the area.

7. Optimum development of the reservoir will result in an initial annual visitation estimated at 1,670,000 and a total visitation of 3,840,000.

Recommendations

1. Approximately 16,800 acres of land should be acquired for public recreation development at the time of project construction. In addition, the shoreline should be further protected by acquiring in fee all the land lying within 500 feet horizontal distance from the fee taking line in those areas not already protected through the activities of some compatible organization.

2. During pre-construction and construction periods, the Corps should maintain close liaison with public agencies, organizations and individuals interested in recreation development and coordinate such development in the best interest of the public.

3. Shoreland use and reservoir zoning plans should be made to protect the recreation values of the project through cooperative efforts of interested agencies.

4. Consideration should be given to the Illinois Department of Conservation as the administering agency for the recreation development and operation of the reservoir.

5. Additional and more comprehensive field work should be accomplished with particular attention given to specific site locations.

6. An archeological survey is necessary to locate archeological values deserving salvage.

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

Region Five
143 South Third Street
Philadelphia 6, Pa.

IN REPLY REFER TO:
L7423

December 1, 1961

District Engineer
U.S. Army Engineer District
Corps of Engineers
420 Locust Street
St. Louis 2, Missouri

Dear Sir:

This is in response to Recreation Planner Richard Cameron's phone call of November 29 in which he requested this Office's evaluation of the effect on the recreation potential of the proposed Rend Lake Reservoir caused by lowering the normal pool elevation five feet.

It is our opinion that there will be no significant change in recreation potential of the area by lowering the normal pool elevation five feet to elevation 405. Neither will there be any important change in annual visitation, cost of facilities or recreation benefits. This statement is based on the assumption that the flood surge pool will be at elevation 410; that is, five feet above the normal pool. We do feel, however, that any further lowering of the normal pool elevation will substantially decrease the recreation potential of the impoundment and that any increase of the present five foot flood surge pool will probably have similar detrimental effects on the recreation value of the project.

Sincerely yours,

J. Carlisle Crouch
Acting Regional Director

REPORT FROM

STATE OF ILLINOIS, DEPARTMENT OF CONSERVATION

EXHIBIT 3

89163 O-62—11

STATE OF ILLINOIS
DEPARTMENT OF CONSERVATION
SPRINGFIELD

WILLIAM T. LODGE
DIRECTOR

December 11, 1961

Alfred J. D'Arezzo, Colonel
U.S. Army Engineer District, St. Louis
Corps of Engineers
420 Locust Street
St. Louis 2, Missouri

Dear Colonel D'Arezzo:

SUBJECT: Illinois Department of Conservation Park Recommendations for Rend Lake Development Program

Referring to the recent November report of the National Park Service, U. S. Department of Interior, and the recent discussions with the U. S. Corps of Engineers, St. Louis Office Recreational Planning Section, this Department would like to support the recommendations prepared by the National Park Service and in particular, the number of acres of land (8,700) recommended by the National Park Service to be acquired for recreational purposes; but at this time, the Department does not feel it is in a position to recommend acquisition by the State for this acreage. We wish to recognize the recreational visitation costs and benefits for Rend Lake by the National Park Service as follows:

RECREATION VISITATION, DEVELOPMENT COSTS AND BENEFITS

Proposed Rend Lake Reservoir by National Park Service

	Initial	Ultimate (Increment)	Total
Annual Visitation	1,670,000	2,170,000	3,840,000
Design Load	31,730	41,230	72,960
Cost of facilities, less land	$5,592,400	$7,380,300	$12,972,700
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Total Annual Costs	642,700	844,700	1,487,400
Total Annual Benefits	$2,672,000	$3,472,000	$6,144,000

"The above table enumerates costs involved to provide adequate facilities for the anticipated annual visitation and to utilize the recreation potential inherent in the project. The annual equivalent of construction costs is

amortized at 2 5/8% over a 25 year period, the estimated life of recreation facilities. The cost of land acquisition has not been included in these estimates. Some of these costs should logically be shared by other activities.

"In order to arrive at a monetary figure which may serve to indicate possible annual recreation benefits, the estimated net annual recreation attendance is multiplied by $1.60, a derived market value for a day of reservoir recreation."

We also wish to vigorously support your office in your recommendations for recreational lands to be acquired for the U.S. Corps of Engineers of 1400 acres plus 4 access sites on the upper arms of the lake area of 120 acres. Due to the relatively flat topography of the reservoir site, it has been determined by all three agencies involved - National Park Service, U. S. Corps of Engineers and the Illinois Department of Conservation that park type recreational areas would be most desirable in the lower half of the lake.

Recommendation No. 1 - From this Department's preliminary surveys, we feel that the Department is in a position to recommend the acquisition of from 1000 to 1500 acres of land to be acquired by the Rend Lake Conservancy District or the Department of Conservation for State park purposes, to be located on the East side of the reservoir area on the peninsula lying between Gun and Casey Creeks, northwest of Whittington. We feel this area lends itself to park purposes for the development of family and group camping, picnic areas, nature areas, trails, boat harbors and marinas with adequate potable water supply and sanitary facilities. This area is designated on the attached maps by Roman Numeral I and would include areas 5 and 6 recommended by your office as possible recreational and launching areas. If this particular area is developed, as recommended, the Department would request of the U.S. Corps of Engineers that the two areas be leased to the Department of Conservation for management. These are accessible from Route 183 to a direct inter-change on Inter-State Route 57.

Recommendation No. 2 - The Department will also recommend further feasibility studies of an area designated by Roman Numeral II, lying East of Sesser and North of Route 183, also accessible from Route 183 to a direct inter-change on Inter-State Route 57. The Department recommends further study of possible park-type recreational development at this area of which a small portion of it has been designated as area #4 by your office as a possible recreational and launching area. If this area is developed by the State of Illinois, - Department of Conservation, it would also be recommended to your office that area #4 be leased to the Department of Conservation for management. The new coal mine and the railroad extension is recognized in this survey. The proposed park area would lie East of the railroad and coal mine.

This Department will further study both areas and prepare a more detailed report for the recommendations and development as needed by your office.

We are enclosing four copies of the National Park Service Region 5 Recommended Acquisition for Recreation Land Map on which we have identified the areas discussed in this report. We are also returning the original of Exhibit #2.

We wish to express our appreciation to you and members of your staff for your cooperation.

Very truly yours,

William T. Lodge
Director

WTL:Pl
Encs.

REPORT FROM

PUBLIC HEALTH SERVICE

EXHIBIT 4

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

PUBLIC HEALTH SERVICE

REGION V
433 WEST VAN BUREN STREET
ROOM 712
CHICAGO 7, ILLINOIS

December 15, 1961

Refer to: WS&PC

District Engineer
U. S. Army Engineer District, St. Louis
420 Locust Street
St. Louis 2, Missouri

Attn: LMLED-PG

Dear Sir:

Enclosed are six copies of the Rend Lake Reservoir, Illinois report pertaining to the water supply and stream flow regulation aspects of this reservoir and the Big Muddy River. The remainder of the 100 copies requested by your office have been shipped, but because of Post Office restrictions regarding bulk mailings at this time, we think that there may be a delay in their arrival.

The authority to undertake this study stems from the Public Health Service Act of 1921 as amended, Public Law 410, 78th Congress, Federal Water Pollution Control Act, Public Law 660, and from Public Law 87-88 (Public Law 660, as amended, July 1961.) Pertinent portions of the law are:

COMPREHENSIVE PROGRAMS FOR WATER POLLUTION CONTROL

Sec. 2 (b) (1) In the survey or planning of any reservoir by the Corps of Engineers, Bureau of Reclamation, or other Federal agency, consideration shall be given to inclusion of storage for regulations of stream-flow for the purpose of water quality control, except that any such storage and water releases shall not be provided as a substitute for adequate treatment or other methods of controlling waste at the source.

Sec. 2 (2) The need for and the value of storage for this purpose shall be determined by these agencies, with the advice of the Secretary, and his views on these matters shall be set forth in any report or presentation to the Congress proposing authorization or construction of any reservoir including such storage.

You will note in the report that water requirements for these purposes have been projected to the year 2010 only, instead of to 2060 as originally requested. This change was made because computations revealed that all available water that could be stored in the reservoir for the above-mentioned uses would be required by the year 2010. Therefore, it was not considered necessary to project beyond that year.

It is recommended that when this project is in the pre-construction planning stage, that an investigation and report be made defining the malaria vector potential of this reservoir.

It has been a pleasure to work with members of your staff on this project pertaining to the health-related aspects. If we can be of further service, in similar matters, please communicate with us.

