Also issued as
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SANDERS, BIG PINE AND COLLIER CREEKS, TEXAS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED AUGUST 1, 1962, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A REVIEW OF THE REPORTS ON THE SANDERS, BIG PINE AND COLLIER CREEKS, TEXAS, REQUESTED BY A RESOLUTION OF THE COMMITTEE ON PUBLIC WORKS, HOUSE OF REPRESENTATIVES, ADOPTED MAY 21, 1957

FEBRUARY 18, 1963.—Referred to the Committee on Public Works and ordered to be printed with three illustrations

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1963

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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.

IN REPLY REFER TO:

January 31, 1963

Honorable John W. McCormack

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 1 August 1962, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on a review of the reports on the Sanders, Big Pine and Collier Creeks, Texas, requested by a resolution of the Committee on Public Works, House of Representatives, adopted 21 May 1957.

In accordance with Section 1 of Public Law 534, 78th Congress, Public Law 85-624, and Public Law 87-88, the views of the Governor of Texas, the Department of the Interior, and the Public Health Service are set forth in the inclosed communications, together with the reply of the Chief of Engineers to the Secretary of the Interior. The views of the Departments of Agriculture and Commerce, and the Federal Power Commission, together with the reply of the Chief of Engineers to the Secretary of Agriculture, are inclosed also.

Section 203 of the Flood Control Act of 1962 authorizes the project for Sanders, Big Pine and Collier Creeks, Texas, substantially as recommended by the Chief of Engineers subject to the recommendations of the Secretary of the Army and the approval of the President. In the accompanying report the Chief of Engineers recommends construction of the project.

I concur in the recommendations of the Chief of Engineers and the President has indicated his approval in the inclosed letter.

Sincerely yours,

Cyrus Vance

Cyrus R. Vance
Secretary of the Army

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

COMMENTS OF THE PRESIDENT OF THE UNITED STATES

THE WHITE HOUSE
WASHINGTON

January 15, 1963

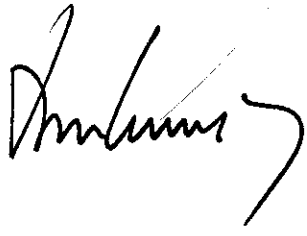
Honorable Cyrus R. Vance
Secretary of the Army
Washington 25, D. C.

Dear Mr. Secretary:

Pursuant to Section 203 of the Flood Control Act of 1962 (Public Law 87-874), your recommendation on construction of the project for Sanders, Big Pine, and Collier Creeks, Texas, has been submitted for my approval.

You have concurred in the recommendation of the Chief of Engineers that the project be constructed as proposed in his report. I hereby approve your recommendation. You are advised that there would be no objection to submission of the report to the Congress.

Sincerely,



COMMENTS OF THE GOVERNOR OF TEXAS

EXECUTIVE DEPARTMENT
AUSTIN 11, TEXAS

PRICE DANIEL
GOVERNOR

April 17, 1962

AIR MAIL

Maj. Gen. Keith R. Barney
Acting Chief of Engineers
United States Army
Washington 25, D. C.

Dear General Barney:

This has further reference to the proposed report of the Chief of Engineers on the Sanders, Big Pine, and Collier Creeks, Texas.

As required by State law, I had this report reviewed by the Texas Water Commission, and a copy of its Order approving feasibility of the project is enclosed. I concur in the Commission finding and urge prompt action by the Department of the Army to secure authorization by Congress at the earliest possible time.

Sincerely yours,

Price Daniel

PD:gs

Enclosure

cc: Hon. Joe D. Carter, Chairman
Texas Water Commission
Capitol Station, Box 2311
Austin 11, Texas

TEXAS WATER COMMISSION

AN ORDER approving the feasibility of the Sanders and Big Pine Creeks Projects, Texas, as proposed in the Interim Report of the Chief of Engineers, United States Army, on Sanders, Big Pine and Collier Creeks, Texas

BE IT ORDERED BY THE TEXAS WATER COMMISSION:

Section 1. Statement of Authority. Article 7472e, Vernon's Annotated Civil Statutes, provides that upon receipt of any engineering report submitted by a Federal Agency seeking the Governor's approval of a Federal Project, the Texas Water Commission shall study and make recommendations to the Governor as to the feasibility of the Federal Project. The Commission shall cause a public hearing to be held to receive the views of persons or groups who might be affected should the Federal Project be initiated and completed.

Section 2. Statement of Jurisdiction. (a) By letter dated March 28, 1962, the Honorable Price Daniel, Governor of Texas, requested the Texas Water Commission to review the Interim Report of the Chief of Engineers, United States Army, entitled Survey Report On Sanders, Big Pine and Collier Creeks, Texas, and to enter its order finding said projects to be feasible or not feasible. (b) In accordance with Article 7472e, the Commission caused a public hearing after due notice by publication, to be held on April 13, 1962, at 2:00 o'clock, P.M., in the offices of the Texas Water Commission, 201 East Fourteenth Street, Austin, Texas, on said Interim Report, and at which time all those interested or who may be affected should the projects recommended in said Report be initiated and completed were requested to come forward and give testimony; the projects recommended in said Report being the Sanders and Big Pine Creeks, Texas, Projects.

Section 3. After fully considering all the evidence and exhibits presented by persons and groups who may be affected should the Sanders and Big Pine Creeks, Texas, Projects be initiated and completed, including the matters set forth in Section 4 of Article 7472e, the Commission finds that said projects are feasible and that the public interest will be served thereby.

Section 4. It is further ordered that a certified copy of the Order be transmitted to the Governor.

Section 5. This Order shall take effect on the 13th day of April, 1962, the date of its passage, and it is so ordered.

SIGNED IN THE PRESENCE OF THE
TEXAS WATER COMMISSION

(SEAL)

/s/ Joe D. Carter
Joe D. Carter, Chairman

ATTEST:

/s/ Ben F. Looney, Jr.
Ben F. Looney, Jr., Secretary

I certify that the foregoing order was adopted by the Texas Water Commission at a meeting held on the 13th day of April, 1962, upon motion of Commissioner Dent, seconded by Commissioner Beckwith, Commissioner Dent voting "aye", Commissioner Beckwith voting "aye", and Chairman Carter voting "aye".

/s/ Ben F. Looney, Jr.
Ben F. Looney, Jr., Secretary

STATE OF TEXAS |
COUNTY OF TRAVIS |

I, Ben F. Looney, Jr., Secretary of the Texas Water Commission do hereby certify that the foregoing is a true and correct copy of an order of said Commission, the original of which is filed in the permanent records of said Commission.

Given under my hand and the seal of the Texas Water Commission, this the 16th day of April, A.D., 1962.

Ben F. Looney, Jr., Secretary

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 Maj. General Barney's letter of March 20 transmitting copies of reports of the Sanders, Big Pine and Collier Creeks Projects, Texas. The report contains recommendations for construction of Pat Mayse Dam and Reservoir on Sanders Creek and Big Pine Reservoir on Big Pine Creek to serve flood control, water supply, recreation, and fish and wildlife purposes. Both streams are right-bank tributaries of the Red River.

The National Park Service recommends that prior to authorization or construction, a comprehensive restudy be made to include justification of the lands and facilities specifically recommended for recreational purposes.

The Bureau of Sport Fisheries and Wildlife is pleased that the project will benefit fishing and, to some extent, water-fowl hunting. It notes, however, that the District Engineer has materially increased the estimates of benefits attributable to fishing and hunting. Benefits rather than losses were assigned to upland-game hunting and an annual benefit was attributed to commercial fishing where none was evaluated by the Bureau of Sport Fisheries and Wildlife. The Bureau believes its estimates were objectively made and that they should not have been altered.

The Bureau is also concerned that its recommendation for the acquisition of land to mitigate project caused losses to wildlife resources was not included as a part of the project plan. The District Engineer found that the recommended acquisition in fee of 2,200 acres of privately owned land does not appear warranted and is not concurred in. We point out that the 2,200 acres of privately owned land is an essential part of a proposed 9,600 acre State wildlife management area which would substantially mitigate the loss of 14,000 acres of big-game and upland-game habitat.

Effective management of the unit would be precluded by private inholdings totaling over twenty percent of the area. The remaining 7,400 acres are now federally owned. Under the Joint-Policies of the Departments of the Interior and of the Army Relative to Reservoir Project Lands, signed February 16, 1962, the 2,200 acres needed for fish and wildlife should

be included as a part of the project lands. The report of the Regional Director, Bureau of Sport Fisheries and Wildlife, includes appropriate justification for the acquisition.

This Department recommends that your report include, as an integral part of the plan for the project, the acquisition in fee of the 2,200 acres of privately owned land needed for mitigation of wildlife losses and that these lands be made available, together with the 7,400 acres of already federally owned lands, to the Texas Game and Fish Commission for wildlife management purposes under the terms of a General Plan as provided for by the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. 661 et seq.).

The opportunity to review this report is appreciated.

Sincerely yours,

Assistant Secretary of the Interior

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

LETTER TO THE SECRETARY OF THE INTERIOR

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

IN REPLY REFER TO

ENGCW-PD

1 August 1962

The Honorable Stewart L. Udall

The Secretary of the Interior

Dear Mr. Secretary:

This will acknowledge the recent letter from the Assistant Secretary of the Interior, commenting on our survey report on Sanders, Big Pine, and Collier Creeks, Texas.

If the proposed reservoirs are authorized by Congress and funds subsequently appropriated for design and construction, you may be assured that the matters of concern to the National Park Service and the Bureau of Sports Fisheries and Wildlife will be carefully considered and fully coordinated with those agencies during preconstruction planning.

Your comments and this reply will accompany my final report to the Congress.

Sincerely yours,

(Signed)

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

COMMENTS OF THE PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE — WASHINGTON 25, D. C.

BUREAU OF STATE SERVICES

June 5, 1962

Refer to:

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 General Barney's letter of March 20, 1962, requesting comments on the U. S. Army Engineers' Report on Sanders, Big Pine and Collier Creeks, Texas.

Water supply and pollution control aspects of this project have been discussed in the Public Health Service report included as Appendix IV of the Report. We have no further comments on those aspects at this time.

With regard to vector control, we recommend:

1. That vector prevention and control measures be incorporated into the design or planning stage of the reservoir projects.

2. That plans for reservoir clearing be concurred in by the Texas State Department of Health.

3. That consideration be given to the following measures in connection with development of recreational areas along the shores of the reservoirs:

   a. Locating recreational areas, particularly those developed for overnight occupancy, along sections where the mosquito potentials are low.

   b. Providing for proper storage, collection, and disposal of refuse for the prevention of flies, wasps, rats, and wild rodents.

   c. Providing for rodentproofed buildings at recreational areas where rodents may create public health hazards.

   d. Providing for periodic removal of debris, rubbish, and other materials which may serve as harborage for rodents and other small mammals.

   e. Providing for removal of brush and weeds along paths, trails, and roadways for the prevention of tick infestations.

f. Providing for supplemental use of insecticides and rodenticides in situations where adequate vector control is not obtained through source reduction measures outlined above.

4. That postimpoundage vector control surveys be conducted to determine what additional measures are needed to provide for adequate public health safeguards.

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,

Keith S. Krause

Keith S. Krause
Chief, Technical Services Branch
Division of Water Supply and
Pollution Control

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D. C.

September 25, 1962

Honorable Cyrus R. Vance
Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Chief of Engineers' letter of March 20, 1962, transmitting for our review and comment his proposed review survey report on Sanders, Big Pine and Collier Creeks, Texas.

The report recommends the construction of two multiple-purpose dams and reservoirs and associated channel improvements for flood control, water supply, fish and wildlife conservation, and recreation. One of the dams would be constructed at the Pat Mayse site on Sanders Creek and would control a drainage area of approximately 112,000 acres of the total of 122,000 acres in the watershed. The other dam would be constructed on Big Pine Creek and would control a drainage area of approximately 61,000 acres of the total of 109,000 acres in the watershed.

The proposed Pat Mayse Reservoir would have a total capacity of 200,800 acre-feet of which 91,600 acre-feet would be for flood control, 101,700 acre-feet for conservation including 99,700 acre-feet for water supply and 7,500 acre-feet for sediment storage. The cost of this reservoir is estimated to be $7,550,000 for construction and $79,700 annually for operation and maintenance. Local interests would be required to reimburse the Federal Government for all costs allocated to water supply.

The proposed Big Pine Reservoir would have a total capacity of 138,000 acre-feet of which 53,600 acre-feet would be for flood control, 80,400 acre-feet for conservation including 79,300 acre-feet for water supply and 4,600 acre-feet for sediment storage. The cost of this reservoir is estimated to be $8,550,000 for construction and $69,000 annually for operation and maintenance. Local interests would be required to reimburse the Federal Government for all costs allocated to water supply.

According to the report the flood control features of the Pat Mayse and the Big Pine Reservoirs would provide a measure of flood protection to 2,100 acres and 4,100 acres of agricultural lands, respectively. The report does not provide specific information on the total area of land which would be required for project purposes. However, data presented in the report indicate that at the top of the flood pools the Pat Mayse and Big Pine Reservoirs would together inundate about 14,350 acres of land. Since the lands in the two watersheds are used principally for crop and livestock production, it would appear that the

acquisition of more than 14,350 acres of land to provide flood protection to approximately 6,200 acres would have significant adverse effects upon the agricultural economy of these watersheds.

This Department has received an application for assistance under the provisions of the Watershed Protection and Flood Prevention Act. Public Law 566, 83d Congress, as amended, from sponsoring local organizations for the Sanders Creek Watershed. However, the development of a project for this watershed is indefinite at this time. We do not have sufficient information to determine if a feasible plan of improvement could be developed for this watershed if the recommended Pat Mayse Reservoir is installed. We suggest, therefore, if the improvements recommended by the Chief of Engineers are authorized, that prior to the initiation of construction, the Corps of Engineers consult with the Soil Conservation Service to determine the status of this potential watershed project.

The U. S. Public Health Service, in response to a request by the Corps of Engineers, conducted investigations to determine the present and prospective water supply needs which could be met by reservoirs on Sanders and Big Pine Creek. The report by the Public Health Service which is appended to the Chief of Engineers' report indicates that the 1960 population of Clarksville, Texas, is 3,311 and the population in the year 2010 is estimated to be 6,000. This report also estimates the water demand for Clarksville to be 0.75 mgd in the year 2010. The Public Health Service's report concludes that although Clarksville has indicated a desire to develop a surface water supply, sufficient water appears to be available from the already contracted-for Langford Creek Project to supply Clarksville's present and prospective demands and, therefore, no economic value is attributable to storage in the proposed Big Pine Reservoir for municipal and industrial water supply.

The Chief of Engineers' report states that the city of Clarksville has furnished a resolution requesting storage in the Big Pine Reservoir to yield 26 mgd. It appears that the 79,300 acre-feet of storage for water supply in this reservoir has been included in response to this request. Irrespective of the conclusion by the Public Health Service that no economic value is attributable to water supply storage in the Big Pine Reservoir, the report estimates that $220,000 or approximately 43 percent of the total average annual benefits used for project justification will accrue from such storage.

Sponsoring local organizations have developed a watershed project for the Langford Creek Watershed. Federal assistance has been authorized under the provisions of Public Law 566 for the installation of the planned works of improvement. The city of Clarksville is a co-sponsor of this project and is to pay for all costs allocated to the provision of 1,118 acre-feet of storage for standby municipal and industrial water supply in a multiple-purpose structure which will be constructed in the

immediate vicinity of the city. This is the Langford Creek Project referred to by the Public Health Service. It is our understanding that the planned water supply storage which is an element of this project will, in conjunction with existing sources, meet the needs of the city in the foreseeable future.

According to the Chief of Engineers' report the provision of water supply storage in the Big Pine Reservoir will be contingent upon assurances by local interests that they will reimburse the United States in accordance with the provisions of the Water Supply Act of 1958, as amended, for the costs allocated to this purpose. These amounts are currently estimated to be $4,131,000 for construction and $20,600 annually for operation and maintenance. The 26 mgd water supply which would be provided by the Big Pine Reservoir is some 35 times the 0.75 mgd estimated by the Public Health Service to be needed in 2010. In view of this and the provision of storage to meet prospective needs which will be included in the Langford Creek Project, it appears that reimbursement by the city of Clarksville for apparently unneeded storage in the Big Pine Reservoir would impose an undue financial burden upon this small city.

In addition to the Langford Creek Project, this Department is providing assistance under the provisions of Public Law 566 to sponsoring local organizations to install watershed improvement measures in the Auds Creek watershed, which is in this same general area. Assistance also is being provided to sponsoring local organizations under the provisions of that Act to develop a watershed project for the Pine Creek Watershed, which is situated between and adjoins the Sanders Creek and Big Pine Creek Watersheds. The works of improvement which are being installed in the Auds and Langford Creek Watersheds and those being planned for the Pine Creek Watershed will provide an adequate level of flood prevention to areas subject to damage throughout these watersheds. Under the provisions of Public Law 566 local interests will be required to provide all lands, easements, and rights-of-way and to assume all costs of operation and maintenance for the structural measures.

However, for the proposed works on the Sanders and Big Pine Creek Watersheds the Chief of Engineers recommends that the Federal Government pay all costs for the installation, operation, and maintenance of the improvements allocated to flood control. Inasmuch as the flood control features of the proposed improvements are similar to those being carried out in adjoining watersheds by local organizations under the provisions of Public Law 566, it would seem appropriate to consider whether local participation should be the same as is required under the provisions of that Act.

Thank you for providing this report for our review.

Sincerely yours,

John A. Baker
Assistant Secretary

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LETTER TO THE SECRETARY OF AGRICULTURE

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

IN REPLY REFER TO
ENGCW-PD

8 November 1962

The Honorable Orville L. Freeman

The Secretary of Agriculture

Dear Mr. Secretary:

This is in reply to the Assistant Secretary of Agriculture's letter of 25 September 1962, commenting on my proposed report on Sanders, Big Pine and Collier Creeks, Texas.

The Assistant Secretary commented to the effect that the acquisition of a total of 14,350 acres for the two reservoirs to provide flood protection to approximately 6,200 acres would have significant adverse effects upon the agricultural economy of these watersheds. With respect to the acreage that would receive flood protection by the Pat Mayse and Big Pine Reservoirs compared to the amount of land inundated at the top of the flood control pools, I would like to point out that only 4,260 acres will be inundated by the storage assigned to flood control. The remaining acreage required is for conservation and sedimentation storage. The conservation pools will be used for municipal and industrial water supply, fish and wildlife, and recreation purposes. The acreage in the flood control pool still can be used for various purposes depending on its frequency of inundation. Some land may be leased back to the original owners and continue in its present usage.

Inclusion of conservation storage in the amounts I have recommended is in keeping with current policies to develop a site to the optimum extent that is economically feasible and to consider anticipated needs in the future. The City of Clarksville has furnished assurances to repay the cost of water supply storage in Big Pine Reservoir suitable for this stage of project development. In addition to strongly supporting the proposal, the Texas Water Commission has indicated that the limited number of reservoir sites in the Red River Basin downstream from Denison Dam highlights the need for consideration of the maximum practical conservation storage being developed on each of the tributaries to the main stem. The Commission has also indicated that if local interests cannot adequately finance such storage, the Commission (formerly the Board of Water Engineers)

is authorized to negotiate for this under the provisions of the Texas Water Planning Act of 1957. In view of the willingness to repay the costs of water supply storage that has been expressed by local interests and the Texas Water Commission, I consider that such storage has definite value for municipal, industrial, and probable water quality control uses and that the value is at least equal to the alternate cost of a single purpose water supply project to provide the proposed yield.

The Assistant Secretary commented that consideration should be given to making the requirements of local cooperation for the two reservoirs in my proposed report the same as that required on flood detention reservoirs which are presently being installed on or planned for adjacent basins under the provisions of Public Law 566. The recommended Pat Mayse and Big Pine Reservoirs would be large reservoirs compared to the structures planned by the Soil Conservation Service and the flood control storage therein would cause some decrease in flood stages on the Red River. Therefore, the flood control effects are not limited to Sanders and Big Pine Creeks. On this basis I consider that full Federal assumption of the costs for flood control storage is consistent with other Corps of Engineers projects of comparable size and having widespread flood control benefits.

You may be assured that the Corps of Engineers will be pleased to consult with the Soil Conservation Service during the advance planning stage of the reservoirs.

Sincerely yours,

(Signed)

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

COMMENTS OF THE DEPARTMENT OF COMMERCE

THE UNDER SECRETARY OF COMMERCE
FOR TRANSPORTATION
WASHINGTON 25

April 13, 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 General Barney's letter of March 20, 1962, I am transmitting herein the comments of the interested Department of Commerce agencies on your proposed report on "Sanders, Big Pine and Collier Creeks, Texas."

The Coast and Geodetic Survey advises that the horizontal and vertical geodetic control in the Pat Mayse Reservoir area are considered adequate for project needs. Horizontal geodetic control also exists near the proposed site of the Big Pine Reservoir. Vertical control is available along the Texas and Pacific Railroad about 12 miles south of the site of the proposed Big Pine Reservoir. If additional control is required in either area or if any existing control monuments should be endangered by the construction of the project, the Coast and Geodetic Survey would appreciate being advised as early as possible.

The Bureau of Public Roads notes that the report contemplates the abandonment of two secondary roads and the relocation of three secondary roads. It appears that the abandonment of the two highways will not seriously affect the transportation service in the project areas. The three roads being relocated will be rebuilt with project funds and it is assumed that they will be reconstructed to standards adequate for the traffic existing at the time the roads are relocated.

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

xx

COMMENTS OF THE FEDERAL POWER COMMISSION

FEDERAL POWER COMMISSION
WASHINGTON 25

May 18, 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 General Barney's letter of March 20, 1962, inviting comments by the Commission relative 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 Sanders, Big Pine and Collier Creeks, Texas.

The cited reports recommend the construction of reservoir projects on Sanders and Big Pine Creeks primarily for flood control and water supply. The proposed Pat Mayse reservoir on Sanders Creek would provide a total storage capacity of 200,800 acre-feet and cost an estimated $7,550,000 for construction. The proposed Big Pine reservoir on Big Pine Creek would provide a total storage capacity of 138,600 acre-feet and would cost an estimated $8,550,000 for construction. The costs of the two projects allocated to water supply would be repaid by local interests.

Studies by the Commission staff show that use of the proposed conservation storages for power purposes would permit the development of continuous power outputs of about 200 kilowatts at the Pat Mayse project and about 135 kilowatts at the Big Pine project. The potential average annual generation at the two projects would amount to approximately 1.6 million and 0.8 million kilowatt-hours, respectively. The studies show that the value of these amounts of power would be substantially less than the costs of the necessary power facilities exclusive of any storage costs.

Accordingly, the Commission concludes that the development of hydroelectric power is not warranted at the reservoir projects proposed in the Sanders, Big Pine and Collier Creeks.

Sincerely yours,

Acting Chairman

SANDERS, BIG PINE AND COLLIER CREEKS, TEXAS

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 1 August 1962

SUBJECT: Sanders, Big Pine and Collier Creeks, Texas

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 response to a resolution of the Committee on Public Works of the House of Representatives, United States, adopted 21 May 1957, concerning the advisability of improvements for flood control, water supply and allied purposes on Sanders, Big Pine and Collier Creeks, Lamar and Red River Counties, Texas.

2. The District and Division Engineers recommend improvement of Sanders and Big Pine Creeks, Texas, by:

a. Construction of a dam and reservoir on Sanders Creek about 4.4 miles above the mouth for flood control, water supply, recreation, and fish and wildlife purposes, at an estimated cost to the United States of $7,550,000 for construction and $79,700 annually for operation, maintenance, and major replacements, subject to certain requirements of local cooperation, including reimbursement of costs allocated to water supply presently estimated at $3,370,000 for construction and $22,500 annually for operation, maintenance, and major replacements; and

b. Construction of a dam and reservoir on Big Pine Creek about 13.2 miles above the mouth for flood control, water supply, recreation, and fish and wildlife purposes, at an estimated cost to the United States of $8,550,000 for construction and $69,000 annually for operation, maintenance, and major replacements, subject to certain requirements of local cooperation, including reimbursement of costs allocated to water supply presently estimated at $4,131,000 for construction and $20,600 annually for operation, maintenance, and major replacements.

3. The Board recommends the proposed works generally in accordance with the plan of the District Engineer, subject to local interests paying all costs allocated to water supply in accordance with the provisions of the Water Supply Act of 1958, as amended, and agreeing to hold and save the United States free from all water-rights claims resulting from construction and operation of the projects.

4. I concur in the recommendations of the Board.

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

24 January 1962

SUBJECT: Sanders, Big Pine and Collier Creeks, Texas

TO: Chief of Engineers
Department of the Army

1. Authority.--This report is in response to the following resolution adopted 21 May 1957:

> 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 Red River and tributaries, Texas, Oklahoma, Arkansas, and Louisiana (Sanders, Big Pine, and Colliers Creek, Texas), published as H. Doc. 602, 79th Congress, to determine whether improvements for flood control, water supply and allied purposes are advisable at this time on Sanders, Big Pine, and Colliers Creek, Lamar and Red River Counties, Texas.

2. Basin description.--Sanders, Big Pine, and Collier Creeks are in Fannin, Lamar, and Red River Counties, Texas, and are right-bank tributaries of Red River.

a. Sanders Creek rises near Honey Grove, Texas, and flows generally northeasterly to Red River at mile 636, about 3 miles above Arthur City, Texas. The basin contains about 190 square miles. The channel is tortuous and choked with brush and timber; it has a slope of about 6.2 feet per mile and a capacity of about 500 cubic feet per second in the lower reach.

b. Big Pine Creek rises about 10 miles northeast of Paris, Texas, and flows generally northeasterly to Red River at mile 585, draining about 170 square miles. The channel, tortuous and choked with brush and timber, has a capacity of about 300 cubic feet per second in the lower reach.

c. Collier Creek rises about 10 miles north of Clarksville, Texas, and flows generally easterly to Red River at mile 571. The channel, with a slope through the lower reach of about 3.7 feet per mile, has a capacity of about 200 cubic feet per second.

3. Economic development.--The Sanders, Big Pine, and Collier Creek watersheds have populations of about 3,000, 2,000, and 600, respectively. The cities of Paris and Clarksville, Texas, which are outside the watersheds, have populations of 20,977 and 3,851, respectively. Although agriculture is the principal occupation in the basins, industries in the surrounding cities contribute to the economy of the general area. These industries include the manufacture of clothing, mobile homes, boats, appliances, chemicals, electrical equipment, building supplies, and processing of agricultural commodities. The Campbell Soup Company has purchased over 500 acres near Paris for a plant which is expected to employ about 3,000 persons.

4. Existing improvements.--There are no existing or authorized Federal improvements for flood control in the three watersheds. The city of Paris has constructed two water-supply reservoirs, Lake Crook and Lake Gibbons, on Pine Creek, which have a combined yield of 9.5 million gallons per day.

5. Floods and damages.--The basins lie in a region subject to heavy rainfall. There are no gaging stations on the streams and estimates of runoff are based on rainfall records and gaging stations in adjacent basins. About five floods a year in the watersheds exceed bankfull capacity by 3 feet. The maximum floods of record on Sanders and Big Pine Creeks occurred in January 1949 and produced peak discharges estimated at 22,800 cubic feet per second at the Pat Mayse Dam site (mile 4.4), and 11,100 cubic feet per second at the Big Pine Dam site (mile 13.2), with volumes of runoff estimated at 48,600 and 25,800 acre-feet, respectively. A recurrence of these floods would cause damages estimated as follows: on Sanders Creek about $30,000, consisting of $12,000 for crop losses and $18,000 for property damages; on Big Pine Creek, $36,000, consisting of $10,000 for crop losses and $26,000 for property damages. The crop losses would be considerably greater should the 1949 flood recur during summer months. The average annual flood damages are estimated at $65,800 and $73,800, respectively.

6. Improvement desired.--At public hearings held by the District Engineer in December 1957, local interests requested reservoirs on Sanders and Big Pine Creeks which would provide storage for flood control and municipal, domestic, and industrial water supply, irrigation, and recreation. They are willing to cooperate in the desired improvements.

7. Plan of improvement.--The District Engineer finds that the most practicable plan of improvement would consist of reservoirs on Sanders and Big Pine Creeks primarily for flood control and water supply. Recreation and fish and wildlife would also be project purposes.

a. Pat Mayse Reservoir. The Pat Mayse Dam would be on Sanders Creek, about 4.4 miles above its mouth, and would control a drainage area of 175 square miles. The dam would be an earth-fill structure about 92 feet high with an uncontrolled concrete-lined chute spillway. The flood-control outlet would consist of a drop-inlet type spillway and conduit. The total reservoir capacity of 200,800 acre-feet would include 7,500 acre-feet for sediment reserve, 91,600 acre-feet for flood control, and 101,700 acre-feet for conservation, including 99,700 acre-feet for water supply. The channel below the dam would be cleared and snagged to increase the capacity to 1,300 cubic feet per second.

b. Big Pine Reservoir. The Big Pine Dam would be on Big Pine Creek, about 13.2 miles above the mouth and would control the runoff from 95 square miles. The dam would be about 77 feet high and similar to that proposed on Sanders Creek. The total reservoir capacity of 138,600 acre-feet would include 4,600 acre-feet for sediment reserve, 53,600 acre-feet for flood control and 80,400 acre-feet for conservation, including 79,300 acre-feet for water supply. The channel below the dam would be improved to provide for a capacity of 800 cubic feet per second.

8. Project evaluation.--The District Engineer reports the economic evaluation of the proposed plans, based on average 1960 price levels and a 100-year period of analysis, as follows:

Item	Pat Mayse Reservoir	Big Pine Reservoir
First cost -		
Federal construction	$4,180,000	$4,419,000
Federal preauthorization studies	40,000	40,000
Non-Federal	3,370,000	4,131,000
Total	$7,590,000	$8,590,000
Annual charges -	$ 301,000	$ 319,000
Annual operation, maintenance, and replacement component	(79,700)	(69,000)
Annual benefits	$ 490,400	$ 506,200
Benefit-cost ratio	1.6	1.6

Costs have been allocated on the basis of the separable costs-remaining benefits method. The costs allocated to water supply would be repaid by local interests. Based on the nature and widespread effects of benefits from recreation and fish and wildlife features the District Engineer considers costs allocated to these purposes to be non-reimbursable. The Public Health Service made a study of water needs, quality, and values. It found need for additional water supply of about 25 million gallons per day in the Sanders Creek area, but no need for additional water supplies in the Big Pine Creek area. Water-supply storages included in the proposed reservoirs would yield an estimated 55 and 26 million gallons per day, respectively, as requested by local interests. The District Engineer considers the requests reasonable, and that the yields would approach the maximum potential development at each site. He recommends construction of the reservoirs on Sanders and Big Pine Creeks, Texas, in accordance with his plans, subject to certain conditions of local cooperation. The Division Engineer concurs.

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

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

10. Views.--The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. The proposed reservoirs operated for flood control, water supply, fish and wildlife conservation, and recreation would afford optimum use of the water resources of Sanders and Big Pine Creeks basins. The plans of improvement presented by the District Engineer are economically justified, with a benefit-cost ratio of 1.6 for each reservoir. The Board notes that improvement for flood control on Collier Creek lacks economic justification.

11. Recommendations.--Accordingly, the Board recommends:

a. Construction on Sanders Creek, Texas, of a multiple-purpose reservoir with dam at the Pat Mayse site, mile 4.4, generally in accordance with the plan of the District Engineer and with such modifications thereof, including reasonable adjustments in the storage capacity for water supply and other purposes, as in the discretion of the Chief of Engineers may be advisable, at an estimated cost of $7,550,000 for Federal construction and $79,700 annually for Federal operation, maintenance, and major replacements: Provided that prior to construction local interests give assurances satisfactory to the Secretary of the Army that they will reimburse the United States in accordance with the Water Supply Act of 1958, as amended, for the first costs and the annual operation, maintenance, and major replacements costs allocated to municipal and industrial water supply storage, these costs being tentatively estimated at $3,370,000 and $22,500, respectively, for the ultimate development;

b. Construction on Big Pine Creek, Texas, of a multiple-purpose reservoir with dam at the Big Pine site, mile 13.2, generally in accordance with the plan of the District Engineer and with such modifications thereof, including reasonable adjustments in the storage capacity for water supply and other purposes, as in the discretion of the Chief of Engineers may be advisable, at an estimated cost of $8,550,000 for Federal construction and $69,000 annually for Federal operation, maintenance, and major replacements: Provided that prior to construction local interests give assurances satisfactory to the Secretary of the Army that they will reimburse the United States in accordance with the Water Supply Act of 1958, as amended, for the first costs and the annual operation, maintenance, and major replacements costs allocated to municipal and industrial water supply storage, these costs being tentatively estimated at $4,131,000 and $20,600, respectively, for the ultimate development; and

c. That prior to construction local interests also be required, with respect to each project, to:

(1) Agree to pay the costs allocated for immediate use of water supply, presently estimated at not less than $1,105,000 for construction and $7,400 annually for operation, maintenance, and major replacements, of the dam and reservoir at the Pat Mayse site, and not less than $1,566,000 for construction and $7,800 annually for operation, maintenance, and major replacements, of the dam and reservoir at the Big Pine site, in accordance with the provisions of the Water Supply Act of 1958, as amended; and

(2) Hold and save the United States free from all water-rights claims resulting from construction and operation of the project.

FOR THE BOARD:

Keith R. Barney

KEITH R. BARNEY
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

S Y L L A B U S

The District Engineer finds a definite need for control of floods and the conservation of water resources on Sanders and Big Pine Creeks, Texas, which can best be met by the construction of reservoirs on those streams. He finds that these projects are economically justified for construction.

The District Engineer finds that there are flood and water conservation problems on Collier Creek, but that construction of improvements on that stream is not justified at this time.

The District Engineer recommends that Pat Mayse Reservoir on Sanders Creek and Big Pine Reservoir on Big Pine Creek be constructed by the United States, provided that local interests repay the cost allocated to water supply storage.

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

1 November 1961

SUBJECT: Sanders, Big Pine & Collier Creeks, Texas - Survey Report

THROUGH: Division Engineer
U. S. Army Engineer Division, Southwestern
Dallas, Texas

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

1. AUTHORITY

This report is submitted in response to resolution of the Committee on Public Works of the House of Representatives, United States, adopted May 21, 1957, which reads as follows:

> "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 Red River and tributaries, Texas, Oklahoma, Arkansas, and Louisiana (Sanders, Big Pine, and Collier Creeks, Texas), published as H. Doc. 602, 79th Congress, to determine whether improvements for flood control, water supply and allied purposes are advisable at this time on Sanders, Big Pine, and Collier Creeks, Lamar and Red River Counties, Texas."

2. EXTENT OF INVESTIGATION

a. The basic investigation was limited to study of improvements for flood control, water supply, and allied purposes on Sanders, Big Pine and Collier Creeks, tributaries of Red River, in Lamar and Red River Counties, Texas, in accordance with the authority quoted above. Preliminary studies of a reservoir on Collier Creek indicated a lack of economic justification. Therefore, no further detailed studies were made of this stream. The detailed field investigations of Sanders and Big Pine Creeks consisted of dam site surveys, stream channel and related surveys, subsurface explorations to determine foundation conditions and availability of construction materials. Office studies consisted of an analysis of the hydrologic and economic data, and the determination of costs and benefits.

b. The District Engineer has inspected the area and discussed the problems and proposed solutions with local interests.

c. The investigation was coordinated with the interested Federal and State agencies, and with local interests. Reports were furnished on municipal and industrial water supply by the U. S. Public Health Service; on fish and wildlife aspects by the U. S. Fish and Wildlife Service, and on irrigation by the Bureau of Reclamation.

d. The Soil Conservation Service, Department of Agriculture, has received an application for assistance under Public Law 566 to plan a program of watershed protection and flood prevention on Sanders Creek watershed and the contiguous Pine Creek watershed. The Service has prepared field examination reports that indicate justification for carrying out works of improvements in the two watersheds. The Pine Creek watershed is not under consideration in this report. No assistance under Public Law 566 has been requested for the Big Pine Creek and Collier Creek watersheds.

3. PRIOR REPORTS

a. House Document No. 602, 79th Congress, 2d Session, published in 1946, is a review report on Red River and Tributaries downstream from Denison Dam. The Chief of Engineers recommended the construction of Boswell, Hugo and Millwood Reservoirs above Fulton, Arkansas, and other reservoirs and improvements downstream from Fulton.

b. Senate Document No. 13, 85th Congress, 1st Session, Development of Water and Land Resources of Arkansas-White and Red River Basins, dated 1957, presents a long-range plan of development which includes land-treatment measures and a number of water-flow retardation structures in the Sanders, Big Pine and Collier Creek areas.