Very truly yours,

H. W. Poston

H. W. Poston
Regional Program Director
Water Supply and Pollution Control

Enclosures

REND LAKE RESERVOIR DEVELOPMENT

Water Supply and Low Flow Augmentation Potential

Prepared at the Request of the
District Engineer, St. Louis District
Corps of Engineers, U. S. Army

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control

Region V, Chicago, Illinois
and
Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

November 1961

WATER SUPPLY AND LOW FLOW AUGMENTATION POTENTIAL

REND LAKE RESERVOIR DEVELOPMENT

SCOPE

The following is a report of the results of a preliminary examination, undertaken in cooperation with other federal agencies, of the water supply and pollution abatement aspects of a proposed development on Big Muddy River in Jefferson and Franklin Counties, Illinois. The Rend Lake Conservancy District, an agency of the State of Illinois, is sponsoring the construction of a dam for water conservation purposes on the Big Muddy River in the vicinity of Benton, Illinois. The physical aspects of the proposed development have been investigated and reported upon by the Division of Waterways, Department of Public Works and Buildings, State of Illinois, and the results of the engineering study are set forth in a report entitled "Report of Survey, Rend Lake Reservoir, Jefferson and Franklin Counties," dated 1957. The physical data upon which the present investigation has been based are taken from this engineering study. The present investigation concerns itself with water quality and quantity effectuated by the proposed development as these would bear on the future growth of the surrounding area. No further

recitation will be made herein of the physical dimensions of the proposed dam and reservoir, for details on this reference are made to the above-cited engineering study. The method of operation of the reservoir storage volume is that stated to be the present intent of the officials of the Rend Lake Conservancy District. In the following, reference will be made to some of the details of the proposed operation, and where these are set forth it will be understood that they comprise the current intent of the Conservancy District. Water quality standards pertinent to the Big Muddy River system and particularly to the proposed Rend Lake Development have been discussed with the officials of the Illinois Sanitary Water Board. Their opinions have been used as the criterion against which assessment of the acceptability of the Rend Lake Reservoir as a public water supply has been judged.

DATA SOURCES

The bases from which the following analyses and conclusions are derived consist exclusively of data and opinions from these sources:

A. Report of Survey, Rend Lake Reservoir, Jefferson and Franklin Counties, dated 1957, prepared by the Division of Waterways, Department of Public Works and Buildings, State of Illinois.

B. Potential Water Resources of Southern Illinois, dated 1957, prepared by the Illinois State Water Survey.

C. Water quality data intermittently collected on the downstream reaches of the Big Muddy River during 1950-1952, inclusive, these data being tabulated in a manuscript by several persons at the Southern Illinois University, Carbondale, Illinois.

D. Discussion of water quality standards applicable to the proposed Rend Lake Development with the officials of the Illinois Sanitary Water Board.

E. An informal discussion with officials of the Board of Economic Development and the Department of Mines and Minerals of the State of Illinois.

The time alloted for examination of the project makes acceptance of these data and opinions a necessity. No critical review has been made of them prior to their use and it has not been possible to supplemant them in those areas in which they are deficient with respect to the needs of this investigation. For instance, questions pertinent as to the effect of reservoir operation on the diminishment of dilution water downstream of the reservoir; the possibility of low flow augmentation from reservoir storage and its effects and value; the mode of operation, the assignment of storage and volume capacities to the various uses; and the method of water supply distribution from the reservoir are in point. At the present time and from

the information available answers to these questions may be subject to future modification or even must be assumed by those preparing this report. It should therefore be recognized that the analyses and conclusions of this report are subject to future verification or change if time and means are available to establich specific data in these areas.

PROSPECTIVE FUTURE WATER DEMAND

The study area for purposes of analyzing the economic growth potential to estimate water demands comprise Jefferson and Franklin Counties in their entirety; the eastern third of Perry County contained in DuQuoin, Paradise, Sunfield, and Tamaroa precincts; the northeast corner of Jackson County known as the Elk Township; and the northern part of Williamson County known as the Blairsville, Herrin and Lake Creek precincts.

The economic activity in the area as measured by population trends has been one of steady decline for the past three decades. Total population dropped from approximately 135,000 in 1930 to 106,000 in 1960. There was a gradual loss during each of the decades in both the total urban population and rural population. The total population in the municipalities decreased 18 percent during this 30-year span - all but two of 24 municipalities suffered losses. The rural area declined at 27 percent during the same period.

Much of the decline in population resulted from a contraction of employment in agriculture and mining. Employment necessary to render aervices to those who out-migrated also decreased.

Total combined production of agriculture, minigg, and manufacturing measured in constant dollars in the study area, however, has had an increasing trend. Much of the decrease in employment has been the result of technological advances particularly in mining and agriculture and without a concomitant increase in other segments of the economy out-migration resulted.

In spite of the previously unfavorable development pattern, these are many factors which suggest a marked reversal of the trend. Mineral resources, particularly coal, can be expected to be of increasing influence in stimulating growth. Known reserves in the study area are estimated to exceed 10 billion tons. Much of this is of high grade but because of its depth (600-800 feet) the strip mines have competitive advantage. Reserves of coal in the State of Illinois capable of being strip mined economically is estimated to last only 112 more years. The coal located in the study area is expected to have a competitive advantage over other sources of coal for the Illinois market by 1975. Present, but of lesser significance, are deposits of oil, clay, limestone, sand, and gravel.

Of greater importance to the growth of the area is the possibility of attracting industries that will use the extracted minerals. A distinct possibility is the use of coal in the study area for aluminum and fertilizer production and thermo-electric generation. An interest has been expressed by firms but were reported to be rejected because of the inadequacy of water supply. Of lesser likelihood, but nevertheless encouraging, is steel production and petrochemicals. With metallurgical coal and limestone at hand and with iron ore nearby in the newly discovered deposit in southern Missouri, steel manufacturing has promise. The anticipated decrease during the next 25 years in the availability of petroleum and natural gas throughout the United States, will favor coal as a feed stock in the petrochemical industry.

Aside from the attraction of one or more resources based large water-using industries mentioned above, the area can be expected to encourage the establishment of many labor and market-oriented firms. Limited access highways under construction and proposed will place the area within a day's trucking distance to a market of 25 million people. In addition six railroads service the area for longer hauls and large transportation is likewise accessible. Particularly promising is metal fabrication, food processing, and wood products.

The economic potential of the area is promising in view of its resources as well as its geographic location with respect to markets. With

an estimated national population growth of 1½ percent per year and a per capita increase in real income of 2 percent per year (resulting in a fourfold increase in the demand for goods and services in a 50-year period) the study area is estimated to grow from the present population base of 106,000 to 160,000, which is half the national rate of increase, by 2010. The rural area will decrease from 38,772 in 1960 to 30,000 in 2010 whereas the total municipal population will increase from 67,135 to 130,000.

Current water consumption for nine municipalities in the study area averages 100 gpcd. This is measurably below the national average of 150 gpcd but it is not abnormal for municipalities in areas that are characteristically rural. With an increase in the future in the level of living, it is estimated that the daily per capita water consumption will increase to 160 gallons, which will result in a total daily municipal demand in the study area of 20.8 million gallons. In addition, an estimated 24 million gallons daily will be required for industrial purposes by large water-using firms not included in the estimate for municipalities. It is assumed that these firms will obtain their water directly from the Conservancy District. With allowances for existing impoundments, the net increase in water demand by 2010 in the aforementioned political subdivisions is expected to be 38.1 million gallons per day. Of this total it is further estimated that those parts of the political subdivisions falling within a five-mile radius of the proposed water treatment

plant at Benton will demand 20 pereent, or 8 million gallons of the total; those within fifteen-mile radius 50 percent, or 20 million gallons of the total; and those within a twenty-five-mile radius will demand the total capacity of the proposed development.

It will be recognized that the uncertanity inherent in methods used to forecast future water demand precludes the exactness inferred by the use of 38.1 million gallong as the demand. This figure is therefore rounded off at 40 million gallons per day, is used as such in the following, and should be used with the percentage given above.

WATER SUPPLY

The development of a public water supply in the proposed Rend Lake Reservoir is being considered as one of the multiple uses of the impoundment. The Rend Lake Conservancy District will be the sponsoring agent. With storage in the proposed Rend Lake Reservoir as a source of supply, the Conservancy District proposes to construct a raw water intake, filtration plant, at a point just upstream of the dam on the east side of the lake. From this point it proposes to furnish finished water to communities within economic delivery distance of the site via closed conducts.

89163 O-62—12

Consideration of the cost of treatment and delivery of this water is beyond the scope of the present investigation; only the quantity and the quality of the raw water supply together with comparable alternate sources of a raw water source has been reviewed.

Reference is made to the hydrologic characteristics of the proposed Rend Lake Reservoir as shown on Plate 20 of the Appendix III to the Report of Survey, Rend Lake Reservoir, Jefferson and Franklin Counties, dated 1957, as prepared by the Division of Waterways, Department of Public Works and Buildings, State of Illinois. Based on stream flow records of the Big Muddy River at Benton, Illinois, for the period 1945 to 1955, inclusive, and the allocation of approximately the upper 9-foot depth of storage in the proposed Rend Lake Reservoir, a safe yield of 40 million gallons per day to water supply development can be obtained. The predicted future population growth with a 25-mile radius of the proposed water treatment plant will be able to use this quantity of water together with that presently available. It is proposed therefore in subsequent analysis of the water supply development of the reservoir to consider a yield of 40 million gallons per day and an allocation of approximately a 9-foot depth of storage as the features of the water supply development under consideration.

The quality of the water in the Rend Lake Development will probably be degraded and to produce a finished potable water supply will require

rigorous application of the best present-day treatment techniques. In addition, close control over sources of pollution entering the lake will probably be required to be exercised. With respect to pollution of the lake waters, several existing and potential sources might render the lake water a questionable supply were other more desirable water supply sources available in the region. Treated sewage effluents from such communities as Mt. Vernon, Sesser, and Ina now pass through the proposed lake area. Salt brine wastes arising from petroleum extraction in the basin is carried on in the basin, and flushing of crude oil spills into the reservoir may contribute to the contamination. Very large coal reserves underlie the basin upstream of the proposed Rend Lake Dam, and while mining operations are not now extensive in the upper basin, future mining may give rise to acid mine drainage into the reservoir. Portions of the reservoir are to be given over to a wildlife refuge the outstanding use of which would be the support of goose and duck population. Natural waste derived from the wildlife population could furnish a high fertility and result in growth of algae in the lake waters. Portions of the lake bottom are now thickly covered with woody growth which is now planned to be allowed to remain in plane. Both of these conditions can be expected to give rise to taste and odor problems in the raw water supply.