4. DESCRIPTION

a. General features of the Sanders, Big Pine and Collier Creeks watersheds and contiguous areas, located in the West Gulf Coastal Plain section of the Coastal Plain Physiographic Province, are shown on plate I. The topography consists of low rolling hills. The valley lands are used for raising of livestock and growing diversified crops.

b. Sanders Creek watershed, located in Fannin and Lamar Counties, Texas, is 30 miles long, 10 miles in maximum width, and has a drainage area of 190 square miles. Sanders Creek rises near Honey Grove, Texas, and flows in a general northeasterly direction to its confluence with Red River at mile 636, about 3 miles upstream from Arthur City, Texas. The original confluence of the stream with Red River was at a point about one-half mile upstream from Arthur City, but Sanders Creek has been diverted by local interests to its present confluence. The stream channel is tortuous and choked with brush. It has a slope of about 6.2 feet per mile and a capacity of about 500 cfs in the lower reach.

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c. Big Pine Creek watershed, located in Lamar and Red River Counties, Texas, is 24 miles long, averages about 7 miles in width, and contains a drainage area of 170 square miles. Big Pine Creek rises about 10 miles northeast of Paris, Texas, and flows in a generally northeasterly direction to its confluence with Red River at mile 585. The stream slope is about 6.7 feet per mile. The stream channel is tortuous and choked with brush and timber. It has a channel capacity of about 300 cfs.

d. Collier Creek watershed, located in Red River County, Texas, is 11 miles long, 5 miles in maximum width, and contains a drainage area of 36 square miles. Collier Creek rises near Negley, Texas, and flows in an easterly direction to its confluence with Red River at about mile 571. The channel slope through the lower reach is about 3.7 feet per mile. The channel capacity is about 200 cfs.

5. ECONOMIC DEVELOPMENT

a. Population. The Sanders, Big Pine and Collier Creeks watersheds have current populations of about 3,000, 2,000 and 600, respectively. The cities of Paris and Clarksville, Texas, have 1960 populations of 20,977 and 3,851, respectively.

b. Industry, land use and resources. The principal occupation in the three basins is agriculture. Numerous industries in Texarkana, Paris and Clarksville, Texas, and smaller cities in the region contribute to the economy in the general area. These industries include the manufacture of clothing, mobile homes, boats, appliances, chemicals, communications and electrical equipment, concrete building materials, lumber, plumbing supplies, and processing of agricultural commodities that include dairy products, meats, poultry, feed, seed and fertilizer. Natural resources of the basins are water, agricultural lands, timber and minerals, including limestone, gravel, sand and burning clay. Water supply in the area is becoming inadequate for municipal and industrial needs, due to droughts and limited ground water supply. The Campbell Soup Company has purchased over 500 acres in the Paris area for the purpose of building a plant for processing truck crops produced in the vicinity. It is estimated that 3,000 persons will be employed in this enterprise. The reservation of former Camp Maxey was located in the lower part of the Sanders Creek watershed. A portion of the former camp and lands remains in possession of the Federal Government. It has been recommended that all Government-owned land in the former Camp Maxey be retained in Government ownership so long as there is a possibility of Federal construction of a reservoir.

c. Supplemental economic data. Details on population, industry, resources, and trends with respect thereto are included in supplement A to this report.

6. CLIMATOLOGY

The basins lie in a region characterized by long, hot summers and moderate winters. Temperatures range from a high of about 115 degrees Fahrenheit to a low of -5 degrees. The mean average temperature of the region is 64 degrees. Normal annual rainfall is about 42 inches, which is sufficient for agricultural production. The heaviest rainfall usually occurs in the months of April, May and June, with the lowest in August and September. The average annual snowfall, generally of short duration, is about 4 inches.

7. RUNOFF AND STREAM FLOW DATA

There are no stream gaging stations on Sanders, Big Pine, or Collier Creeks. Estimates of runoff and stream flow were based on regional rainfall records and stream gaging stations in adjacent basins. It is estimated that the average runoff from the basin above Pat Mayse Dam site, at mile 4.4 on Sanders Creek, is 122,300 acre-feet per year. This is equivalent to an average flow of about 165 cfs. Estimates indicate the average runoff from Big Pine Creek Basin above Big Pine Dam site at mile 13.2 is 67,680 acre-feet per year. This is equivalent to an average flow of about 92 cfs. Both Sanders and Big Pine Creeks are known to have periods of little or no flow. The periods of no flow are estimated to have occurred in July through December, inclusive, and usually during the months of July, August and September. It is estimated that the average runoff from the basin above the Acworth Dam site (at mile 3.9) on Collier Creek is about 18,500 acre-feet per year. This is equivalent to an average flow of about 25 cfs. The periods of zero stream flow on Collier Creek are estimated to have occurred at about the same time as on Sanders and Big Pine Creeks. Details of estimates of stream flow for Sanders and Big Pine Creeks are presented in appendix I.

8. FLOODS OF RECORD

Floods have been experienced in the watersheds about 10 times per year. Over one-half of the floods exceeded bankfull capacity by approximately 3 feet. The flood of January 1949 produced the greatest depth of flooding and peak discharges at the 3 dam sites and the largest volume of runoff from the watersheds. The floods of November 1957, September 1936 and April 1942 produced the second highest discharge at Pat Mayse, Big Pine and Acworth Dam sites, respectively. Additional data on the experienced floods are presented in appendix I.

9. STANDARD PROJECT FLOODS

The standard project flood applicable to the analyses of flood possibilities and flood control requirements on Sanders Creek has a peak discharge of 84,000 cfs and a total volume of 160,300 acre-feet. This is 3.7 times the peak discharge and 3.3 times the 6-day volume of the maximum flood of record. The standard project flood on Big Pine

Creek has a peak discharge of 59,000 cfs and a total volume of 91,000 acre-feet. This is 5.3 times the peak discharge and 3.5 times the 6-day volume of the maximum flood of record. On each stream, the standard project flood is equivalent to 50 percent of the spillway design flood, and represents a flood that may be expected from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare conditions.

10. MAXIMUM PROBABLE FLOODS

The maximum probable flood is one that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. It is applicable to projects where consideration is to be given to virtually complete security against potential floods. The maximum probable flood estimated to have a possibility of occurrence in the Sanders Creek watershed has a peak discharge of 168,000 cfs, which is 7.4 times the discharge estimated for the maximum flood of record, and a volume of 320,600 acre-feet, which is 6.7 times the volume of the maximum flood of record. The maximum probable flood estimated to have a possibility of occurrence in the Big Pine Creek watershed has a peak discharge of 118,000 cfs and a volume of 181,900 acre-feet, which are 10.6 and 7.05 times the discharge and volume of the maximum flood of record, respectively. These maximum probable floods provide bases for design of the spillways. The derivations of these floods are shown in appendix I.

11. EXTENT AND CHARACTER OF FLOODED AREA

Downstream from the proposed Pat Mayse Dam site, there are 2,100 acres which are subject to flooding along Sanders Creek. Approximately 50 percent of the flood plain is under cultivation, the remainder being used for pasture. Annual gross value of crops is estimated at $98,400, and property subject to flood damage (exclusive of crops) is estimated to have a value of $620,000. Downstream from the proposed Big Pine Dam site, there are 4,100 acres which are subject to flooding along Big Pine Creek. Approximately 34 percent of the flood plain is under cultivation, the remainder being used for pasture. Annual gross value of crops is estimated at $113,300, and property subject to flood damage (exclusive of crops) is estimated to have a value of $916,000. Downstream from the Acworth Dam site on Collier Creek, 500 acres are subject to flooding along the stream. The entire flood plain is used for pasture. Annual gross value of crops is estimated at $8,300, and property subject to flood damage (exclusive of crops) is estimated to have a value of $196,000. The property subject to flood damages in the three basins includes transportation and communication facilities, power lines, rural supplies, stock and equipment, and rural land and improvements.

12. FLOOD DAMAGES

Annual tangible flood damages in Sanders Creek Basin are estimated to amount to $65,800, of which $31,200 are damages to crops. Annual flood damages in Big Pine Creek Basin are estimated to be $73,800, of which $25,710 are damages to crops. The annual flood damages in Collier Creek Basin are estimated to be $2,400, all of which are damages to structures. These data are based on September 1960 prices. See appendix II for additional flood damage data.

13. EXISTING CORPS OF ENGINEERS' PROJECTS

There are no existing or authorized flood control projects in the three watersheds.

14. IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

a. Other Federal agencies. There are no improvements by other Federal agencies in the basins.

b. Non-Federal agencies. The City of Paris has constructed two water supply reservoirs, Lake Crook and Lake Gibbons, on Pine Creek (a tributary of Red River), which have an estimated combined yield of 9.5 mgd.

15. IMPROVEMENTS DESIRED

a. Public hearings were held by the District Engineer at Paris, Texas, on December 9, 1957 concerning Sanders Creek, and at Clarksville, Texas, on December 10, 1957 concerning Big Pine and Collier Creeks. A digest of the hearing records is included in appendix VII. Attendance at the hearings included the United States Representative from the district; State, County and municipal officials; representatives of business, agricultural, industrial and railroad interests; representatives of local civic groups, flood control and conservation organizations; and private interests. At both hearings consideration was requested of reservoirs which would provide storage for flood control and municipal, domestic and industrial water supply, irrigation, and recreation. Local interests have furnished considerable data on flood damages, indicating that past floods have caused serious and extensive damages in the rural areas. Proponents for improvements emphasized that surface water supplies were urgently needed for expected increases in population, industrial development, and irrigation of arable lands in the basins. They strongly urged the construction of flood control works to alleviate flood conditions.

b. Statements presented at the hearings emphasized the inadequacy of existing water supplies. Testimony indicated that the development of reservoirs on Sanders Creek, on Big Pine Creek and on Collier Creek for flood control and water supply purposes is the

primary desire of local interests. Interest was also expressed in the potential recreational and waterfowl and fishery management aspects of reservoirs in the locality. Local interests advised that they had made some preliminary studies of multiple-purpose reservoirs on Sanders, Big Pine and Collier Creeks for flood control, water supply, irrigation, and other purposes.

16. FLOOD PROBLEMS AND RELATED PROBLEMS

a. General. Major floods originating in the Sanders, Big Pine and Collier Creek watersheds cause appreciable damages along those streams and contribute in a minor way to the flood conditions and damages along Red River below Denison Dam. The frequent floods on these creeks and tributaries have retarded agricultural use of the valley lands. Periods of prolonged drought, regional upward trends in population, and expansion of industrial and municipal developments have made evident the increasing need for the conservation of surface runoff for other beneficial purposes in the area.

b. Flood problems:

(1) Sanders Creek. The flood problem on Sanders Creek results from frequent floods caused by heavy and frequent storm rainfall and inadequate channel capacity. During the period from 1934 to 1958, several major floods have occurred, producing peak discharges varying from 11,800 to 22,800 cfs at Pat Mayse Dam site. Sanders Creek has a capacity of 500 cfs at Pat Mayse Dam site. The flood problem area in Sanders Creek watershed investigated for this report covers the flood plain reach extending from Pat Mayse Dam site at mile 4.4 to the mouth.

(2) Big Pine Creek. The flood problem on Big Pine Creek results from frequent floods caused by heavy and frequent storm rainfall and inadequate channel capacity. From 1934 to 1958, several major floods occurred, producing peak discharges varying from 6,900 to 11,100 cfs at Big Pine Dam site. Big Pine Creek has a capacity of 300 cfs at Big Pine Dam site (mile 13.2). The flood problem in Big Pine Creek watershed, investigated for this report, covers the flood plain reach extending from Big Pine Dam site to the mouth.

(3) Collier Creek. The flood problems on Collier Creek were considered only in the initial studies, which indicated unfavorable justification of a plan of improvement on this stream. The flood problem on Collier Creek results from frequent floods caused by heavy and frequent storm rainfall and inadequate channel capacity. From 1934 to 1958, several major floods occurred on Collier Creek, producing peak discharges slightly less than those on Big Pine Creek. Collier Creek has a channel capacity of 200 cfs at Acworth Dam site. The flood problem area in Collier Creek watershed investigated for the initial preliminary study covered the flood plain reach extending from Acworth Dam site to the mouth.

c. Water supply:

(1) A large portion of the area is dependent upon surface water supplies. Part of the ground water supply of the region is highly mineralized and unsuitable for domestic and industrial use. The present water supply for Paris, Texas, is from Lake Crook and Lake Gibbons, about 3 miles north of the city, on Pine Creek, a tributary of Red River. These two lakes have a combined dependable yield of about 9.5 mgd, adequate to meet present needs. However, city interests desire an additional source of water supply to provide for an expected increase in population and expansion of industrial development.

(2) The present water supply for Clarksville is obtained from wells adequate for present need; however, attempts to expand the supply have resulted in pollution of the wells by salt water. New wells do not offer the inducement for industrial development that a visible water supply reservoir would. Consequently, the city is interested in development of a surface water supply.

(3) The U. S. Public Health Service, in cooperation with the Corps of Engineers, has prepared a report covering the needs, values, and quality of water in the watersheds. The report, which is presented in appendix IV, states the following conditions and problems:

(a) The water in Sanders and Big Pine Creeks watersheds is acceptable for municipal and industrial use, with the exception of high iron and manganese concentrations, which can be removed by treatment. In addition, softening appears desirable for Sanders Creek water.

(b) The potential demand area for municipal and industrial water from Sanders Creek is the city of Paris. It is estimated to require about 7 and 25 mgd additional water yields by years 1965 and 2010, respectively. A projected demand of 0.75 mgd for year 2010 for the city of Clarksville can be met from ground water. However, Clarksville has requested the Soil Conservation Service to include storage for municipal water supply in a small reservoir under consideration in connection with a watershed improvement program near the city under authority of Public Law 566. The City has contracted for storage sufficient to yield 1 mgd from the Soil Conservation Service reservoir. There appears to be no demand for water supply storage on Collier Creek.

(c) Pollution problems do not affect the quality of water in the projects under consideration in this study.

(d) The report also contains an analysis of the value of water supply storage in Pat Mayse Reservoir.

d. Power. Electrical energy available in the area is sufficient to meet present needs, but additional sources will need to be developed in the next 50 years.

e. Irrigation. Based on preliminary considerations, the Bureau of Reclamation advised that there is little or no possibility for development of irrigation on the watershed lands. They advised that lands along Red River are well-suited to development for irrigation; however, the repayment capacity of these lands and the cost of irrigation works are such that it is not likely that irrigation would be able to pay for storage. The bureau states that there would not be more than a few hundred acres of irrigable lands along Sanders Creek below Pat Mayse site. They also advised that the lands below Big Pine Dam site have not been classified; however, they are characterized by poor drainage and it is not likely that there would be any sizable areas of land suitable for irrigation. According to the Bureau, an area between Big Pine Creek and Red River, consisting of about 850 acres, has been designated as "arable, needing drainage" and would be suitable for irrigation if adequate drainage is provided.

17. PROJECT FORMULATION

a. General considerations. The investigation of the advisability of improvements for flood control and water supply considered that any project should provide adequate flood protection and optimum water resources development to fulfill existing and future needs of the area. There are no stream gaging stations on Sanders Creek or on Big Pine Creek; therefore, hydrologic data of adjacent areas, for which records are available, were used in determining the flood control needs for the report area. Consideration was given in formulating the projects for flood control and water supply to provide for a maximum of benefits over cost, insofar as possible. Details of economic tests for the various scales of development of flood control and water supply storages are presented in appendix II.

b. Solutions considered. In developing a plan for flood control, consideration was given to all practicable methods of providing the desired flood protection. The construction of levees, channel improvement, and diversion of floodwaters (either within the basins or to adjacent watersheds) were considered but found to be less desirable than development by means of reservoirs. Studies for a reservoir on Collier Creek were discontinued when the project was found to lack economic justification at this time. The only logical plan for providing the desired flood control development involves the use of a multiple-purpose reservoir on Big Pine Creek and another on Sanders Creek. Three reservoir sites (shown on plate I) were considered on Sanders Creek. However, only the site nearest the mouth would provide sufficient storage to meet flood control needs and the water supply requirements of the city of Paris, Texas.

c. Flood control. Flood control benefits are not sufficient to justify flood-control-only reservoirs on either of the streams under study. Accordingly, flood control capacity was considered in conjunction with water supply in multiple-purpose reservoirs on the two streams. Rainfall records and estimates of runoff were used to determine the flood control storage requirements in the Pat Mayse and Big Pine Reservoirs for various degrees of flood protection. Storage requirements were determined by assuming both natural and improved channel conditions below the respective dam sites. It was found that when channel improvement is provided, it is possible to control floods more economically and with less reservoir storage than can be done by a reservoir without channel improvement. On that basis, channel improvement works are included as integral features of the basic flood control plans for the two sites under study. Each plan studied was subjected to tests of economic feasibility designed to reveal the flood control plan which would render a maximum of benefits in relation to costs. Flood control storages subjected to these tests ranged from less to more than those required to control the flood of once-in-50-years occurrence. Also, the degree of flood protection provided was based on pertinent data for stream gaging stations located in adjacent watersheds with similar characteristics. Based on these considerations, it was determined that flood control storage of 91,600 acre-feet in the Pat Mayse Reservoir and 53,600 acre-feet in Big Pine Reservoir (see appendix I) should be provided in the plan of improvement on Sanders and Big Pine Creeks. These storages would provide complete protection from floods with a frequency of occurrence up to once in 50 years.

d. Water supply:

(1) In the development of a water conservation plan for the Sanders and Big Pine Creek watersheds, consideration has been given to future demands for municipal and industrial water supply as estimated by the Public Health Service and the needs for water estimated by local interests. The magnitude of water supply development was determined by subjecting various storage volumes to tests of economic feasibility (see appendix II) and considering hydrologic and hydraulic conditions. In considering water supply storage on Sanders and Big Pine Creeks, it was assumed that such storage would be in addition to flood control storage.

(2) The estimated maximum dependable yield (continuous withdrawal through the most severe drought of record) from Pat Mayse Reservoir on Sanders Creek is 65 mgd when storage in the amount of 172,000 acre-feet is provided. The request by the City of Paris for water supply storage capable of yielding 55 mgd would require 99,700 acre-feet of storage in Pat Mayse Reservoir. This amount of storage is included in the project plan for Pat Mayse Reservoir. Big Pine Reservoir is estimated to have a maximum dependable yield of 31 mgd when 126,000 acre-feet of storage is provided. However, when flood control and sedimentation storage requirements are considered, the

storage available for water supply use is about 79,300 acre-feet. This amount of storage would have an estimated dependable yield of 26 mgd, and would meet the needs indicated by the City of Clarksville. This amount of storage is included in the project plan. The conservation storages included in the Pat Mayse and Big Pine project plans approach the maximum dependable yields of the reservoir sites. These plans are considered reasonable for meeting the foreseeable future demands of Paris and Clarksville.

(3) Alternate means of obtaining water supply for the study area were considered, and the most favorable alternate plan appeared to be from Hugo and Boswell Reservoirs in Oklahoma. The alternate cost of obtaining water from Hugo and Boswell Reservoirs exceeded the cost of storage in the Pat Mayse and Big Pine Reservoirs.

(4) Additional conservation storage at both sites may be needed for long-range water needs. The Public Health Service and the Corps of Engineers are making a study to determine the feasibility of removing natural pollution from Red River Basin. Water quality improvement is possible by storing high-quality surface waters for dilution of tributary and main stem flows. The quantity of water needed from Sanders and Big Pine Creeks for this purpose cannot be clearly determined at this time. Should there be a demand in the future for the maximum potential water yields of the reservoirs, additional storage can be provided by constructing Pat Mayse Dam to a higher elevation. Retention of required flood control storage and increase of the water yield at the Big Pine Dam site would require extensive diking. Additional conservation storage might be developed at upstream locations on Sanders Creek, or by reallocation of flood control storage in both reservoirs to this purpose.

e. Power. The stream yield of Sanders and Big Pine Creeks is too small to support hydroelectric power plants at the dam site. The installation of pump-back power generating facilities around the reservoirs would also be impractical, since the topographic relief would not provide sufficient head for operation of these units.

f. Irrigation. The Bureau of Reclamation, in their preliminary views, concluded that most of the lands suitable for irrigation development by water from reservoirs on Sanders and Big Pine Creeks can also obtain an adequate and more economical water supply by pumping directly from Red River. Therefore, the project plan does not provide for irrigation storage.

g. Multiple-purpose features. The basic development proposed for the Pat Mayse and Big Pine Reservoirs consists of provisions for flood control and water supply. This multiple-purpose combination was found to be more practical from an economic standpoint than single-purpose reservoirs at the respective sites. The proposed plan would also be of significant importance to the area with respect to

recreation and fish and wildlife as a result of the conservation pools provided in the proposed reservoirs.

18. PLAN OF IMPROVEMENT

a. The selected plan of improvement on Sanders and Big Pine Creeks consists of a reservoir on each stream for the primary purposes of flood control and water supply. Recreation and fish and wildlife are also considered as project purposes. The project designated as Pat Mayse Reservoir controls a drainage area of 175 square miles. The reservoir, with dam site at Sanders Creek, mile 4.4, would have a total capacity of 200,800 acre-feet (including 7,500 acre-feet for sediment reserve), with 91,600 acre-feet allocated to flood control, and 101,700 acre-feet allocated to conservation uses (including 99,700 acre-feet for water supply). The dam would be an earthfill structure with an uncontrolled concrete-lined chute spillway. The flood control outlet would consist of a drop-inlet conduit with crest at elevation 448.0. A 42-inch pipe is provided for water supply. The present channel would be cleared and snagged below the dam site to the mouth, as required, to increase the discharge capacity to 1,300 cfs from a present 500 cfs.

b. The plan of improvement on Big Pine Creek consists of Big Pine Reservoir, which controls a drainage area of 95 square miles. The reservoir, with dam site at mile 13.2, would have a total capacity of 138,600 acre-feet (including 4,600 acre-feet for sediment reserve), with 53,600 acre-feet allocated to flood control, and 80,400 acre-feet allocated to conservation (including 79,300 acre-feet for water supply). The dam would be an earthfill structure with an uncontrolled concrete-lined chute spillway. The flood control outlet would consist of a drop-inlet type conduit with crest at elevation 420.0. A 30-inch pipe is provided for water supply. The present channel would be cleared and snagged below the dam site to the mouth, as required, to increase the discharge capacity to 800 cfs from 300 cfs.

c. Basic facilities are provided for public use of each project area, including access roads, parking areas, boat-launching ramps, drinking water, sanitary facilities, and other developments.

19. ENGINEERING DATA

Pertinent engineering features with reference to the plan of improvement on Sanders and Big Pine Creeks are shown in table 1.

TABLE 1

PHYSICAL FEATURES AND ENGINEERING DATA
PAT MAYSE AND BIG PINE RESERVOIRS

Feature	Reservoir	
	Pat Mayse	Big Pine
Stream	Sanders Creek	Big Pine Creek
Miles above mouth	4.4	13.2
Drainage area, square miles	175	95
Purposes	Flood Control, Water Supply, Recreation & Fish & Wildlife	
General elevations, ft, msl:		
Top of dam	487.0	451.0
Top of flood control pool	462.0	430.0
Top of conservation pool	448.0	420.0
Reservoir area, acres:		
Top of flood control pool	7,950	6,400
Top of conservation pool	5,450	4,640
Reservoir storage, acre-feet:		
Flood control	91,600	53,600
Water supply	99,700	79,300
Sediment	7,500	4,600
Inactive	2,000	1,100
Total	200,800	138,600
Dam:		
Type	Earthfill	Earthfill
Gross length, ft	7,010	5,390
Maximum height, ft	92	77
Crown width, ft	28	28
Spillway:	Right abutment	Right abutment
Type	Uncontrolled	Uncontrolled
Width	200	200
Crest elevation, feet, msl	462.0	430.0
Capacity at maximum pool, cfs	55,400	41,400
Outlet works:		
Flood control	5.5' drop inlet	4' drop inlet
Low flow	36" pipe	24" pipe
Water supply	1-42" pipe	1-30" pipe
Channel capacity at dam site, cfs:		
Existing	500	300
Rectified	1,300	800
Water supply yield, mgd	55	26

20. ESTIMATES OF FIRST COST

The estimated first cost for construction of Pat Mayse and Big Pine Reservoirs, based on average 1960 prices, is summarized in table 2.

TABLE 2

ESTIMATED COST

Item	Pat Mayse Reservoir	Big Pine Reservoir
Lands and damages	$ 808,000	$ 810,000
Relocations	243,000	974,000
Reservoir	390,000	336,000
Dam	4,418,900	4,476,300
Roads, railroads and bridges	168,000	231,000
Channels and canals, snagging and clearing	7,200	87,000
Recreation facilities	200,000	200,000
Building, grounds and utilities	163,000	163,000
Permanent operating equipment	57,000	57,000
Preauthorization studies	40,000	40,000
Engineering and design	531,700	586,400
Supervision and administration	563,200	629,300
Total project cost	$7,590,000	$8,590,000

21. ESTIMATES OF ANNUAL COSTS

The estimated annual costs of the reservoir plan are summarized in table 3.

TABLE 3

ESTIMATES OF ANNUAL CHARGES

Item	Pat Mayse Reservoir	Big Pine Reservoir
Interest	$204,300	$230,900
Amortization	17,000	19,100
Operation and maintenance	78,800	68,300
Major replacements	900	700
Total	$301,000	$319,000

22. ESTIMATES OF BENEFITS

a. Flood control benefits. Flood control benefits estimated to accrue from the operation of the two reservoirs would consist of flood losses prevented, including allowances for future development, increase in net return by higher land-use in the flood plain, and land rental benefits from reservoir lands. The two reservoirs would cause some decrease in flood stages on the Red River. However, for the purpose of this study, flood control benefits were not claimed on Red River. Detailed information on the flood control benefits, based on a 100-year period of analysis, is given in appendix II, and summary information follows:

(1) Flood losses prevented. Pat Mayse Reservoir would provide essentially complete protection to crops and structures in the Sanders Creek flood plain below the dam site. The reservoir is credited with preventing annual damages in the amount of $65,200. Big Pine Reservoir provides a high degree of protection on Big Pine Creek and is credited with preventing annual damages in the amount of $68,600.

(2) Future development. During the 100-year period of analysis, average increases of 14 and 19 percent in crop production on Sanders and Big Pine Creeks, respectively, are expected through technological development and cropping practices. It was considered that there would be comparable increases in structural development. Therefore, crop and structural losses prevented were increased by these percentages for determination of future development benefits. The resulting future development benefits amount to $9,100 and $13,000 annually for Pat Mayse and Big Pine Reservoirs, respectively.

(3) Increased land utilization. The flood protection attained by the Pat Mayse and Big Pine Reservoirs will result in change in land-use consisting of increased crop production, a wider latitude in timing of farming operations, and reduction of land erosion by floodwaters. This type of benefit, which would follow flood protection, is reflected in the degree of protection provided by the plan of improvement, and amounts to $13,800 and $24,900 annually for Pat Mayse and Big Pine Reservoirs, respectively.

(4) Land rental benefits. The annual benefits to be derived from land rentals and other leases in the reservoir area are estimated to be $3,000 for Pat Mayse and $2,500 for Big Pine Reservoirs. Since the benefits are primarily from lands in the flood control pool of the reservoirs, they have been considered as flood control benefits.

b. Water supply benefits. As recommended by the Public Health Service, the water supply benefit for the Pat Mayse Reservoir was based on present-day costs of providing a single-purpose water supply reservoir at the proposed site. The alternative cost of a

water-supply-only project, based on non-Federal design and financing, was considered to offer a measure of the water supply benefit. On this basis, the average annual water supply benefit was estimated to be $189,400 for Pat Mayse Reservoir. On a similar basis (although not evaluated by the Public Health Service), the annual water supply benefits for Big Pine Reservoir would be $220,000.

c. Recreational benefits. The inclusion of water supply storage would provide a reservoir pool of 5,450 acres at Pat Mayse Reservoir and 4,640 acres at Big Pine Reservoir. The reservoir would be of widespread recreational importance to the area. It is estimated that the Pat Mayse and Big Pine Reservoirs, respectively, would have 185,000 and 150,000 visitors annually, excluding those participating in sport fishing and hunting activities. At the conservative rate of 50 cents per day, the recreational benefits would be $92,500 at Pat Mayse Reservoir and $75,000 at Big Pine Reservoir. These benefits were credited to the projects, as they are considered of sufficient magnitude to designate recreation as a project purpose.

d. Fish and wildlife benefits. The Pat Mayse and Big Pine projects would replace limited stream fisheries with improved reservoir-type fisheries. The provision of conservation storage would greatly improve the waterfowl habitat, and would greatly increase the opportunities for hunting ducks and geese. Project perimeter lands would provide upland game habitat and would afford opportunities for hunting of certain upland game species. The reservoirs would result in substantial net gains in fish and wildlife resources and would provide a greater diversification of fish and wildlife habitat. By proper management of project perimeter lands, any specific losses of wildlife habitat could be replaced. Significant benefits can be expected from the increased fish and wildlife resources at the project. It is estimated that there would be 100,000 participants in sport fishing, plus 15,000 in hunting waterfowl and upland game, at Pat Mayse Reservoir annually. Similarly, it is estimated that Big Pine Reservoir would attract 90,000 participants for sport fishing and 10,000 for hunting annually. Annual benefits for commercial fishing have been estimated at $2,400 and $2,200 at Pat Mayse and Big Pine Reservoirs, respectively. A conservative value of $1 per visitor day for hunting and fishing and 15 cents per pound, dockside price, for commercial fish harvest were used to estimate the value of the fish and wildlife resources. On that basis, annual fish and wildlife benefits of $117,400 on Pat Mayse Reservoir and $102,200 on Big Pine Reservoir were credited to these projects. These benefits are considered equivalent to the net value of the fish and wildlife resources, evaluated with and without the projects. This method of considering the recreational, harvest, and conservation values of the fish and wildlife resources is believed reasonable and compatible with the provisions of the Fish and Wildlife Coordination Act (Public Law 85-624). These evaluations compare with net benefits of $91,100 and $64,975 (without recommended mitigation measures) estimated by the

Fish and Wildlife Service for Pat Mayse and Big Pine Reservoirs, respectively. Recommendations of the Fish and Wildlife Service in their report (see appendix V), together with the comments of the District Engineer, are summarized in paragraph 28b.

e. Intangible benefits. Other benefits not susceptible to evaluation in terms of an average monetary value would be realized through development of the proposed improvements. Such benefits would include elimination of delays in transportation; enhancement of the general welfare; increase in the value of non-Federal recreational developments; security of the people; and removal of the hazard of epidemics. These benefits would be real and of significant importance to the valley areas.

f. Summary of tangible benefits. Annual average benefits estimated to accrue to the two reservoirs are listed in table 4.

TABLE 4

SUMMARY OF AVERAGE ANNUAL BENEFITS

Item	Pat Mayse Reservoir	Big Pine Reservoir
Flood control:		
Flood losses prevented	$ 65,200	$ 68,600
Future development	9,100	13,000
Increased land utilization	13,800	24,900
Land rentals	3,000	2,500
Subtotal, flood control benefits	91,100	109,000
Water supply	189,400	220,000
Recreation	92,500	75,000
Fish and wildlife	117,400	102,200
Total	$ 490,400	$ 506,200

23. ECONOMIC ANALYSIS AND PROJECT JUSTIFICATION

a. Economic analysis. Reservoirs on Sanders and Big Pine Creeks offer the most practicable means of controlling floods, and are adaptable to multiple-purpose use, including water supply storage which is desired by local interests. The scale of project development was determined by considering the hydrologic and hydraulic conditions of the sites, and subjecting various scales of development to tests of economic feasibility. Economic analyses were made of various flood

control storage volumes, based on independent project operation. Flood-control-only reservoirs on the two streams are not feasible, but the proposed flood control storages in the multiple-purpose Pat Mayse and Big Pine Reservoirs are economically justified. The flood control and water conservation features of the plan of improvement were found to be reasonable from the standpoints of physical requirements and of excess benefits over cost. The recreation and fish and wildlife features are well supported by separate benefits.

b. Project justification. The annual charges for the plan of development, based on a 100-year analysis, amount to $301,000 for the Pat Mayse project and $319,000 for the Big Pine project. Average annual benefits are estimated to be $490,400 for Pat Mayse and $506,200 for Big Pine, based on flood control, water supply, recreation, and fish and wildlife aspects. The benefit-cost ratio for both reservoirs is 1.6.

24. PROPOSED LOCAL COOPERATION

In accordance with the Water Supply Act of 1958, as amended by Section 10 of Public Law 87-88, the State of Texas or local interests are required to repay to the United States all costs allocated to water supply (exclusive of preauthorization costs) and also pay the annual cost of operation and maintenance chargeable to water supply.

25. COST ALLOCATION

The costs allocated to the flood control, water supply, recreational, and fish and wildlife functions by the separable costs-remaining benefits method are shown in table 5.

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TABLE 5

ALLOCATION OF COST

Reservoir & Purpose	First Cost	Annual Cost	Annual Benefits	B-C Ratio
	$	$	$	
Pat Mayse Reservoir:				
Flood control	1,823,000	75,700	91,100	1.2
Water supply	3,388,000	121,400	189,400	1.6
Recreation	1,054,000	48,600	92,500	1.9
Fish and wildlife	1,325,000	55,300	117,400	2.1
Total	7,590,000	301,000	490,400	1.6
Big Pine Reservoir:				
Flood control	2,269,000	85,600	109,000	1.3
Water supply	4,150,000	141,500	220,000	1.6
Recreation	925,000	41,300	75,000	1.8
Fish and wildlife	1,246,000	50,600	102,200	2.0
Total	8,590,000	319,000	506,200	1.6

26. COST APPORTIONMENT

a. Pat Mayse Reservoir. The entire construction cost of Pat Mayse Reservoir, currently estimated at $7,550,000, and the preauthorization cost of $40,000, or a total of $7,590,000, would be borne initially by the Federal Government. Local interests would be required to repay to the Federal Government all costs allocated to water supply, currently estimated to be $3,370,000 ($3,388,000, less allocated preauthorization study costs of $18,000). Also, local interests would be required to bear the annual operation and maintenance cost for the water supply facilities, currently estimated at $22,100. Based on the nature and widespread effects of benefits from recreation and fish and wildlife features, costs allocated to these functions should be nonreimbursable.

b. Big Pine Reservoir. The entire construction cost of Big Pine Reservoir, currently estimated at $8,550,000, and the preauthorization cost of $40,000, or a total of $8,590,000, would be borne initially by the Federal Government. Local interests would be required to repay to the Federal Government all costs allocated to water supply, currently estimated to be $4,131,000 ($4,150,000, less allocated preauthorization study costs of $19,000). Also, local interests would be required to bear the annual operation and maintenance cost for the water supply facilities, currently estimated at $20,300. Based on the nature and widespread effects of benefits from recreation and fish and wildlife features, costs allocated to these functions should be nonreimbursable.

27. CORRELATION WITH WATER REGULATORY LAWS

Local interests would be required to obtain water rights from the State of Texas before contracting for water supply storage in the projects.

28. COORDINATION WITH OTHER AGENCIES

Federal, State and local agencies were consulted during the preparation of this report. Field-level comments of other agencies regarding the plan of improvement are included in appendix VI. Their comments, which were considered in the preparation of the final report, indicated general concurrence with the proposed plan of improvement. Further coordination, as needed, will be accomplished in detail planning, if the proposed reservoirs are authorized. Studies and comments by Federal and State agencies prior to field-level review are summarized below.

a. Public Health Service. The Public Health Service made a study of water needs, quality and values. They found that there is a need for additional water supplies of about 25 mgd in Sanders Creek area, which might be advantageously obtained from Pat Mayse Reservoir. The quality of water in Sanders Creek is indicated to be acceptable, except for high iron and manganese content which can be removed by treatment. They concluded that the annual value of storage to yield 55 mgd for municipal and industrial water supply is $222,000, based on a 4 percent interest rate. The Public Health Service found no need for additional water supplies in the Big Pine Creek area. The quality of water in Big Pine Creek is indicated to be acceptable, except for high iron and manganese content which will require treatment. They considered that there is no economic value for the storage with a yield of 26 mgd for municipal and industrial water supply since there is no projected demand for the water. The Public Health Service report is included as appendix IV. Their estimated value of water supply storage in Pat Mayse Reservoir, adjusted to an interest rate of 3 percent, was used in the project evaluation.

b. Fish and Wildlife Service:

(1) The Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, furnished a report which presents the views of that agency concerning the plan of improvement. Their report has received the concurrence of the Texas Game and Fish Commission. The report (included in appendix V) indicates that construction of the Pat Mayse and Big Pine projects would result in substantial losses of deer and upland game habitat. It also shows a minor loss of stream fishery habitat with construction of the dams and proposed channel improvement downstream therefrom. However, the report indicates that construction of the projects would create significant reservoir fishery benefits and an increase in waterfowl habitat and hunting opportunities, which result in an over-all benefit to the fish and wildlife resources. The report indicates that deer and upland game losses can be partially mitigated and stream fishing can be enhanced with the recommended improvements and project modification.

(2) The recommendations contained in the report of the Fish and Wildlife Service are summarized below, together with the views and comments of the District Engineer, Corps of Engineers:

Recommendation No. 1: That conservation and development of fish and wildlife be included as a project purpose.

Comment: Fish and wildlife aspects are inherent in the plan of improvement, and are considered a project purpose.

Recommendation No. 2: That a minimum of 8 parking-access areas on Pat Mayse Reservoir and 6 on Big Pine Reservoir, with boat-launching facilities in each area, be provided.

Comment: Basic facilities provided by the Corps of Engineers plan of improvement include access roads, parking areas, launching ramps, drinking water, sanitary facilities, and related improvements. Detailed project planning for these facilities will consider the needs required for use by sportsmen.

Recommendation No. 3: That consideration be given in spillway design to prevent upstream movements of fishes into the reservoir.

Comment: The estimated frequency of spillway operation is once in 50 years on the Pat Mayse and Big Pine projects. Overhang design would cause stability and cavitation problems on the spillway. In view of this and the infrequency of spillway operation, it is not believed that special design of the spillway should be provided.

Recommendation No. 4: That seining areas be provided in each reservoir.

Comment: This recommendation is concurred in, and will be considered in connection with detailed project planning.

Recommendation No. 5: That disturbance of natural stream channels be minimized to reduce fishery losses due to channel rectification.

Comment: The proposed channel improvement will reduce the flood control storage requirements in Pat Mayse and Big Pine Reservoirs. Channel improvement by clearing and snagging is more economical than the additional storage; however, this cannot be done without causing some disturbance of the natural stream channels. The disturbances will be kept at a minimum.

Recommendation No. 6: That provision be made, to the extent legally feasible, for minimum release of 8 second feet and storage of 11,800 acre-feet in Pat Mayse Reservoir and for minimum

release of 6 second feet with storage of 4,000 acre-feet in Big Pine Reservoir, to protect and enhance downstream fishery, recognizing these storages would not provide for flows during the most critical dry periods.

Comment: This recommendation has merit, in view of the benefits given by the Fish and Wildlife Service for enhancement of the downstream fishery and the minor storage required for partial maintenance of the stream flows. It is believed that, under normal operation of the two reservoirs, the recommended flows will be satisfied most of the time and it would seldom be necessary to withdraw from storage to meet these requirements. Should low-flow releases for pollution abatement be required, it is possible that these flows would also serve the needs for downstream fishery habitat. In view of the above, and the fact that fish and wildlife has been included as a project purpose for Pat Mayse and Big Pine Reservoirs, it is believed that this recommendation warrants further consideration and study during detailed planning after authorization. At that time more detailed hydrologic data will be available as a basis for determining storage requirements.

Recommendation No. 7: That 2,200 acres of land be purchased in fee at Pat Mayse Reservoir, together with approximately 7,400 acres of presently-owned Government land (former Camp Maxey), to be made available to the Texas Game and Fish Commission for a wildlife management public hunting area.

Comment: The Tulsa District concurs in the recommendation that certain lands in Federal ownership in the Pat Mayse project area be made available to the Texas Game and Fish Commission for wildlife management and public hunting. However, the recommendation of acquiring an additional 2,200 acres in fee does not appear warranted, and is not concurred in.

Recommendation No. 8: That the boundaries of purchased (Government-owned) land be adequately marked for public information.

Comment: Consideration will be given to this request at time of project construction.

Recommendation No. 9: That Federal lands and project waters be open to free use for hunting and fishing.

Comment: All Government-owned land and project waters will be open to the public for hunting and fishing, except those areas required for control and operation of the project and areas designated for other specific public uses. Also, all agricultural lease agreements on project fee lands would provide that lands be open to the public for fishing and hunting in accordance with the agreement between the Fish and Wildlife Service and the Corps of Engineers, approved August 20, 1954.

c. Texas Game and Fish Commission. The Texas Game and Fish Commission did not furnish recommendations, but indicated in letter dated October 17, 1960 (included in appendix V) that information and recommendations would be included in a report to be prepared jointly with the Fish and Wildlife Service.

d. Soil Conservation Service. The plans considered in this report were coordinated in conference with representatives of the Soil Conservation Service offices of Temple and Fort Worth, Texas. It was determined from discussion of preliminary Public Law 566 studies made of Sanders Creek watershed by the Service and the Corps of Engineers Pat Mayse project plan that there was no conflict of interest in planning, since further studies of improvements under Public Law 566 for this watershed were indefinite.

e. Bureau of Reclamation. The Bureau of Reclamation was consulted in regard to irrigation from Pat Mayse and Big Pine Reservoirs. They made no specific proposal for inclusion of irrigation as a project purpose, as discussed in paragraph 16e.

f. Department of the Army. The Department advised that the Government-owned lands of the former Camp Maxey are excess to their military needs, but that the lands needed for the proposed Pat Mayse Reservoir will be retained in Government ownership as long as there is a possibility of Federal construction of the reservoir.

29. ASSURANCES OF LOCAL COOPERATION

The proposed repayment requirement for the water supply storage included in the plan of improvement has been discussed with local interests. The City of Paris passed a resolution on January 25, 1961, requesting water supply storage in Pat Mayse Reservoir sufficient to yield 55 mgd. The City of Clarksville passed a resolution on January 25, 1961, requesting water supply storage to provide a yield of 26 mgd in Big Pine Reservoir. The resolutions indicate willingness to assume the responsibility of repayment of the allocated water supply costs, and are included in appendix VI.

30. DISCUSSION

a. Sanders and Big Pine Creeks are small tributaries of Red River in northeastern Texas, on which damaging floods are frequently experienced. The flood plain areas downstream from the projects included in the plan of improvement amount to 2,100 acres of agricultural land on Sanders Creek and 4,100 acres of agricultural land on Big Pine Creek. The surface waters of the streams are suitable for municipal and industrial use. This is highly significant, since underground water in the region is limited in quantity, so that municipalities and industries in the area must rely largely on surface sources for any major amount of water supply. There is an increasing demand for the development of additional sources of water supply for towns and cities in the

area to meet these needs. There is also a demand for flood protection for the lands along the streams.

b. Pat Mayse Reservoir would provide a total storage capacity of 200,800 acre-feet. The flood control storage, 91,600 acre-feet, provides complete control at the dam site of all floods up to the magnitude of the 50-year flood. The channel would be cleared and snagged below the dam site to its mouth to increase the capacity. The water supply storage, 99,700 acre-feet, is estimated to have a dependable yield of 55 mgd. This yield is sufficient to meet the future additional needs anticipated by the City of Paris, Texas. The provision of additional storage for water supply purposes is physically possible, but such storage would be more expensive because of greater evaporation losses and high construction costs.

c. The Pat Mayse Reservoir would be located in the area of the former Camp Maxey reservation. Plate 1, appendix III shows the present status of land ownership. Noncontiguous parcels of the reservation lands remain in Government ownership, a large block of the area has been deeded to the Texas National Guard, and the remaining lands are privately owned. The Government-owned lands have been designated as excess to military needs, and it is contemplated that the Department of the Army would retain all acreage of the Government-owned lands which would be required for the Pat Mayse Reservoir. If development of the reservoir is authorized, the suitable excess Government lands could be made available to the Texas National Guard for exchange on a dollar-value basis of lands required for the reservoir. Privately-owned lands required for the reservoir would be acquired in fee and/or flowage easements in accordance with the joint land acquisition policy. Government-owned lands in excess of the requirements of the reservoir development, and unsuitable for exchange with the Texas National Guard, would be available for disposition.

d. Big Pine Reservoir provides a total storage capacity of 138,600 acre-feet. The flood control storage, 53,600 acre-feet, provides complete control at the dam site of all floods up to the magnitude of the 50-year flood. The channel would be cleared and snagged below the dam site to its mouth to increase the capacity. The water supply storage, 79,300 acre-feet, is estimated to have a dependable yield of 26 mgd. This yield is sufficient to meet the future additional needs anticipated by the City of Clarksville, Texas. If more storage were provided for water supply purposes, a decrease in flood control storage would be necessary.

e. Water supply storages included in each reservoir would supply the yields requested by local interests. They are considered reasonable and approach the maximum potential development of each site. This scope of development is consistent with the policy expressed in the Texas Board of Water Engineers' publication entitled "A Plan for Meeting the 1980 Water Requirements of Texas", dated May 1961.

f. The total estimated first cost of Pat Mayse Dam and Reservoir with channel improvement (including preauthorization cost) is $7,590,000, and the estimated average annual cost is $301,000. The estimated average annual benefits, amounting to $490,400, result from flood control ($91,100), water supply ($189,400), recreation ($92,500) and fish and wildlife ($117,400). The benefit-cost ratio is 1.6. The total estimated first cost of Big Pine Reservoir with channel improvement is $8,590,000 (including preauthorization cost), and the estimated average annual cost is $319,000. The estimated average annual benefits, amounting to $506,200, result from flood control ($109,000), water supply ($220,000), recreation ($75,000) and fish and wildlife ($102,200). The benefit-cost ratio is 1.6. These data are on a 100-year period of analysis.

g. The allocated cost to the flood control feature is a Federal responsibility. The allocated costs to the recreation and fish and wildlife features should be nonreimbursable on the basis of the nature and widespread benefits from these functions.

h. Information was also developed on benefits and costs for the two reservoirs, based on a 50-year period of analysis. On that basis, the annual charges for Pat Mayse Reservoir are $361,000, and the annual benefits are $487,900, which result in a benefit-cost ratio of 1.4. On the same basis, the annual costs for Big Pine Reservoir are $387,000, and annual benefits are $502,200, resulting in a benefit-cost ratio of 1.3.

i. The plan of improvement presented herein does not preclude the development of watershed improvements under Public Law 566. In the event watershed programs are planned before construction of the Pat Mayse and Big Pine Reservoirs, the planning of the reservoirs should take into account the effects of the watershed program.

j. Based on preliminary studies, a reservoir on Collier Creek for flood control and conservation storage was found to be less than half-justified. Therefore, detailed studies were not made.

k. Additional information on recommended and alternative projects called for by Senate Resolution 148, 85th Congress, adopted January 28, 1958, is contained in supplement B to this report.

l. The responsibility of repayment to the United States of the costs allocated to water supply is recognized by local interests. The Cities of Clarksville and Paris, Texas, after being informed of the approximate magnitude of payments for initial use storage and storage for future use, adopted resolutions which indicate their willingness to sponsor water supply storage in the two proposed reservoirs.

31. CONCLUSIONS

a. Pat Mayse and Big Pine Reservoirs, as proposed herein for flood control and water supply and related purposes, are economically justified, and should be constructed by the United States.

b. Local interests are willing and able to meet the requirement of local cooperation.

c. It is concluded that Pat Mayse and Big Pine Reservoirs should be constructed essentially as proposed herein, to provide for flood protection along Sanders and Big Pine Creeks and to provide water supply storage to meet future needs of the area. It is also concluded that channel improvements on Sanders and Big Pine Creeks, as proposed herein, are an essential part of the projects since these works are necessary to provide increased floodwater discharge capacity.

32. RECOMMENDATIONS

I recommend that Pat Mayse Reservoir be constructed for flood control and municipal and industrial water supply, including provisions for recreation and fish and wildlife, and for channel improvement on Sanders Creek, at a cost presently estimated at $7,550,000 (not including preauthorization cost) and an annual operation and maintenance cost of $78,800, all generally in accordance with the plan of improvement described herein, with such modifications thereof as in the discretion of the Chief of Engineers may be advisable. I also recommend that local interests be required to reimburse the United States, in accordance with the Water Supply Act of 1958 and any applicable amendments thereto, including Section 10 of Public Law 87-88, for the first costs allocated to water supply storage, currently estimated at $3,370,000, and the annual operation and maintenance costs chargeable to water supply storage, currently estimated at $22,100. I recommend that Big Pine Reservoir be constructed for flood control and municipal and industrial water supply, including provision for recreation and fish and wildlife and for channel improvement on Big Pine Creek, at a cost presently estimated at $8,550,000 (not including preauthorization cost), and an annual operation and maintenance cost of $68,300, all generally in accordance with the plan of improvement described herein, with such modifications thereof as in the discretion of the Chief of Engineers may be advisable. I also recommend that local interests be required to reimburse the United States, in accordance with the Water Supply Act of 1958 and any applicable amendments thereto, including Section 10 of Public Law 87-88, for the first costs allocated to water supply storage, currently estimated at $4,131,000, and the annual operation and maintenance costs, chargeable to water supply storage, currently estimated at $20,300.

HOWARD W. PENNEY
Colonel, CE
District Engineer

[First endorsement]

SWDGW-4
SUBJECT: Sanders, Big Pine and Collier Creeks, Texas - Survey Report

United States Army Engineer Division, Southwestern, Dallas, Texas, November 15, 1961

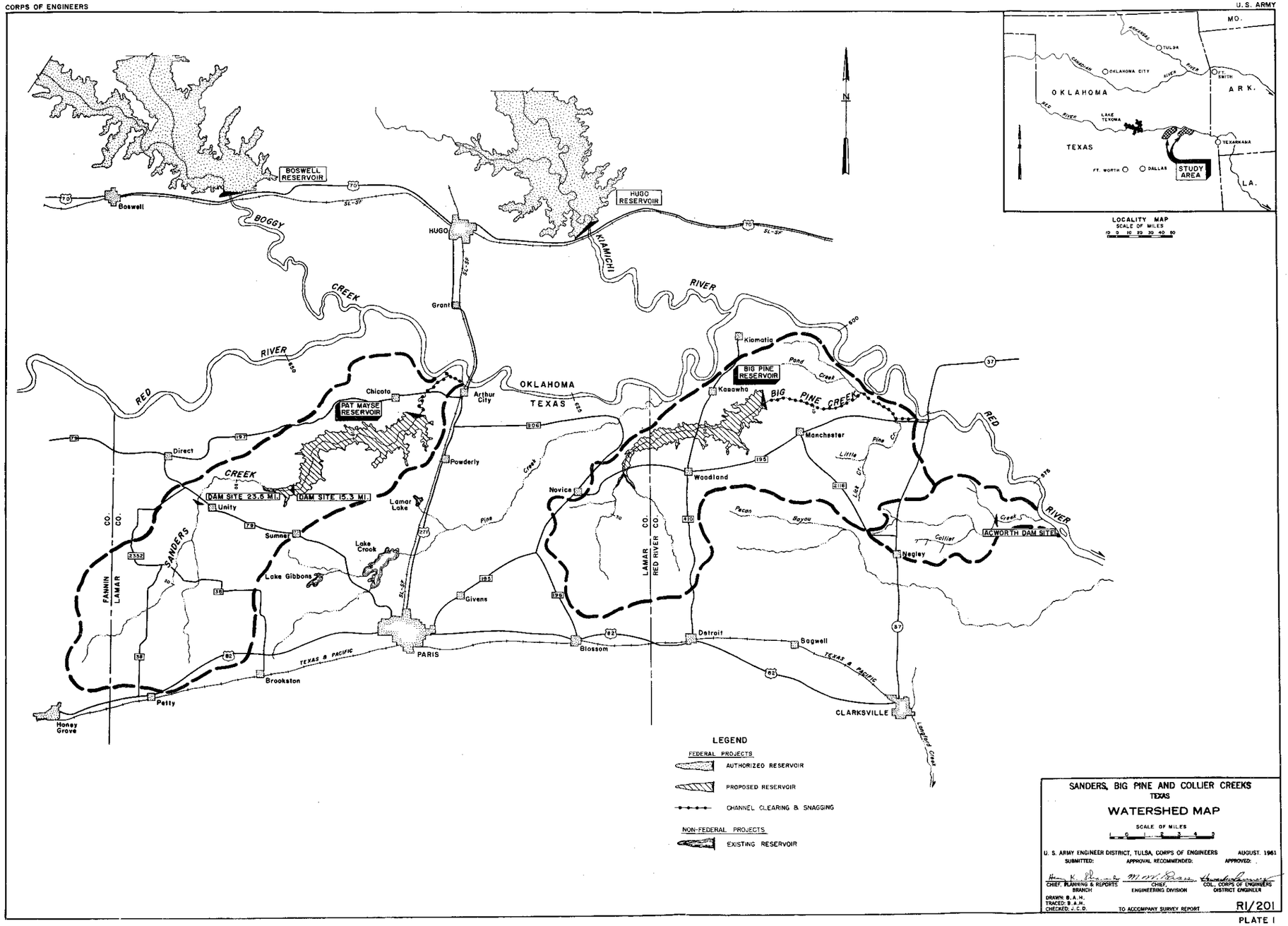
TO: Chief of Engineers, Department of the Army, Washington, D.C.

I concur in the conclusions and recommendations of the District Engineer.

ROBERT J. FLEMING, JR.
Major General, USA
Division Engineer

CORPS OF ENGINEERS

U. S. ARMY



LOCALITY MAP
SCALE OF MILES
10 0 10 20 30 40 50

LEGEND

FEDERAL PROJECTS

AUTHORIZED RESERVOIR

PROPOSED RESERVOIR

CHANNEL CLEARING & SNAGGING

NON-FEDERAL PROJECTS

EXISTING RESERVOIR

SANDERS, BIG PINE AND COLLIER CREEKS
TEXAS

WATERSHED MAP

SCALE OF MILES
1 0 1 2 3 4 5

U. S. ARMY ENGINEER DISTRICT, TULSA, CORPS OF ENGINEERS — AUGUST, 1961

SUBMITTED: APPROVAL RECOMMENDED: APPROVED:

CHIEF, PLANNING & REPORTS BRANCH — CHIEF ENGINEERING DIVISION — COL, CORPS OF ENGINEERS DISTRICT ENGINEER

DRAWN: B. A. H.
TRACED: B. A. H.
CHECKED: J. C. D.

TO ACCOMPANY SURVEY REPORT

RI/201

PLATE I

94758 O-63 (Face p. 36)

APPENDIX I

HYDROLOGY

1. PURPOSE

This appendix presents data relative to hydrology and related subjects, supplementing those contained in the main report for Sanders and Big Pine Creeks. The main report provides general hydrologic information on Collier Creek, for which only preliminary investigations were made.

2. CLIMATOLOGY

a. Weather. The Sanders and Big Pine watersheds lie in a region characterized by long, hot summers and moderate winters. Pertinent data relative to U. S. Weather Bureau stations in the vicinity of the watersheds are shown in table 1, and the locations are shown on plate 1.

TABLE 1

U. S. WEATHER BUREAU STATION DATA

Station	County	Elevation in Feet (msl)	Length of Record (years)	Mean Annual Precipitation (inches)
Arthur City, Texas	Lamar	411	67	(1) 40.11
Clarksville, Texas	Red River	432	64	(1) 47.92
Honey Grove, Texas	Fannin	660	42	(1) 42.63
Idabel, Oklahoma	McCurtain	504	41	(1) 46.53
Negley, Texas	Red River	400	12	(2)
Paris, Texas	Lamar	592	75	(1) 40.30
Valliant, Oklahoma	McCurtain	511	16	(2)

(1) 1958 Annual Summary. (2) Mean not established.

b. Precipitation. The normal annual precipitation over Sanders Creek Basin is about 41.4 inches and over Big Pine Creek Basin about 42.5 inches, as determined by representative stations listed in table 1. The area is subject to thunderstorms with intense rainfall and of short duration, usually occurring during the summer. General rains of several days' duration may occur during any season. The average annual snowfall is about 4 inches, and does not ordinarily contribute to flooding. The monthly distribution of the normal annual precipitation is shown in table 2.

TABLE 2

MONTHLY DISTRIBUTION OF NORMAL ANNUAL PRECIPITATION

Month	Sanders Creek (inches)	Sanders Creek (percent)	Big Pine Creek (inches)	Big Pine Creek (percent)
January	2.90	7.0	2.98	7.0
February	2.90	7.0	2.98	7.0
March	3.68	8.9	3.78	8.9
April	4.80	11.6	4.93	11.6
May	5.13	12.4	5.27	12.4
June	3.93	9.5	4.04	9.5
July	3.35	8.1	3.44	8.1
August	2.48	6.0	2.55	6.0
September	2.86	6.9	2.93	6.9
October	3.23	7.8	3.32	7.8
November	3.07	7.4	3.14	7.4
December	3.07	7.4	3.14	7.4
Annual	41.4	100.0	42.5	100.0

c. Temperature. The average annual temperature in the area is about 64 degrees Fahrenheit. The maximum recorded temperature in the vicinity was 115 degrees on August 10, 1936 at Paris, Texas, and the minimum was -5 degrees on February 2, 1951 at Clarksville, Texas.

d. Wind. The prevailing wind direction is from a south-southeasterly direction, with the greatest wind movement occurring during the spring months. Data from wind recording stations in the general vicinity of the basin indicate that a velocity of 45 miles per hour is the maximum wind velocity that can reasonably be expected for durations of 1 hour or more.

e. Evaporation. Relatively high humidity and light wind movements in the subject area are conducive to comparatively low rates of evaporation. The estimated monthly evaporation rates listed in table 3 were determined from regional station data and are considered to represent standard U. S. Weather Bureau Class A land-pan evaporation rates at the dam sites.

TABLE 3

ESTIMATED MONTHLY PAN EVAPORATION

Month	Evaporation (inches)	Month	Evaporation (inches)
January	1.9	August	8.6
February	2.5	September	6.3
March	4.4	October	4.3
April	6.0	November	3.1
May	6.5	December	2.0
June	7.9		
July	8.5	Annual	62.0

3. BASIN CHARACTERISTICS

Sanders and Big Pine Creeks are in Fannin, Lamar and Red River Counties, Texas, and are right-bank tributaries to Red River. The watersheds lie in a region of low rolling hills. Locations of the watersheds are shown on plate 1.

a. Sanders Creek. Sanders Creek has its source near Honey Grove, Texas, and flows in a generally northeasterly direction to its confluence with the Red River at river mile 636, about 3 miles upstream from Arthur City, Texas. The basin is about 30 miles in length and has a maximum width of about 10 miles near the upper end. The total drainage area of Sanders Creek is 190 square miles, and the area above the dam site is 175 square miles. The upper portion of the basin is moderately steep and is well drained. The main stream channel is very tortuous and choked with brush and timber. Elevations range from about 690 feet msl at the source to about 400 feet at the mouth. The weighted slope of the stream is about 6.2 feet per mile and is about 2.5 feet per mile near the mouth. (See plate 2.) The channel capacity at the dam site is about 500 cfs.

b. Big Pine Creek. Big Pine Creek has its source about 10 miles northeast of Paris, Texas, and flows in a generally northeasterly direction to its confluence with the Red River at river mile 585, in Red River County, Texas. The basin is about 24 miles in length. It is about 8 miles wide near the source, narrows to about 4 miles, then expands to about 12 miles at the lower end. The total drainage area of Big Pine Creek is 170 square miles and the area above the dam site is 95 square miles. The upper portion of the basin is moderately steep and is well drained. The main stream channel is very tortuous and choked with brush and timber. Elevations range from about 600 feet msl at the source to about 340 feet at the mouth. The weighted slope of the stream is about 6.7 feet per mile and is about 3.5 feet per mile near the mouth. (See plate 2.) The channel capacity at the dam site is about 300 cfs.

4. RUNOFF

a. Stream gage and discharge records. There are no stream gaging stations on Sanders Creek or Big Pine Creek. Pertinent data for stream gaging stations which were used in the determination of loss rates, unit hydrograph coefficients, and runoff data on the subject streams are shown in table 4. Daily discharges are available for 9 or more complete water years at 2 of the gaging stations shown in table 4.

b. Runoff data. The mean annual runoff in acre-feet and inches and other pertinent data are shown in table 5.

TABLE 4

PERTINENT DATA FOR STREAM GAGING STATIONS

Station	Stream	Miles Above Mouth	Drainage Area (sq.mi.)	Elevation of Zero on Gage (m.s.l.)	Flood Stage (feet)	Maximum of Record: Stage (feet)	Maximum of Record: Discharge (c.f.s.)	Maximum of Record: Date	Minimum of Record: Stage (feet)	Minimum of Record: Discharge (c.f.s.)	Minimum of Record: Date	Maximum Flood of Record: Volume (acre-feet)	Maximum Flood of Record: Inclusive Dates	Daily Stages (agency)	Discharge Measurements (agency)	Period of Record (inclusive dates)
Bonham, Texas	Bois d'Arc Creek	34.0	131	526.54	18	23.35(1)(2)	(3)	5/11/53	(4)	-	(5)	(3)	-	C.E.	C.E.	4/20/48 - 9/30/54
Cooper, Texas	North Sulphur River	(6)	276	381.42	(6)	25.86(7)	42,800	4/29/53	(4)	0	(5)	69,220	11/4 - 6/1957	U.S.G.S.	U.S.G.S.	10/1/49 - 9/30/59(8)
Arthur City, Texas	Red River	633.1	44,531	380.07	22	43.2	400,000	5/28/08	1.5	(3)	1/15/1892	10,820,000	4/20-7/16/57	U.S.W.B. U.S.G.S. C.E.	(3) U.S.G.S. C.E	1/31/1891 - 9/30/59(8) 10/ 1/05 - 12/31/11 7/ 1/36 - 9/30/59(8)

(1) Highest reading obtained.
(2) Maximum stage known 24.6 feet (floodmark) February 1938.
(3) Stages only.
(4) Pool at gage or streambed dry; stage not significant.
(5) At times.
(6) Not determined.
(7) Maximum stage known since at least 1915, 26.6 feet, May 2, 1944.
(8) Continued in operation.

TABLE 5

ANNUAL RUNOFF DATA

Station	River	Drainage Area, Square Miles	Complete Water Years of Record (1)	Annual Runoff, in Acre-feet			Average Annual Runoff in Inches
				Maximum	Minimum	Average	
Cooper, Texas	North Sulphur	276	9	391,300	61,020	184,200	12.51
Arthur City, Texas	Red	44,531	28	15,570,000	1,792,000	6,504,000	2.74

(1) Complete water years of record to September 30, 1958.

c. Monthly and annual flows. The monthly and annual flows at Pat Mayse and Big Pine Dam sites have been computed for the 25-year period, 1934 through 1958. These flows were determined from monthly rainfall-drainage area-flow relationship of adjacent basins and/or antecedent precipitation-rainfall-runoff curves developed by the U. S. Weather Bureau. These flows are shown in tables 6 and 7.

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TABLE 6

MONTHLY AND ANNUAL FLOWS IN ACRE-FEET - SANDERS CREEK AT PAT MAYSE DAM SITE

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1933	-	-	-	-	-	-	-	-	-	4,126	150	477	4,750
1934	3,905	2,038	21,180	20,910	2,490	490	1,968	0	5	0	1,160	1,107	55,250
1935	20,230	4,499	7,748	23,330	69,620	60,200	1,556	173	525	652	3,999	8,178	200,700
1936	240	197	1,088	57	10,450	339	347	3	39,940	5,374	1,494	6,210	65,740
1937	25,460	3,238	16,910	20,230	2,115	328	95	695	392	424	6,546	10,820	87,250
1938	35,090	45,640	51,420	35,940	658	7,617	652	183	55	0	512	57	177,800
1939	2,736	25,310	18,820	32,670	128	882	649	3	0	3	24	47	81,270
1940	138	1,494	643	19,540	74,200	8,869	12,520	55	298	20	132	28,490	146,400
1941	26	102	17,240	29,310	10,640	16,660	7,958	522	185	398	1,150	4,872	89,060
1942	569	1,461	8,390	81,200	26,110	9,310	139	651	1,872	155	929	80	130,900
1943	1,089	977	8,616	5,377	5,040	12,880	88	56	148	745	62	1,290	36,370
1944	4,134	11,310	14,240	4,412	56,460	10,570	162	121	2,047	76	2,805	10,740	117,100
1945	15,490	43,960	44,140	16,430	15,000	57,230	20,380	575	1,746	35,090	3,410	707	254,200
1946	28,840	28,280	32,140	18,420	26,790	15,960	364	1,171	3,348	282	65,650	5,101	226,300
1947	730	859	17,950	22,310	8,960	11,329	806	436	642	283	10,330	30,990	95,620
1948	10,510	31,170	20,910	5,257	41,250	1,574	1,798	288	252	342	209	419	114,000
1949	69,720	28,280	17,200	9,336	18,480	2,535	997	597	689	4,318	43	235	152,400
1950	37,980	34,720	946	8,490	49,840	1,230	20,280	1,089	17,490	203	42	57	172,400
1951	154	23,120	362	1,701	3,800	53,010	1,053	9	297	2,203	31,270	39	117,000
1952	110	173	6,470	60,100	7,050	2,168	24	0	0	0	6,070	2,460	84,620
1953	2,657	411	10,650	40,970	22,210	44	5,943	757	357	276	2,560	7,671	94,510
1954	8,965	5,780	129	5,650	44,520	2,320	0	0	5	228	1,600	381	69,580
1955	883	3,610	33,040	8,870	3,136	339	5,015	1,230	584	858	0	0	57,560
1956	221	41,620	470	1,610	7,601	345	0	0	0	14	1,208	248	53,340
1957	606	1,720	11,470	58,800	78,960	33,690	644	3,112	15,890	9,520	48,220	5,479	268,100
1958	13,550	895	21,980	20,350	30,050	17,320	1,564	74	372	-	-	-	106,200
Mean	11,360	13,630	15,370	22,050	24,620	13,220	3,400	472	3,486	2,624	7,583	5,046	122,300

TABLE 7

MONTHLY AND ANNUAL FLOWS IN ACRE-FEET - BIG PINE CREEK AT BIG PINE DAM SITE

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1933	-	-	-	-	-	-	-	-	-	1,882	110	310	2,300
1934	4,455	1,024	6,840	4,863	1,665	271	3,045	0	4	0	965	862	23,990
1935	14,320	2,730	5,198	14,390	29,740	34,860	803	128	268	415	2,889	6,234	111,900
1936	144	122	862	32	9,977	372	383	1	9,221	2,573	1,154	4,388	29,200
1937	14,510	2,040	11,130	11,960	1,591	262	79	400	139	235	5,350	8,252	56,950
1938	11,910	16,670	5,079	19,300	534	4,175	494	107	33	0	360	37	58,700
1939	1,537	12,350	8,968	12,060	85	287	487	1	0	1	15	43	28,230
1940	56	821	512	13,320	21,890	4,943	7,952	27	139	17	90	1,800	51,570
1941	22	66	12,530	15,810	12,640	9,728	6,354	411	151	217	972	2,760	61,660
1942	479	1,064	4,913	36,830	21,010	5,517	382	534	705	104	553	61	72,150
1943	683	493	4,614	5,472	1,778	18,800	85	26	60	611	44	946	33,600
1944	2,790	8,281	8,702	2,939	22,090	6,976	135	83	1,358	46	1,553	8,552	63,510
1945	6,688	30,350	43,780	9,576	11,180	32,980	12,530	431	1,016	12,520	2,453	468	164,000
1946	19,760	15,450	21,790	11,400	16,620	6,384	281	538	2,156	223	23,830	2,993	121,400
1947	399	759	12,220	18,300	24,080	944	456	290	667	149	6,294	24,300	88,860
1948	7,876	18,290	15,200	3,920	28,580	849	1,463	464	151	268	145	263	77,470
1949	33,690	20,590	12,310	5,438	11,300	1,895	634	332	525	2,623	33	149	89,520
1950	13,380	25,890	900	1,232	31,350	681	12,920	643	17,200	166	50	2	104,400
1951	116	15,990	324	1,161	2,330	18,490	765	17	256	1,354	334	49	41,190
1952	126	144	4,197	32,120	4,429	1,598	17	0	0	0	4,502	1,720	48,850
1953	1,952	318	7,357	22,500	20,180	40	3,672	354	293	142	1,525	4,648	62,980
1954	6,002	3,721	74	12,970	17,230	1,016	0	0	2	196	1,305	299	42,820
1955	596	2,300	11,800	7,625	2,623	132	2,782	1,049	396	523	0	0	29,830
1956	157	23,810	370	871	4,852	383	0	0	0	6	944	165	31,560
1957	561	1,354	7,697	23,000	35,820	18,390	605	2,623	11,540	1,853	23,660	3,518	130,500
1958	7,516	580	6,029	16,520	21,680	9,945	1,913	78	282	-	-	-	64,540
Mean	6,028	8,208	8,536	11,840	14,210	7,192	2,330	342	1,862	1,045	3,165	2,913	67,680

5. STORMS

a. Storms of record. The two basins lie in an area subject to storms of intense rainfall of short duration which create severe floods, and storms of longer duration and less intensity which may cause a prolonged series of floods. The maximum recorded 24-hour rainfall in the area was 6.28 inches at Arthur City, Texas, on September 27, 1936. The longest storm series occurred in 1957, when rainfall was recorded on 30 days of the 47-day period, April 20 to June 5. Storms having average rainfall of more than 2 inches in one day and storm total of more than 3 inches for the 25-year period, 1934 through 1958, are listed in table 8.

TABLE 8

MAJOR STORMS

Sanders Creek			Big Pine Creek		
Date of Storm		Average Rainfall (inches)	Date of Storm		Average Rainfall (inches)
Nov 19-22	1934	5.15	Nov 19-22	1934	5.20
Apr 25 to May 5	1935	7.38	Apr 25 to May 5	1935	8.06
May 29 to Jun 3	1935	4.14	Jun 12-21	1935	8.32
Jun 12-21	1935	8.61	Sep 23-28	1936	7.90
Sep 15-28	1936	8.72	Feb 14-18	1938	5.44
Feb 14-22	1938	6.90	Mar 27-31	1938	5.01
Mar 26-31	1938	5.69	Apr 16-17	1939	3.34
Apr 15-17	1939	3.08	Apr 5-7	1940	3.09
Apr 5-7	1940	3.70	May 9-10	1940	3.27
May 9-10	1940	3.05	May 16-29	1940	8.53
Apr 12-30	1941	7.00	Apr 12-25	1941	5.36
Jun 6-16	1941	4.70	Jul 11-14	1941	6.05
Jul 11-14	1941	5.35	Apr 6-14	1942	8.77
Apr 6-10	1942	6.01	Apr 17-18	1943	3.22
Apr 19-26	1942	5.32	Apr 29 to May 2	1944	4.21
Apr 29 to May 6	1944	6.45	Feb 16-21	1945	4.45
Feb 25 to Mar 6	1945	3.10	Feb 26 to Mar 6	1945	4.49
Mar 28 to Apr 1	1945	4.61	Mar 29 to Apr 1	1945	5.76
Aug 25-29	1946	4.02	Apr 23-25	1946	3.46
Nov 1-10	1946	10.37	May 13-21	1946	4.79
Jan 22-31	1949	7.97	Nov 1-10	1946	9.78
Feb 21-24	1949	3.46	May 11-12	1948	4.49
Jan 28 to Feb 5	1950	3.72	Jan 22-31	1949	6.99
Feb 11-13	1950	3.46	Feb 12-13	1950	4.23
Jun 1-16	1951	9.90	Jun 3-16	1951	8.56
Apr 9-13	1952	3.34	Apr 20-23	1952	5.80
Apr 19-23	1952	4.98	Apr 28-29	1953	3.74
Apr 24-29	1953	5.53	May 9-13	1954	4.74
May 9-13	1954	4.50	Sep 29 to Oct 1	1954	6.47
Sep 29 to Oct 1	1954	6.26	Mar 18-22	1955	3.48
Mar 18-22	1955	3.85	Feb 15-18	1956	3.17
Feb 15-18	1956	3.73	Apr 19 to May 4	1957	8.64
Apr 20 to May 5	1957	9.75	May 22-26	1957	6.74
May 21-26	1957	8.82	May 31 to Jun 5	1957	5.15
May 30 to Jun 5	1957	7.20	Nov 4-8	1957	4.38
Nov 4-6	1957	5.99	Apr 25 to May 3	1958	8.55
Apr 25 to May 3	1958	7.10			

b. Storm occurrences. The number of occurrences and magnitude of the storms listed in table 8 are shown in table 9.

TABLE 9

NUMBER AND MAGNITUDE OF STORMS

Rainfall (inches)	Sanders Creek		Big Pine Creek	
	Number of Occurrences	Accumulated Number of Occurrences	Number of Occurrences	Accumulated Number of Occurrences
10.37	1	1	0	0
9.90	1	2	0	0
9.78	0	2	1	1
9.75	1	3	0	1
8.50 - 8.99	3	6	5	6
8.00 - 8.49	0	6	2	8
7.50 - 7.99	1	7	1	9
7.00 - 7.49	4	11	0	9
6.50 - 6.99	1	12	2	11
6.00 - 6.49	3	15	2	13
5.50 - 5.99	3	18	2	15
5.00 - 5.49	3	21	5	20
4.50 - 4.99	4	25	2	22
4.00 - 4.49	2	27	6	28
3.50 - 3.99	4	31	1	29
3.00 - 3.49	6	37	7	36

6. FLOOD HISTORY

a. General. There are no stream gaging stations on Sanders or Big Pine Creeks. Major flooding was determined from a study of rainfall and flow records of adjacent basins, antecedent precipitation-rainfall-runoff curves developed by the U. S. Weather Bureau, and field reconnaissance. Flood peak discharges were determined by rainfall excess-unit hydrograph method. The computed number and magnitude of floods for the 25-year period, 1934 through 1958, at the Pat Mayse and Big Pine Dam sites are shown in table 10.