Conditions analogous with those anticipated within the Rend Lake Reservoir now exist within the basin. East of Carbondale, Illinois, on the Crab Orchard Creek, tributary of the Big Muddy River, the Crab Orchard Lake Reservoir has been in existence for several years. The city of Marion, whose population is similar to that of Mt. Vernon, lies upstream of the reservoir and discharges its treated sewage effluent into the reservoir. The reservoir is a wildlife refuge which in season accommodates a large goose and duck population. Waters of the reservoir are used as a public water supply for the city of Carbondale. In the opinion of the Illinois public health officials, the reservoir, with proper attention to water treatment processes, has proven to be an acceptable source of water supply.

The quality of water to be expected in Rend Lake Reservoir has been discussed with the Illinois public health officials. They advise that the State of Illinois has not adopted water quality standards against which a prospective Rend Lake supply could be measured but that each case concerning water quality standards is considered on the basis of facts pertaining to it. In their opinion the facts pertaining to, and the circumstances of the area, indicate Rend Lake will be an acceptable source of raw water.

As a basis for making comparative costs of the water supply it is believed that two alternate sources are open to consideration. Inasmuch as the Rend Lake Conservancy District is sponsoring agent for development

of water supply and that their plan of operation contemplates both a raw water delivered to the treatment plant at Benton and volume of water delivered shall be 40 million gallons per day, it is believed that such alternate sources as are considered shall meet the need of this agency. Rend Lake Reservoir developed as a single-purpose project devoted solely to water supply requirements will meet these conditions. A second alternate will be the construction of an intake and pumping station on the Mississippi River in the vicinity of Grand Tower, Illinois, with pipeline delivering the raw water to the proposed water treatment plant at Benton.

Consideration has also been given the possibility of developing ground water as an alternate supply. Geology of the region including Franklin and Jefferson Counties and the area contiguous thereto is such as to preclude the possibility of developing underground water sources in the quantity required. Test drillings have shown that permeable underground aquifers are extremely limited in extent, consequently yield small amounts of sustained flow, and such water as is derived from underground sources is generally so highly mineralized as to render it unacceptable as a potable supply.

LOW FLOW AUGMENTATION

The forecasted future population growth in the basin will contribute a large domestic and industrial waste load to the stream even after such

waste loads have been processed through a high degree of sewage treatment. Under the low flow conditions characteristic of this reach of the Big Muddy a severe degradation of the water quality will take place. Improvement of these prospective conditions can be brought about by the discharge from Rend Lake Reservoir, during periods of low stream flow, in order to dilute the waste load. The value of this improvement can be measured by comparing the natural reductive affects of the stream flow to the cost of achieving the same results in a hypothetical present-day sewage treatment plant.

Based upon the forecasted population and industrial growth to the year 2010, and assuming that the waste loads deriving therefrom are given secondary treatment and reduced by 75 percent, it is computed that waste loads in the following amounts will be discharged via tributary streams into the Big Muddy River from the indicated sources:

Benton	1275 lbs BOD
Christopher	450 lbs BOD
Zeigler	375 lbs BOD
Johnson City and West Frankfort	3460 lbs BOD
Herrin and Carterville	2500 lbs BOD
Carbondale	2625 lbs BOD
Murphysboro	1275 lbs BOD

During the period of stream flow records on the Big Muddy River the following low flow rates have been observed:

Benton	0.3 cfs average flow, July 1-7, 1954
Plumfield	1.5 cfs average flow, September 15-21, 1953
Murphysboro	1.5 cfs average flow, September 9-15, 1953

Assuming that repetition of these flows could take place, and that the above-computed waste loads would be discharged to the stream during this flow condition, the concentration of wastes in the river would be beyond the capacity of the stream to assimilate them. Under these conditions a septic condition would prevail throughout the length of the river between Benton and a point downstream of Murphysboro.

Computations for the Rend Lake Reservoir have shown that a discharge to the stream below the dam of 30 cubic feet per second during periods of low flow will be required. Of the total load of 11960 lbs per day of BOD discharged, 3785 lbs of BOD will be exerted by the 30 cubic feet per second during the period of flow from Benton to below Murphysboro. The exertion of this portion of the load will not depress the dissolved oxygen below 4 ppm. As a monetary measure of the value of this improved assimilation capacity of the stream, comparison is made with the average cost of obtaining equivalent waste reduction in a sanitary sewage treatment plant. In the vicinity of the Big Muddy River Basin it is estimated that

this could be accomplished at the unit cost of $16.00 per pound of BOD per day. On these bases, it is estimated that the low flow augmentation of 30 cfs from Rend Lake Reservoir will have an annual value of $60,600.

CONCLUSIONS

The analysis on which the foregoing report has been based leads to the following conclusions:

a. The probable future population and industry increase in the Jefferson-Franklin County area can beneficially use a daily average quantity of 40 million gallons for water supply in addition to that now developed and serving this area.

b. Such supply can be developed in the proposed Rend Lake Reservoir. The raw water derived therefrom, with proper and continuous attention to treatment of it, would yield an acceptable potable public water supply.

c. The alternate sources which should be considered on a comparative basis to that found in Rend Lake should consist of:

   1. Rend Lake developed to a single-purpose public water supply project, and

   2. A source of supply in the Mississippi River with the raw water piped to Benton, Illinois.

d. Low flow augmentation releases from the reservoir in the amount of 30 cfs will bring about a future needed improvement in water quality from Benton on downstream. The annual value of this improvement is computed as $60,600.

REPORT FROM

U. S. FISH AND WILDLIFE SERVICE

Exhibit 5

UNITED STATES DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Clarence F. Pautzke, Commissioner

REND LAKE RESERVOIR

ILLINOIS

A SPECIAL REPORT ON FISH AND WILDLIFE RESOURCES

December 1961

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
1006 WEST LAKE STREET
MINNEAPOLIS 8, MINNESOTA

ADDRESS ONLY THE
REGIONAL DIRECTOR

December 21, 1961

NORTH CENTRAL REGION
(REGION 3)
ILLINOIS
INDIANA
IOWA
MICHIGAN
MINNESOTA
MISSOURI
NEBRASKA
NORTH DAKOTA
OHIO
SOUTH DAKOTA
WISCONSIN

District Engineer
U. S. Army Engineer District
St. Louis
420 Locust Street
St. Louis 2, Missouri

Dear Sir:

In accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the Bureau of Sport Fisheries and Wildlife, with the assistance of the Illinois Department of Conservation, has prepared this special report on the Rend Lake Reservoir, Big Muddy River, Illinois. The report discusses the anticipated effects of the project on fish and wildlife resources and contains our recommendations for their conservation and development. It is supported in greater detail by information provided in the attached Substantiating Report.

It is our understanding that the Corps of Engineers has undertaken this study at the request of the Area Redevelopment Administration and that it has been carried out under the authority of a resolution adopted on July 6, 1949 by the Public Works Committee of the House of Representatives.

The purposes of the project would be flood control, water supply, pollution abatement, fish and wildlife conservation, general recreation and the socio-economic development of a generally depressed area.

The dam creating Rend Lake Reservoir would be constructed on the Big Muddy River near Rend City in south-central Illinois and the impoundment would lie in Franklin and Jefferson Counties.

According to information furnished by your office, the dam would be an earth-fill structure 8,230 feet in length with a crest elevation of 424.0 m.s.l. An uncontrolled, weir-type, concrete spillway 500 feet in width would discharge into a 320-foot wide stilling basin and outlet channel. There would also be an auxiliary spillway at elevation 415.0. The outlet works would consist of two 6' x 6' concrete-box sluices equipped with gates and trash racks.

The reservoir would be operated to maintain a normal pool at elevation 405.0. At this elevation the reservoir would have a surface area of 18,900 acres. The flood control pool,

elevation 410.0, would inundate 24,800 acres. A minimum release from the reservoir of 30 c.f.s. is planned.

The Big Muddy River and its tributaries which would be affected by the project do not support a significant fishery. The fishing pressure is extremely light. Species most commonly harvested include carp, bullheads, channel catfish and an occasional largemouth black bass.

Loss of the warm-water stream fishery within the impoundment area would be offset by the improvement of the stream fishery below the dam as a result of stabilized flow, maintenance of a minimum discharge and development of the reservoir tailwater fishery.

Construction of Rend Lake dam would create a comparatively stable, not unattractive, reservoir with a surface area of nearly 19,000 acres. The impoundment would unquestionably provide a valuable and heavily-utilized fishery in an area generally lacking this resource. It is believed that game fishes such as largemouth black bass, crappies, sunfishes, and channel catfish would be taken in large numbers.

The net annual fishery benefit attributable to the Rend Lake Reservoir would be approximately $254,000.

The project area contains good wildlife habitat. The flood plain of the Big Muddy is heavily timbered and largely uncultivated. It supports good populations of squirrels, raccoons, and foxes. On the upland slopes, much of the land has been cleared and cultivated. However, the fields are not large and the numerous oak-hickory woodlots, brushy ravines, field borders, and small waste areas support bobwhite quail, cottontails, and mourning doves. Little use is presently made of the area by waterfowl.

Although good wildlife habitat and game populations are the rule, hunting pressure is extremely light, particularly in the timbered bottoms which would be inundated by the reservoir. Above elevation 410.0, the uplands within the project area would be little affected by operation of the dam.

The reservoir would be attractive to waterfowl. Its location in relation to migration routes and wintering areas virtually assures heavy use. However, the length of time the impoundment might hold a concentration of birds would be limited by the availability of food unless certain waterfowl development and management measures are carried out.

Fortunately, the Rend Lake Reservoir presents an excellent opportunity to incorporate improvements for waterfowl in a water resource

development project. The East and West Arms in the upper end of the project area and the Gun Creek Arm on the east side are ideally situated for this purpose.

Construction of subimpoundment dikes containing water level control facilities in both the East Arm and West Arm would provide good conditions for the growth and utilization of natural duck foods and would make the entire reservoir more attractive to ducks. Management of available uplands adjacent to the subimpoundments would increase their attractiveness.

Generally, management of the subimpoundments would require that their water levels be raised in the fall to flood the existing pin-oak timber, thereby making the mast crop available to ducks. Besides providing excellent natural food, flooded timber will accommodate a much higher density of hunters per unit area than any other kind of wetland habitat. Cultivated food crops could also be produced on open areas and could be flooded along with the timber. After the waterfowl season, water levels in the subimpoundments would be drawn down to equalize with the normal pool of the reservoir below.

The Gun Creek Arm would furnish the basic requirements for a goose management area without the necessity of a subimpoundment structure; provided that sufficient additional land could be acquired and made available for this purpose. It lies in the path of important migration routes and within a short distance of established wintering flocks on Federal and State refuges. The uplands adjacent to Gun Creek are mostly cleared and comparatively level agricultural lands on which could be grown the forage and grain crops necessary to attract and hold geese during the fall and winter. The permanent water area within the Gun Creek Arm at normal pool elevation is sufficient to accommodate large numbers of geese.

However, a goose management unit must be large enough to provide a refuge area and a buffer zone wherein the geese can be free from harassment by hunters. Approximately 3,800 acres of land would be required in addition to the 1,900 acres proposed to be acquired in the Gun Creek Arm. The attached map indicates the suggested boundary of the management area.

The East Arm, West Arm and Gun Creek units would be operated and managed by the Illinois Department of Conservation.

These three proposed wildlife management units would increase materially the net annual wildlife benefits of Rend Lake Reservoir. Without the development and management of these units, the annual benefit would be $13,000. If the West Arm and East Arm units are developed, primarily for ducks, the net annual wildlife benefit of the reservoir would be $58,000. If only the Gun Creek Arm is

developed, the net annual benefit would be $35,500. The overall net annual wildlife benefit with all three units developed and managed for ducks and geese would amount to $80,500.

In view of the potential fish and wildlife resource values of the Rend Lake Reservoir area, we are submitting these recommendations:

It is recommended that:

1. A minimum release of 30 c.f.s. be maintained at all times to the Big Muddy River below the reservoir.

2. A minimum of 15 acres of land, with public access thereto, including 1,000 feet of streambank frontage on each side of Big Muddy River immediately below the stilling basin, be acquired as an integral part of the project to provide for public use of the reservoir tailwaters for fishery purposes.

3. The Gun Creek Arm be developed for goose management purposes through the purchase of an additional 3,800 acres of land located approximately as outlined on the attached map. The operation, control and management of this unit, which would total 5,700 acres, should be vested in the Illinois Department of Conservation.

4. The East and West Arms of Rend Lake Reservoir be developed for waterfowl management purposes through the construction of subimpoundment dikes and the control works necessary to manipulate water levels between elevations 405.0 and 410.0. Operation, control and management of these units should be vested in the Illinois Department of Conservation.

5. Every possible effort be made to acquire the lands within the East Arm and West Arm subimpoundment areas before the bottom-land timber can be removed.

6. Appropriate consideration be given to the development of a reservoir zoning plan in connection with overall recreational planning to insure that certain areas or periods will be available for fishing, hunting, and other wildlife purposes without conflicting use for general recreation.

7. Prior to establishment of clearing specifications and determination of plans for recreational development, a joint discussion be held between representatives of the Corps of Engineers, the Rend Lake Conservancy

District, the Bureau of Sport Fisheries and Wildlife, and the Illinois Department of Conservation to formulate mutually acceptable plans for reservoir clearing, zoning, and provision of public access.

8. All project lands and waters within the established fee-taking line, except for areas reserved for general recreation or other specific public purposes, be made available to the Illinois Department of Conservation for fish and wildlife management through the provisions of a General Plan in accordance with Section 3 of the Fish and Wildlife Coordination Act.

9. The following language be incorporated in the report of the District Engineer, Corps of Engineers: "That all lands acquired in fee as a part of the project, together with project waters, be open to free public use for hunting and fishing in accordance with regulations prescribed by the Illinois Department of Conservation, except for sections reserved for safety, efficient operation, or protection of public property."

This report is based on engineering information contained in the Report of Survey--Rend Lake Reservoir--1957, prepared by the Illinois Division of Waterways and additional information furnished by your staff between October 15 and December 1, 1961. Please advise us of any significant changes in project plans in order that we may revise our report accordingly.

The cooperation, information, and assistance provided by you and your staff are greatly appreciated.

Sincerely yours,

R. W. Burwell
Regional Director

SUBSTANTIATING REPORT

PREFACE

Based on authority contained in a resolution of the Public Works Committee, House of Representatives, adopted on July 6, 1949, the District Engineer, U. S. Army Engineer District, St. Louis, has recently been directed to make a special report as a part of the authorized overall basin investigation of the Big Muddy River and its tributaries. The Corps of Engineers' special investigation will be limited to a review of the Report on Rend Lake Reservoir, Jefferson and Franklin Counties, Illinois, prepared in 1957 by the Division of Waterways, Department of Public Works and Buildings, State of Illinois. This report discusses two separate design studies - one for a reservoir with spillway crest at elevation 405.0 feet m.s.l.* and one for a reservoir with spillway crest at 410.0.

Our report is based on the engineering information contained in the above document as it relates to a reservoir with spillway crest at 410.0 and which would be operated to maintain a normal pool at elevation 405.0. It discusses the anticipated effects on fish and wildlife resources of the proposed Rend Lake Reservoir and includes substantiating data in support of the recommendations contained in the report of the Regional Director, Bureau of Sport Fisheries and Wildlife. Resources which will be benefited by the project have been evaluated in accordance with the procedure adopted by the Inter-Agency Committee on Water Resources.

* All elevations refer to Mean Sea Level datum.

We wish to express our appreciation to the St. Louis District, Corps of Engineers, the Illinois Department of Conservation, and the Rend Lake Conservancy District for the information and assistance they provided.

INTRODUCTION

Studies undertaken by the Illinois Division of Waterways have determined the feasibility of damming the Big Muddy River in the vicinity of Rend City in south-central Illinois. The dam would be located approximately 2.5 miles west of Benton, and about 3 miles north of State Highway 14. The reservoir area would be in Franklin and Jefferson Counties. At normal pool elevation 405.0 it would inundate an area of 18,900 acres and at spillway crest elevation 410.0 it would cover 24,800 acres.

The purposes of the project are flood control, water supply, pollution abatement, fish and wildlife conservation, general recreation, and the socio-economic improvement of a generally depressed area.

DESCRIPTION OF THE AREA

Physical Features

The Big Muddy River, located in southwestern Illinois, heads in Jefferson County near Cravat and flows generally south and west to the Mississippi River near Grand Tower, Illinois. It drains all or part of Jefferson, Franklin, Williamson, Johnson, Union, Jackson, Perry, and Washington Counties. The drainage is characterized by rugged upland topography and broad, almost flat, swampy lowlands along the principal

streams. Maximum relief in the watershed varies from 625 feet near the headwaters to 380 feet at the damsite - a drop of 245 feet in approximately 33 miles. However, most of the fall is in the rugged, headwater reaches.

The river within the project area is a tortuous, meandering, timber-canopied stream varying in width from 30 to 60 feet, with an average depth of less than 3 feet. The channel capacity is limited and flows on the order of 1,000 c.f.s. result in flooding. It is joined by several large tributaries similar in physical features. The more important of these are Rayse, Casey, and Gun Creeks. Along the Big Muddy and its major tributaries, 4 to 20 foot vertical banks rise abruptly from the water's edge to secondary banks with a gradual 1:2 slope. The permanently wet and relatively uncultivated flood plain, confined between distinct bluffs and low-rolling hills, varies in width from three-quarters to one and one-half miles. Bottom-land timber of mixed age classes covers most of the flood plain. The timber is mostly river birch, oaks, maples, elms, sycamore and blue beech. Throughout the timbered bottoms is a dense, ungrazed understory of buttonbush, alder, briar thickets, and woody-stemmed annuals.

The gently rolling lands distal to the flood plain are largely cultivated. The upland soils of moderate fertility are used primarily for row crops, mainly corn. The fields are usually small and irregular due to the interspersion of the upland oak-hickory woodlots and the brush-lined draws of intermittent stream courses.

Crab Orchard National Wildlife Refuge lies approximately 25 miles southwest of the reservoir area.

Commercial Features

The population of Jefferson and Franklin Counties in 1960 was approximately 71,000 of which about half was rural and half urban. These two counties, like many others in southern Illinois, have been steadily declining in population. However, within 50 miles of the Rend Lake Reservoir area the population is about 400,000 people. Also, the project area is less than 100 miles from the greater St. Louis metropolitan complex. Over 3,500,000 people live within a 100-mile radius of the proposed lake.