TABLE 10

NUMBER AND MAGNITUDE OF FLOODS

Peak Stage (feet above bankfull) (1)	Pat Mayse Dam Site: Number of Occurrences	Pat Mayse Dam Site: Accumulated Number of Occurrences	Big Pine Dam Site: Number of Occurrences	Big Pine Dam Site: Accumulated Number of Occurrences
11.4	1	1	0	0
10.1	1	2	0	0
9 - 9.9	5	7	0	0
8 - 8.9	7	14	0	0
7 - 7.9	13	27	0	0
6 - 6.9	17	44	3	3
5 - 5.9	20	64	5	8
4 - 4.9	27	91	26	34
3 - 3.9	34	125	43	77
2 - 2.9	36	161	55	132
1 - 1.9	39	200	68	200
0 - 0.9	38	238	62	262

(1) Bankfull stage (ft, msl): Pat Mayse Dam site elevation 403.0 and Big Pine Dam site elevation 378.8.

b. Peak flows and volumes. Peak discharge and volume data, including stage elevations for the 10 largest floods at the Pat Mayse and Big Pine Dam sites during the 25-year computed record of 1934 through 1958, are shown in table 11.

TABLE 11

TEN LARGEST FLOODS AT DAM SITES

Crest Date	Stage (feet, msl)	Estimated Peak Discharge (cfs)	Flood Period	Estimated Volume Acre-feet	Estimated Volume Inches
Pat Mayse Dam Site					
Jan 24 1949	414.4	22,800	Jan 24-29	48,600	5.21
Nov 5 1957	413.1	17,000	Nov 5- 8	31,100	3.33
Apr 8 1942	412.6	15,400	Apr 7-11	30,200	3.24
Jun 16 1935	412.5	15,200	Jun 15-23	27,300	2.93
Feb 17 1938	412.4	14,700	Feb 16-22	26,000	2.79
Sep 27 1936	412.3	14,500	Sep 26-30	26,100	2.80
May 24 1957	412.2	14,200	May 21-27	55,800	5.98
Apr 29 1953	411.7	12,400	Apr 29-May 1	21,900	2.35
Feb 12 1950	411.6	12,000	Feb 12-14	20,200	2.17
Apr 22 1952	411.5	11,800	Apr 20-24	23,300	2.50
Big Pine Dam Site					
Jan 24 1949	385.2	11,100	Jan 24-30	25,800	5.10
Sep 27 1936	385.0	10,600	Sep 27-29	15,200	3.00
Feb 17 1938	384.8	10,100	Feb 17-19	20,200	4.00
Apr 8 1942	384.6	9,500	Apr 7-11	16,800	3.32
Feb 12 1950	384.5	9,100	Feb 12-14	14,900	2.94
Apr 22 1952	384.5	8,900	Apr 21-25	14,900	2.95
Apr 29 1953	384.4	8,800	Apr 29-May 1	12,400	2.45
Mar 29 1945	384.1	8,000	Mar 29-Apr 1	17,000	3.35
Nov 5 1957	383.7	6,900	Nov 5- 8	10,000	1.98
Nov 2 1946	383.7	6,900	Nov 2-12	8,600	1.69

c. Flood of January 1949. The storm of January 24-26, 1949 produced the maximum peak discharges at both dam sites. The storm produced an average rainfall of 6.47 inches above Pat Mayse Dam site and 6.28 inches above Big Pine Dam site. Honey Grove, Texas, near the upper end of Sanders Creek Basin, reported 7.31 inches, and the maximum rainfall in the vicinity of Big Pine Creek was 6.58 inches at Paris, Texas. The estimated peak discharges are 22,800 cfs at the Pat Mayse Dam site and 11,100 cfs at the Big Pine Dam site; whereas, the volumes of runoff are 48,600 acre-feet (5.21 inches) and 25,800 acre-feet (5.10 inches), respectively.

d. Flood of November 1957. The storm of November 5-7, 1957 produced the second highest flood at Pat Mayse Dam site, with an average rainfall of 5.95 inches over the basin and a maximum of

7.12 inches reported at Honey Grove, Texas. The estimated peak discharge at the dam site was 17,000 cfs and the volume of runoff was 31,100 acre-feet, which is the equivalent of 3.33 inches over the basin.

e. Flood of April 1942. The storm of April 6-9, 1942 produced the third highest flood at Pat Mayse Dam site, with an average rainfall of 5.90 inches over the basin above the dam site and a maximum of 6.50 inches reported at Honey Grove, Texas. The estimated peak discharge at the dam site was 15,400 cfs. The volume of runoff was 30,200 acre-feet, which is the equivalent of 3.24 inches over the basin.

f. Flood of September 1936. The second highest flood at Big Pine Dam site resulted from the storm of September 27-28, 1936. The average rainfall over the basin above the dam site was 7.03 inches, and the maximum in the vicinity was 7.47 inches at Arthur City, Texas. The estimated peak discharge was 10,600 cfs and the volume of runoff was 15,200 acre-feet, which is the equivalent of 3.00 inches over the basin.

g. Flood of February 1938. The storm of February 16-18, 1938 produced the third highest flood at Big Pine Dam site, with an average rainfall of 5.10 inches over the basin above the dam site and a maximum in the vicinity of 7.36 inches at Arthur City, Texas. The estimated peak discharge was 10,100 cfs and the volume of runoff was 20,200 acre-feet, which is the equivalent of 4.0 inches over the basin.

7. PROPOSED STORAGE CAPACITIES AND RESERVOIR OPERATIONS

a. Area and capacity curves. The area curve for Pat Mayse Reservoir was determined from U.S.G.S. quadrangle maps, scale 1:62,500, contour interval of 10 feet, dated 1949. The area curve for Big Pine Reservoir was determined from U.S.G.S. quadrangle maps, scale 1:24,000, contour interval of 10 feet, dated 1951. The capacity curves were computed by 2-foot intervals from the area curve by the end-area method. The area and capacity curves for Pat Mayse and Big Pine Reservoirs are shown on plates 3 and 4, respectively.

b. Channel capacities. The channel of Sanders Creek at Pat Mayse Dam site is about 70 feet wide and about 8 feet deep. The depth increases to about 12 feet at Highway 197 and about 18 feet near the mouth. The channel capacity at the dam site is about 500 cfs, increasing to about 1,500 cfs near the mouth. The minimum channel of Big Pine Creek from the dam site to the mouth of Pond Creek (river mile 3.9) is about 60 feet wide and 6 feet deep and the capacity is about 300 cfs. Below the mouth of Pond Creek, the capacity increases to about 600 cfs.

c. Channel improvement considerations. In a study of reservoir release rates and flood control storage requirements, the reservoirs

were operated to release one-half the existing channel capacities in order to avoid saturation of the adjacent bottom lands. The maximum flood of record at Pat Mayse Dam site would require flood control storage of 148,000 acre-feet, equivalent to 15.9 inches of runoff, and about 300 days would be required to empty the flood control storage if there were no additional inflow. The maximum flood series of record at Big Pine Dam site would require flood control storage of 63,000 acre-feet, equivalent to 12.5 inches of runoff, and emptying time of about 200 days considering no additional inflow. On the basis of these and additional studies, release rates of 800 cfs from Pat Mayse Reservoir and 400 cfs from Big Pine Reservoir were selected. The channels of both streams should be cleared and dressed to increase the hydraulic efficiency. This would permit passing the selected release rates at stages below bankfull and would avoid possible flooding in excess of natural conditions in the lower reaches of Big Pine Creek. The cost of additional flood control storages of 53,200 acre-feet in Pat Mayse Reservoir and 22,500 acre-feet in Big Pine Reservoir to provide the same degree of protection without channel improvement would greatly exceed the cost of improving the channels by clearing and snagging.

d. Flood control storage requirement. The major floods for the 25 years of computed record were routed through the reservoirs, using the release rates selected in paragraph 7c, based on channel improvement. These studies indicate the frequent need for a large amount of flood control storage. Due to the limited channel capacities requiring low releases, the reservoirs would be in operation for long periods of time. The maximum flood series above Pat Mayse Reservoir, April-June 1957, would require 96,800 acre-feet of flood control storage and the reservoir would be in operation for 108 days. The maximum flood series above Big Pine Reservoir would require 40,500 acre-feet of flood control storage and the reservoir would be in operation for 96 days. The five maximum flood series of each reservoir, based on storage requirements, are listed in table 12.

TABLE 12

REQUIRED FLOOD CONTROL STORAGE

Flood		Flood Volume Past Dam Site (acre-feet)	Flood Control Storage Required	
			Acre-feet	Inches
		Pat Mayse Dam Site		
April-June	1957	171,500	96,800	10.37
April-June	1935	153,200	62,400	6.69
April	1942	81,200	50,200	5.38
January	1949	69,700	47,800	5.12
May	1940	29,800	42,400	4.55
		Big Pine Dam Site		
April-June	1957	77,500	40,500	7.99
March	1945	43,800	34,000	6.72
April-May	1958	38,200	31,800	6.28
April-June	1935	76,300	30,000	5.93
April	1952	32,100	25,000	4.93

e. Selected flood control storage. Pool elevation probabilities for Pat Mayse and Big Pine Reservoirs were computed on the basis of flood events during 25 years of computed record. The 50-year pool events resulted in required storage of 91,600 acre-feet (9.81 inches of runoff) for Pat Mayse Reservoir and 53,600 acre-feet (10.58 inches of runoff) for Big Pine Reservoir. This storage is 95 percent of the largest flood event at the Pat Mayse Dam site and 133 percent of the maximum flood event at the Big Pine Dam site. The watersheds are in an area of relatively high annual runoff, as indicated by the records on the North Sulphur River at Cooper, Texas, immediately south of the proposed project. The average annual runoff of the 276 square miles of drainage area is about 12.5 inches and the maximum annual runoff during the 9 years of record (October 1949 through September 1959) was about 25.6 inches. Authorized, under-construction, and existing reservoirs in the vicinity have flood control storages ranging from 9.0 inches to 13.8 inches. Flood control storages of 91,600 acre-feet in Pat Mayse Reservoir and 53,600 acre-feet in Big Pine Reservoir are needed for the purpose of obtaining control of floods in the magnitude of the once-in-50-years flood. ...

f. Sediment requirements. Sanders and Big Pine Creeks both carry a relatively small sediment load, probably averaging about 1,000 parts per million in the flow of the streams. The Soil Conservation Service has prepared a "Report on Sedimentation Survey of Lakes Crook and Gibbons", dated August 1956. The lakes are in the watershed of

Pine Creek, which is located between the Sanders Creek and Big Pine Creek watersheds. Based upon findings of this report, and by reference to other data from the same general vicinity, average annual sediment deposits of about 150 acre-feet and 92 acre-feet are estimated for Pat Mayse and Big Pine Reservoirs, respectively. In a period of 50 years, this would total about 7,500 acre-feet in Pat Mayse Reservoir and 4,600 acre-feet in Big Pine Reservoir.

g. Hydroelectric power. Inspection of estimated stream flow data and the available head differential between headwater and tailwater pools indicate that the stream yield would be too small to support a hydroelectric power plant at either the Pat Mayse or Big Pine projects. Therefore, penstocks or other provisions for future power are not proposed for inclusion in the projects. Inspection of reservoir area topography indicates that the maximum head available for a pump-back installation would be much less than 150 feet, which is considered the minimum head for which a pump-back installation would be justified.

h. Irrigation. A preliminary study of the feasibility of irrigation storage in the two subject reservoirs was conducted by the Bureau of Reclamation and information was furnished this office by letter dated March 9, 1960. This study indicated that there may be a few hundred acres of irrigable land along Sanders Creek below Pat Mayse Dam site and about 850 acres along Big Pine Creek below the dam site. In addition, there are lands totaling about 15,000 acres on both sides of Red River suitable for irrigation. The Bureau's findings are that most of the land suitable for irrigation can obtain an adequate and more economical water supply by pumping from Red River, rather than irrigation from the two reservoirs. On the basis of these findings, irrigation storage in the two reservoirs is not needed.

i. Water quality and water supply needs. The Public Health Service has investigated the water quality of Big Pine and Sanders Creeks and has prepared a report on the investigation. They concluded that water from the creeks is acceptable for municipal and industrial use, with the exception of high iron and manganese concentrations which could be removed by treatment. The Public Health Service has estimated the potential water supply needs from Pat Mayse Reservoir will be about 25 mgd for the city of Paris, Texas. The City of Bonham, Texas, plans to develop a single-purpose reservoir nearby to meet their future water supply needs. The Public Health Service stated that Clarksville, the nearest city to Big Pine Reservoir, plans to contract with the Soil Conservation Service for 1 mgd from a reservoir to be built under Public Law 566 on Langford Creek, a tributary of the Sulphur River. According to Public Health Service, this amount of water will be sufficient for the future needs of the city of Clarksville, and they found no apparent need at the present time for water supply storage in Big Pine Reservoir. However, resolutions from Clarksville and Paris indicate the need for a larger quantity of water.

The City of Clarksville has furnished the Corps of Engineers a resolution requesting storage in Big Pine Reservoir to yield 26 mgd. The City of Paris has furnished a resolution requesting storage in Pat Mayse Reservoir to yield 55 mgd.

j. Conservation storage requirements. Studies were made of the maximum yield (continuous withdrawal through the most severe drought of record) from the streams, based on flows computed for the Pat Mayse and Big Pine Reservoir sites. These studies indicated that 172,000 acre-feet of storage at the Pat Mayse site would be required to provide a maximum dependable yield of about 65 mgd, and at the Big Pine site 126,000 acre-feet of storage would be required to provide the maximum dependable yield of about 31 mgd. These yields would require 2,650 acre-feet per mgd at Pat Mayse and 4,060 acre-feet per mgd at Big Pine. Storage requirements to provide the water supply yields requested by local interests are as follows: 99,700 acre-feet in Pat Mayse to yield 55 mgd; and 79,300 in Big Pine to yield 26 mgd. These yields would require 1,810 acre-feet per mgd at Pat Mayse and 3,050 acre-feet per mgd at Big Pine. Extensive diking would be required at Big Pine Reservoir to increase the water supply storage above 79,300 acre-feet and maintain the required flood control storage. Storage yield curves for Pat Mayse and Big Pine Reservoirs are shown on plates 9 and 10.

k. Adopted capacities. The reservoir capacities selected are shown in table 13.

TABLE 13

RESERVOIR CAPACITIES

Feature	Pat Mayse Reservoir Storage		Big Pine Reservoir Storage	
	acre-feet	inches	acre-feet	inches
Flood control	91,600	9.82	53,600	10.58
Water supply	99,700	10.68	79,300	15.65
Sediment	7,500	0.80	4,600	0.91
Inactive	2,000	0.21	1,100	0.22
Total	200,800	21.51	138,600	27.36

1. Spillway and outlet works:

(1) Pat Mayse Reservoir. The uncontrolled spillway would consist of a concrete gravity type chute 200 feet wide, with crest at top of flood control pool elevation 462.0. This spillway would discharge 55,400 cfs at maximum pool elevation 481.9. The flood control conduit would consist of one 5.5 foot-diameter drop inlet conduit with entrance invert at elevation 448.0. This uncontrolled conduit would

discharge 890 cfs at top of flood control pool elevation 462.0. A gate-controlled 42-inch diameter pipe would furnish water supply requirements downstream. A gated 36-inch pipe would be provided for low flow.

(2) Big Pine Reservoir. The uncontrolled spillway would consist of a concrete gravity-type chute 200 feet wide with crest at top of flood control pool elevation 430.0. This spillway would discharge 41,400 cfs at maximum pool elevation 445.9. The flood control conduit would consist of one 4 foot-diameter drop inlet conduit with entrance invert at elevation 420.0. This uncontrolled conduit would discharge 415 cfs at top of flood control pool elevation 430.0. One gated 30-inch-diameter pipe would furnish water supply requirements downstream. A gated 24-inch pipe would be provided for low flow.

m. Effect of potential SCS plan on storage requirements. A drainage district in the Sanders Creek watershed has made application to the Soil Conservation Service for assistance under Public Law 566, and a field examination has been made. Their preliminary plan includes 11 water retardation structures which would detain the runoff from about 35 percent of the basin. Based on a release rate of 10 csm from the Soil Conservation Service structures and an uncontrolled drop inlet at Pat Mayse Reservoir, the flood control storage in Pat Mayse Reservoir could be reduced about 16,000 acre-feet or the release rates could be decreased accordingly. Construction of floodwater retardation structures and installation of land treatment measures could reduce the yield during critical dry periods, thus requiring additional conservation storage to assure the water supply yield. Considering these data and the status of the SCS program, the storage requirements are based on no Soil Conservation Service improvement. Upon authorization of Pat Mayse Reservoir, a more detailed study of storages, outlet capacities, and extent of channel improvement will be made giving consideration to the Soil Conservation Service program. No applications have been received by SCS for assistance in the Big Pine Creek watershed.

n. Reduction in flooding. Pat Mayse Reservoir and the channel improvement would provide complete protection from the dam site to river mile 2.8 for all floods up to the magnitude of the 50-year flood event. Below river mile 2.8, the frequency of flooding would be reduced from about 10 floods per year to about 1 flood per year. Big Pine Reservoir and the channel improvement would provide complete protection at the dam site for all floods up to magnitude of the 50-year flood event and would provide a high degree of protection from the dam site to the mouth of Pond Creek, river mile 4.1. The reduction in flooding at river mile 3.9, below Pond Creek, is presented in table 14.

TABLE 14

NUMBER AND MAGNITUDE OF FLOODS ON BIG PINE CREEK
BELOW MOUTH OF POND CREEK (RIVER MILE 3.9)
1934 THROUGH 1958

Peak Stage (feet above *bankfull)	Natural		Modified	
	Number of Occurrences	Accumulated Number of Occurrences	Number of Occurrences	Accumulated Number of Occurrences
8 - 8.9	7	7		
7 - 7.9	7	14		
6 - 6.9	15	29		
5 - 5.9	25	54		
4 - 4.9	24	78	2	2
3 - 3.9	29	107	1	3
2 - 2.9	26	133	3	6
1 - 1.9	26	159	2	8
0 - 0.9	23	182	9	17

* Bankfull stage 367.0 feet, msl

o. Basis for relocations and land acquisition. The elevation of the once-in-50-years pool will serve as a guide for relocations and land acquisition in the flat pool area. The envelope curve of backwater effects of the 50-year flood will serve as a guide for relocations and land acquisitions in the upper reaches of the reservoir. Lands in the once-in-5-years pool not presently owned by the Federal Government will be acquired in fee.

8. DETERMINATION OF SPILLWAY REQUIREMENTS

a. General. In accordance with established procedures, the maximum probable floods were submitted Office, Chief of Engineers, for approval by letter dated December 11, 1959, subject "Maximum Probable and Standard Project Floods, Sanders and Big Pine Creeks, Texas". The floods were approved as the spillway design floods by Office, Chief of Engineers, in 2d Indorsement dated January 26, 1960. The data are included in this appendix as a matter of record.

b. Initial losses and infiltration indices. Stream gaging records are not available in the Sanders or Big Pine Creek watersheds. Initial losses and infiltration data were determined for Bois D'Arc Creek, an adjacent basin to the west of Sanders Creek, for North Sulphur Creek, the adjacent basin to the south of Sanders and Big Pine Creeks, and for an intervening area of the Red River which includes Sanders Creek. Relative data for the three gaged areas are shown in table 15.

TABLE 15

INITIAL LOSSES AND INFILTRATION INDICES

Storm Period (inclusive dates)	Average Rainfall (inches)	Storm Runoff (inches)	Initial Loss, Li (inches)	Infiltration Index, Fav (inches/hour)
Bois D'Arc near Bonham Texas				
May 10 1948	4.80	3.52	0.96	0.04
Jul 5 1950	2.70	1.37	1.01	0.04
North Sulphur River near Cooper, Texas				
Feb 11-12 1950	3.63	3.39	0	0.02
Apr 28-29 1953	4.70	3.63	0.71	0.04
Mar 20-21 1955	2.65	1.36	1.01	0.04
Feb 16-17 1956	3.00	1.69	0.95	0.04
(1) Red River at Arthur City, Texas				
Apr 19-20 1942	3.23	2.72	0.30	0.015
Apr 23-25 1942	2.59	2.22	0.10	0.010
Jun 8-14 1945	5.92	2.51	1.40	0.098
Jun 16-18 1945	2.86	1.82	0.80	0.037
Dec 9-12 1946	4.00	2.68	1.13	0.008

(1) Intervening area below Colbert on Red River, Blue on Blue River, Caney on Clear Boggy Creek, and Farris on Muddy Boggy Creek.

From a study of the above data and consideration of soil, vegetative and topographic conditions, an initial loss of 0.80 inch and an infiltration index of 0.03 inch per hour were selected for the provisional spillway design storms for the subject areas.

c. Unit hydrographs. There are no stream gaging records on Sanders Creek or Big Pine Creek; therefore, synthetic unit hydrographs were derived. Two floods on Bois D'Arc Creek near Bonham, Texas (131 square miles) and 4 floods on North Sulphur River near Cooper, Texas (276 square miles) were analyzed for determination of flood conditions. A comparison of the watershed characteristics and vegetative cover of the 4 basins indicates values of $C_t = 1.8$ and $C_p = 0.6$, applicable for both Sanders Creek and Big Pine Creek. The 6-hour unit hydrographs are shown on plate 5.

d. Maximum probable storms and floods. The maximum probable storms for the areas above the dam sites on Sanders and Big Pine Creeks were derived from charts in Hydrometeorological Report No. 33,

dated April 1956. In previous studies, transpositions of storms over small watersheds have resulted in less rainfall than is obtained from subject report; therefore, no actual storms were transposed over the watershed. A storm period of 60 hours was used for the 175 square miles and the 95 square miles above the dam sites on Sanders and Big Pine Creeks, respectively. Total storm rainfall values were determined by extrapolation of the data from Report No. 33 beyond 48 hours. The shapes of the two watersheds are in close agreement with the elliptical isohyetal storm pattern shown on plate 12 of CEB 52-8, and no appreciable reduction for shape factor is indicated. Therefore, the average storm rainfall, derived as previously described, was used without adjustment.

e. Spillway design floods. The maximum probable storms were arranged by 6-hour periods in accordance with Civil Engineer Bulletin 52-8. Rainfall excess, as determined using the selected loss rates, was applied to the adopted unit hydrographs for natural flow at the dam sites. These computations and the resulting spillway design floods at Pat Mayse and Big Pine Dam sites are shown in tables 16 and 17, respectively.

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TABLE 16

SPILLWAY DESIGN FLOOD - PAT MAYSE DAM SITE

Hour	Rainfall (inches)	Loss (inches)	Rainfall Excess (inches)	Adopted Unit Hydrograph	Base Flow (1,000 cfs)	Spillway Design Flood (1,000 cfs)
2	0.60	0.60	0	30	0.5	0.5
4				290	0.5	0.5
6				990	0.5	0.5
8	0.80	0.34	0.46	2,220	0.5	0.5
10				3,600	0.5	0.6
12				4,800	0.5	1.0
14	0.80	0.18	0.62	5,600	0.5	1.5
16				5,750	0.5	2.3
18				5,500	0.5	3.3
20	1.00	0.18	0.82	5,000	0.5	4.5
22				4,400	0.5	5.6
24				3,750	0.5	6.8
26	3.40	0.18	3.22	3,060	0.5	8.2
28				2,450	0.5	10.0
30				1,900	0.5	12.8
32	25.60	0.18	25.42	1,500	0.5	17.5
34				1,200	0.6	28.1
36				950	0.6	48.9
38	1.10	0.18	0.92	740	0.7	81.9
40				590	0.8	116.8
42				460	0.9	146.2
44	1.00	0.18	0.82	370	1.0	165.3
46				290	1.1	168.0
48				230	1.2	160.7
50	0.80	0.18	0.62	180	1.3	147.1
52				140	1.4	131.0
54				110	1.5	113.7
56	0.60	0.18	0.42	90	1.5	95.6
58				70	1.5	79.5
60				50	1.5	64.8
62				40	1.5	53.8
64				30	1.5	45.2
66				30	1.5	37.7
68				20	1.5	31.1
70				20	1.5	25.9
72				10	1.5	21.1
74				10	1.5	17.5
76					1.5	14.3
78					1.4	11.6
80					1.4	9.5
82					1.4	7.7
120					0.8	0.8
Total	35.70	2.38	33.32	56,470	57.9	1,939.5

TABLE 17

SPILLWAY DESIGN FLOOD - BIG PINE DAM SITE

Hour	Rainfall (inches)	Loss (inches)	Rainfall Excess (inches)	Adopted Unit Hydrograph	Base Flow (1,000 cfs)	Spillway Design Flood (1,000 cfs)
2	0.60	0.60	0	30	0.3	0.3
4				200	0.3	0.3
6				900	0.3	0.3
8	0.80	0.34	0.46	1,950	0.3	0.3
10				3,100	0.3	0.4
12				3,780	0.3	0.7
14	0.90	0.18	0.72	3,930	0.3	1.2
16				3,600	0.3	1.9
18				3,000	0.3	2.7
20	1.00	0.18	0.82	2,400	0.3	3.5
22				1,880	0.3	4.4
24				1,440	0.3	5.1
26	3.50	0.18	3.32	1,100	0.3	5.9
28				830	0.3	7.0
30				620	0.3	9.2
32	27.30	0.18	27.12	470	0.3	13.0
34				350	0.3	20.7
36				270	0.3	41.0
38	1.10	0.18	0.92	200	0.4	69.3
40				150	0.4	97.4
42				110	0.5	115.6
44	0.90	0.18	0.72	90	0.5	118.2
46				70	0.6	108.5
48				50	0.7	91.7
50	0.80	0.18	0.62	40	0.7	75.0
52				30	0.8	60.6
54				20	0.8	48.3
56	0.50	0.18	0.32	20	0.8	38.7
58				10	0.8	31.0
60				10	0.8	24.8
62					0.8	20.1
64					0.8	16.2
66					0.8	13.2
68					0.8	10.5
70					0.8	8.4
72					0.8	6.5
74					0.8	5.4
76					0.8	4.3
78					0.8	3.4
80					0.8	2.8
82					0.8	2.0
84					0.7	1.8
98					0.5	0.6
Total	37.40	2.38	35.02	30,650	27.1	1,098.5

f. Magnitude of spillway design floods. The envelope curves of maximum experienced peak discharges of record for areas east of the 97th Meridian within the Tulsa District, together with curves derived by Myer and by Creager, are shown on plate 6. The peak discharges for the spillway design floods for Pat Mayse and Big Pine Dam sites are shown thereon. Peak discharges and flood volumes for the maximum probable floods and related data are shown in table 18.

TABLE 18

COMPARATIVE FLOOD DATA

Item	Pat Mayse Dam Site	Big Pine Dam Site
Drainage area, sq mi	175	95
Spillway design flood volume:		
acre-feet	320,600	181,900
inches	34.35	35.90
Spillway design flood peak discharge:		
cfs	168,000	118,000
cfs/sq mi	960	1,242
Myer's rating	1.27	1.21
Creager's C	1.00	0.97
Ratio spillway design flood to envelope of floods east of 97th Meridian	1.73	1.80

g. Routing of the spillway design floods. The spillway design floods were adjusted for conditions of inflow into full pool for routing through the reservoir. The reservoirs were assumed at top of flood control pool at the beginning of the spillway design floods. The spillway design floods were routed with several spillway widths for each reservoir to determine the most economical design. A 200-foot spillway width was selected for both reservoirs. The spillway design flood operational hydrographs for Pat Mayse Reservoir are shown on plate 7 and for Big Pine Reservoir on plate 8.

h. Standard project flood. No local protection projects are required within Pat Mayse or Big Pine Reservoir areas; hence, detailed derivations of standard project floods were not made. One-half of the spillway design flood was adopted as the standard project flood.

9. PERTINENT DATA

Pertinent data on the recommended reservoirs are shown in tables 19 and 20.

TABLE 19

PERTINENT DATA - PAT MAYSE RESERVOIR

LOCATION: Sanders Creek at mile 4.4

DRAINAGE AREA: 175 square miles

ELEVATION, AREAS AND STORAGE:

Feature	Elevations (feet above msl)	Reservoir Area (acres)	Reservoir Capacity (acre-feet)	Equivalent Runoff (inches)
Top of dam	487.0	-	-	-
Maximum pool	481.9	-	-	-
Top of flood control pool & spillway crest	462.0	7,950	200,800	21.51
Top of conservation pool	448.0	5,450	107,200	11.48
Flood control storage	448.0-462.0	-	(1) 93,600	10.03
Conservation storage	Below-448.0	-	(2) 107,200	11.48

(1) Includes 2,000 acre-feet sediment reserve.
(2) Water supply storage: 99,700 acre-feet; yield 55 mgd; sediment reserve 5,500 acre-feet; inactive storage 2,000 acre-feet.

SPILLWAY: 200-foot uncontrolled
Discharge at maximum pool, 55,400 cfs

HYDROLOGIC DATA:

Spillway design flood:	peak flow	168,000	cfs
	volume	320,600	acre-feet
	runoff	34.35	inches
	duration	5	days
Maximum experienced flood: (January 1949)	peak flow	22,800	cfs
	volume	48,600	acre-feet
	runoff	5.21	inches
	duration	5	days
Channel capacity at dam site:	natural	500	cfs
	improved	1,300	cfs

TABLE 20

PERTINENT DATA - BIG PINE RESERVOIR

LOCATION: Big Pine Creek at mile 13.2

DRAINAGE AREA: 95 square miles

ELEVATION, AREAS AND STORAGE:

Feature	Elevation (feet above msl)	Reservoir Area (acres)	Reservoir Capacity (acre-feet)	Equivalent Runoff (inches)
Top of dam	451.0	-	-	-
Maximum pool	445.9	-	-	-
Top of flood control pool & spillway crest	430.0	6,400	138,600	27.36
Top of conservation pool	420.0	4,640	83,900	16.56
Flood control storage	420.0-430.0	-	(1) 54,700	10.80
Conservation storage	Below-420.0	-	(2) 83,900	16.56

(1) Includes 1,100 acre-feet sediment reserve.
(2) Water supply storage: 79,300 acre-feet; yield 26 mgd; sediment reserve 3,500 acre-feet; inactive storage 1,100 acre-feet.

SPILLWAY: 200-foot uncontrolled
Discharge at maximum pool, 41,400 cfs

HYDROLOGIC DATA:

Spillway design flood:	peak flow	118,000	cfs
	volume	181,900	acre-feet
	runoff	35.90	inches
	duration	4	days
Maximum experienced flood: (January 1949)	peak flow	11,100	cfs
	volume	25,800	acre-feet
	runoff	5.10	inches
	duration	5	days
Channel capacity at dam site:	natural	300	cfs
	improved	800	cfs

APPENDIX II

DAMAGES, BENEFITS, PROJECT JUSTIFICATION AND COST ALLOCATION

1. PURPOSE

The purpose of this appendix is to present economic data regarding values, damages and benefits, project justification and cost allocation supplemental to that contained in the main body of the report. Damages and benefits herein were computed using a 100-year period of analysis, September 1960 price levels and development, and considering existing and authorized projects in the Red River Basin in operation.

2. SCOPE

Economic studies made of Sanders and Big Pine Creeks are of survey scope, but only preliminary investigations were made of Collier Creek. It was found that because of physical limitation of the Acworth Dam site (at mile 3.9), on Collier Creek, the total storage would be limited to flood control storage required to control only floods of record, water supply storage which would yield 2.5 mgd, and sediment storage. This project would cost over 3 million dollars. The total annual benefits for flood control, water supply and other aspects of this project would amount to less than one-half of the annual costs. Accordingly, a study of survey scope was not considered warranted for the Collier Creek area.

3. AREA UNDER CONSIDERATION

The area under consideration is the area subject to overflow on Sanders Creek below the Pat Mayse Dam Site (mile 4.4) and on Big Pine Creek below the Big Pine Dam site (mile 13.2). The area overflowed is entirely rural and varies in width from 0.5 mile to 1.5 and 2.0 miles on Big Pine Creek and Sanders Creek, respectively. The classification of land by streams and reaches is shown in table 1.

TABLE 1

CLASSIFICATION OF LAND
(in acres)

	Sanders Creek Pat Mayse Dam Site to Mouth	Big Pine Creek Big Pine Dam Site to Mouth
Cultivated	1,050	620
Tillable pasture	630	1,840
Woods pasture	420	1,640
Total	2,100	4,100

4. POPULATION

There are no residents within the overflow limits and the only employees there are engaged in raising of livestock and the production of crops. There are no large cities located within the watersheds; however, Paris, Bonham, Clarksville and Honey Grove, Texas, in the general vicinity, have 1960 populations of 20,977, 7,357, 3,851 and 2,071 respectively.

5. ECONOMIC DEVELOPMENT

The flood plains under consideration are used for the production of diversified crops and raising livestock. Most of the farms are owner-operated. Property subject to flood damages include highways and bridges, power lines, telephone and telegraph lines, rural supplies stock and equipment, and rural land and improvements. Estimated property values based on September 1960 price levels and including proven and unproven minerals are shown in table 2.

TABLE 2

VALUATION OF PROPERTY

Classification of Property	Sanders Creek Pat Mayse Dam Site to Mouth	Big Pine Creek Big Pine Dam Site to Mouth
	$	$
Publicly-owned property:		
Highways & bridges	125,000	130,000
Privately-owned property:		
Public utilities	3,000	2,000
Rural supplies, stock & equipment	267,000	442,000
Rural land & improvements	225,000	342,000
Subtotal - privately-owned property	495,000	786,000
Total - all property	620,000	916,000

6. VALUE OF CROPS

The principal crops grown in the flood plain areas are alfalfa, cotton, corn, oats and sorghum. The annual value of crops, based on September 1960 prices, is summarized in table 3.

TABLE 3

ANNUAL VALUE OF CROPS

Crop	Sanders Creek Pat Mayse Dam Site to Mouth		Big Pine Creek Big Pine Dam Site to Mouth	
	Acres	Value	Acres	Value
		$		$
Alfalfa	420	30,000	410	29,300
Cotton	150	26,300	-	-
Corn	270	11,300	210	8,800
Oats	190	4,900	-	-
Sorghum	20	300	-	-
Tillable pasture	630	25,200	1,840	73,600
Woods pasture	420	400	1,640	1,600
Total	2,100	98,400	4,100	113,300

7. EXPERIENCED FLOOD LOSSES

The areas under consideration have experienced several major floods during the 25-year period of record beginning in 1934. The maximum flood of record occurred in January 1949 on Sanders and Big Pine Creeks. A recurrence of the 1949 flood would cause flood damages on Sanders Creek estimated to be $30,000 of which $12,000 would be crop losses (on 2,100 acres of farm land), and $18,000 structural losses. The 1949 flood would cause flood damages on Big Pine Creek estimated to be $36,000, of which $10,000 would be crop losses (on 4,100 acres of farm land), and $26,000 structural losses. The crop losses would be considerably greater should the 1949 flood recur during summer months.

8. METHOD OF INVESTIGATION

A field survey of damages resulting from the maximum floods of record on the three streams under study, using current prices and present-day development, was made by representatives of the Tulsa District in the winter of 1958 and a field check of the flood plain areas was made in 1960. From these data, stage-damage curves for each classification of property and stage-area curves for each reach were constructed. The stage-damage curves indicate the estimated structural damage for any intermediate stage between bankfull and the maximum stage; the stage-area curves indicate the estimated area in acres that would be overflowed for any intermediate stage between bankfull and the maximum stage. These curves were utilized in estimating the damages to be expected from the various floods of record. Annual crop damages were based on losses weighted to reflect frequency, duration of flooding, and season of year. Plate 1 shows the various curves used in the loss and benefit analysis for a portion of the area affected by the proposed projects.

9. USE OF EXPERIENCED FLOOD DATA

Experienced flood data pertaining to magnitude and frequency were considered to offer the most reasonable basis for the prediction of future flood occurrences. Accordingly, frequency curves were constructed, based on the assumption that past floods occurring over an extended period would be repeated in the future. Use was made of discharge probability curves (determined by using general procedures as outlined in part VI, paragraphs 2 and 3 of "Statistical Method of Hydrology", dated July 1952, distributed under Civil Works Engineer Bulletin 52-24) for developing discharge-frequency and duration-frequency curves. Rating (stage-discharge) curves were developed from known and synthetic data, with stage as the ordinate and discharge as the abscissa. The frequency curves (discharge and duration) were applied to the rating (stage-discharge) curves to develop a stage-frequency and stage-duration relationship. Flood loss expectancies were computed by applying this relationship (with and without the proposed projects) against the stage-damage and stage-area curves at increments ranging from the no-damage stage to the maximum stage to be expected in the period of 100 years.