The number of farms in the general vicinity of the reservoir area has greatly decreased in recent years while the average size of farms has increased, indicating liquidation of small farm units. Agricultural products include corn, forage, fruit and orchard crops.

Coal production, although not as significant as in past years, is still an important economic factor. Also, there are a large number of oil wells in the project area and adjacent to it. Forty-one producing wells would be inundated by the reservoir. To continue pumping operations after construction of the reservoir would require the construction of elevated platforms for housing the pumps and equipment above the water level. However, since oil production in this area is now rather limited, outright acquisition and capping of the wells is being considered.

A number of State Highways, a well-developed system of county and township roads and five railroad lines furnish transportation facilities within or immediately adjacent to the project area.

In addition, the planned east-west Interstate Highway Route 64 will pass just north of the reservoir area and the planned north-south Interstate Highway Route 57 will be located along the east side of the reservoir area, crossing the Gun Creek Arm.

PROJECT PLAN

Engineering Features

Rend Lake Reservoir would be formed by the construction of a compacted rolled earth-fill dam across the main valley of the Big Muddy River near Benton, Illinois. The 8,230-foot dam, excluding the spillway, would have a crest elevation at 424.0, about 44 feet above the channel floor. A concrete spillway, crest elevation 410.0, would consist of a broad-crested weir 500 feet in width converging to a 320-foot wide stilling basin and outlet channel. An auxiliary earth spillway would be placed at elevation 415.0 to pass exceedingly high flows. The outlet works would consist of two 6' x 6' concrete-box sluices equipped with gates and trash racks. The flowline of the outlet sluices, set at channel bottom elevation 375.0, would permit dewatering the lake in approximately 54 days.

At normal pool elevation (405.0), the reservoir would have a surface area of 18,900 acres and a capacity of 191,000 acre-feet. At spillway design elevation (410.0) the reservoir would inundate 24,800 acres and would have a capacity of 302,500 acre-feet.

Operation

The reservoir would be operated to maintain a pool as close to elevation 405.0 as possible. All discharges from the impoundment

would be via the two sluice gates as long as the pool remains below elevation 410.0. At this level, water would begin passing over the spillway.

A minimum sustained discharge of 30 c.f.s. would be passed through the sluices to provide for downstream pollution abatement, domestic water supply and maintenance of fish and wildlife resources.

Only minor fluctuations in the level of the reservoir are anticipated. During years of normal rainfall, the lake level would vary no more than two feet. A maximum drawdown of approximately 10 feet would occur during periods of extreme drouth and about a 10-foot rise above normal lake levels would result with the occurrence of the project design flood.

Land Acquisition

Elevation 415.0 has been established as the guide contour for fee acquisition. All lands would be acquired in fee. Acquisition of flowage easements is not proposed. Approximately 35,000 acres of land would be acquired for the project.

Table I

Rend Lake - Pertinent Engineering Data

Dam (compacted earthfill)		
Top elevation	424.0	feet
Crest length - excluding spillway	8,230.0	"
Crest width	44.0	"
Spillway (concrete broad-crested weir)		
Crest elevation	410.0	"
Crest width	500.0	"
Auxiliary Spillway (earth)		
Crest elevation	415.0	"
Crest width	800.0	"
Outlet Works (2 - 6 x 6 foot concrete sluices controlled by slide gates)		
Flow line elevation of sluices	375.0	"

FISHERY SECTION

Without-the-Project

The project area includes 33 miles of the Big Muddy River, 24 miles of major tributaries and several miles of small, intermittent feeder streams. The available fish habitat is marginal and the fishing pressure is correspondingly low. Fishermen utilizing the Big Muddy are largely local residents who gain access to the river at road and bridge crossings. The standard fishing equipment includes cane poles, drop lines, and trot lines. A few hoop nets are occasionally used.

Fishes commonly occurring in the Big Muddy River system are crappies, bluegills, green sunfish, black bass, yellow bass, channel catfish, black bullhead, fresh water drum, carp, buffalo, suckers, dogfish, gizzard shad, gars and a number of species of minnows.

With-the-Project

Construction of the proposed dam across the Big Muddy River would create a relatively stable and somewhat scenic 18,900-acre lake. It unquestionably would provide a valuable and heavily utilized lake-type warm-water fishery within an area of high human population density.

The normal pool would extend upstream about 14 miles, would have a maximum width of 3 miles, and would be about 25 feet deep at the dam. The lake would be confined by low, partially timbered slopes. The 162 miles of shore line, markedly extended by numerous bays, small coves, and points would provide excellent access areas for fishermen from well-serviced county and township roads.

It is expected that populations of game fishes such as crappies, sunfishes, largemouth bass and catfish, could be developed in the reservoir. The rate of fish growth would be good since the moderately fertile lake water would provide ample fish food. It is assumed that any pollution resulting from municipal and industrial development around Rend Lake would be rigidly controlled.

Extended areas of shallow waters protected from the wind, particularly in the bays, would support vegetation adequate for fish spawning and cover. The bottom conditions would be suitable for most nest-builders. Siltation and water level fluctuations may at times adversely affect spawning success; however, a series of poor spawning years in succession is highly unlikely. During the expected life of the lake, a good population of harvestable pan fishes is anticipated.

A large, rough-fish population, including carp, bullheads, freshwater drum, buffalo fish and gizzard shad would develop in Rend Lake. Control of these undesirable fishes would be necessary in order to maintain good fish populations.

Loss of the warm-water stream fishery within the reservoir area would be largely offset by improvement of the stream fishery below the dam as a result of stabilization of flow, maintenance of a minimum discharge and development of a tailwater fishery. Fishing pressure in the tailwaters would be heavy.

The net annual fishery benefit attributable to Rend Lake would be approximately $254,000.

WILDLIFE SECTION

Without-the-Project

The project area contains good quality, terrestrial wildlife habitat. There are approximately 14,000 acres of mixed hardwood timber in the bottoms. Much of this timber is mast-producing trees which are used intensively by fox and gray squirrels. Permanently wet and generally inaccessible, the bottomlands also support high populations of raccoons, opossums, red and gray foxes. On the upland slopes, the timbered edges, oak-hickory woodlots, brush-covered ravines and small field borders provide excellent quail, dove and rabbit habitat. Deer are present and increasing in numbers.

Even though the bottom-land habitat supports a good wildlife population, hunting pressure in the bottoms is low. This phenomenon, while difficult to explain, is apparently due to the fact that the extensive and somewhat dense monotype cover in the Big Muddy bottoms does not appeal to the average hunter and therefore he has little desire to hunt there even though it is well known that desirable game species are abundant. For the most part, hunters are largely local residents who hunt the uplands primarily and rarely are hunters attracted to the project area from the larger communities.

Although the Big Muddy bottoms are usually too wet for cultivation, aquatic habitat is lacking. Muskrat production is limited by poor bank-den conditions and fluctuating water levels caused by frequent late winter and spring floods. Mink are scarce. Local farm boys engage in the limited trapping for muskrats and minks.

Generally, there is little use made of the proposed Rend Lake area by waterfowl other than nesting wood ducks, although there is some jump shooting. When floods occur during the spring migration period, intensive use, particularly by mallards, is made of the flooded timber flats. This condition rarely occurs during the hunting season but when it does, the hunting pressure is heavy.

With-the-Project

Approximately 19,000 acres of bottom-land habitat supporting several species of upland game as well as terrestrial fur animals and deer would be lost as a result of permanent inundation at normal pool level. This habitat cannot be replaced in kind or its loss mitigated by any practical modification of reservoir operation. In many respects it is unfortunate that such a large block of bottom-land wildlife cover, even though currently little used by hunters, must be lost. One redeeming feature, however, is the fact that both above and below the reservoir area the Big Muddy bottoms contain similar cover types for many miles.

Notwithstanding the terrestrial wildlife habitat losses, waterfowl and to a lesser extent aquatic fur animals, would measurably benefit by the construction of Rend Lake.

The impoundment would be attractive to waterfowl. It is strategically located along major flight paths and it lies in an area climatically suited to wintering waterfowl, especially geese. The large water surface acreage would serve as a natural refuge for resting waterfowl even during periods of hunting activity. The Crab Orchard

National Wildlife Refuge is only 25 miles away. Federal and State refuges and public shooting areas are located on the Illinois and Mississippi Rivers and the Union County and Horseshoe Lake Conservation Areas lie to the south.

Although natural waterfowl foods may develop in the shallow bays and the adjacent cultivated fields would provide grain-crop foods, the food supply would be limited and, in effect, would restrict waterfowl use of Rend Lake to a relatively short period. During this period, however, use of the reservoir by waterfowl hunters would greatly exceed the without-the-project use.

Rend Lake would not provide valuable waterfowl production habitat although wood ducks would continue to nest in the remaining areas of timber adjacent to the pool.

Only nominal use of the lake would be made by mink and muskrats. Preferred foods, especially for muskrats, would be in short supply. Although it is doubtful that either mink or muskrat populations would substantially increase, it is expected that more of these furbearers would be harvested by trappers than are currently being taken from the river.

The net annual wildlife benefit attributable to Rend Lake would be approximately $13,000. This benefit is based primarily on the anticipated increased use of the area by waterfowl and waterfowl hunters.

DISCUSSION

Construction of the Rend Lake Reservoir would result in significant fishery and waterfowl benefits, slight aquatic fur animal benefits and moderate upland wildlife habitat losses.