10. AVERAGE ANNUAL LOSSES

Recurring losses in the flood plain areas under consideration were converted to average annual losses by use of damage-frequency curves with and without the proposed projects. The damage-frequency curves for crops were derived by correlation of the duration of floods, crop loss per acre, stage-area curves, and the stage-frequency relationship. Similarly, the damage-frequency curve for structures was obtained by correlation of the stage-damage curve and the stage-frequency relationship. Plate 1, appendix II, shows the results obtained by these procedures for the area affected by the Pat Mayse project on Sanders Creek. Data for crops and structural losses in the remaining areas were treated in like manner. The average annual structural and crop damages, natural and modified, were determined by measuring the area under the damage-frequency curves which were plotted with damages as the ordinate and percent-chance-of-occurrence as the abscissa. Details of the estimated average annual losses for the areas under consideration, based on September 1960 price levels and development, are shown in table 4.

TABLE 4

AVERAGE ANNUAL LOSS EXPECTANCIES

Classification of Property	Sanders Creek Pat Mayse Dam Site to Mouth	Big Pine Creek Big Pine Dam Site to Mouth
	$	$
Publicly-owned property:		
Highways & bridges	11,100	6,540
Privately-owned property:		
Public utilities	600	390
Rural supplies, stock & equipment	10,700	24,330
Rural land & improvements	12,200	16,830
Crops	31,200	25,710
Subtotal - privately-owned property	54,700	67,260
Total - all property	65,800	73,800

11. FLOOD CONTROL BENEFITS

a. General. The tangible flood control benefits which would accrue to the Pat Mayse and Big Pine Reservoirs include flood losses prevented, future development benefits, benefits from increased land utilization, and land rentals from leasing of reservoir lands. These benefits have been analyzed for a 50-year period and a 100-year period. Flood control benefits for the 100-year period were adjusted to include an allowance for encroachment by the sediment pool on the flood control storage. Flood control benefits, based on the 100-year analysis for the two projects, are discussed in the following paragraphs and are shown in table 5.

b. Flood losses prevented. With the Pat Mayse Dam and Reservoir in operation, all floods of record would be completely controlled at the dam site and essentially controlled downstream to the mouth, to the extent that annual flood losses prevented would become practically the same as natural flow losses in table 4, or $65,200. The Big Pine Dam and Reservoir would provide a high degree of protection from floods on Big Pine Creek with the total flood losses prevented estimated to be $68,600, of which $23,500 are crop losses prevented and $45,100 are structural losses prevented. Details of the flood losses prevented by the proposed projects are shown in table 5.

c. Future development. These benefits were based on an examination of population trends and consideration of the past and future economic production trends in both the areas under study and in similar areas having comparable transportation, natural resources, and technological development. Also, an examination of the area was made

by representatives of the Tulsa District. It is estimated that during the 100-year period of analysis, Sanders and Big Pine Creeks areas would experience average increases in development of 14 and 9 percent respectively, without protection from floods and development of the water resources potential. Basic data for this increase are shown in supplement A. Based on the above, benefits from future development are considered applicable and the percentages applied against the losses prevented by the projects result in future development benefits of $9,100 and $13,000 annually for the Pat Mayse and Big Pine Reservoirs, respectively.

d. Increased land utilization. The flood protection provided by the proposed projects would result in change in land-use, an increase in crop production (due to elimination of weed infestation), wider latitude in the timing of farm operations, and reduction of land erosion by floodwaters. These benefits are determined by the difference in the annual net earning power of land before and after flood protection, based on flood-free years. The benefits from increased land utilization were reduced by application of the percentage of damage reduction provided by the projects. These benefits are estimated to be $13,800 and $24,900, respectively, for the Pat Mayse and Big Pine Reservoirs.

e. Red River benefits. The two reservoirs would cause some decrease in flood stages on the Red River. However, for purposes of this study, flood control benefits were not claimed on Red River.

f. Land rental benefits. Estimates of income to be derived from land rentals and other leases in the reservoir areas were made by agricultural appraisers of the Tulsa District. Benefits from these sources are estimated to be $3,000 and $2,500 annually for the Pat Mayse and Big Pine Reservoirs, respectively. Since these benefits are primarily from lands in the flood control pool, they are considered herein as flood control benefits. As required by existing law, 75 percent of such revenue would be returned to the State of Texas for the use of the counties involved.

g. Summary of flood control benefits. The estimated average annual flood control benefits which would accrue to the Pat Mayse and Big Pine Reservoirs based on a 100-year period of analysis, are summarized in table 5.

TABLE 5

SUMMARY OF FLOOD CONTROL BENEFITS
100-Year Analysis (1)

Item	Project	
	Pat Mayse	Big Pine
	$	$
Flood losses prevented:		
Crops	30,900	23,500
Structures	34,300	45,100
Subtotal	65,200	68,600
Future development	9,100	13,000
Increased land utilization	13,800	24,900
Land rental benefits	3,000	2,500
Total, flood control benefits	91,100	109,000

(1) Based on 50-year analysis, the total flood control benefits are $88,600 and $105,000 for Pat Mayse and Big Pine Reservoirs, respectively.

12. OTHER RESERVOIR BENEFITS

a. Water supply benefits. A Public Health Service report on water supply requirements is included in appendix IV. That report concludes that the cost of an alternative water-supply-only project at the site, based on non-Federal design and financing, would be a reasonable value for the 99,700 acre-feet of storage for water supply in the Pat Mayse Reservoir. Their estimated annual cost of such a project, based on 4 percent interest rate, was $222,000, but using the same project first cost and 3 percent interest rate, the annual cost becomes $189,400, which is used herein as a benefit for the Pat Mayse project. The Public Health Service report indicated there appeared to be no source of demand for water supply storage in the Big Pine Reservoir and did not present any value for such storage. However, in view of the assurances from the City of Clarksville that the water would be utilized by that city, it was included as a project purpose with the benefits based on the cost of a non-Federal designed water supply reservoir at 3 percent interest rate. The annual cost of such a project is estimated to be $220,000, which has been used as the water supply benefit for the Big Pine Reservoir.

b. Recreational benefits. Both the Pat Mayse Reservoir on Sanders Creek and the Big Pine Reservoir on Big Pine Creek are located in low hill country adjoining the Red River valley of northeast Texas. Although there are no outstanding scenic features in the immediate

areas, the large lake and irregular shoreline of each project would be interesting and attractive for recreational use. The Pat Mayse Dam would be located only one mile from U. S. Highway 271, a principal north-south trafficway between Texas and Oklahoma. Because of existing and authorized reservoir projects in the vicinity, the effective use of the lakes will be by people in the localities. The nearest cities are Paris (population 20,977) and Clarksville (population 3,841), Texas, and Hugo (population 6,287) and Idabel (population 4,967), Oklahoma. (1960 census.) It is estimated that, excluding sport fishing and hunting, 185,000 and 150,000 visitors, respectively, would be attracted annually to the Pat Mayse and Big Pine projects by their scenic quality and water recreation opportunities. At the conservative rate of 50 cents per visitor day, the recreational benefits would be $92,500 and $75,000 annually for the Pat Mayse and Big Pine Reservoirs, respectively.

c. Fish and wildlife benefits.

(1) Existing habitat. The Big Pine and Pat Mayse Reservoirs are in an area characterized by low rolling hills lying along the Red River Valley in Red River and Lamar Counties, Texas. The principal types of wildlife habitat within the reservoir areas are postoak and blackjack forest with bottomland - hardwood along the streams. Predominate wildlife species in the area are bobwhite, quail, squirrels, mourning doves, and rabbits. The Big Pine and Sanders Creeks offer only fair stream fishery because of erratic flows which fluctuate from flood conditions to zero occurrences periodically. Channel catfish and sunfish are the predominate sport species along with rough-fish species. Largemouth bass, white bass and crappie are also found in small numbers.

(2) Fish and Wildlife Service report. The Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, in a draft report submitted 10 February 1960, indicates that construction of the Pat Mayse and Big Pine projects would result in substantial losses of deer and upland game habitat. It also shows a minor loss of stream fishery habitat resulting from the construction and improvement of the channel downstream. However, the report shows that construction of the projects would create significant reservoir fishery benefits and increase the waterfowl habitat and hunting opportunities, which would result in an over-all increase in the fish and wildlife resources. Net benefits of $91,000 and $64,975 (without recommended mitigation measures) are shown for the Pat Mayse and Big Pine projects, respectively. With the recommended improvements, the report indicates that deer and upland game losses can be partially mitigated and stream fishery can be enhanced.

(3) The Corps of Engineers considers that the provision of conservation storage in the Pat Mayse and Big Pine Projects, as planned, would replace a limited stream fishery with an improved reservoir-type fishery. The principal sport fish population would consist of largemouth bass, white bass, white and black crappie and channel

catfish. Flathead and blue catfish would also contribute to the fisheries of the two reservoirs. Waterfowl habitat would also be increased by impoundments by providing resting and feeding areas. Hunting for ducks and geese would be greatly increased. Project perimeter lands would support upland game, such as bobwhite quail, squirrels and cottontail rabbits. The reservoirs would offer a greater diversification of fish and wildlife habitat, and any specific losses could be replaced by proper management of lands in the reservoir areas. The natural attractiveness of the projects is expected to draw fishermen and hunters from a widespread area, with much of the visitation from residents of Texas and Oklahoma. The Tulsa District has considered the fish and wildlife benefits from the standpoint of values based on visitor-day use for hunting and fishing. It is estimated there would be 100,000 participants in sport fishing and 15,000 in hunting waterfowl and upland game at the Pat Mayse Reservoir annually, while the estimated annual visitor use for sport fishing and hunting in the Big Pine Reservoir would be 90,000 and 10,000, respectively. Credited annual fish and wildlife benefits, totaling $117,400 at Pat Mayse and $102,200 at Big Pine, were based on a total unit value of $1 each visitor day for hunting and fishing and 15 cents per pound dockside price for commercial fish harvested from the reservoirs. These benefits are considered equivalent to the net value of the fish and wildlife resources evaluated with and without the project. This method for evaluating the recreational, harvest and conservation values of the fish and wildlife resources is believed reasonable and compatible with the Fish and Wildlife Coordination Act (Public Law 85-624). Fur-bearing animals in the project area are limited, and it is not expected that the reservoir will materially affect these resources.

13. INTANGIBLE BENEFITS

Intangible benefits are those benefits which are difficult to evaluate or for which no satisfactory method of evaluation has been established. Construction of the proposed reservoirs would minimize the anxiety of the flood plain residents downstream from the project by reducing the dangers accompanying floods, and the threat of epidemics that follows. Other intangible benefits include reduction of pollution of wells and other water supplies; increase in the value of non-Federal recreational developments; and reduction of interruption to traffic movement and other normal social processes in the valley. While these unevaluated intangible benefits are not utilized in computation of the benefit-cost ratios, it is apparent that they add to the desirability of the projects.

14. SUMMARY OF CREDITABLE BENEFITS

The estimated average annual benefits credited to the Pat Mayse and Big Pine Reservoirs are $490,400 and $506,200, respectively. These benefits, based on a 100-year period of analysis, are summarized in table 6.

TABLE 6

SUMMARY OF CREDITABLE BENEFITS

Item	Pat Mayse Reservoir	Big Pine Reservoir
	$	$
Flood control	91,100	109,000
Water supply	189,400	220,000
Recreation	92,500	75,000
Fish & wildlife	117,400	102,200
Total	490,400	506,200

15. ESTIMATED COST AND ANNUAL CHARGES

The costs and annual charges for the Pat Mayse and Big Pine Reservoirs were based on January 1960 price levels. The interest rate of 2-5/8 percent on the land investment was considered ample to reflect any net loss that might occur due to use of the lands for project purposes, when considered in conjunction with other unevaluated benefits such as increased tax returns from land adjacent to the reservoir. Since, in addition to the above, the projects as planned would not require any future additions, it was concluded that financial and economic costs would be the same. Based on a 100-year period of analysis, the estimated cost and annual charges for the Pat Mayse project are estimated to be $7,590,000 and $301,000, respectively. The estimated cost and annual charges for the Big Pine project for a 100-year period of analysis are estimated to be $8,590,000 and $319,000, respectively.

16. PROJECT JUSTIFICATION

Based on annual benefits of $490,400 and annual charges of $301,000, the benefit-cost ratio for the Pat Mayse project is 1.6. Based on annual benefits of $506,200 and annual cost of $319,000, the benefit-cost ratio for the Big Pine project is 1.6.

17. PROJECT FORMULATION

a. The recommended projects for Sanders and Big Pine Creeks were developed from the concept that they would provide (1) project benefits exceeding project costs; (2) benefits at least equal to the cost of each separable segment or purpose; (3) would provide a practical means of fulfilling existing and prospective needs; (4) would be more economical to develop than other alternatives; (5) would consider all beneficial and detrimental effects; and (6) insofar as consistent with the above, would provide a maximum of benefits over cost. The preliminary studies indicated that, to meet the above conditions, a desirable flood control plan for each stream would be a reservoir with sufficient flood control storage to provide maximum protection against floods in the magnitude of once-in-50-years occurrence. These studies found that

although flood-control-only reservoirs to control the 50-year flood on the two streams could not be justified economically, provision of flood control storage would be feasible in conjunction with water supply capacity of the scope desired by local interests at the Pat Mayse and Big Pine sites. Since effective flood control operation of the reservoirs would require increased capacity of the outlet channels, this item was included in the project costs. As the flood problem, water needs and related recreation and fish and wildlife uses are not conducive to individual solution, their solution by multiple-purpose development was studied.

b. Economic tests of the water supply function considered constant flood control capacities of 84,100 acre-feet at the Pat Mayse site and 49,000 acre-feet at the Big Pine site. Various scales of project development for water supply were analyzed for the two reservoirs, to determine the point of maximum project benefits over cost, and fulfill (but not overanticipate) the prospective needs. From these studies, an annual benefit-total storage curve and an annual cost-total storage curve were constructed for each project. These two curves were then utilized to prepare a curve for each project, indicating the excess benefits over cost versus water supply storage. These curves (figures 1 and 2) indicate that the recommended plans for the Pat Mayse and Big Pine projects are reasonable and provide practicable means of fulfilling existing and prospective water supply needs for the Sanders and Big Pine Creek areas.

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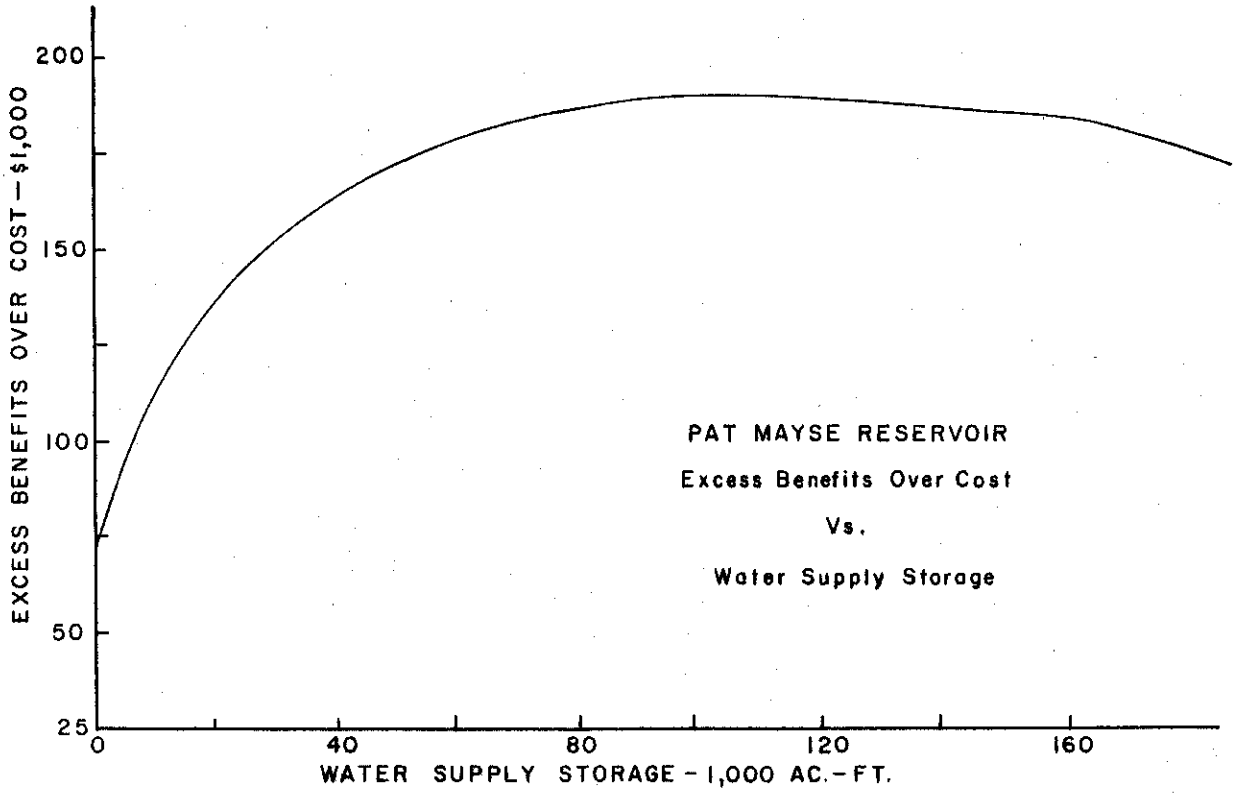

Figure 1

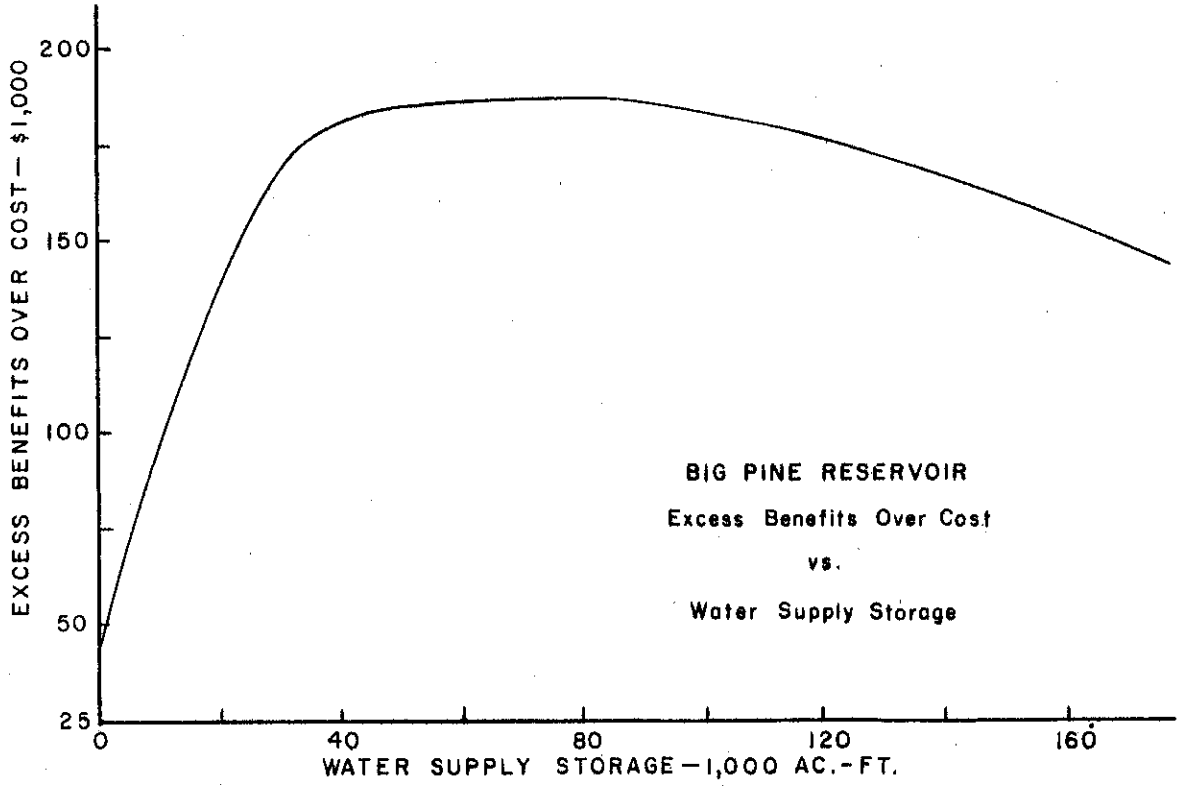

Figure 2

c. The flood control segments of Pat Mayse and Big Pine Reservoirs were formulated with the existing and authorized reservoirs in the Red River Basin considered in operation. Hydrologic studies (appendix I) found the following storage requirements: For Pat Mayse Reservoir; 96,800 acre-feet to control the maximum flood series of record, 91,600 acre-feet for the 50-year flood series, and 160,300 acre-feet to control the standard project flood; for Big Pine Reservoir; 40,500 acre-feet to control the maximum flood series, 53,600 acre-feet for the 50-year flood series, and 91,000 acre-feet to control the standard project flood. Benefits were credited to the reservoirs only for reduction of damages caused by the tributary stream overflows. The reservoirs would have some effect on Red River flood flows. However, for purposes of this study, flood control benefits were not claimed on Red River. Results of economic tests of various volumes of flood control storages on such incremental project operation, considering a constant water supply capacity of 99,700 and 79,300 acre-feet, respectively, for Pat Mayse and Big Pine Reservoirs, are shown on figures 3 and 4.

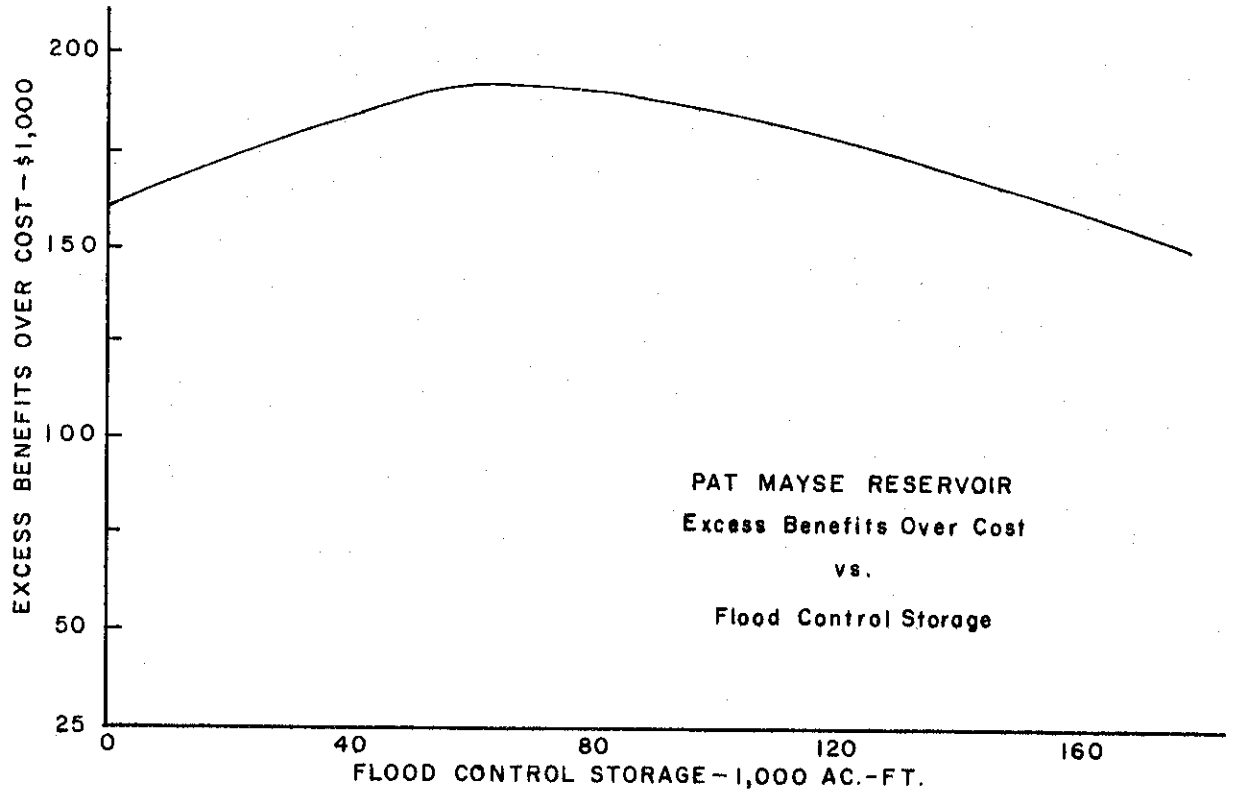

Figure 3

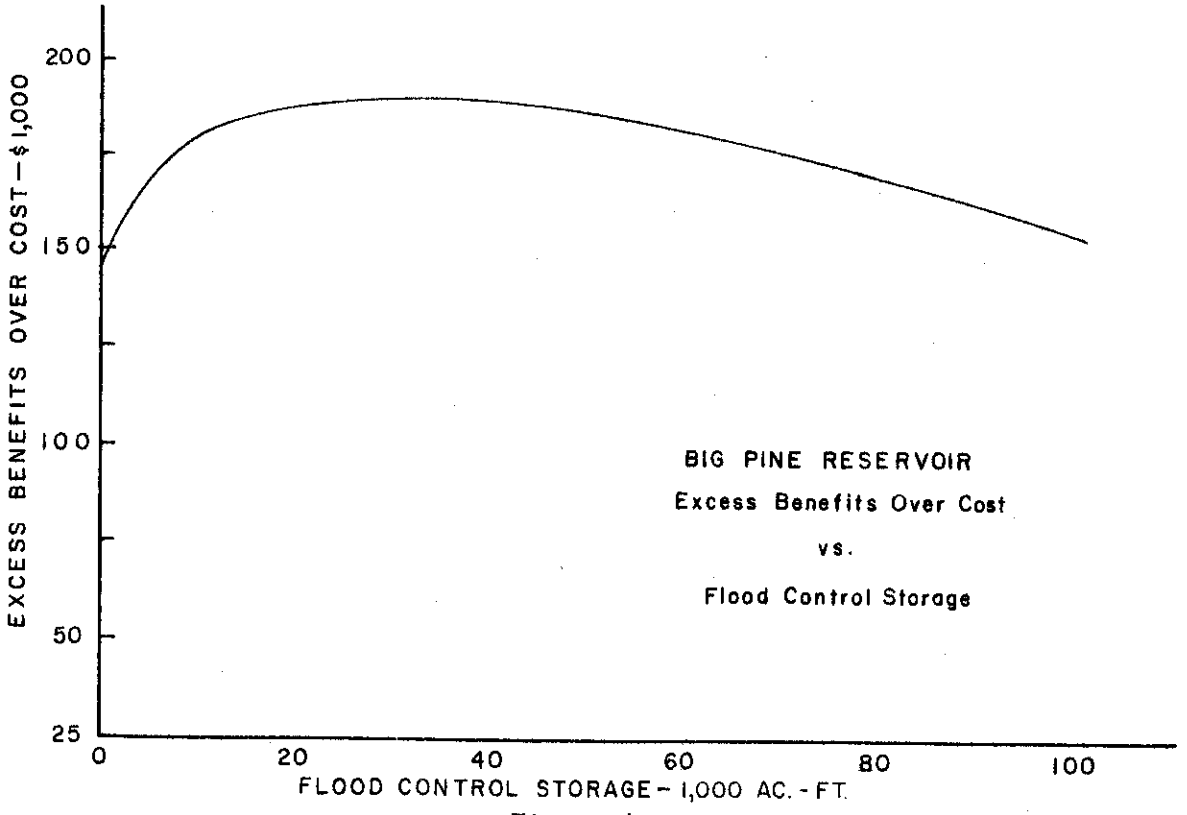

Figure 4

Hydrologic studies (appendix I) indicate that control of the 50-year flood events would be attained with storage 5 percent less than that required for the maximum flood of record at Pat Mayse Reservoir (91,600 acre-feet, compared to 96,800 acre-feet) and 33 percent more than that required for the maximum flood of record at Big Pine Reservoir (53,600 acre-feet, compared to 40,500 acre-feet). Storages to provide for control of the 50-year flood on Sanders and Big Pine Creeks exceed the point of maximum tangible benefits over cost. Maximum benefits over costs would be attained with flood control storage of approximately 70,000 and 30,000 acre-feet at the Pat Mayse and Big Pine Reservoir sites, respectively. Because of the greater degree of flood protection attained with relatively small additional cost, storages of 91,600 and 53,600 acre-feet were selected for Pat Mayse and Big Pine Reservoirs, respectively, to control the 50-year floods. Although the analyses show less economic justification for the added incremental storage for control of the 50-year flood series at the Pat Mayse and Big Pine sites, it is considered that the minor deficiency in tangible benefits would be offset by the important unevaluated intangible benefits cited in paragraph 13 of this appendix.

d. The formulated multiple-purpose plans are supported by overall project justification based on Pat Mayse and Big Pine Reservoirs operating independently of other projects in Red River Basin. Procedures used for inclusion of recreation and fish and wildlife as project purposes are discussed in paragraph 12 of this appendix.

18. COST ALLOCATION

The separable costs-remaining benefits method of cost allocation was used for the Pat Mayse and Big Pine projects. For this method of allocation, the benefit, alternate cost and separable cost are estimated for each purpose. The separable cost is then deducted from the lesser of each purposes' benefits or alternate cost. The lesser figure is used, since alternate cost is used in this method only if it represents a justifiable expenditure; that is, if it does not exceed the benefits. The remainders are used to distribute the residual costs (joint cost), which are the total costs remaining after deduction of the total separable costs from the total cost of the multiple-purpose project. The distributed residual cost and the separable cost are added together to obtain the total cost allocated to each purpose. The separable and specific costs of public-use facilities were prorated to recreation and fish and wildlife by the ratio of annual visitor days for each purpose. A summary of costs, annual charges, and benefits for multiple-purpose and single-purpose projects are given in tables 7 and 8. Details of the allocations are shown in tables 9 and 10.

19. COST SHARING

Local interests' share of the Pat Mayse Reservoir first cost of $7,550,000 (not including preauthorization costs), shown in table 9,

would include reimbursement of the water supply cost of $3,370,000. Local interests would also be required to contribute the proportionate part of the cost of operation and maintenance of the Pat Mayse Reservoir chargeable to water supply, now estimated at $22,100 annually, and bear replacement cost (when incurred) and interest cost for annual payments. Local interests' share of the Big Pine Reservoir first cost of $8,550,000 (not including preauthorization costs), shown in table 10 would include reimbursement of the water supply cost of $4,131,000. Local interests would also be required to contribute the proportionate part of the cost of operation and maintenance of the Big Pine Reservoir chargeable to water supply, now estimated at $20,300 annually, and bear replacement cost when incurred and interest cost for annual payments.

TABLE 7

PAT MAYSE RESERVOIR

SUMMARY OF COSTS, ANNUAL CHARGES AND BENEFITS
(100-year analysis in thousands of dollars)

Item	Multiple-Purpose Project								Single-Purpose Projects (2)	
	Dam and Reservoir				Public Use Facils (1)			Total M-P Proj		
	Flood Cont	Water Sup	Joint Use	Sub-Total	Recre-ation	Fish & WL	Sub-Total		Flood Cont	Water Sup (3)
Federal first cost	369.6	51.3	6,854.1	7,275.0	194.0	121.0	315.0	7,590.0	5,210.0	5,755.0
Period of construction, years				2			1		2	2
Interest rate, percent				2-5/8			2-5/8	2-5/8	2-5/8	2-5/8
Interest during construction	9.7	1.3	180.0	191.0	-	-	-	191.0	137.0	151.0
Federal investment	379.3	52.6	7,034.1	7,466.0	194.0	121.0	315.0	7,781.0	5,347.0	5,906.0
Annual charges:										
Interest on investment	10.0	1.4	184.6	196.0	5.1	3.2	8.3	204.3	140.4	155.0
Amortization of investment	0.8	0.1	15.2	16.1	.6	0.3	0.9	17.0	11.4	12.6
Operation and maintenance	13.0	7.7	40.3	61.0	11.0	6.8	17.8	78.8	49.6	41.2
Major replacements	0.2	0.1	0.6	0.9	-	-	-	0.9	0.6	0.7
Total	24.0	9.3	240.7	274.0	16.7	10.3	27.0	301.0	202.0	209.5
Annual benefits:										
Flood control	91.1	-	-	91.1	-	-	-	91.1	91.1	-
Water supply	-	189.4	-	189.4	-	-	-	189.4	-	189.4
Recreation	-	-	-	-	92.5	-	92.5	92.5	-	-
Fish and wildlife	-	-	-	-	-	117.4	117.4	117.4	-	-
Total	91.1	189.4	-	280.5	92.5	117.4	209.9	490.4	91.1	189.4
Benefit-cost ratio								1.6	0.5	0.9

(1) Cost prorated to recreation and fish and wildlife on an annual visitor-day basis.
(2) Excludes public use facilities.
(3) Based on Federal design and financing. Based on non-Federal design and three percent interest rate the cost and annual charges are $3,880,000 and $160,500 respectively.

TABLE 8

BIG PINE RESERVOIR

SUMMARY OF COSTS, ANNUAL CHARGES AND BENEFITS
(100-year analysis in thousands of dollars)

Item	Multiple-Purpose Project								Single-Purpose Projects (2)	
	Dam and Reservoir				Public Use Facils (1)			Total M-P Proj		
	Flood Cont	Water Sup	Joint Use	Sub-Total	Recreation	Fish & WL	Sub-Total		Flood Cont	Water Sup (3)
Federal first cost	252.7	34.6	7,989.7	8,277.0	188.0	125.0	313.0	8,590.0	5,810.0	6,507.0
Period of construction, years				2			1	-	2	2
Interest rate, percent				2-5/8			2-5/8	2-5/8	2-5/8	2-5/8
Interest during construction	6.6	0.9	209.5	217.0	-	-	-	217.0	153.0	171.0
Federal investment	259.3	35.5	8,199.2	8,494.0	188.0	125.0	313.0	8,807.0	5,963.0	6,678.0
Annual charges:										
Interest on investment	6.8	0.9	215.0	222.7	4.9	3.3	8.2	230.9	156.5	175.3
Amortization of investment	0.6	0.1	17.4	18.1	0.6	0.4	1.0	19.1	12.9	14.1
Operation and maintenance	11.4	6.7	35.4	53.5	8.9	5.9	14.8	68.3	46.1	38.0
Major replacements	0.1	0.1	0.5	0.7	-	-	-	0.7	0.5	0.6
Total	18.9	7.8	268.3	295.0	14.4	9.6	24.0	319.0	216.0	228.0
Annual benefits:										
Flood control	109.0	-	-	109.0	-	-	-	109.0	109.0	-
Water supply (4)	-	220.0	-	220.0	-	-	-	220.0	-	220.0
Recreation	-	-	-	-	75.0	-	75.0	75.0	-	-
Fish and wildlife	-	-	-	-	-	102.2	102.2	102.2	-	-
Total	109.0	220.0	-	329.0	75.0	102.2	177.2	506.2	109.0	220.0
Benefit-cost ratio								1.6	0.5	0.96

(1) Cost prorated to recreation and fish and wildlife on an annual visitor-day basis.
(2) Excludes public use facilities.
(3) Based on Federal design and financing. Based on non-Federal design and 3 percent interest rate the cost and annual charges are $4,870,000 and $184,000 respectively.
(4) Based on non-Federal design and 3 percent interest rate and 50-year amortization period.

TABLE 9

PAT MAYSE RESERVOIR

COST ALLOCATION BY SEPARABLE COST-REMAINING BENEFIT METHOD
(In thousands of dollars)

Item	Project Purposes: Flood Control	Water Supply	Recreation	Fish & Wildlife	Total
ALLOCATION OF ANNUAL CHARGES					
Benefits, $	91.1	189.4	92.5	117.4	490.4
Alternate cost, $	202.0	209.5	(1)	(1)	-
Benefits limited by alternate cost, $	91.1	189.4	92.5	117.4	490.4
Separable cost, $	64.5	72.0	16.7	10.3	163.5
Remaining benefits, $	26.6	117.4	75.8	107.1	326.9
Allocated joint cost, $	11.2	49.4	31.9	45.0	137.5
Total allocation, $	75.7	121.4	48.6	55.3	301.0
Benefit-cost ratio	1.2	1.6	1.9	2.1	1.6
Cost per 1,000 gallons yield, ¢	-	.605	-	-	-
ALLOCATION OF OPERATION & MAINTENANCE COSTS					
Separable cost, $	19.8	11.4	11.0	6.8	49.0
Remaining cost, $	2.4	10.7	6.9	9.8	29.8
Total allocation, $	22.2	22.1	17.9	16.6	78.8
Specific costs, $	13.0	7.7	11.0	6.8	38.5
Allocated joint use cost, $	9.2	14.4	6.9	9.8	40.3
Ratio for allocation of joint use O & M	.2283	.3573	.1712	.2432	1.0000
ALLOCATION OF MAJOR REPLACEMENTS					
Separable cost, $	0.2	0.3	-	-	0.5
Remaining cost, $	0.1	0.1	0.1	0.1	0.4
Total allocation, $	0.3	0.4	0.1	0.1	0.9
ALLOCATION OF INVESTMENT					
Annual investment cost, $	53.2	98.9	30.6	38.6	221.3
Allocated investment, $	1,871.0	3,477.0	1,076.0	1,357.0	7,781.0
ALLOCATION OF CONSTRUCTION EXPENDITURES					
Specific investment, $	379.3	52.6	194.0	121.0	746.9
Investment in joint use facilities, $	1,491.7	3,424.4	882.0	1,236.0	7,034.1

TABLE 9 (Contd)

Item	Project Purposes: Flood Control	Water Supply	Recreation	Fish & Wildlife	Total
ALLOCATION OF CONSTRUCTION EXPENDITURES (Contd)					
Interest during construction on joint use facilities, $	38.3	87.7	22.0	32.0	180.0
Construction expenditures in joint use facilities, $	1,453.4	3,336.7	860.0	1,204.0	6,854.1
Percentage of construction expenditures in joint use facilities	21.20	48.45	12.55	17.57	100.0
Construction expenditures in specific facilities, $	369.6	51.3	194.0	121.0	735.9
Total construction expenditures, $	1,823.0	3,388.0	1,054.0	1,325.0	7,590.0
Preauthorization expenditures, $	9.0	18.0	6.0	7.0	40.0
Total net construction expenditures, $	1,814.0	3,370.0	1,048.0	1,318.0	7,550.0

(1) Alternate cost considered to approximate alternate cost of water supply project or in excess of benefits shown.

TABLE 10

BIG PINE RESERVOIR

COST ALLOCATION BY SEPARABLE COST-REMAINING BENEFIT METHOD
(In thousands of dollars)

Item	Project Purposes				
	Flood Control	Water Supply	Recreation	Fish & Wildlife	Total
ALLOCATION OF ANNUAL CHARGES					
Benefits, $	109.0	220.0	75.0	102.2	506.2
Alternate cost, $	216.0	228.0	(1)	(1)	-
Benefits limited by alternate cost, $	109.0	220.0	75.0	102.2	506.2
Separable cost, $	67.0	79.0	14.4	9.6	170.0
Remaining benefits, $	42.0	141.0	60.6	92.6	336.2
Allocated joint cost, $	18.6	62.5	26.9	41.0	149.0
Total allocation, $	85.6	141.5	41.3	50.6	319.0
Benefit-cost ratio	1.3	1.6	1.8	2.0	1.6
Cost per 1,000 gallons yield, ¢	-	1.49	-	-	-
ALLOCATION OF OPERATION & MAINTENANCE COSTS					
Separable cost, $	15.5	7.4	8.9	5.9	37.7
Remaining cost, $	3.8	12.9	5.5	8.4	30.6
Total Allocation, $	19.3	20.3	14.4	14.3	68.3
Specific costs, $	11.4	6.7	8.9	5.9	32.9
Allocated joint use cost, $	7.9	13.6	5.5	8.4	35.4
Ratio for allocation of joint use O & M	.2231	.3842	.1554	.2373	1.0000
ALLOCATION OF MAJOR REPLACEMENTS					
Separable cost, $	0.1	0.2	-	-	0.3
Remaining cost, $	0.1	0.1	0.1	0.1	0.4
Total allocation, $	0.2	0.3	0.1	0.1	0.7
ALLOCATION OF INVESTMENT					
Annual investment cost, $	66.1	120.9	26.8	36.2	250.0
Allocated investment, $	2,329.0	4,259.0	944.0	1,275.0	8,807.0
ALLOCATION OF CONSTRUCTION EXPENDITURES					
Specific investment, $	259.3	35.5	188.0	125.0	607.8
Investment in joint use facilities, $	2,069.7	4,223.5	756.0	1,150.0	8,199.2
Interest during construction on joint use facilities, $	53.4	108.1	19.0	29.0	209.5
Construction expenditures in joint use facilities, $	2,016.3	4,115.4	737.0	1,121.0	7,989.7

TABLE 10 (Contd)

Item	Project Purposes: Flood Control	Water Supply	Recreation	Fish & Wldlfe	Total
ALLOCATION OF CONSTRUCTION EXPENDITURES (Contd)					
Percentage of construction expenditures in joint use facilities	25.24	51.51	9.22	14.03	100.0
Construction expenditures in specific facilities, $	252.7	34.6	188.0	125.0	600.3
Total construction expenditures, $	2,269.0	4,150.0	925.0	1,246.0	8,590.0
Preauthorization expenditures, $	11.0	19.0	4.0	6.0	40.0
Total net construction expenditures, $	2,258.0	4,131.0	921.0	1,240.0	8,550.0

(1) Alternate cost considered to approximate alternate cost of water supply project or in excess of benefits shown.

APPENDIX III

PROJECT PLANS AND COST ESTIMATES

1. PURPOSE

The primary purpose of this appendix is to present data on the proposed plan of improvement consisting of Pat Mayse and Big Pine Reservoirs on Sanders and Big Pine Creeks, respectively. Each reservoir is discussed separately following the brief statement on alternative sites studied.

2. ALTERNATE SITES

On Sanders Creek, alternate sites were considered at mile 15.3 and at mile 23.5. Neither of these sites would provide sufficient storage to meet the water supply requirements of the City of Paris, Texas, when added to flood control. A reconnaissance of Big Pine Creek and study of topographic maps showed that there are no suitable alternative dam sites on that stream. The possibility of using Hugo or Boswell Reservoirs (in Oklahoma) as an alternate water supply source was also investigated. However, the estimated cost for water supply from these sources was more than double the cost from Pat Mayse Reservoir and more than one and one-half the cost from Big Pine Reservoir.

PAT MAYSE RESERVOIR

3. GENERAL

The Pat Mayse Reservoir Dam site is located about 12 miles north of Paris, Texas, at mile 4.4 on Sanders Creek. The proposed project would include a rolled earth embankment, an uncontrolled chute spillway, a drop-inlet drawdown structure, and a water supply conduit. Clearing and snagging of the channel from the dam site to the mouth of Sanders Creek would also be a part of the project. In order to provide access to the project a road two miles in length would be constructed between the dam site and Trout (U. S. Highway 271). The location of this access road is shown on plate 1. Plan and section of the dam, spillway and outlet works are shown on plate 2.

4. DAM

a. Embankment. - The rolled earth-filled dam would be 7,010 feet in length and would have a 28-foot crown width. The top of the dam would be at elevation 487.0 m.s.l., with a maximum height above the stream bed of 92 feet. Both upstream and downstream slopes of the embankment would be 1 on 3. An inspection trench 5 feet deep would be constructed along the axis of the dam. The bottom width of this trench would be 12 feet, and the side slopes would be 1 on 1. The

upstream portion of the dam would be constructed of impervious material. This impervious section of the embankment would have a top width of 14 feet, on upstream slope of 1 on 3, and a downstream slope of 1 on 1. The remainder of the embankment would be constructed of random materials. The upstream face of the embankment would be protected by 2 feet of dumped riprap placed on 9 inches of gravel backing and extending from the crown to elevation 415.0. The downstream slope would be seeded to grass and mulched. A gravel surfaced road would be constructed along the crown of the embankment for use in maintaining the project.

b. General geology and topography. Pat Mayse dam site is located on Sanders Creek, a tributary of the Red River, in northern Lamar County, Texas. This area of low relief and flat-lying to gently dipping formations is in the Western Hills section of the Gulf Coastal Plains Physiographic Province. The right abutment is wooded, but the flood plain and the left abutment are cleared. The Eagleford shale and Woodbine formation of Cretaceous age underlie the entire area.

c. Geology of the site. - Overburden on the right abutment consists of about 35 feet of terrace deposits of sand and some sandy clay (see plate 3). The left abutment has an overburden thickness of from 10 to 25 feet of sand, sandy clay, clay, and gravel. Overburden in the flood plain consists of fat clays and averages 35 feet in thickness. Rock in the flood plain and on the left abutment is tentatively assigned to the Woodbine formation. The strata range from a moderately hard fossiliferous calcareous sandstone to a soft shaly sandstone. Moderately soft sandy shale of the Eagleford shale forms the right abutment.

d. Soils of the site. - At the proposed dam site, Sanders Creek flows in a northeasterly direction about 500 feet from the eastern edge of a 1/2-mile wide flood plain. From the western edge of the plain the ground rises about 25 feet on a 6 percent grade to a broad undulating terrace, which in turn terminates against a 4 percent grade rising to the left abutment. On the east side of the valley, the terrain starts a continuous rise on about 10 percent grade to a wooded terrace about 90 feet above the floor.

An exploration program, conducted in March 1960 along the proposed center line of the dam, shows that overburden in the floodplain varies in thickness from about 35 feet on the eastern side to 15 feet at the western edge. The cover is predominately fat clay (CH), though toward the eastern side of the valley the lower 6 feet of this layer grades down through CL to a thin layer of sand at bedrock. One hole drilled down through the high terrace at the right abutment showed about 9 feet of impervious clay underlain by 27 feet of nonplastic sand extending down to bedrock. At the left abutment, the overburden increases from about 10 feet on the slope leading up

from the flood plain to 25 feet on top of the broad terrace. This horizon consists of random layers of sand and lean to fat clay.

The borrow areas have not been selected since suitable material should be available both from the flood plain upstream from the dam and from upland locations.

e. Scope of explorations. - Explorations comprise five 4-inch core holes and one drive-sample hole drilled in 1960. Logs of the holes are included. (Plates 3 through 9.)

5. SPILLWAY

The spillway structure would be located in the right abutment and would be an uncontrolled chute with training walls and stilling basin. The weir would be a modified broad crested section, and would be 200 feet wide with crest at elevation 462, m.s.l. The chute would be 285 feet long, would have a longitudinal slope of 1 on 4 and would terminate in the stilling basin, the floor of which would be at elevation 393.0. An outlet channel about 2,000 feet long and 200 feet wide would connect the stilling basin with the channel of Sanders Creek.

6. OUTLET WORKS

The outlet works, located at station 58 + 00, would consist of a drop inlet, a 5.5-foot diameter conduit, and a stilling basin. The crest of the drop inlet weir would be at elevation 448.0. The invert of the conduit at its exit into the stilling basin would be at elevation 400.0. A water supply conduit 42 inches in diameter would be constructed adjacent to the outlet works conduit. A gate valve would regulate the flow in the water supply conduit and would be operated from a valve chamber located in the drop-inlet structure. The water supply conduit would end in a manhole located near the toe of the embankment. A 36-inch diameter low flow pipe would also be provided. The low flow pipe flow would be controlled by a gate valve located in the valve chamber in the drop-inlet structure. The low flow pipe would discharge into the outlet works conduit.

7. CHANNEL CLEARING AND SNAGGING

In order to provide adequate capacity for emptying the flood control storage of the reservoir, it is necessary to improve flow conditions of the channel by clearing and snagging. The area to be cleared would be 300 feet wide and would extend from the dam site to the mouth of the stream, a distance of 4.4 miles. Snags and drift would be removed from the channel and banks. Easement on about 160 acres would be required for this purpose.

8. RELOCATIONS

a. General. - Relocations that would be required by the construction of Pat Mayse Dam and Reservoir would consist of county roads and electric transmission lines.

b. Roads. - Relocation and improvement of 0.6 mile of county road would be required.

c. Utilities. - Relocation of 1.2 miles of electric transmission line would be required.

d. Cemeteries. - There are no known cemeteries in the reservoir area, however it is expected that isolated family plots and graves will require removal.

9. RESERVOIR DEVELOPMENT FOR PUBLIC USE

a. Recreational evaluation. - The reservoir is located in the low rolling hill country adjoining the Red River valley of northeast Texas. There are no outstanding scenic features in the basin; however, the large lake and irregular shore line would be interesting and attractive for recreational use. Access is favorable because the lake would be only about a mile from U. S. 271, a principal traffic way of east Texas to Oklahoma. There are many secondary roads leading to the lake because of the former Camp Maxey development adjoining the reservoir area. The project would be of significance in that area. The largest city within 25 miles of the dam is Paris, Texas (1960 population 20,977). There would also be a considerable visitation from a fifty mile radius of the dam. Annual attendance is estimated to be 300,000.

b. Facilities. - The basic public use facilities that would be provided would consist of access roads, parking areas, boat-launching ramps, sanitary facilities, picnic units, drinking water, signs and markers.

10. BASIS FOR COST ESTIMATES

a. Unit prices. - The unit prices are based on average bid prices for similar projects constructed or under construction in the Tulsa District, adjusted to 1960 price levels.

b. Contingencies, engineering, and overhead. - To cover contingencies, construction and relocation costs have been increased 20 percent. Engineering, design, supervision, and administration for construction are based on percentages taken from curves compiled from experience on similar projects.

c. Interest during construction. - A two-year construction period was assumed for purposes of determining the total investment. The interest was taken as 2-5/8 percent over one-half of the construction period.

d. Annual charges. - The estimate for annual charges is based on a 2-5/8 percent interest rate with the cost of the project amortized over a 100-year period.

11. SUMMARY OF COST ESTIMATES

A summary of the estimated costs is shown in table 1.

TABLE I

SUMMARY OF COST ESTIMATES
PAT MAYSE DAM AND RESERVOIR

No.	Item	Amount
01	Lands and Damages	$ 808,000
02	Relocations	243,000
03	Reservoir and Pool Preparation	390,000
04	Main Dam	4,418,900
08	Roads, Railroads and Bridges	168,000
09	Channels and Canals	7,200
14	Recreation Facilities	200,000
19	Buildings, Grounds and Utilities	163,000
20	Permanent Operating Equipment	57,000
29	Preauthorization Studies	40,000
30	Engineering and Design	531,700
31	Supervision and Administration	563,200
	Total Project Cost	7,590,000

12. DETAILS OF ESTIMATED COSTS

Details of the estimated cost for the construction of Pat Mayse Dam and Reservoir are shown in table 2.

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TABLE 2

DETAILS OF ESTIMATED COSTS
PAT MAYSE DAM AND RESERVOIR

No.	Item	Unit	Quantity	Cost	Amount
				$	$
01.	LANDS AND DAMAGES				
.1	Acquisition	Job	-	L.S.	640,975
.2	Acquisition expense	Job	-	L.S.	39,000
	Subtotal, direct cost				679,975
	Contingencies				128,025
	Total estimated cost, Lands & Damages				808,000
02.	RELOCATIONS				
.1	Roads				
	County roads	Job	-	L.S.	170,000
	Right-of-way	Job	-	L.S.	2,500
	Subtotal				172,500
	Contingencies				34,500
	Total estimated cost, Roads				207,000
.3	Cemeteries, Utilities & Structures				
	Cemeteries	Job	-	L.S.	11,000
	Power line	Job	-	L.S.	19,000
	Subtotal				30,000
	Contingencies				6,000
	Total estimated cost, Cemeteries, Utilities & Structures				36,000
03.	RESERVOIR AND POOL PREPARATION				
.1	Clearing Zone A to Elev. 443.0	Acre	4,600	50.00	230,000
.1	Clearing Zone B to Elev. 451.0	Acre	1,400	50.00	70,000
.1	Clearing recreation areas	Acre	400	50.00	20,000
.3	Erosion control and drainage	Job	-	L.S.	5,000
	Subtotal, direct cost				325,000
	Contingencies				65,000
	Total estimated cost, Reservoir & Pool Preparation				390,000

TABLE 2 (Contd)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
04.	DAM				
.1	Main Dam - Embankment				
	Clearing and grubbing	Acre	81	200.00	16,200
	Diversion and care of river	Job	-	L.S.	50,000
	Stripping for embankment	C.Y.	99,000	0.30	29,700
	Excavation trench, earth	C.Y.	23,000	0.60	13,800
	Excavation borrow, impervious	C.Y.	2,589,000	0.35	906,150
	Excavation borrow, random	C.Y.	549,000	0.35	192,150
	Compacted fill, impervious	C.Y.	2,251,000	0.12	270,120
	Compacted fill, random	C.Y.	1,269,000	0.12	152,280
	Riprap	C.Y.	70,530	5.00	352,650
	Gravel or crushed rock backing	C.Y.	23,480	5.50	129,140
	Seeding or sodding	Acre	30	300.00	9,000
	Foundation preparation	Sq.	26,800	1.00	26,800
	Roadway surfacing, incl base course	S.Y.	15,600	2.25	35,100
	Roadway gravel, shoulders	C.Y.	1,050	5.00	5,250
	Guardrail, metal plate	L.F.	14,020	3.50	49,070
	Embankment drainage system	Job	-	L.S.	22,500
	Piezometers, settlement gages, etc.	Job	-	L.S.	6,000
	Abutment dressing	Job	-	L.S.	72,000
	Power and gas to dam site	Job	-	L.S.	10,000
	Subtotal, direct cost				2,347,910
	Contingencies				469,090
	Total estimated cost, Embankment				2,817,000
.1	Main Dam - Spillway				
	Clearing work areas	Acre	24	200.00	4,800
	Excavation, common	C.Y.	948,000	0.30	284,400
	Excavation, special	C.Y.	4,200	11.00	46,200

TABLE 2 (Contd)

No.	Item	Unit	Quantity	Cost $	Amount $
.1	Main Dam - Spillway (Continued)				
	Backfill, compacted	C.Y.	540	2.00	1,080
	Derrick stone	C.Y.	2,600	7.00	18,200
	Spalls	C.Y.	520	5.00	2,600
	Gravel in drains	C.Y.	900	5.50	4,950
	Concrete, sills and baffles	C.Y.	330	35.00	11,550
	Concrete, walls	C.Y.	5,210	38.00	197,980
	Concrete, slabs and keys	C.Y.	9,170	30.00	275,100
	Concrete, mass	C.Y.	1,630	25.00	40,750
	Reinforcement steel	Lb.	497,000	0.13	64,610
	Drilling and grouting	L.F.	2,000	6.00	12,000
	Drill and place anchors	L.F.	2,000	3.00	6,000
	Drill drain holes	L.F.	1,000	4.00	4,000
	Foundation protection	S.Y.	12,200	0.60	7,320
	Head and tailwater gages	Job	-	L.S.	3,000
	Subtotal, direct cost				984,540
	Contingencies				196,460
	Total estimated cost, Spillway				1,181,000
.3	Main Dam - Outlet Works				
	Clearing work areas	Acre	4	200.00	800
	Excavation, common	C.Y.	27,000	0.50	13,500
	Excavation, rock	C.Y.	1,000	4.00	4,000
	Excavation, special	C.Y.	300	11.00	3,300
	Backfill	C.Y.	4,900	2.00	9,800
	Concrete, conduit	C.Y.	580	75.00	43,500
	Concrete, walls	C.Y.	1,370	38.00	52,060
	Concrete, structural	C.Y.	1,270	60.00	76,200
	Concrete, slabs and keys	C.Y.	70	30.00	2,100
	Reinforcement steel	Lb.	244,000	0.13	31,720
	Gravel in drains	C.Y.	120	5.50	660
	Structural steel	Lb.	9,000	0.30	2,700
	Misc. steel and iron	Lb.	17,000	0.75	12,750
	Water stops, copper	Lb.	750	2.00	1,500
	Water stops, rubber	L.F.	270	3.00	810
	Misc. pipe and fittings	Lb.	46,000	0.75	34,500
	Drilling and grouting	L.F.	140	6.00	840
	Drilling and placing anchors	L.F.	120	3.00	360
	Handrail pipe	L.F.	130	6.00	780
	Foundation protection	S.Y.	870	0.60	520
	Staff gages	Job	-	L.S.	3,000
	36" low flow	Job	-	L.S.	8,430
	Derrick stone	C.Y.	530	7.00	3,710

TABLE 2 (Contd)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
.3	Main Dam - Outlet Works (Continued)				
	Spalls	C.Y.	100	5.00	500
	Subtotal, direct cost				308,040
	Contingencies				61,560
	Total estimated cost, Outlet Works				369,600
.3	Outlet Works - 42" W.S. Line				
	Excavation, common	C.Y.	640	0.30	190
	Excavation, special	C.Y.	60	11.00	660
	Backfill, common	C.Y.	280	2.00	560
	Concrete, conduit	C.Y.	250	60.00	15,000
	Concrete, structural	C.Y.	50	80.00	4,000
	Reinforcement steel	Lb.	29,000	0.13	3,770
	42" pipe and fittings	Job	-	L.S.	18,540
	Subtotal, direct cost				42,720
	Contingencies				8,580
	Total estimated cost, Outlet Works - Water Supply				51,300
08	ROADS, RAILROADS, AND BRIDGES				
	Access roads	Mi	2	70,000	140,000
	Contingencies				28,000
	Total estimated cost, Roads				168,000
09	CHANNELS AND CANALS				
	Clearing and snagging creek	Acres	30	200	6,000
	Contingencies				1,200
	Total estimated cost, Channels and Canals				7,200
14	RECREATION				
	Direct cost				166,700
	Contingencies				33,300
	Total estimated cost, Recreation				200,000
19	BUILDINGS, GROUNDS AND UTILITIES				

TABLE 2 (Contd)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
19	BUILDINGS, GROUNDS AND UTILITIES (Continued)				
	Operational buildings	Job	-	L.S.	88,600
	Grading and landscaping	Job	-	L.S.	32,000
	Utilities	Job	-	L.S.	15,400
	Subtotal, direct cost				136,000
	Contingencies				27,000
	Total estimated cost, Buildings, Grounds and Utilities				163,000
20	PERMANENT OPERATING EQUIPMENT				
	Standby electrical equipment	Job	-	L.S.	15,000
	Motor grader (small)	Each	1	10,000	10,000
	Dump truck	Each	1	4,500	4,500
	Flatbed truck w/winch	Each	1	5,000	5,000
	Farm tractor w/mowing attachments	Each	1	5,500	5,500
	Boat and motor	Each	1	2,500	2,500
	Misc. small tools and equipment	Job	-	L.S.	5,000
	Subtotal, direct cost				47,500
	Contingencies				9,500
	Total estimated cost, Permanent Operating Equipment				57,000
29	PREAUTHORIZATION STUDIES				40,000
30	ENGINEERING AND DESIGN				531,700
31	SUPERVISION AND ADMINISTRATION				563,200
	TOTAL PROJECT COST				7,590,000

13. ESTIMATED INVESTMENT AND ANNUAL COSTS

Details of the estimated investment costs and annual charges are shown in table 3. Table 9 of Appendix II gives a detailed cost allocation of investment and annual costs for the flood control, water supply, fish and wildlife, and recreation features of the project.

TABLE 3

DETAILS OF INVESTMENT AND ANNUAL COSTS
PAT MAYSE DAM AND RESERVOIR

Item	Dam and Reservoir	Public Use	Total
	$	$	$
Investment			
Construction cost	7,275,000	315,000	7,590,000
Interest during construction	191,000	-	191,000
Total	7,466,000	315,000	7,781,000
Annual costs			
Interest	196,000	8,300	204,300
Amortization	16,100	900	17,000
Operation & maintenance	51,000	17,800	68,800
Major replacements	900	0	900
Engineering studies (1)	10,000	0	10,000
Total	274,000	27,000	301,000

(1) Part of operation and maintenance cost.

14. GENERAL

The Big Pine Dam site is located about 22 miles northwest of Clarksville, Texas, at mile 13.2 on Big Pine Creek. The proposed project would include a rolled earth embankment, an uncontrolled chute spillway, a drop-inlet drawdown structure, and a water supply conduit. Clearing and snagging of the channel from the dam site to the mouth of Big Pine Creek would also be a part of the project. In order to provide access to the project, a road 2.8 miles in length would be constructed between the dam site and Manchester, Texas, located at the intersection of Texas Farm and Ranch Roads Nos. 195 and 2118. The location of this access road is shown on plate 10. Plan and section of the dam, spillway and outlet works are shown on plate 11.

15. DAM

a. Embankment. - The rolled earth-filled dam would be 5,390 feet in length and would have a 28-foot crown width. The top of the dam would be at elevation 451.0 m.s.l., with a maximum height above the stream bed of 77 feet. Both upstream and downstream slopes of the embankment would be 1 on 3. An inspection trench 5 feet deep would be constructed along the axis of the dam. The bottom width of this trench would be 12 feet, and the side slopes would be 1 on 1. The upstream portion of the dam would be constructed of impervious material. This impervious section of the embankment would have a top width of 14 feet, on upstream slope of 1 on 3, and a downstream slope of 1 on 1. The remainder of the embankment would be constructed of random materials. The impervious and random fills are separated by 3 feet of filter material. The upstream face of the embankment would be protected by 2 feet of dumped riprap placed on 9 inches of gravel backing and extending from the crown to elevation 390.0. The downstream slope would be seeded to grass and mulched. A gravel surfaced road would be constructed along the crown of the embankment for use in maintaining the project.

b. General Geology and Topography. - The Big Pine Creek dam site is located in northern Red River County, Texas. This region is in the Western Hills section of the Gulf Coastal Plains Physiographic Province, an area of low relief and generally flat-lying to gently dipping formations. The flood plain is wooded and lies about 80 feet below the abutments. The entire area is underlain by the Woodbine formation of Cretaceous age.

c. Geology of the Site. - Overburden on the right abutment consists of terrace deposits of sand and gravel about 50 feet in thickness. The sloping left abutment was not explored. Information derived from a hole drilled in the center of the flood plain about 3/4 mile upstream from the axis indicated the overburden does not exceed 20

feet in thickness across the flood plain. Rock of the Woodbine formation was exposed along a steep slope from the stream to the right abutment. On the right abutment the strata consist of soft shale with some coal seams and soft shaly fine-to medium-grained sandstone (see plate 12).

d. Soils of the Site. - The flood plain at the dam site is approximately 3,000 feet wide, covered with a growth of brush and trees that continues on up the slopes of the abutments. Big Pine Creek crosses the area near the right abutment, flowing a northeasterly direction. At the right abutment, the terrain rises almost vertically for about 25 feet, from which point it continues on approximately an 8% grade to a terrace about 75 feet above the valley floor. On the opposite side of the plain, the ground rises on an even grade of about 4% to the left abutment.

In March 1960, one NX core hole was drilled to a depth of 101 feet through the high terrace at the right abutment. Overburden comprised 48 feet of terrace sand, interspersed by random layers of impervious clay. A 4-inch core hole drilled on the slope of the right abutment showed 3 feet of nonplastic sand over rock. A third hole (3-inch drive tube), put down in the flood plain upstream from the dam site, evidenced 19 feet of overburden consisting of alternate layers of lean clay and nonplastic sand. No exploratory work was done on the left abutment.

Suitable embankment material should be available adjacent to the dam site. Due to a high water table in the flood plain, it may be necessary to obtain most of the material from upland locations.

e. Scope of Explorations. - Explorations comprise one NX and one 4-inch core hole and one drive-sample hole drilled in 1960. The core holes were located on the right abutment, and the drive-sample hole was located on the left bank of Big Pine Creek upstream from the site. Logs of the holes are shown on plates 12, 13 and 14.

16. SPILLWAY

The spillway structure would be located in the right abutment and would be an uncontrolled concrete chute with training walls and stilling basin. The weir would be an ogee section, 200 feet wide with crest at elevation 430, m.s.l. The chute would be 315 feet long, would have a longitudinal slope of 1 on 10 and would terminate at the stilling basin, the floor of which would be at elevation 373.0, m.s.l.

17. OUTLET WORKS

The outlet works, located at station 3 + 90, would consist of a drop inlet, a 4-foot diameter conduit, and a stilling basin. The crest of the drop-inlet weir would be at elevation 420.0. The invert

of the conduit at its exit into the stilling basin would be at elevation 375.0. A water supply conduit 30 inches in diameter would be constructed adjacent to the outlet works conduit. A gate valve would regulate the flow in the water supply conduit and would be operated from a valve chamber located in the drop-inlet structure. The water supply conduit would end in a manhole located near the toe of the embankment. A 24-inch diameter low flow pipe would also be provided. The low flow pipe flow would be controlled by a gate valve located in the valve chamber in the drop-inlet structure. The low flow pipe would discharge into the outlet works conduit.

18. CHANNEL CLEARING AND SNAGGING

In order to provide adequate capacity for emptying the flood control storage of the reservoir, it is necessary to improve flow conditions of the channel by clearing and snagging. The area to be cleared would be 275 feet wide and would extend from the dam site to the mouth of Big Pine Creek, a distance of 13.2 miles. Snags and drift would be removed from the channel and banks. Easement on about 440 acres would be required for this purpose.

19. RELOCATIONS

a. General. - Relocations that would be required by the construction of Big Pine Dam and Reservoir would consist of county roads, telephone lines and electric transmission lines.

b. Roads. - Relocation of 1.1 miles of Texas Farm Road 410 and relocation of 1.0 mile of Red River county roads would be required. Provision for erosion protection of the embankment slopes on Texas Farm Road 195 would also be required.

c. Utilities. - Relocation of 0.8 mile of telephone line and 1.6 miles of electric transmission line would be required.

d. Cemeteries. - There are no known cemeteries in the reservoir area; however, it is expected that isolated family plots and graves will require removal.

20. RESERVOIR DEVELOPMENT FOR PUBLIC USE

a. Recreational evaluation. - The reservoir is located in the low rolling hill country adjoining the Red River valley of northeast Texas. There are no outstanding scenic features in the basin; however, the large lake and irregular shore line would be interesting and attractive for recreational use. Because of existing reservoir projects or authorized projects in the vicinity, the effective use of the lake would be from people in a widespread locality. The nearest cities within 25 miles of the dam are Paris, Texas (population 20,977) and Clarksville, Texas (population 3,851). Annual visitation is estimated to be 250,000.

b. Facilities. - The basic public use facilities that would be provided would consist of access roads, parking areas, boat-launching ramps, sanitary facilities, picnic units, drinking water, signs and markers.

21. BASIS FOR COST ESTIMATES

a. Unit prices. - The unit prices are based on average bid prices for similar projects constructed or under construction in the Tulsa District, adjusted to 1960 price levels.

b. Contingencies, engineering, and overhead. - To cover contingencies, construction and relocation costs have been increased 20 percent. Engineering, design, supervision, and administration for construction are based on percentages taken from curves compiled from experience on similar projects.

c. Interest during construction. - A two-year construction period was assumed for pusposes of determining the total investment. The interest was taken as 2-5/8 percent over one-half of the construction period.

d. Annual charges. - The estimate for annual charges is based on a 2-5/8 percent interest rate with the cost of the project amortized over a 100-year period.

22. SUMMARY OF COST ESTIMATES

A summary of the estimated costs is shown in table 4.

TABLE 4

SUMMARY OF COST ESTIMATES
BIG PINE DAM AND RESERVOIR

No.	Item	Amount
01.	Lands and Damages	$ 810,000
02.	Relocations	974,000
03.	Reservoir and Pool Preparation	336,000
04.	Main Dam	4,476,300
08.	Roads, Railroads and Bridges	231,000
09.	Channels and Canals	87,000
14.	Recreation Facilities	200,000
19.	Buildings, Grounds and Utilities	163,000
20.	Permanent Operating Equipment	57,000
29.	Preauthorization Studies	40,000
30.	Engineering and Design	586,400
31.	Supervision and Administration	629,300
	Total Project Cost	$8,590,000

23. DETAILS OF ESTIMATED COSTS

Details of the estimated cost for the construction of Big Pine Dam and Reservoir are shown in table 5.

TABLE 5

DETAILS OF ESTIMATED COSTS
BIG PINE DAM AND RESERVOIR

No.	Item	Unit	Quantity	Cost	Amount
				$	$
01	Lands and Damages				
.1	Acquisition	Job	-	L.S.	615,100
.2	Acquisition Expense	Job	-	L.S.	72,500
	Subtotal, direct cost				687,600
	Contingencies				122,400
	Total cost of Lands and Damages				810,000
02	Relocations				
.1	Roads				
	County roads	Job	-	L.S.	775,000
	Right-of-way	Job	-	L.S.	6,400
	Subtotal, direct cost				781,400
	Contingencies				156,600
	Total estimated cost, Roads				938,000
.3	Cemeteries, Utilities & Structures				
	Cemeteries	Job	-	L.S.	10,000
	Power & Telephone lines	Job	-	L.S.	20,000
	Subtotal, direct cost				30,000
	Contingencies				6,000
	Total estimated cost, Cemeteries, Utilities & Structures				36,000
03	Reservoir and Pool Preparation				
.1	Clearing Zone A - Elev. 415.0	Acres	3,920	50.00	196,000
.1	Clearing Zone B - Elev. 423.0	Acres	1,180	50.00	59,000
.1	Clearing recreation areas	Acres	400	50.00	20,000
.3	Erosion control and drainage	Job	-	L.S.	5,000
	Subtotal, direct cost				280,000
	Contingencies				56,000

TABLE 5 (Contd)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
	Total estimated cost, Reservoir and Pool Preparation				336,000
04	Dam				
.1	Main Dam - Embankment				
	Clearing work areas	Acres	58	200.00	11,600
	Stripping for embankment	C.Y.	73,000	0.30	21,900
	Excavation trench, common	C.Y.	18,100	0.60	10,860
	Excavation borrow, impervious	C.Y.	1,788,000	0.35	625,800
	Excavation borrow, random	C.Y.	616,000	0.35	215,600
	Compacted fill, impervious	C.Y.	1,630,000	0.12	195,600
	Compacted fill, random	C.Y.	805,000	0.12	96,600
	Filter material	C.Y.	111,240	5.00	556,200
	Riprap	C.Y.	47,200	5.00	236,000
	Backing	C.Y.	17,500	5.50	96,250
	Roadway gravel	C.Y.	2,000	5.00	10,000
	Guide posts	Each	270	7.00	1,890
	Seeding and mulching	Acre	23	300.00	6,900
	Foundation preparation	Sqs.	19,600	1.00	19,600
	Diversion and care of water	Job	-	L.S.	50,000
	Piezometers and settlement gages	Job	-	L.S.	6,000
	Power and gas to dam site	Job	-	L.S.	10,000
	Embankment drainage	Job	-	L.S.	14,000
	Drilling and grouting dam	L.F.	-	-	-
	Drilling and grouting abut.	L.F.	-	-	-
	Subtotal, direct cost				2,184,800
	Contingencies				437,200
	Total estimated cost, Embankment				2,622,000
.1	Main Dam - Spillway				
	Clearing work areas	Acre	9	200.00	1,800
	Excavation, common	C.Y.	192,000	0.30	57,600
	Excavation, rock	C.Y.	82,600	4.00	330,400
	Excavation, special	C.Y.	3,570	11.00	39,270
	Backfill compacted	C.Y.	5,300	2.00	10,600
	Line drilling	S.F.	12,300	2.00	24,600
	Gravel in drains	C.Y.	810	5.50	4,460
	Concrete, sills and baffles	C.Y.	260	35.00	9,100
	Concrete, walls and piers	C.Y.	2,420	38.00	91,960

TABLE 5 (Contd)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
.1	Main Dam - Spillway (Continued)				
	Concrete, slabs and keys	C.Y.	16,330	30.00	489,900
	Concrete, mass	C.Y.	8,220	25.00	205,500
	Reinforcement steel	Lbs.	312,000	0.13	40,560
	Drilling and grouting	L.F.	2,040	6.00	12,240
	Drilling and placing anchors	L.F.	2,040	3.00	6,120
	Drill Drainage Holes	L.F.	1,020	4.00	4,080
	Foundation Protection	S.Y.	10,700	0.60	6,420
	Handrail, Pipe	L.F.	880	6.00	5,280
	Head and Tailwater Gages	Job	-	L.S.	3,000
	Subtotal direct cost				1,342,890
	Contingencies				268,110
	Total estimated cost, Spillway				1,611,000
.3	Main Dam - F.C. Outlet				
	Excavation, common	C.Y.	1,700	0.30	510
	Excavation, structural	C.Y.	180	11.00	1,980
	Backfill, common	C.Y.	450	2.00	900
	Concrete, conduit	C.Y.	270	75.00	20,250
	Concrete, structural	C.Y.	900	60.00	54,000
	Concrete, walls and piers	C.Y.	460	38.00	17,480
	Concrete, slabs and keys	C.Y.	40	30.00	1,200
	Reinforcement steel	Lbs.	123,000	0.13	15,990
	Derrick stone	C.Y.	75	7.00	530
	Spalls	C.Y.	30	5.00	150
	Gravel in drains	C.Y.	110	5.50	610
	Misc. steel and iron	Lbs.	17,000	0.75	12,750
	Water stops, copper	Lbs.	650	2.00	1,300
	Water stops, rubber	L.F.	170	2.00	340
	Misc. Pipe and Fittings	Lbs.	46,000	0.75	34,500
	Drilling and grouting	L.F.	140	6.00	840
	Drilling and placing anchors	L.F.	100	3.00	300
	Handrail pipe	L.F.	220	4.00	880
	Foundation protection	S.Y.	540	0.60	320
	Electrical system	Job	-	L.S.	2,250
	Staff gages	Job	-	L.S.	3,000
	24" low flow pipe	Job	-	L.S.	8,100
	Subtotal direct cost				178,180
	Contingencies				35,820
	Total estimated cost, F.C. Outlet				214,000

TABLE 5 (Contd)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
.3	Water Supply Line				
	Excavation, common	C.Y.	200	0.30	60
	Excavation, structural	C.Y.	60	11.00	660
	Backfill	C.Y.	140	2.00	280
	Concrete, conduit	C.Y.	120	75.00	9,000
	Concrete, structural	C.Y.	40	60.00	2,400
	Reinforcement steel	Lbs.	15,000	0.13	1,950
	30" Pipe and fittings	Job	-	L.S.	10,100
	Subtotal direct cost				24,450
	Contingencies				4,850
	Total estimated cost, Water Supply Line				29,300
08	Roads, Railroads and Bridges				
	Access roads	Mi	2.75	70,000	192,500
	Contingencies				38,500
	Total estimated cost, Roads, Railroads, and Bridges				231,000
09	Channels and Canals				
	Clearing and snagging creek	Acres	290	250.00	72,500
	Contingencies				14,500
	Total estimated cost, Channels and Canals				87,000
14	Recreation				
	Subtotal direct cost	Job	-	L.S.	166,700
	Contingencies				33,300
	Total estimated cost, Recreation				200,000
19	Buildings, Grounds and Utilities				
	Operational buildings	Job	-	L.S.	88,600
	Grading and landscaping	Job	-	L.S.	32,000
	Utilities	Job	-	L.S.	15,400
	Subtotal direct cost				136,000
	Contingencies				27,000
	Total estimated cost, Buildings, Grounds and Utilities				163,000

TABLE 5 (Contd)

No.	Item	Unit	Quantity	Cost	Amount
				$	$
20	Permanent Operating Equipment				
	Standby electrical equipment	Job	-	L.S.	15,000
	Motor grader (small)	Each	1	10,000	10,000
	Dump truck	Each	1	4,500	4,500
	Flatbed truck w/winch	Each	1	5,000	5,000
	Farm tractor w/mowing attachments	Each	1	5,500	5,500
	Boat and motor	Each	1	2,500	2,500
	Miscellaneous small tools and equipment	Job	-	L.S.	5,000
	Subtotal direct cost				47,500
	Contingencies				9,500
	Total estimated cost, Permanent Operating Equipment				57,000
29	Preauthorization Studies				40,000
30	Engineering and Design				586,400
31	Supervision and Administration				629,300
	Total Project Cost				8,590,000

24. ESTIMATED INVESTMENT AND ANNUAL COSTS

Details of the estimated investment costs and annual charges are shown in table 6. Table 10 of Appendix II gives a detailed cost allocation of investment and annual costs for the flood control, water supply, fish and wildlife, and recreation features of the project.