Although the total acreage of wildlife habitat which would be inundated is large, its loss would not seriously reduce the upland game and deer hunting pressure in the project area. Nevertheless, all lands acquired in fee above the normal pool elevation of 405.0, except for areas specifically designated for other public purposes should be made available to the Illinois Department of Conservation for wildlife management purposes in order to offset the terrestrial wildlife habitat losses.

In view of the potential public use of Rend Lake, conflicts between fishing, hunting, industrial development, general recreation, park development, power boating, water skiing, etc., doubtless would occur. These conflicts may best be resolved through zoning, an accepted practice on many natural lakes and Federal reservoirs.

Zoning can be accomplished in many ways; on an area basis, on a time of day basis, or by specific use restrictions. For example, selective clearing, a means of zoning, would make portions of the lake more attractive to fishermen and hunters. Water skiers and power boats cannot use areas of submerged and standing timber which provide a productive place for fishing and waterfowl hunting.

Establishment of mutually acceptable objectives in regard to reservoir clearing, zoning and hunter and fisherman access could

best be accomplished through joint discussions by representatives of the agencies concerned. Agreements as to use should be established prior to the initial impoundment but subject to later modifications as conditions and developments warrant.

Of grave concern to us is the potential pollution problem presented by the existing oil wells that lie within the reservoir area. It is our understanding that the mineral rights will either be acquired or subordinated so that no oil wells would be in operation within the reservoir area. If this understanding is not correct, a revision of our analysis of project effects on fish and wildlife resources would be required. Also, oil holding pools and waste pits should be filled prior to impoundment and extreme care should be taken to prevent oil or wastes from wells adjacent to the reservoir area from reaching the pool through natural drainage ways.

The foremost fishery problem would be the control of rough fishes. Carp, in particular, would be an abundant nuisance. Reasonable control of undesirable fishes could be effected through a combination of annual seining, periodic chemical treatment, manipulation of water levels during the spawning periods of rough fishes and commercial fishing.

It has been stated that the reservoir itself and the adjacent lands would lack the food supply necessary to hold large concentrations of waterfowl for very long. However, the greatest wildlife potential of Rend Lake lies in the possibilities it presents for development and management for waterfowl.

The parts of the reservoir which appear to provide the greatest opportunities for waterfowl development and management are the East and West Arms in the upper end of the project area and the Gun Creek Arm on the east side.

Construction of subimpoundments and the appropriate water level manipulation in both the East and West Arms would provide good conditions for the growth and utilization of natural duck foods and would make the entire reservoir much more attractive to ducks. Management of available uplands adjacent to these subimpoundments would increase their attractiveness.

The Gun Creek Arm would furnish the basic requirements for a goose management area without the necessity of a subimpoundment structure; provided that sufficient additional lands beyond those proposed to be acquired could be made available.

Generally, management of the East Arm and West Arm subimpoundments for ducks would require that their water levels be raised in the fall to flood the existing pin oak timber - thereby making the acorn crop available to ducks. Cultivated food crops could also be produced on open areas and could be flooded along with the timber. After the waterfowl season, water levels in the subimpoundments would be drawn down to equalize with the normal pool of the reservoir below.

This is known as "green-tree" reservoir management and has proved to be a highly successful waterfowl management practice. Flooded timber will accommodate a much higher density of hunters per unit area than any other type of wetland habitat, thus making for

maximum hunter utilization. Also, when necessary and desirable, "green-tree" reservoirs serve as extremely valuable and effective refuges.

Specifically, the physical features and merits of each of the potential management areas are as follows:

1. West Arm

The West Arm of Rend Lake lies upstream from the Chicago and Eastern Illinois Railroad grade, north and west of Nason and due east of Waltonville, Illinois. It includes portions of Rayse Creek and the Big Muddy River.

The area is ideally suited for waterfowl development. It embodies nearly level lands, largely timbered, which can readily be flooded. There are no roads, railroads or important utility lines that would be adversely affected by the subimpoundment.

At normal pool elevation approximately 560 acres of river bottomland would be permanently impounded above the subimpoundment dike and control structure. (See Map) Characteristics of the river valley above the proposed structure include a broad, nearly flat flood plain on both sides of the river, a relatively narrow, entrenched channel, and moderately high bluffs on each side of the valley.

There would be approximately 3,000 acres of land acquired for primary project purposes above the proposed structure. Well over half of this acreage is now timbered.

It is proposed to manipulate water levels in the subimpoundment between elevations 405.0 and 410.0. There are about 900 acres of land between these two contours on which water levels would be controlled. Most of this area is timbered and contains a high percentage of oaks. Between elevations 410.0 and 415.0 there are an additional 1,600 acres of land, some of which could be cultivated to furnish supplemental food for waterfowl.

The scheme of development includes construction of a dike with a crest at elevation 415.0, containing a wide uncontrolled notch at elevation 410.0 and gated conduits set approximately at stream bottom elevation.

Examination of existing hydrologic information regarding availability of inflow in the fall of the year reveals that on some occasions it would not be possible to fill the subimpoundment completely up to elevation 410.0. To supplement flow during those years when the natural runoff is not sufficient to permit the optimum flooding of about 6 inches per week, additional water could be pumped from Rend Lake into the subimpoundment at relatively low cost.

Prior to and during the hunting season, gradual flooding of 900 acres of timber and seeded lowlands available between elevations 405.0 and 410.0 would provide optimum feeding conditions for ducks. The entire Rend Lake area would benefit through increased waterfowl utilization.

Hunter use of the subimpoundment area would greatly exceed the use which the area would otherwise provide.

2. East Arm

The East Arm lies north and east of Nason and due west of Bonnie, Illinois. It would include the extreme upper northeast prong of Rend Lake Reservoir which, when impounded to elevation 405.0 would permanently inundate about 300 acres of the flood plain of Casey Creek.

The general terrain, current land use and stream characteristics of the East Arm are similar to those already described for the West Arm. The East Arm subimpoundment has the same waterfowl development and management potential as the West Arm. Approximately 2,600 acres of land would be acquired in fee for primary project purposes above the proposed subimpoundment dike. Between elevation 405.0 and 410.0, approximately 1,000 acres of bottomland, most of which is now timbered, could be managed for waterfowl. Between elevation 410.0 and the fee-taking line there are an additional 1,300 acres, some of which could be cultivated to furnish a supplemental waterfowl food supply.

The physical features and operating regimen for this subimpoundment would be essentially identical to those previously described for the West Arm.

3. Gun Creek Arm

The Gun Creek Arm, located north and east of

Whittington, Illinois includes that portion of the Rend Lake Reservoir which lies upstream from the State Highway #37 crossing. The highway right-of-way would serve as a natural point of separation between the main reservoir and the management area.

This particular area has outstanding potential for Canada goose management. It lies in the path of established migration routes and within the ancestral wintering area for Canada geese. It is within a short flight distance from well established wintering flocks on Federal and State refuges. The uplands surrounding the permanent pool are largely cleared and relatively flat agricultural lands well suited to growing the forage and grain crops necessary to attract and hold geese during the fall and winter. The permanent water area is sufficient to accommodate large numbers of resting geese. The general area is surrounded by township roads which would provide well-defined and easily maintained boundaries and which could also serve as buffer strips between the management area and adjacent privately-owned land.

Experience has shown that development of an attractive, managed facility in an area that is traversed by geese or is adjacent to presently used migration routes, will quickly be discovered and used by these birds. This process can be assisted through use of proven management techniques such

as the establishment of a captive goose flock on the newly developed area. The captive flock will "decoy" wild birds into the management area which, in turn, provides protection, water, food, and resting areas for the migrants. In this way a tradition of use is established on the area by these birds and their young in succeeding years.

However, a successful goose management area must be large enough to provide an inviolate refuge area and buffer zone wherein the birds can be free from harassment by hunters. Approximately 1,900 acres of land would be acquired in fee above the highway fill including the 350 acres which would be inundated at normal pool elevation. This acreage, unfortunately, is not adequate to provide a manageable goose refuge in conjunction with a public goose hunting unit.

The attached map of the Gun Creek Arm delineates a suggested goose management area boundary which includes about 5,700 acres above the state highway crossing. The boundary includes roughly 3,800 acres of land in excess of that which would be purchased for primary project purposes. Management plans call for maintaining the entire 5,700-acre goose area as an inviolate refuge at least until a sizeable goose flock is established and there is reasonable assurance that portions of the area can safely be opened to controlled hunting.

We are convinced that if the necessary additional land could be acquired, the Gun Creek Arm would serve a useful purpose in the overall goose management program of the Mississippi Flyway. Certainly it will provide additional goose hunting opportunities for the people of the Rend Lake area, thereby increasing the overall value of the entire reservoir area.

We wish to emphasize at this point that the proposed goose management area boundary should be considered reasonably flexible. The time available to us to consider this project did not permit a detailed determination of the absolute minimum acreage necessary to provide a practical management unit. For this reason, the boundary indicated on the map is somewhat arbitrary and subject to revision if it is found to include substantial and costly developments.

However, the outstanding potential of the Gun Creek Arm for Canada goose management makes it imperative, in the interest of complete and balanced water resource development planning, to explore every available avenue leading to the realization of this potential.

There is one more very important item with regard to the proposed East Arm and West Arm subimpoundments. The presence of the bottom-land timber, particularly the oaks, is the basis for the waterfowl development and management potential of each of these areas

and it is upon this base that the monetary benefits contained in this report must stand. Should the Rend Lake Reservoir be authorized and funded for construction, the lands within these two management units should be acquired immediately to forestall the removal of the bottom-land timber by current landowners.