TABLE 6

DETAILS OF INVESTMENT AND ANNUAL COSTS
BIG PINE DAM AND RESERVOIR

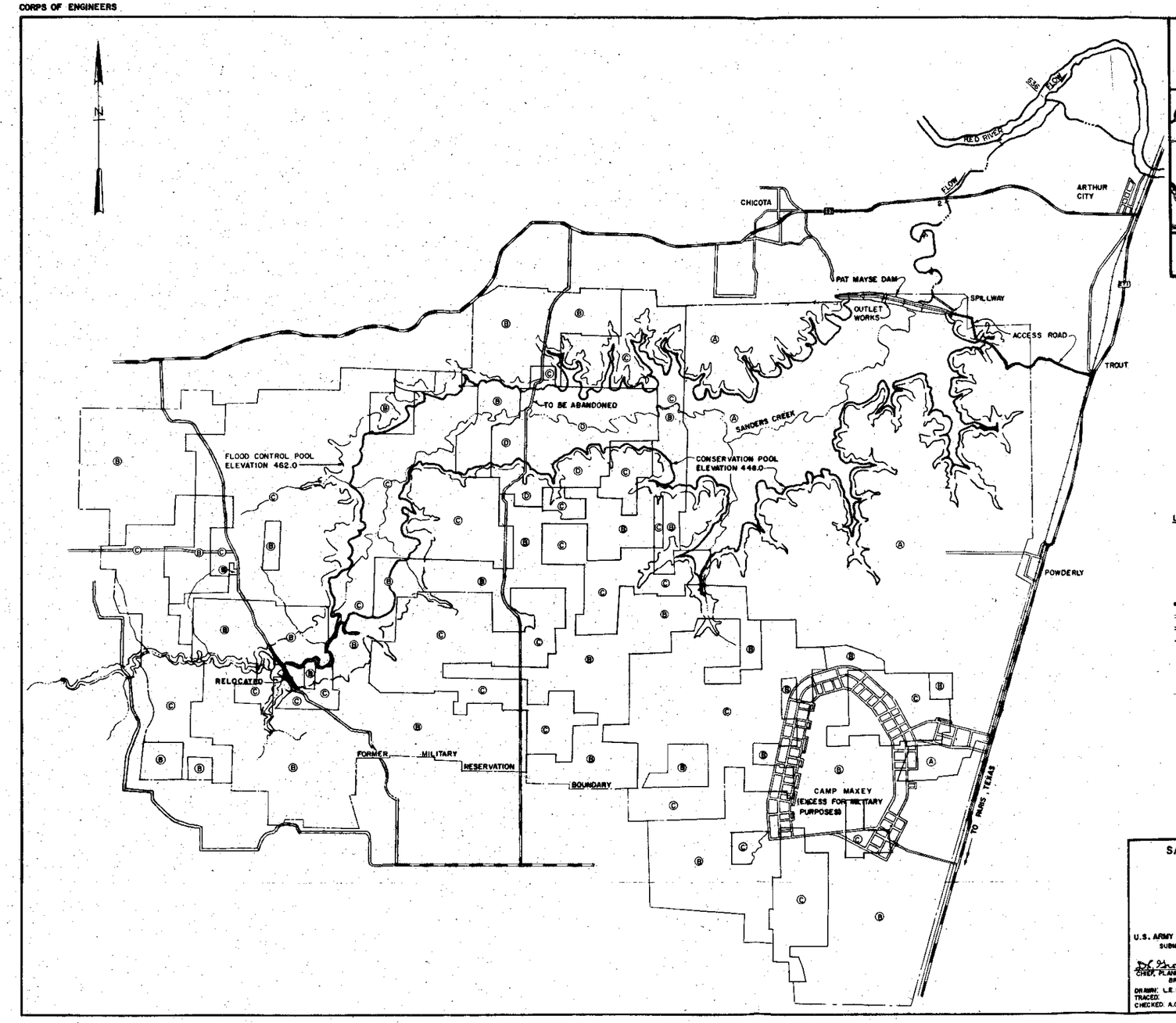
Item	Dam and Res	Public Use	Total
	$	$	$
Investment			
Construction cost	8,277,000	313,000	8,590,000
Interest during construction	217,000	0	217,000
Total	8,494,000	313,000	8,807,000
Annual Costs			
Interest	222,700	8,200	230,900
Amortization	18,100	1,000	19,100
Operation and maintenance	44,500	14,800	59,300
Major replacements	700	0	700
Engineering studies (1)	9,000	0	9,000
Total	295,000	24,000	319,000

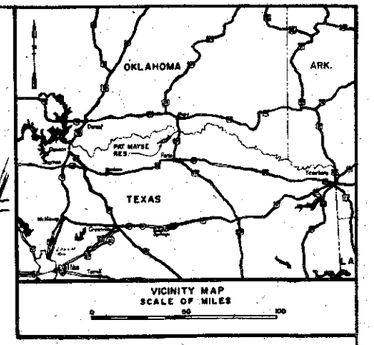
(1) Part of operation and maintenance cost.

94758 O - 63 - 9

CORPS OF ENGINEERS

U.S. ARMY





LEGEND

CAMP MAXEY LAND DISPOSITION

Ⓐ OWNED BY THE STATE OF TEXAS (TEXAS NATIONAL GUARD)

Ⓑ PRIVATELY OWNED

Ⓒ U.S. ARMY (OUTLEASED)

Ⓓ LEASED TO EAST TEXAS STATE TEACHERS COLLEGE

PROPOSED RELOCATION

FEDERAL, STATE HIGHWAYS & FARM ROADS

COUNTY ROADS

CHANNEL CLEARING

DATUM IS MEAN SEA LEVEL

SANDERS, BIG PINE, AND COLLIER CREEKS
TEXAS

PAT MAYSE RESERVOIR
RESERVOIR AREA

SCALE OF MILES

U.S. ARMY ENGINEER DISTRICT, TULSA, CORPS OF ENGINEERS

SUBMITTED: CHIEF, PLANNING & REPORTS BRANCH

APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION

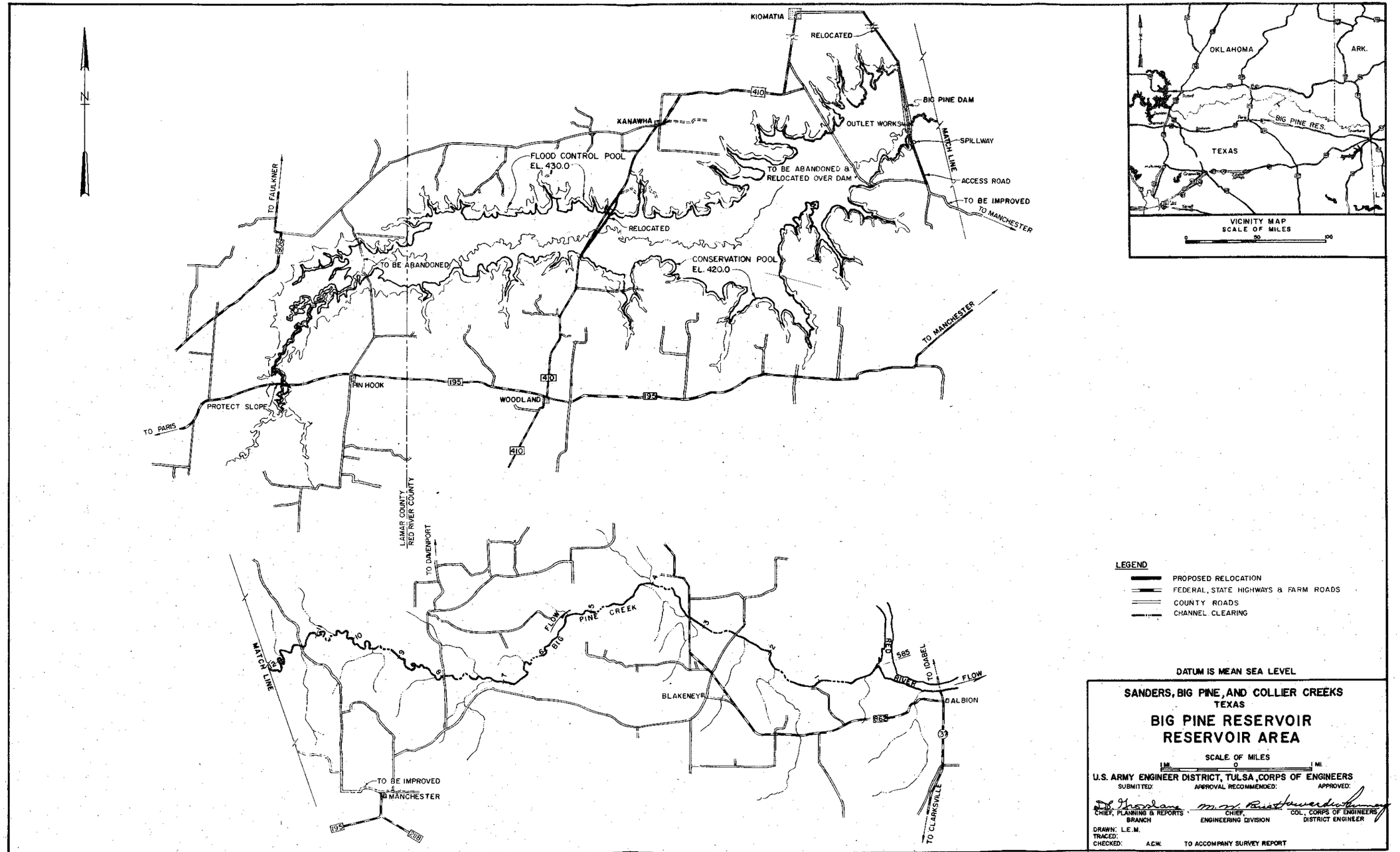
APPROVED: COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN: L.E.M.
TRACED:
CHECKED: A.C.W.

TO ACCOMPANY SURVEY REPORT

APPENDIX III PLATE I

94758 O–63 (Face blank p. 108) No. 1



LEGEND

- PROPOSED RELOCATION
- FEDERAL, STATE HIGHWAYS & FARM ROADS
- COUNTY ROADS
- CHANNEL CLEARING

DATUM IS MEAN SEA LEVEL

SANDERS, BIG PINE, AND COLLIER CREEKS
TEXAS

BIG PINE RESERVOIR
RESERVOIR AREA

SCALE OF MILES
1 MI. 0 1 MI.

U.S. ARMY ENGINEER DISTRICT, TULSA, CORPS OF ENGINEERS

SUBMITTED:	APPROVAL RECOMMENDED:	APPROVED:
CHIEF, PLANNING & REPORTS BRANCH	CHIEF, ENGINEERING DIVISION	COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN: L.E.M.
TRACED:
CHECKED: A.C.W.

TO ACCOMPANY SURVEY REPORT

APPENDIX III PLATE 10

94758 O-63 (Face blank p. 108) No. 2

SURVEY REPORT
ON
SANDERS, BIG PINE AND COLLIER CREEKS,
TEXAS

APPENDIX IV

REPORT BY PUBLIC HEALTH SERVICE

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

INTRODUCTION

General

The District Engineer of the Tulsa District, U. S. Army Corps of Engineers in a letter dated October 2, 1959, requested the Dallas Office of the U. S. Public Health Service to conduct such investigations as required to determine the present and prospective water supply needs which could be met by reservoirs on Sanders and Big Pine Creeks, the quality of water on the respective streams, and the economic value of water supply storage. In addition to the above mentioned sites, it was requested that a preliminary survey of the Acworth Dam site on Collier Creek be undertaken.

The study of municipal and industrial water supply is undertaken in accordance with the Memorandum of Agreement, dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare and authorized under the Water Supply Act of 1958, Title III of Public Law 85-500.

Acknowledgments

Information and data utilized in this report were obtained from many sources. The cooperation and assistance of the following, either through personal contact or publications, is gratefully acknowledged:

Forrest and Cotton, Consulting Engineers, Dallas, Texas

Industrial Development Department, Texas Power and Light Company

Wisenbaker, Fix, and Associates, Consulting Engineers, Tyler, Texas

Bureau of Business Research, University of Texas

Chamber of Commerce, Bonham, Texas

Chamber of Commerce, Clarksville, Texas

Chamber of Commerce, Paris, Texas

City of Clarksville, Texas

City of Bonham, Texas

City of Paris, Texas

Texas State Department of Health

SUMMARY AND CONCLUSIONS

1. The projects considered in this report are located as follows:

   Sanders - Sanders Creek north of Paris, Texas

   Big Pine- Big Pine Creek northwest of Clarksville, Texas

   Acworth - Collier Creek northeast of Clarksville, Texas

2. The water in Big Pine and Sanders Creeks is acceptable for municipal and industrial use with the exception of a high iron and manganese concentration, which can be removed by treatment. In addition, softening appears to be desirable for Sanders Creek water. No data are available on water quality in Collier Creek.

3. Present water demands of Bonham and Clarksville are supplied from ground water. Paris utilizes a surface water supply. Clarksville and Bonham plan to utilize surface water in developing new sources of supply.

4. Bonham (1960 population 7,508) and Clarksville (1960 population 3,811) are expected to maintain a rate of growth similar to that experienced in the past. It is anticipated that Paris (1960 population 20,696) will grow at a rapid rate through 1970 due to direct and indirect effects of the proposed location of a large food processor in that city. It is predicted that the rate of growth will decrease slightly after 1970. The estimated populations in 2010 are 20,000 for Bonham, 6,000 for Clarksville, and 97,000 for Paris.

5. Water demands for the three cities in 2010 are estimated at 3 mgd for Bonham, .75 mgd for Clarksville, and 33 mgd for Paris.

6. To meet these demands, Bonham has begun the initial stages of developing a single-purpose water supply project on Timber Creek which can supply their needs through 2010. It does not appear that Bonham has a need for storage in the Corps of Engineers projects.

7. The projected demand for Clarksville can be met from present sources of ground water; however, the city desires to develop a surface water supply. The city of Clarksville has passed a resolution requesting the inclusion of storage to yield 26 mgd in the Big Pine Project and indicating its intent to pay for such storage. However, sufficient water appears to be available from the already contracted for Langford Creek Project to supply Clarksville's demands from a surface water source. There is no economic value attributable to storage in the Corps of Engineers Big Pine Project for municipal and industrial water supply.

8. The demand for Paris requires a source of approximately 25 mgd yield in addition to the present source of supply. The city has furnished the Corps of Engineers a resolution indicating its intent to purchase the entire 55 mgd yield of the Sanders Creek Project. The average annual value of storage capable of yielding 55 mgd in the Sanders Creek Project is $222,000, the cost of a single-purpose water supply structure at the same site.

9. There does not appear to be any demand for water supply storage in the Acworth Project. This site should be investigated only if Clarksville desires to purchase storage in it for municipal and industrial water supply.

10. The value of water supply storage in the several projects is as follows:

Project and Expected Demand-2010	Average Annual Value of Storage
Sanders Creek (55 mgd)	$222,000
Big Pine Creek	) No projected demand) on these projects;) therefore, no economic) value is attributable) to water supply storage.
Acworth	

11. There does not appear to be a pollution problem associated with the discharge of Clarksville's wastes into the Sulphur River. It is anticipated that pollution problems will be encountered in Pine Creek due to the discharge of wastes in the Paris area, with a possibility of problems in the Red River. However, this pollution would not affect the quality of water in the projects under consideration in this study. Further study of pollution problems will be undertaken in conjunction with a comprehensive study of southeastern Oklahoma and adjacent areas.

DESCRIPTION OF AREA

The area involved in this study consists of Fannin, Lamar, and Red River Counties in northeastern Texas (See Watershed Map, Figure 1.)

The economy of the area is based principally on agriculture. The soil, primarily black lands, is especially suitable for farming. The principal crops are cotton, corn, rye, and peanuts. There is also a considerable amount of truck farming in the area and cattle, sheep, chicken and turkey raising play an important part in the area's economy. It has been stated that Lamar County, in which both Sanders and Big Pine are located, is one of the best balanced and diversified agricultural economies in the State. 11,12/

The average annual rainfall is approximately 43 inches per year with a mean temperature of about 64°F.

The largest city in the study area is Paris with a 1960 Census population of 20,696. Next in size is Bonham, with a population of 7,508 in 1960, and then Clarksville, 1960 population 3,811. 3/

Industry has not played an important role in the past although there are some lumber operations, manufacturing activities, and agricultural processing. It appears that industry will play a larger role in any future development of the area.

DESCRIPTION OF CORPS OF ENGINEERS PROPOSED PROJECTS

The Sanders Creek Project is located on Sanders Creek approximately thirteen miles north of Paris, Texas. Sanders Creek rises in Fannin County approximately three miles northeast of Honey Grove, Texas. It flows in a northeasterly direction for about fifteen miles and then turns eastward joining the Red River at River Mile 632. The proposed storage for water supply purposes is 99,700 acre feet with an estimated yield of 55 mgd. Pertinent physical data are presented in Table 1.

The Big Pine Project is located at River Mile 13.2 on Big Pine Creek, which rises in Lamar County, approximately five miles north of Blossom, Texas. Big Pine Creek flows north until it reaches the Red River County line, from which point it flows east to its confluence with the Red River at River Mile 585. The proposed Big Pine Project impoundment for water supply purposes is 79,300 acre feet with an estimated yield of 26 mgd. Pertinent physical data are presented in Table 1.

The Acworth dam site is located at River Mile 3.9 on Collier Creek, approximately twelve miles northeast of Clarksville, Texas. Collier Creek rises in Red River County near Negley, Texas, and flows generally eastward to the Red River. The estimated water supply yield from this reservoir is 2.5 mgd with a conservation storage of 2,100 acre feet. Pertinent physical data for the Acworth Project are presented in Table 1.

Table 1

Preliminary Pertinent Data for Proposed Corps of Engineers Projects on Sanders, Big Pine, and Collier Creeks*

Feature	Reservoir		
	Sanders	Big Pine	Acworth
Location:			
Stream	Sanders Creek	Big Pine Creek	Collier Creek
River Mile	4.4	13.2	3.9
Purpose:	F. C. & C.	F. C. & C.	F. C. & C.
Drainage area, sq. mi.	175	95	26
Elevations, ft., m.s.l.			
Top of pool, Flood Control	462.0	430.0	392.0
Top of pool, Conservation	448.0	420.0	376.0
Reservoir area, acres:			
Top of pool, Flood Control	7,950	6,400	1,520
Top of pool, Conservation	5,450	4,640	440
Reservoir storage, ac-ft			
Flood Control	93,600	54,700	13,700
Conservation (W.S.)	99,700	79,300	2,100
Sediment	7,500	4,600	1,600
Total	200,800	138,600	17,400
Water supply yield, mgd	55	26	2.5

*Source: Corps of Engineers, Tulsa District Office

WATER QUALITY IN PROJECT STREAMS

This section presents available quality data as an indication of the water quality to be anticipated from an impoundment on the project streams. Water characteristics which may require special treatment in addition to normal surface water treatment are also discussed.

Sanders Creek

The chemical analyses presented below are averages of samples taken during a portion of one year and, while they may not be entirely representative of the over-all water quality obtained from a large impoundment, they are the best available data.

Table 2

Chemical Characteristics - Sanders Creek [15]
(All units ppm unless otherwise specified)

	Average	Maximum	Minimum
Calcium	73	150	31
Magnesium	14.8	31	6
Iron	1.6	2.6	0.6
Manganese	2.4	4	0.6
Sodium	36	49	16
Carbonate (CO_3)	0	Trace	0
Bicarbonate (HCO_3)	242.6	468	73
Sulfate (SO_4)	46	110	5
Chlorides	52.7	120	17
Fluoride	0.36	0.4	0.3
Nitrate (NO_4)	less than 0.4		
Specific Conductance micromhos/cm.[3]	706.2	1,260	400
Total Alkalinity as $CaCO_3$	233.8	384	165
Hardness	237.5	505	133
pH	7.15	7.3	7.0
Total Solids	385	756	230

Based upon these analyses, the water in Sanders Creek does not appear to be of exceptionally good quality. It is extremely high (4.0 ppm) in iron and manganese, the Public Health Service Drinking Water Standards accepted limit being 0.3 ppm for iron and manganese combined; [19] however, iron and manganese can be removed with suitable treatment. The average hardness of 237.5 ppm is high for most uses and it appears that softening will be desirable.

Big Pine Creek

The following table presents the results of the two chemical analyses of the water in Big Pine Creek.

Table 3

Chemical Characteristics - Big Pine Creek [15]
(All units ppm unless otherwise specified)

Calcium	26.5
Magnesium	5
Iron	2.0
Manganese	0.6
Carbonate	0
Bicarbonate	100
Sulfate	11.5
Chlorides	7
Fluoride	0.35
Nitrates	less than 0.4
Specific Conductance micromhos/cm.[3]	205
Total Solids	153
Total Alkalinity	82
Hardness	88
pH	6.7

The results of the two samples taken from Big Pine Creek indicate that the water is of suitable quality for most domestic and industrial use with the exception of a high iron and manganese concentration. The observed concentration of 2.6 ppm for iron plus manganese greatly exceeds the Public Health Service's recommended limit of 0.3 ppm so treatment for iron and manganese removal should be practiced in addition to normal surface water treatment.

Collier Creek

No quality data are available for the water in Collier Creek at this time. Should this data prove to be necessary, field investigations must be conducted to make the determinations.

ECONOMIC OUTLOOK

The purpose of this section is to define the present and the potential economy of the Sanders - Big Pine - Acworth area.

The 1960 population for the three counties is 73,352. The combined population shows a steady downward trend since 1920. Table 4 presents the county trends.

Table 4

Population for Fannin, Lamar, and Red River Counties [3/]
1900 - 1960

	1900	1910	1920	1930	1940	1950	1960
Fannin	51,793	44,801	48,186	41,163	41,064	31,253	23,735
Lamar	48,627	46,544	55,742	48,529	50,425	43,033	33,973
Red River	29,893	28,564	35,829	30,923	29,769	21,851	15,644
TOTALS	130,313	119,909	139,757	120,615	121,258	96,137	73,352

Contrary to the downward trend in the county totals, the major cities have shown an increase since 1930. The city with the most significant growth is Paris. Paris, located in Lamar County, showed a slight loss from 1950 to 1960; however, Paris has demonstrated appreciable growth in the past and exhibits greater growth possibilities for the future. Bonham and Clarksville, which are the second and third largest cities respectively, have also shown increases since 1930. Population figures for the three cities are shown in Table 5.

Table 5

Population for Cities of Bonham, Paris, and Clarksville [3/]
1910 - 1960

	1910	1920	1930	1940	1950	1960
Bonham	4,844	6,008	5,655	6,349	7,049	7,508
Clarksville	2,065	3,386	2,952	4,095	4,353	3,811
Paris	11,269	15,040	15,649	18,678	21,643	20,696

The greatest decrease in population has been caused by a decrease in agricultural employment. Increased farm mechanization has had a significant influence in replacing farm labor and has resulted in a decrease in farm population. Table 6 shows the trends in rural population in the past.

Table 6

Population for Rural Areas in Fannin, Lamar, and Red River Counties 1920 - 1950 3/

	1920	1930	1940	1950
Fannin	33,696	28,591	27,191	17,193
Lamar	38,912	31,411	30,102	19,902
Red River	32,443	27,545	22,852	15,023

Agriculture

The rural population has had a significant decrease since 1920. The greatest decrease was from 1940 to 1950. As has taken place in the past, increased technical advancements will probably result in an additional decrease in farm population over the next 25 years.

Not only has a decrease in farm population occurred, but the number of farms and total cropland harvested have also decreased. However, there has been an increase in livestock and livestock production. The number of cattle and calves has increased over 40 per cent from 1950 to 1954; the milk production has more than doubled during that time for the area. 12/

Minerals Resources and Forest Products

There are few mineral resources of commercial value in the study area. The area has deposits of limestone, gravel, sand, burning clay, and miscellaneous stone. 21/ This would indicate insignificant growth potential for basic mineral industries in the study area. However, some of the surrounding counties, Grayson, Titus, and Franklin Counties produced over $46,000,000 of minerals in 1958. 4/ It is possible that some processing of minerals from surrounding areas may occur in the study area.

There is a considerable amount of timber which supports a number of wood-products industries. A high rate of depletion in the past caused great concern throughout the State and resulted in the

introduction of rigid conservation techniques which limit annual production to its present level. Therefore, no growth in this field is expected at the present time. With reforestation now being put into affect, possibilities of employment growth in the future appear likely. 21/

Industry

Manufacturing industry will be the major influence on the rate of growth of the area's population in the future. There are many factors which influence industrial development in a region, such as raw materials, markets, industrial power, transportation, and building sites.

Mineral and forest raw materials available in this area for future development are insignificant and offer no attraction to new industrial operations. Agricultural products are abundant, indicating a possible increase in the food and kindred products industries.

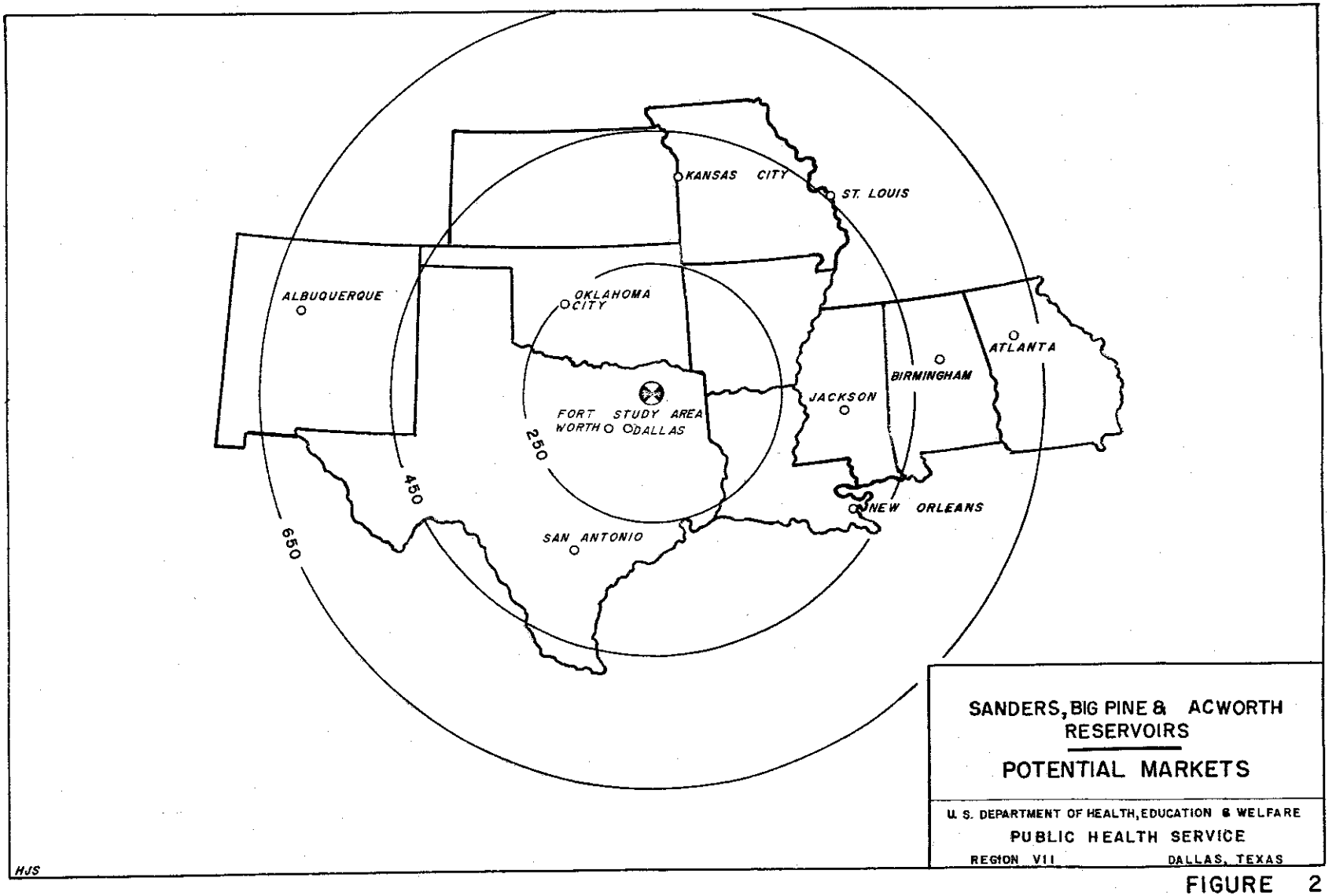
The Sanders - Big Pine area is favorably located for markets in the Southwest. The geographic location makes large metropolitan areas in nine states readily accessible from the Big Pine - Sanders area. The map on the following page shows the distances to these market areas.

North Texas has access to low-cost electric power for industrial development. Natural gas reserves appear adequate to care for industrial expansion for the next fifty years. Supplies of lignite are available as a supplementary fuel source if needed. 21/

This area has good highways and railroad facilities. Trucking may be the most important mode of transportation for this area. With excellent highways, trucks allow flexibility, speed, and low-cost advantages. Truck transportation will help transport an increasing variety of products to and from this area. Railroads, still the leading carrier in the United States, offer economical and dependable service to and from all parts of the United States. The Texas and Pacific Railway Company serves the area.

There are excellent industrial sites available at relatively low cost, close to highways and railroad facilities.

It does not appear that any significant growth will occur in the area outside of the three largest cities. The rural area population, which has been declining, should continue to decrease in the immediate future, after which it should level off; it may even increase slightly near the year 2010 since the area is excellent for agriculture; and, as the Nation grows, there will be a larger demand for food; this should bring about the reversal of the rural trend. 21/



SANDERS, BIG PINE & ACWORTH RESERVOIRS

POTENTIAL MARKETS

U. S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE 2

Clarksville

Clarksville, the smallest of the three principal cities, reveals signs of modest increase. Clarksville has an adequate number of industrial sites, good transportation connections, and a good labor supply; but there are no definite signs of industrialization. The last industrial plant to locate in the city was in 1954. This plant manufactures doors for trailers and has between thirty-five and forty-five employees. In the meantime, Clarksville has lost at least one other prospective firm. 14/ The competition is keen for industrial prospects, and since Clarksville has no outstanding competitive advantages over other communities in this part of the United States, it does not appear that it will experience dynamic growth. By the year 2010 the population should be 6,000.

Bonham

Bonham, located about 36 miles west of Paris, Texas, has had an impressive industrial growth during the past decade. Eight new firms have established there in the past ten years. Three of these firms employ from 190 to 400 workers each. The Bonham Industrial Foundation stands ready to assist firms interested in locating in Bonham.

Recently Bonham has taken steps to attract more industry by hiring consulting engineers to make a water supply development survey. 13/

Bonham has an adequate labor supply, both skilled and semi-skilled. The transportation facilities are good; the railroad and truck service is scheduled to all parts of the United States. There are also good building sites, as well as satisfactory fuel and power.

The steady population growth is attributable to industrial expansion. Assuming this expansion will continue, the population is expected to reach 20,000 by 2010.

Paris

Paris, the largest of the three cities under consideration, has been increasing steadily in population and should continue to do so at a rate greater than that experienced in the past.

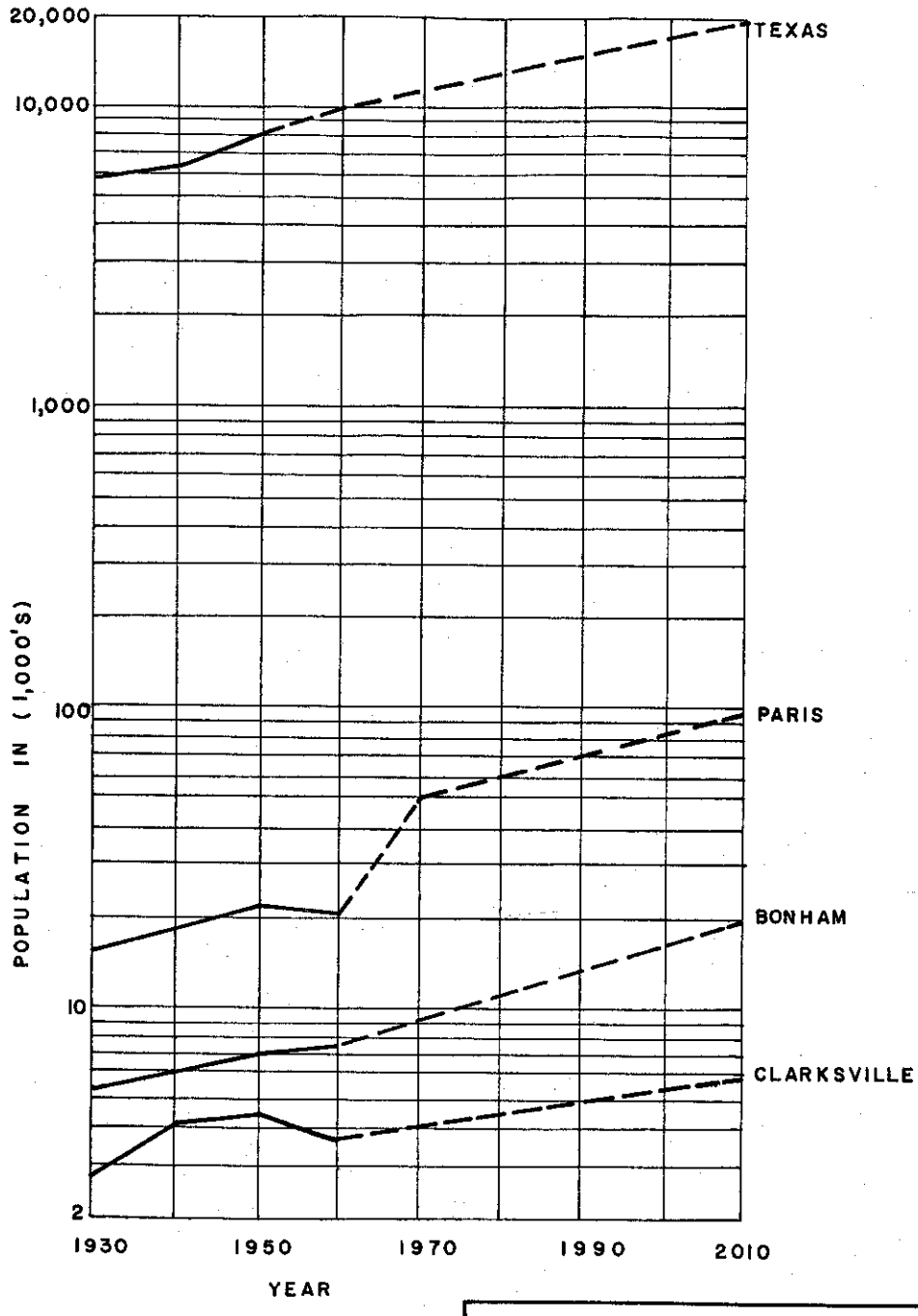
In 1954, there were thirty-six manufacturing establishments located in Paris, four of which employed over 100. 2/ At the present time there are forty-six such establishments, six of which employ

over 100. [17] The area is well suited to a continued growth in the apparel and food processing industries.