These three proposed wildlife management units would increase materially the net annual wildlife benefits of Rend Lake Reservoir. Without the development and management of these units, the annual benefit would be $13,000. If the West Arm and East Arm units are developed, primarily for ducks, the net annual wildlife benefit of the reservoir would be $58,000. If only the Gun Creek Arm is developed, the net annual benefit would be $35,500. The overall net annual wildlife benefit with all three units developed and managed for ducks and geese would amount to $80,500. (Table II.)

Table II

REND LAKE RESERVOIR, ILLINOIS

Summary of Annual Wildlife Values

Group	Without the Project	With the Project							
		Undeveloped		With East & West Arms		With Gun Cr. Dev.		With All Developments	
		Value	Diff.	Value	Diff.	Value	Diff.	Value	Diff.
Big Game	$ --	$ --	$ --	$ --	$ --	$ --	$ --	$ --	$ --
Upland Game	3,500	0.	-3,500	0.	-3,500	0.	-3,500	0.	-3,500
Fur Animals	--	1,500	+1,500	1,500	+1,500	1,500	+1,500	1,500	+1,500
Waterfowl									
Ducks	--	15,000	+15,000	60,000	+60,000	15,000	+15,000	60,000	+60,000
Geese	--	--	--	--	--	22,500	+22,500	22,500	+22,500
Total	$ 3,500	$16,500	+$13,000	$61,500	+$58,000	$39,000	+$35,500	$84,000	+$80,500

APPENDIX A

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APPENDIX A

In addition to an analysis of the Rend Lake project as described in the Project Plan section of the preceding Substantiating Report, we have been requested to briefly discuss the effects of the project if it were to be operated with the normal pool at elevation 410.0. Under this plan of operation, all other physical features of the project (height of dam, spillway crest elevation, outlet works, etc.) would remain the same. Operated in this manner, the normal pool would inundate 24,800 acres and only valley storage would be available for flood control.

In our opinion, the larger reservoir which would thereby be maintained would not result in a significant increase in utilization by fishermen. The net annual fishery benefit estimated for the reservoir, if operated with a 405.0 normal pool, would remain unchanged.

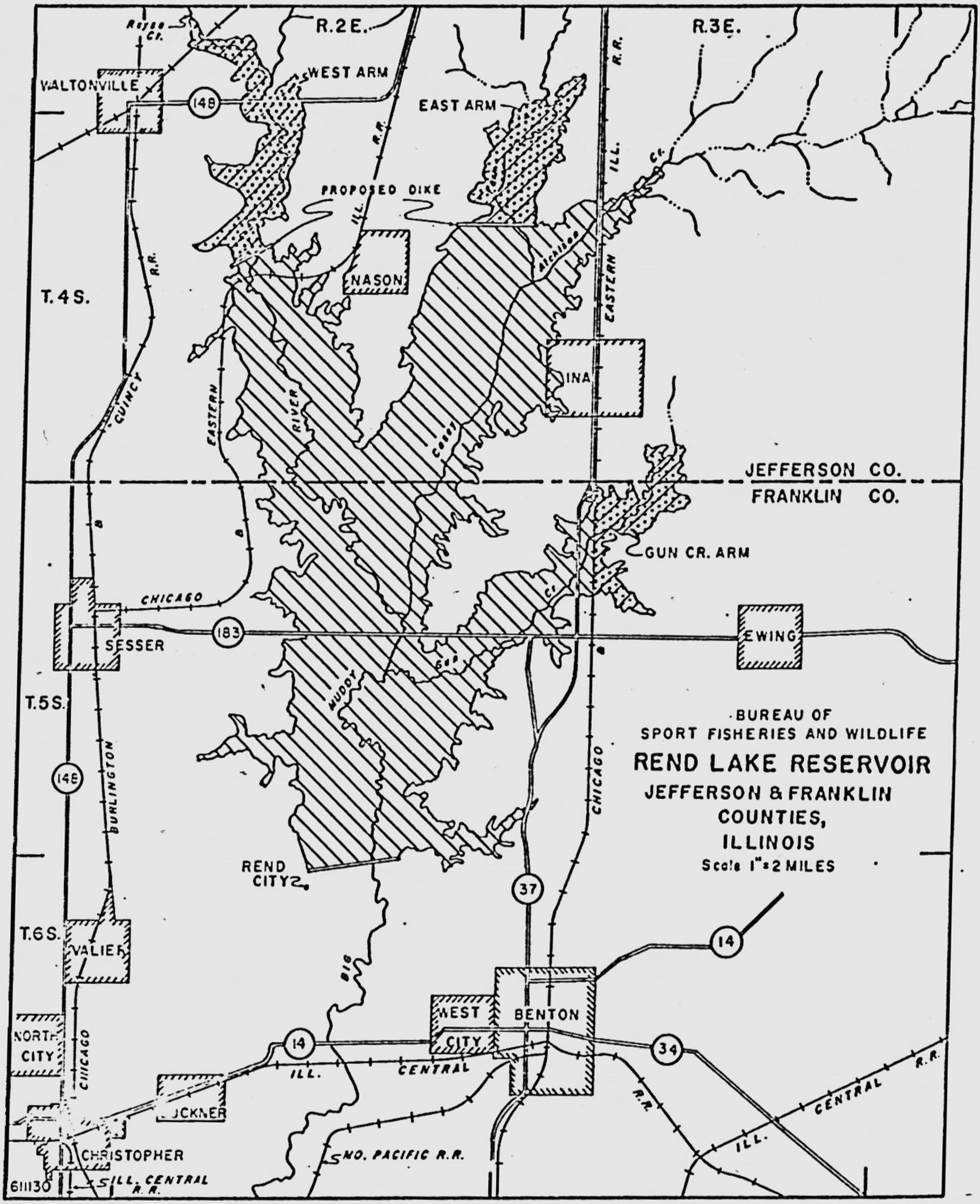
On the other hand, operation of the normal pool at elevation 410.0 would have a pronounced effect on the waterfowl development potential of the project. Specifically, it would eliminate the opportunity for development and management of the East Arm and West Arm subimpoundments.

At elevation 410.0 almost all of the bottom-land timber in these two arms would be permanently inundated. There are no practical means of keeping the waters of the reservoir out of this timber during the growing season except by continual pumping, the cost of

which would be prohibitive. Although there is some timber above elevation 410.0, and also cleared lands which could be planted to waterfowl foods and flooded, the controlling elevations on certain upstream highway and railroad grades would preclude the operation of subimpoundments significantly above elevation 410.0.

Operation of the normal pool at elevation 410.0 would not result in any change in the goose management opportunities presented by the Gun Creek Arm.

Therefore, the net annual wildlife benefit with this schedule of operation in effect would be $13,000 with no waterfowl developments and $35,500 with the Gun Creek Arm developed and managed for geese.


BUREAU OF
SPORT FISHERIES AND WILDLIFE
REND LAKE RESERVOIR
JEFFERSON & FRANKLIN
COUNTIES,
ILLINOIS
Scale 1" = 2 MILES
R.2E.
R.3E.
T.4S.
T.5S.
T.6S.
WALTONVILLE
WEST ARM
EAST ARM
PROPOSED DIKE
NASON
INA
JEFFERSON CO.
FRANKLIN CO.
GUN CR. ARM
SESSER
EWING
REND CITY
VALIER
NORTH CITY
WEST CITY
BENTON
BUCKNER
CHRISTOPHER
CHICAGO
BURLINGTON
QUINCY
EASTERN
ILL. CENTRAL
MO. PACIFIC R.R.
RIVER
MUDDY
BIG
148
183
37
14
34
611130

LETTER FROM

STATE OF ILLINOIS DEPARTMENT OF CONSERVATION

Exhibit 6

State of Illinois
Department of Conservation
Springfield

December 27, 1961

Alfred J. D'Arezzo, Colonel, CE
District Engineer
U. S. Army Corps of Engineers
420 Locust Street
St. Louis 2, Missouri

Dear Colonel D'Arezzo:

Re: Rend Lake Reservoir, Illinois, U. S. Fish and Wildlife Service Report

The State of Illinois Department of Conservation wishes to concur in the report prepared by the Bureau of Sport Fisheries and Wildlife, Region 3, Minneapolis, Minnesota. This report is on Rend Lake Reservoir, Illinois, entitled "A Special Report on Fish and Wildlife Resources, December 1961". This Department has worked with and assisted the U. S. Fish and Wildlife Service in preparation of the report and wishes to concur fully in its recommendations.

Respectfully,

/s/ William T. Lodge

William T. Lodge
Director

EXHIBIT 6

REND LAKE RESERVOIR, ILLINOIS

Information called for by
Senate Resolution 148, 85th Congress
adopted 28 January 1958

SECTION I - REND LAKE RESERVOIR

1. PROJECT DESCRIPTION AND ECONOMIC LIFE

a. Description. The Rend Lake Dam and Reservoir would be located on the Big Muddy River approximately 104 miles above its mouth. The dam consists of a compacted earth embankment with an uncontrolled spillway and outlet channel. Total storage in the reservoir is 302,500 acre-feet. The reservoir would be operated for flood control, water supply, low flow augmentation in the interest of sanitation in the Big Muddy River, fish and wildlife conservation and recreation.

b. Economic life. In the project analysis, an economic life of 100 years was used.

2. PROJECT COSTS AND BENEFITS

First costs of $30,400,000, exclusive of preauthorization study charges, are detailed in appendix B to the survey report. Average annual benefits attributable to the Rend Lake Reservoir under the recommended plan of operation are equal to $1,675,000. Based on an average annual charge of $1,075,300, determined by applying the principles of EM 1120-2-104 to cost allocations of the separable cost - remaining benefits method, Rend Lake Reservoir has a benefit-cost ratio of 1.6 to 1.

SECTION II - ALLOCATION AND APPORTIONMENT OF COSTS

3. GENERAL

Cost allocations have been made on the basis of a 100-year economic life and on the basis of: (1) separable costs - remaining benefits method as used in the survey report and detailed in appendix B; (2) priority of use method; (3) incremental cost method. Cost allocations for the priority of use method and the incremental cost method are summarized below and presented in exhibit A attached hereto. Preauthorization costs have been excluded in the allocation of costs summarized in the following tables.

4. ALLOCATION OF COSTS

Cost allocations for the project purposes are shown below. A construction period of 3 years was assumed for the recommended plan. Amortization of the investment was computed on the sinking fund basis of 2 5/8 percent for an assumed life of 100 years.

Table 1
Cost allocations in thousands of dollars

Purpose	First costs		O and M including major replacements	
	Priority of use	Incremental cost	Priority of use	Incremental cost
Flood control	$6,550	$2,834	$23.3	$13.7
Water supply	8,818	1,275	-	8.7
Pollution abatement	1,953	356	3.0	3.2
Fish and wildlife	990	990	14.0	14.0
Recreation	2,424	2,424	47.7	47.7
Area redevelopment	9,665	22,521	-	0.7
Total	$30,400	$30,400	$88.0	$88.0

5. APPORTIONMENT OF COSTS

Based on the foregoing allocations, apportionment of costs has been made between the United States and local interests. Storage allocated to water supply would be reimbursed by the water users. The costs allocated to fish and wildlife conservation, excluding costs of subimpoundments proposed by the U. S. Fish and Wildlife Service, have been apportioned equally between Federal and non-Federal interests in recognition of the national aspects. Project cost allocated to recreation in the amount of 15 percent of the total project costs, plus the cost of facilities and lands provided under Section 4, Flood Control Act of 1944, have been assigned to the Federal Government. The remainder of the costs allocated to recreation have been assigned to non-Federal interest. Apportionment of costs for the two methods of allocation are shown in the following table:

Table 2
Apportionment of costs in thousands of dollars

Purpose	First costs		O and M including major replacements	
	Priority of use	Incremental cost	Priority of use	Incremental cost
Federal				
Flood control	$6,550	$2,834	$23.3	$13.7
Pollution abatement	1,953	356	3.0	3.2
Fish and wildlife	990	990	14.0	14.0
Recreation	2,424	2,424	47.7	47.7
Area redevelopment	9,665	22,521	-	.7
Subtotal	$21,582	$29,125	$88.0	$79.3
Non-Federal				
Fish and wildlife	-	-	-	-
Recreation	-	-	-	-
Water supply	8,818	1,275	-	8.7
Subtotal	$ 8,818	$ 1,275	$ -	$ 8.7
Total Federal/Non-Federal	$30,400	$30,400	$88.0	$88.0

EXHIBIT A

ALLOCATION OF COSTS

REND LAKE RESERVOIR

Allocation by priority-of-use method (100-year life basis)

Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

	Flood control		Water supply		Pollution abatement		Fish, wildlife & recreation	Fish and wildlife	Recreation		Area re-development		Total
Allocation of annual charges													
Benefits	$216,500		$300,700		$60,600		$848,100	$312,000	$536,100		$285,100		$1,711,000
Alternate costs	784,300		472,500		601,200		878,300				285,100		3,021,400
Justifiable expenditures	216,500		300,700		60,600		848,100	312,000	536,100		285,100		1,711,000
Specific costs	---		---		---		162,400	43,200	119,200		---		162,400
Remaining justifiable expenditures	216,500		300,700		60,600		685,700	268,800	416,900		285,100		1,548,600
Allocated remaining costs	216,500		260,100		60,600		---				285,100		822,300
Total allocation, economic costs	$216,500		$260,100		$60,600		$162,400	$43,200	$119,200		$285,100		$984,700
Taxes foregone	---		---		---		---				---		---
Total allocation, project costs	$216,500		$260,100		$60,600		$162,400	$43,200	$119,200		$285,100		$984,700
Benefit-cost ratio	1.00		1.16		1.00		5.22	7.22	4.50		1.00		1.74
Allocation of O & M costs													
Justifiable expenditure	$22,600		$19,000		$18,000		$33,400	$14,000	$19,400		---		$93,000
Specific costs	---		---		---		33,400	14,000	19,400		---		33,400
Remaining justifiable expenditures	22,600		19,000		18,000		---				---		59,600
Allocated remaining costs	22,600		---		3,000		---				---		25,600
Total allocation, O & M costs	$22,600		---		$3,000		$33,400	$14,000	$19,400		---		$59,000
Allocation of major replacement costs													
Justifiable expenditures	$700		$700		$700		$30,000	---	$30,000		---		$32,100
Specific costs	---		---		---		28,300	---	28,300		---		28,300
Remaining justifiable expenditures	700		700		700		1,700				---		3,800
Allocated remaining costs	700		---		---		---				---		700
Total allocation, major replacement costs	$700		---		---		$28,300	---	$28,300		---		$29,000
Allocation of investment													
Annual investment	$193,200		$260,100		$57,600		$100,700	$29,200	$71,500		$285,100		$896,700
Allocated investment	$6,807,800		$9,165,100		$2,029,600		$3,548,400	$1,028,900	$2,519,500		$10,046,100		$31,597,000
Allocation of construction expenditures													
Specific investment	---		---		---		$3,545,900	$1,026,900	$2,519,000		---		$3,545,900
Investment in joint-use facilities	$6,807,800		$9,165,100		$2,029,600		2,500	2,000	500		$10,046,100		28,051,100
Interest during construction on joint-use facilities	257,900		347,200		76,900		100	100	---		380,600		1,062,700
Construction expenditures in joint-use facilities	6,549,900		8,817,900		1,952,700		2,400	1,900	500		9,665,500		26,988,400
Percent of construction expenditures in joint-use facilities	24.27		32.67		7.24		0.01	---	---		35.81		100.00
Construction expenditures in specific facilities	---		---		---		3,411,600	988,000	2,423,600		---		3,411,600
Total construction expenditures	$6,549,900		$8,817,900		$1,952,700		$3,414,000	$989,900	$2,424,100		$9,665,500		$30,400,000

Allocation by incremental cost method (100-year life basis)

Rend Lake Reservoir - multiple-purpose for flood control, water supply, pollution abatement, fish and wildlife conservation, recreation, area redevelopment

	Flood control		Water supply		Pollution abatement		Fish, wildlife, & recreation	Fish and wildlife	Recreation		Area re-development		Total
Allocation of annual charges													
Benefits	$216,500		$300,700		$60,600		$848,100	$312,000	$536,100		$285,100		$1,711,000
Alternate costs	784,300		472,500		601,200		878,300				285,100		3,021,400
Benefits limited by alternate costs	216,500		300,700		60,600		848,100	312,000	536,100		285,100		1,711,000
Separable costs	97,300		46,300		13,700		162,400	43,200	119,200		---		319,200
Remaining costs	119,200		254,400		46,900		685,700	268,800	416,900		285,100		1,391,300
Allocated joint costs	---		---		---		---				599,700		599,700
Total allocation, economic costs	$97,300		$46,300		$13,700		$162,400	$43,200	$119,200		$599,700		$919,400
Savings in unemployment compensation	---		---		---		---				65,300		65,300
Total allocation, project costs	$97,300		$46,300		$13,700		$162,400	$43,200	$119,200		$665,000		$984,700
Benefit-cost ratio	2.23		6.49		4.42		5.22	7.22	4.50		0.43		1.74
Allocation of O & M costs													
Separable costs	$13,700		$8,700		$3,200		$33,400	$14,000	$19,400		---		$59,000
Allocated joint costs	---		---		---		---				---		---
Total allocation, O & M costs	$13,700		$8,700		$3,200		$33,400	$14,000	$19,400		---		$59,000
Allocation of major replacement costs													
Separable costs	---		---		---		$28,300	---	$28,300		---		$28,300
Allocated joint costs	---		---		---		---				$700		$700
Total allocation, major replacement costs	---		---		---		$28,300	---	$28,300		$700		$29,000
Allocation of investment													
Annual investment	$83,600		$37,600		$10,500		$100,700	$29,200	$71,500		$664,300		$896,700
Allocated investment	$2,945,800		$1,324,900		$370,000		$3,548,400	$1,028,900	$2,519,500		$23,407,500		$31,597,000
Allocation of construction expenditures													
Specific investment	---		---		---		$3,545,900	$1,026,900	$2,519,000		---		$3,545,900
Investment in joint-use facilities	$2,945,800		$1,324,900		$370,000		2,500	2,000	500		$23,407,900		28,051,100
Investment during construction on joint-use facilities	111,600		50,200		14,000		100	100	---		886,800		1,062,700
Construction expenditures in joint-use facilities	2,834,200		1,274,700		356,000		2,400	1,900	500		22,521,100		26,988,400
Percent of construction expenditures in joint-use facilities	10.50		4.72		1.32		0.01				83.45		100.00
Construction expenditures in specific facilities	---		---		---		3,411,600	988,000	2,423,600		---		3,411,600
Total construction expenditures	$2,834,200		$1,274,700		$356,000		$3,414,000	$989,900	$2,424,100		$22,521,100		$30,400,000