The city possesses excellent transportation facilities with four rail lines, five main highways, and commercial air service. There is adequate power in the area. An independent agency has developed land for an industrial park, thereby providing good industrial sites for new industries. In addition, Paris lies in an excellent agricultural area providing abundant livestock and truck crops for the food processing industry.

The Campbell Soup Company has recently purchased over 500 acres in the Paris area to utilize the truck crops produced in the area. Originally, the plant was to employ some 1,200 people, but the latest information indicates that this figure has been increased to between 2,500 and 3,000. [16,17]

In addition to the direct effects of Campbell Soup, there are several indirect effects which will tend to further add to the population growth. It is anticipated that several smaller food processing operations will spring up in the area to handle agricultural products produced in excess of Campbell's requirements. The growth of the food processing industry should also provide an impetus to the development of secondary manufacturing operations, such as jars, cans, food preservatives and other material and equipment for the processing industry. A population increase of 17,000 is projected for the period 1960-1965 due to direct and indirect effects of growth in the food processing industry. The city will experience a very rapid growth from the period 1961 to 1970, probably reaching a population of 60,000. It appears probable that the rate of growth will then tend to decrease, with the population reaching 97,000 by 2010.



SANDERS, BIG PINE & ACWORTH RESERVOIRS

POPULATION TRENDS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

HJS

FIGURE 3

Bonham

The town of Bonham obtains its municipal water from three wells drilled approximately 1,200 feet into the Woodbine sand formation underlying the area. The static water level is approximately 300 feet. The maximum dependable draft is approximately 1.5 mgd. The quality is good for domestic purposes but only fair for industrial use because of a high bicarbonate content. 9/

Present use from the municipal system averages 0.8 mgd with peak demands of 1.0 mgd during the summer months. Per capita consumption averages 100 gpd. These figures include all industrial use, as there are no self-supplied industries. 6,9/

The estimated 2010 demand is 2.8 mgd based upon population and industry forecasts developed in the previous section and a per capita use of 140 gpd. The present water supply source is inadequate to meet these demands.

The city is presently in the preliminary stages of developing a source of water supply on Timber Creek north of Bonham. The reservoir will have a drainage area of 29.56 square miles and a capacity of 11,165 acre feet, with a pool elevation of 565.0 feet, msl. The dependable yield is estimated at 7 mgd which is more than sufficient to meet Bonham's estimated needs through 2010. 9/ It does not appear that the city of Bonham will require storage for water supply purposes in any of the Corps of Engineers projects.

Clarksville

Water use from the municipal system in Clarksville is presently 0.4 mgd or 81 gpcd. This water is supplied from four wells having a maximum dependable draft of 2.0 mgd. The water is of good quality; however, the town does not feel the supply dependable enough, or of good enough quality, to be an attraction to industry; and, therefore, desires to develop a surface water supply to meet future needs as well as to replace the present ground water supply. In addition, the aquifer providing the present source of supply is reported to be relatively small and crescent shaped, surrounded by a formation yielding saline water. This situation caused some concern that total dissolved solids in the present source of supply may increase to a concentration which would render it useless as a source of water supply for municipal and industrial purposes.

Projections of water use indicate a demand of 750,000 gpd by the year 2010, based upon a per capita use of 125 gpd and a population of 6,000. The city has agreed to take 1.0 mgd from a Soil Conservation Service dam located adjacent to the town on Langford Creek.

Assuming that the city retains its present wells in operating condition for use as a source to meet peak demands and that the 1.0 mgd Langford Creek Project is used as the major source of supply, it appears that Clarksville will have adequate water to meet municipal and industrial needs through 2010.

City officials contacted have expressed an intention to purchase the entire output of 26 mgd from the Big Pine Project for municipal and industrial water supply and have furnished the Corps of Engineers with a resolution to that effect. However, it is the opinion of this office that they will not have need for this amount of water in the 50-year future.

Value of Storage in Big Pine Project

There is no demand evident at the present time for water supply storage in the Big Pine Reservoir. Therefore, no economic value is attributable to storage in this project for municipal and industrial water supply.

Paris

Paris, Texas, presently obtains its water from Lakes Crook and Gibbons. Both lakes are on the same watershed and have a combined yield of approximately 9.5 mgd. The water is of good quality and suitable for most purposes.

The average water use supplied from the municipal system in 1959 was 2.40 mgd or 98.5 gallons per capita per day. The table below presents water use data from 1925 to the present and indicates an increasing water use from 1925 to 1955. Average daily use decreased from 2.79 mgd in 1956 to 2.40 in 1959. During the same period, per capita use decreased from 120.8 gpd to 98.5 gpd. It is assumed that this trend, presumably reflecting the abnormally high uses during the 1955-56 drought, is transitory in nature and that the average water demands will resume the long-range, upward trend in the future.

Table 7

Historical Water Use Data - Paris, Texas [5,15]

Year	Average Use mgd	Per Capita Use gpd
1925	0.95	63.4
1930	0.96	61.1
1935	0.95	55.6
1940	1.23	69.3
1945	1.89	93.6
1950	1.91	106.5
1955	2.56	109.9
1956	2.79	120.8
1957	2.44	101.2
1958	2.49	101.1
1959	2.40	98.5

It is expected that per capita use will increase in the future due to normal increases in water using devices and increased industrial development, leveling off at approximately 150 gpcd exclusive of use by food processing industries. The following are the projected per capita demands for various years throughout the study period.

Table 8

Estimated Per Capita Water Use for Paris, Texas
1960 - 2010

Year	gpcd
1960	100
1970	125
1980	140
1990	145
2010	150

Based upon the population growth indicated in the previous section and the per capita consumptions, the projected water demands are:

Table 9

Estimated Demand (Exclusive of Food Processing)

Year	mgd
1960	2.7
1970	7.5
1980	10.2
1990	12.3
2010	14.6

In addition to the demands presented above, it is anticipated that a large demand will be developed by the expected influx of food processing industries into the area. The Campbell Soup Company will require 2.0 mgd initially with an ultimate demand of 8.0 mgd expected to develop by 1965. 16,17/ Smaller food processors anticipated to locate in the area should create an additional demand of approximately 10 mgd. Total water use by the food processing industry will reach 18 mgd by the year 1970.

Total water demands for the Paris area for all municipal and industrial uses are estimated at 32.6 mgd by the year 2010. Table 10 presents the projected demands from 1960 to 2010.

Table 10

Estimated Water Demands for Paris, Texas
1960 - 2010

Year	Water Demand mgd
1960	2.7
1961	5.2
1965	16.0
1970	25.5
1980	28.2
1990	30.3
2010	32.6

The estimated yield of Lakes Crook and Gibbon in 2010 is 7.4 mgd based upon a siltation study made by the Soil Conservation Service in 1956. 8/ The present supply is adequate, therefore, to meet municipal demands through 1961 and the initial demand created by the Campbell plant. In other words, the Campbell plant cannot be put into full production without the development of supplemental water sources to augment the present supply. As a point of interest, it has been learned from the Paris Chamber of Commerce that several firms have declined to locate in the area due to the inadequacy of the present supply to meet their demands. 17/

The anticipated supplemental water needs for Paris are shown in Table 11.

Table 11

Estimated Additional Water Supply Needs for Paris, Texas
1960 - 2010

Year	mgd
1960	Present supply adequate
1961	Present supply adequate
1965	6.9
1970	16.6
1980	19.7
1990	22.2
2010	25.2

Since the present supply will be inadequate so soon, it appears that the development of a new source of supply must be begun now in order to have it in operation by the time it is needed.

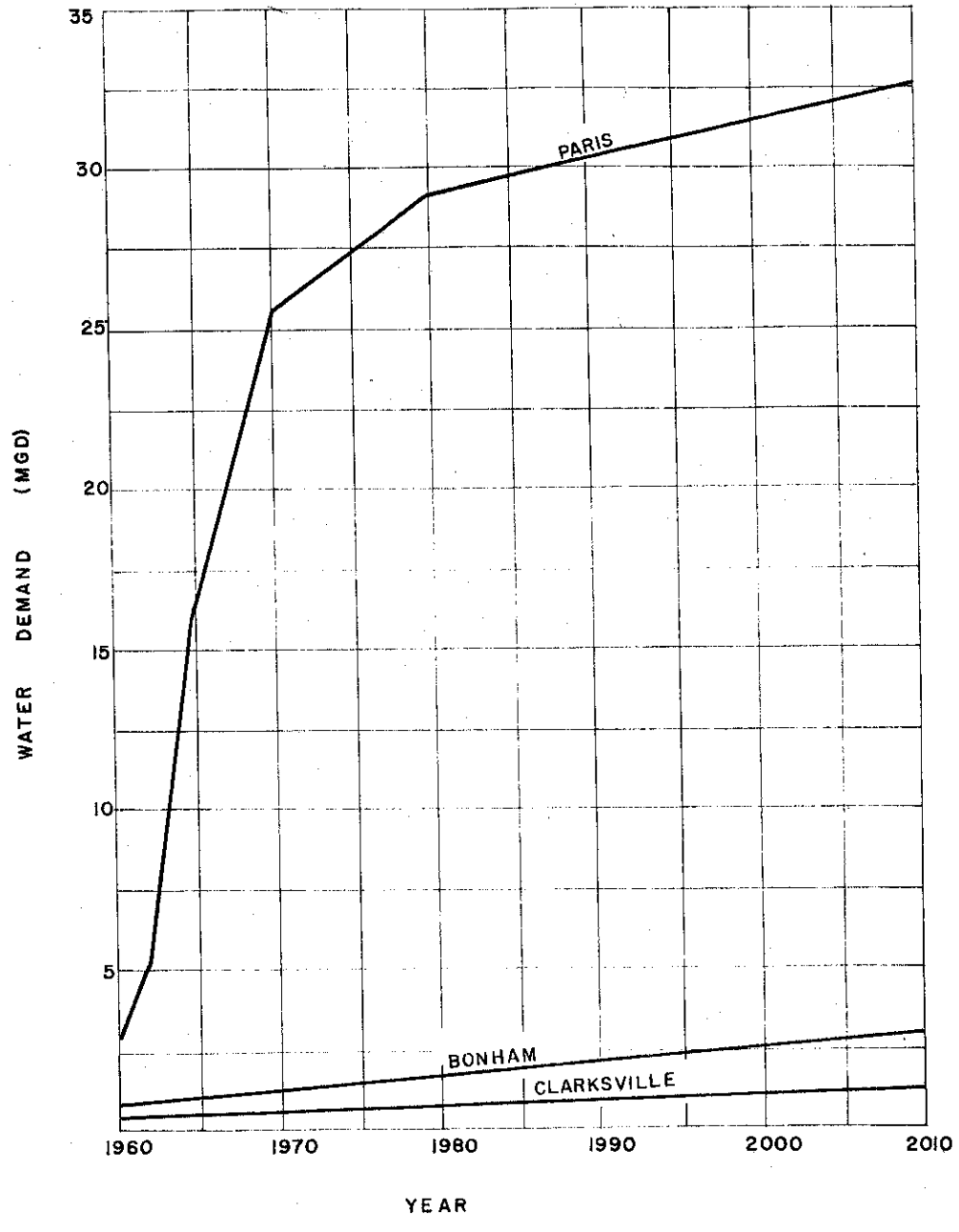
Although the future water needs for Paris are below the 55 mgd yield of the proposed Sanders Creek Project, the city has furnished the Corps of Engineers with a resolution indicating that it desires to purchase the entire output. Therefore, in determining alternative sources for use as a measure of the value of water supply and storage, only those sources capable of supplying 55 mgd were considered. In the case of the Corps of Engineers Sanders Creek Project, ground water studies indicate that this source is inadequate as an alternative. In so far as surface water is concerned, the only alternative to the proposed multipurpose project capable of yielding 55 mgd appears to be a single-purpose project at the same site.

Value of Storage in Sanders Creek Project

Since the alternative site is identical to the proposed Sanders Creek Project, there will be no difference in water quality, treatment required, or transmission costs to the point of use between the alternatives and the Sanders Creek Project. Therefore, the average annual value of storage in the Corps of Engineers proposed Sanders Creek Project, capable of yielding 55 mgd, is $222,000, the cost of constructing a single-purpose project at the same site, based upon amortization of the alternative over 50 years at 4 per cent interest.

Acworth Dam Site

A preliminary survey of possible water supply needs which might be satisfied by a dam and reservoir on Collier Creek indicates that no demand exists for water from this reservoir. It appears that no further study at the Acworth Project is warranted at the present time.



SANDERS, BIG PINE & AGWORTH RESERVOIRS

ESTIMATED WATER DEMAND

U. S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

HJS

FIGURE 4

WASTE DISPOSAL

The use of large quantities of water for municipal and industrial purposes is possible only if satisfactory disposal can be provided for resulting wastes. The principal source of wastes utilizing water from the Sanders Project is anticipated to be the city of Paris.

Paris discharges its treated wastes into Pine Creek, which could have a sustained flow of 9.5 mgd if the use of Lakes Crook and Gibbons as a source of municipal and industrial water supply is discontinued and all water is obtained from the Sanders Creek Project. If these lakes continue to be used as a source of water supply, it appears that the flow downstream of the reservoirs will be negligible during certain periods of the year, except for the waste discharges. In either case, the flow does not appear to be adequate to assimilate the wastes anticipated from the development of the large scale food processing industry plus other industrial and municipal wastes, if the locations of such industries are such that all wastes discharge into Pine Creek. Some limitation or regulation of the locations of industry may be necessary to prevent adverse conditions of pollution in Pine Creek.

Under average low-flow conditions, it appears that the Red River can assimilate the wastes from Paris. However, under conditions of extreme low flow, there may be insufficient assimilative capacity, and regulation of waste discharges may be necessary to prevent a serious pollution problem.

A detailed study of other waste discharges into the same reach of the Red River and/or analysis of flow data are necessary to more clearly define the problem. The discharges will, however, have no effect on the water quality impounded in the Sanders Creek project.

A more thorough study of the effects of waste discharges on water quality is necessary on both the Sulphur and Red Rivers to provide a more definitive statement as to possible pollution problems. Such a study is beyond the scope of this report, due to time and fund limitations. Consideration of the waste problem will be undertaken in a comprehensive water resources study of southeastern Oklahoma and adjacent areas, to be made by the Public Health Service.

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20. Water Quality Criteria, State Water Pollution Control Board, SWPCB Pub. No. 3, Sacramento, California, 1957.

21. Water Requirements Survey, Red River Basin, Texas, Bureau of Business Research, University of Texas, Austin, Texas, 1952.

22. Water Supply and Waste-Water Disposal, Fair, G. M., and Geyer, J. C. Wiley and Sons, Inc., New York, 1954.

SURVEY REPORT
ON
SANDERS, BIG PINE AND COLLIER CREEKS,
TEXAS

APPENDIX V

FISH AND WILDLIFE

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

SOUTHWEST REGION
(REGION 2)
ARIZONA
COLORADO
KANSAS
NEW MEXICO
OKLAHOMA
TEXAS
UTAH
WYOMING

ADDRESS ONLY THE
REGIONAL DIRECTOR

March 22, 1961

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

This letter constitutes the preliminary report of the Bureau of Sport Fisheries and Wildlife in relation to the proposed developments on Sanders, Big Pine, and Collier Creeks, Red River and Lamar Counties, Texas. This report has been prepared pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and is intended to meet the needs of your survey report scheduled for completion about May 1961. Our report has been prepared in cooperation with the Texas Game and Fish Commission and has received concurrence from that agency by letter of February 17, 1961, signed by H. D. Dodgen, Executive Secretary. This report also has been coordinated with the Bureau of Commercial Fisheries.

It is our understanding that the plan of improvement includes the construction of two reservoirs: Pat Mayse Reservoir on Sanders Creek in Lamar County; Big Pine Creek Reservoir on Big Pine Creek, Lamar and Red River Counties, Texas; and channel rectification to increase capacity of the respective stream channels downstream from the dam sites to the Red River.

Channel rectification of the two streams will involve those improvements necessary to increase the channels' capacity from 500 second-feet to 1,300 second-feet along the 4.4 miles of Sanders Creek downstream from the dam site to Red River, and from 300 second-feet to 800 second-feet on the 13.2 miles of Big Pine Creek downstream from the dam site to Red River.

The proposed project will provide flood control on Sanders and Big Pine Creeks as well as provide water conservation for municipal and industrial uses. Tables 1 and 2 present the pertinent data relative to the project.

94758 O - 63 - 11

Table I

Pertinent Data - Pat Mayse Reservoir

Location: Sanders Creek at mile 4.4
Drainage Area. 175 square miles
Elevations, Areas, and Capacities

Feature	Elevation (m.s.l.)	Area (acres)	Capacity (acre-feet)
Top of dam	487.0		
Maximum pool	481.9	14,225	418,555
Flood control pool	462.0	7,950	200,800
5-year flood frequency pool	455.0	6,650	150,470
Conservation pool	448.0	5,450	107,200
Streambed	398.0		
Flood control storage			
Initial	448.0-462.0		93,600
After 50 years	448.0-462.0		91,600
Conservation storage			
Initial	448.0		107,200
After 50 years	448.0		101,700

Spillway: Crest elevation 462.0
200-foot uncontrolled
Discharge at maximum pool 55,400 second-feet

Channel capacity at dam site: Natural 500 second-feet
Improved 1,300 second-feet

Outlet works: One Drop-Inlet - 5.5 feet

Table 2

Pertinent Data - Big Pine Creek Reservoir

Location: Big Pine Creek at mile 13.2
Drainage Area: 95 square miles
Elevations, Areas, and Capacities

Feature	Elevation (m.s.l.)	Area (acres)	Capacity (acre-feet)
Top of dam	451.0		
Maximum pool	445.8	10,000	268,000
Flood control pool	430.0	6,400	138,600
5-year flood frequency pool	425.0	5,450	110,000
Conservation pool	420.0	4,640	83,900
Streambed	376.0		
Flood control storage			
Initial	420.0-430.0		54,700
After 50 years	420.0-430.0		53,600
Conservation storage			
Initial	420.0		83,900
After 50 years	420.0		80,400

Spillway: Crest elevation 430.0
200-foot uncontrolled
Discharge at maximum pool 41,400 second-feet

Channel capacity at dam site: Natural 300 second-feet
Improved 800 second-feet

Outlet works: One conduit - 4 feet

Project plans involve purchase in fee of lands lying below the 5-year flood frequency elevation and easements to the top of the flood pool. Preliminary estimates for fee land requirements are 8,750 acres on Pat Mayse Reservoir and 7,350 acres on Big Pine Creek Reservoir. Flowage easement will be taken on 1,550 acres between elevation 455 1/ and 465 at the Pat Mayse Reservoir site and 1,150 acres between elevations 425 and 433 at the Big Pine Creek Reservoir site.

Sanders Creek Watershed above Pat Mayse Reservoir site lies predominately in the Blackland Prairie physiographic region; however, the dam site and northern boundary of the reservoir are in the fringe area of the Post Oak Belt physiographic region that extends along the Red River. Soils range from the red chocolate clay loam along the Red River Valley to sandy clay loam on the uplands. Vegetal cover is primarily a grass understory with post oak, blackjack, pecan, hackberry, cottonwood, and osage-orange overstory.

The Big Pine Creek Reservoir site lies in the fringe area between the Blackland Prairie, East Cross Timbers, and Pine Belt physiographic regions. The dam site and lower portion of Big Pine Creek Reservoir are in the Pine Belt region characterized by light-colored, acid sandy loams, and alluvial sands, supporting pine, bottomland oaks, gum, and ash.

Land use throughout the project area is predominately based on livestock production; however, within the general region are selected areas of highly productive cropland. Land use trends are changing in favor of improved pastures over cultivated lands. Pat Mayse Reservoir would be situated entirely within the Camp Maxey Military Reservation boundaries; however, much of the land has been revested to private ownership and the remaining Federal lands are leased for livestock grazing.

The project area is in a moderately humid region having an average annual rainfall of about 40 inches in Lamar County and 47 inches in Red River County. Mean annual temperature is about 64° F. Average frost-free period is about 238 days.

1/ All elevations are in feet and refer to mean sea level datum.

Sanders Creek is formed by the confluence of Craddock Creek with Little Creek and joins the Red River near Arthur City, Texas. Streamflow data based on rainfall and runoff over the period of record, 1933 to 1958, indicate that an average annual flow of approximately 169 second-feet or 122,300 acre-feet may be expected at the dam site. Minimum streamflow normally occurs in August. Zero monthly flow occurred 14 times during the period of record.

Big Pine Creek, with tributary headwaters in Lamar County, is formed by the confluence of Tanyard Creek with Little Pine Creek and flows into the Red River near Albion, Texas. Rainfall and runoff records indicate that the average annual streamflow at the dam site approximates 93 second-feet or 67,680 acre-feet. Minimum flows occur in August with zero monthly flows occurring 14 times during the period of record.

The area of project influence for fishery resources evaluation includes 26 miles of Sanders Creek within and downstream from Pat Mayse Reservoir site and 13 miles of Big Pine Creek within and downstream from Big Pine Creek Reservoir site.

Sanders and Big Pine Creeks are small, sluggish, silt-bottomed, tree-lined streams with numerous pools and few riffle areas. The fishery is of moderate quality comprising such species of fish as largemouth bass, spotted bass, yellow bass, white bass, white crappie, black crappie, various sunfishes, channel catfish, flathead catfish, bullheads, carp, buffalofishes, drum, gizzard shad, and numerous minnows.

Fishing pressure is light on the streams in the project area chiefly because of limited access and the moderate quality of the fishery. However, fishing afforded by the streams is considered important because it fills a need for low-cost recreation and food supplement for a segment of the population that is in a low income bracket.

Fishing on the 26 miles of Sanders Creek within the project area is estimated to have average annual fishing of 300 man-days valued at $150 annually with the majority of fishing in the lower 5 miles of stream. Fisherman use on the 35 miles of Big Pine Creek is estimated at about 1,600 man-days valued at $800 annually, with the heaviest fishing on the lower segment of the stream. A moderate quality fishery, limited access, and a declining rural population preclude assumption of a significant increase in fishing during the period of analysis.

Both reservoirs will be reasonably clear bodies of water possessing high-quality fisheries. Although inflowing waters will be turbid, the reservoirs are expected to clear rapidly. Fertile watersheds, reasonably stable reservoir water levels, and suitable fishery habitat will make the reservoirs productive of largemouth bass, white crappie, white bass, various sunfishes, channel catfish, flathead catfish, carp, buffalofishes, and drum. Dense populations of carp, buffalofishes, drum, as well as gizzard shad, may become a management problem within a few years after impoundment.

Although rough fish populations would provide a potential commercial fishery of economic value, sport fishing success would decline. It is estimated that Pat Mayse Reservoir would be capable of providing a commercial catch of about 82,000 pounds annually and that of Big Pine Creek Reservoir, about 70,000 pounds annually. The significance of the project's commercial fishery is dependent on future consumer demands, market trends, and utilization of the existing commercial fishery.

The project will be located in an area which has a high demand for fishing, but lacks sufficient fishing water to meet the demands. There are some 152,000 Texas and Oklahoma residents within a day-use distance (50-mile radius) of the project area. Many of these travel considerably greater distances to utilize the closest available public fishing waters. The project reservoirs will be in competition with each other for fisherman use. Singly, either would be capable of providing adequate reservoir fishing opportunities for the anglers of the area. However, based on the assumption that the reservoirs will be constructed simultaneously, it is estimated that Pat Mayse Reservoir together with the intermittent downstream flows will provide about 82,000 man-days of fishing valued at $82,000 annually, while Big Pine Creek Reservoir and the intermittent flows in Big Pine Creek will provide about 70,000 man-days of fishing valued at about $70,000 annually over the period of analysis.

Wildlife

The area of project influence evaluated for wildlife includes a total of 10,300 acres within Pat Mayse Reservoir site and the downstream flood-protected area along Sanders Creek and a total of 8,500 acres within Big Pine Creek Reservoir site and the downstream flood-protected area along Big Pine Creek. Both reservoir sites provide excellent

game habitat. Game species in the project area include white-tailed deer, fox squirrel, gray squirrel, and bobwhite. Common, but supporting little hunting pressure, are mourning doves, cottontails, raccoons, and foxes. Waterfowl hunting is insignificant although the area provides some habitat. Lack of public access prevents full utilization of the wildlife resources in the project area.

The pine-oak forest interspersed with improved pasture lands on the Big Pine Creek Reservoir area and the hardwood-pasture combination in the Pat Mayse Reservoir area provides excellent deer habitat for increasing deer populations. Bottom-land hardwoods support good populations of gray squirrel, while uplands provide habitat for fox squirrel. Bobwhites make excellent use of the edge effect provided by the reverted cultivated lands and the upland timber cover.

Northeast Texas has long been known for its outstanding squirrel hunting. It is also becoming well known for its deer-hunting possibilities. Hunting leases are in demand in the Big Pine Creek area and normally entitle the lessee to hunt all species of game birds and mammals. It is estimated that without the project there will be 1,700 man-days of deer hunting annually valued at $5,950 and 1,050 man-days of upland-game hunting valued at $1,575.

Deer hunting is also of major importance in the Pat Mayse Reservoir area. During recent years, deer populations have been on the increase and are expected to reach the carrying capacity of the habitat within a few years. Bobwhite populations provide good hunting in the Sanders Creek area. This is evidenced by the fact that state and national bird dog field trials have been held on the area during recent years. Squirrel habitat is chiefly confined to the bottom lands along the watercourses and supports a large population of squirrels. It is estimated that without the project, the Pat Mayse Reservoir project lands will provide about 1,100 man-days of deer hunting annually valued at $3,850 and approximately 325 man-days of upland-game hunting valued at $650.

Pat Mayse Reservoir will eliminate about 7,500 acres of deer habitat, about 6,200 acres of bobwhite habitat, and about 4,000 acres of squirrel habitat. Big Pine Creek Reservoir will result in a loss of about 6,500 acres of deer habitat and about 5,700 acres each of bobwhite and squirrel habitat. These acreages include the lands inundated, lands for project construction purposes, perimeter flood lands where habitat will be altered, and those areas where human disturbance will have an adverse effect on wildlife.

Downstream channel rectification will adversely affect wildlife habitat, but losses of hunting are considered insignificant.

The project will result in an increase of waterfowl habitat. The reservoirs will provide resting and, to some extent, feeding habitat for migrating waterfowl. Within a few miles to the north of the project area are the famed Red River Bottoms where waterfowl have historically congregated in great numbers. The relatively shallow waters and gently sloping shorelines of the reservoirs should prove attractive to both dabbling and diving ducks.

Loss of habitat caused by the project will result in considerable reduction of big-game and upland-game hunting. Waterfowl hunting, however, will increase. Waterfowl hunting will amount to 600 man-days annually valued at $2,400 on Big Pine Creek Reservoir and 3,400 man-days annually valued at $13,600 on Pat Mayse Reservoir.

Discussion

Fishing and hunting evaluations are based on the assumption that adequate access roads to the reservoir areas would be assured and that parking areas and boat-launching ramps would be provided. Pat Mayse Reservoir would require a minimum of 8 access-parking sites, while Big Pine Creek Reservoir would need 6 such areas to assure anticipated sportsmen use. Parking areas should be of sufficient size to handle a minimum of 200 parked cars and boat trailers. Location of specific parking areas is not feasible at this stage of planning; however, when detailed maps and operational data become available, the areas will be identified.

The Texas Game and Fish Commission employes a number of techniques in fishery management in large impoundments. One technique, involving the use of chemicals, has been widely used throughout the State to eliminate or reduce existing populations of undesirable fishes and is being proposed for both these watersheds. Sanders and Big Pine Creeks, with their relatively small watersheds and the limited amount of standing water, present an opportunity to eliminate or reduce existing fish populations in the watersheds prior to impoundment. This, in effect, would help control undesirable fish populations and permit establishment of a better sport fishery in the reservoir, and would assure a longer period of high quality sport fishing. The cost of the watersheds treatment, a State expense, is estimated to be about $7,500. Treatment of the reservoirs after impoundment would involve an additional expense of $15,000 to $20,000 per treatment.

To prevent reinfestation of the reservoirs with undesirable species and to protect the State's investment in the project, it will be necessary that the upstream movement of fishes over spillways and through reservoir outlets be prevented. In the event that spillway design will permit upstream movement of fishes, the prevention of this unwanted movement could be achieved at each reservoir by modification of the spillway structure. A barrier consisting of a minimum drop of 48 inches over a horizontal lip having a 12-inch overhang would be adequate.

Another method of control to be used in reservoir fishery management is that of large scale seining operations, either on a commercial basis or by the Texas Game and Fish Commission on a management basis. To assure maximum success by this method, adequate areas of obstruction-free reservoir bottom must be available. Consequently, seining areas, free from obstructions, are being proposed as part of the project plan of improvement. The desired seining areas cannot be located specifically from the operational data and maps available; however, the estimated acreage is approximately 500 acres in each reservoir.

The downstream channel rectification is assumed to consist primarily of channel straightening and the clearing of drifts, timber, and other obstacles from the stream. Rectification, as such, will eliminate most of the fishery habitat from the affected sections of the streams.

The Texas Game and Fish Commission has indicated their desire to hold alteration of the downstream channels to a minimum. In addition, they have requested a minimum instantaneous release from each reservoir sufficient to maintain and, if practicable, enhance stream fishing. It is estimated that a minimum instantaneous flow of 8 second-feet in the unaltered stream below Pat Mayse Reservoir will not only preserve the existing fishery, but also would create an enhanced fishery providing about 9,000 man-days of fishing annually. The fishery downstream from Big Pine Creek Reservoir resulting from a minimum instantaneous flow of 6 second-feet in an unaltered stream course would provide about 4,500 man-days of fishing annually with a value of $4,500 over the period of analysis.

A storage allocation for fish and wildlife of approximately 11,800 acre-feet in Pat Mayse Reservoir would provide instantaneous minimum flows of 8 second-feet below the dam during an estimated 32 out of 36 years of record. Similarly, a storage allocation of 4,000 acre-feet in Big Pine Creek Reservoir would provide instantaneous minimum flows of 6 second-feet below the dam during an estimated 28½ out of 36 years of record. Releases would be made from the fishery storage only when

other project releases were less than the desired minimum instantaneous flows. As a result of these releases, stream fishing could be maintained.

Additional benefits to the downstream fishery could be realized if flood releases were made at a rate lower than that currently proposed. A reduction in volume of the flood releases would prolong flows and assure a better downstream fishery. When definite channel improvement plans are available, adjustments in the evaluations of the fishery resources in conjunction with minimum instantaneous releases and proposed channel rectifications will be made.

The above-mentioned enhanced fisheries values are based on the assumption that adequate public access will be provided to the sections of stream immediately downstream from the outlet works. It is suggested that fishermen safety be provided for by the construction of guard rails and fishing platforms wherever necessary to assure maximum safe use of the fishery of the tail waters.

The Texas Game and Fish Commission has indicated a desire for mitigation of wildlife losses through provision of a wildlife management and public hunting area in conjunction with the project. Hunting lost as a result of the project may be partially mitigated by the provision of a federally purchased State-managed wildlife area adjacent to project lands. The interspersion of Federal and privately owned lands in and adjacent to the Pat Mayse Reservoir segment of the project presents an especially economical opportunity to acquire the much needed management lands. An area of approximately 9,600 acres, of which about 7,400 acres are in Federal ownership, could be acquired by the purchase of only 2,200 acres of privately owned land. Flowage easement for project purposes will be taken on approximately 485 acres of the 2,200 acres. After acquisition the area should be made available to the Texas Game and Fish Commission under the terms of a General Plan as provided in Section 3 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

Should the two segments of the presently considered project become divided into separate projects, it would be necessary to re-examine the wildlife mitigation aspects of both in order to establish separate areas for compensation of losses. However, since both areas are considered as a single project, wildlife losses are combined and mitigation measures are proposed in what we believe is the most economically justifiable manner.

In summary, the greatest benefits to fish and wildlife resources resulting from the project are attributable to the establishment of a reservoir-type fishery in an area where this type of fishing is in great demand. Losses will occur to the stream fishery as a result of inundation and channel rectification. These losses, however, could be mitigated and enhancement benefits could be gained by the provision of minimum instantaneous flows and the deletion of channel modifications from project plans. Big-game and upland-game hunters will lose hunting; however, these losses may be mitigated by the provision of a wildlife management and public hunting area. Waterfowl hunting will increase as a result of the habitat and public hunting provided by the reservoir lands and waters. In essence, this project offers excellent opportunities for multiplying public benefits through multipurpose planning which includes fish and wildlife conservation as one of the project purposes.

Therefore, it is recommended - -

(1) That the report of the District Engineer, Tulsa District, Corps of Engineers, include conservation and development of fish and wildlife among the purposes for which the project is authorized.

(2) That the project include provision of a minimum of 8 parking-access areas on Pat Mayse Reservoir and 6 parking-access areas on Big Pine Creek Reservoir with boat launching facilities provided in each area.

(3) That consideration be given in spillway design to the prevention of upstream movement of fishes into the reservoir.

(4) That properly cleared and charted seining areas be provided in each reservoir; selection and locations of said seining areas to be made by the Texas Game and Fish Commission and the Bureau of Sport Fisheries and Wildlife upon receipt of additional operational data and detailed maps.

(5) That reduction of fishery losses resulting from channel rectification in Sanders and Big Pine Creeks be accomplished through minimizing disturbance of the natural stream channels.

(6) That provision be made, to the extent legally feasible, for reservoir storage of 11,800 acre-feet in Pat Mayse Reservoir and 4,000 acre-feet in Big Pine Creek Reservoir to sustain minimum instantaneous releases of 8 second-feet at the Pat Mayse Reservoir Dam and 6 second-feet at the Big Pine Creek Dam to protect and enhance downstream fishery habitat.

(7) That, in order to mitigate wildlife losses, approximately 2,200 acres of land outside the fee purchase line on the Pat Mayse Reservoir be purchased to the extent that such purchase can reasonably be accomplished by the Corps of Engineers and that said 2,200 acres together with the approximately 7,400 acres which are now in Federal ownership, as delineated on Plate 1, be made available to the Texas Game and Fish Commission under the terms of a General Plan as provided in Section 3 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et Seq.).

(8) That the boundaries of project purchased lands be adequately marked immediately after purchase so as to identify those areas that are available to the public for hunting, fishing, and other recreational uses.

(9) That Federal lands and project waters in the project area be open to free use for hunting and fishing except for sections reserved for safety, efficient operation, protection of public property, or fish and wildlife management, and particularly that leases of Federal land in the project area reserve the right of free public use of such land for hunting and fishing.

The comments herein are based on information supplied by your agency prior to November 1, 1960, and are subject to revision on receipt of more detailed project data.

Sincerely yours,

John C. Gatlin

John C. Gatlin

Distribution:

(6) Executive Secretary, Texas Game and Fish Commission, Austin, Texas
(2) Regional Director, Region 3, National Park Service, Santa Fe, New Mexico
(2) Regional Director, Region IV, Bureau of Mines, Bartlesville, Oklahoma
(2) Regional Engineer, Region VII, Public Health Service, Dallas, Texas
(1) Regional Director, Region 5, Bureau of Reclamation, Amarillo, Texas
(1) Chairman, Southwest Field Committee, Department of the Interior, Muskogee, Oklahoma
(2) Regional Director, Region 2, Bureau of Commercial Fisheries, St. Petersburg Beach, Florida
(2) Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Tulsa, Oklahoma

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

SOUTHWEST REGION
(REGION 2)
ARIZONA
COLORADO
KANSAS
NEW MEXICO
OKLAHOMA
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UTAH
WYOMING

ADDRESS ONLY THE
REGIONAL DIRECTOR

March 27, 1961

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

This replies to Lt. Colonel Thomas D. Quaid's letter of February 27, 1961, file number SWPKB, commenting upon our draft report for the Sanders, Big Pine, and Collier Creeks Project, Texas.

We have amended the draft report to include the estimated man-days of fishing to be expected in the downstream areas with provision of our recommended minimum flows.

Based upon re-examination of project data, which you supplied our Tulsa, Oklahoma, Branch of River Basin Studies office, we have learned that approximately 11,800 acre-feet of storage in Pat Mayse Reservoir would provide instantaneous minimum flows of 8 second-feet below the dam during an estimated 32 out of 36 years. Similarly, 4,000 acre-feet of storage in Big Pine Creek Reservoir would provide instantaneous minimum flows of 6 second-feet below the dam during an estimated 28½ out of 36 years. Although these storages would not provide for flows during the most critical dry periods, it is thought that the benefits from sustained flows during all but those dry periods will justify provision of the recommended storages.

The proposed state wildlife management and public hunting area discussed in the first paragraph on page 16 of our draft of a report is recommended as a measure to mitigate, in part, upland-game and big-game hunting which will be lost as a result of the project. It is the policy of this Bureau that fish and wildlife losses do not require a monetary evaluation and that monetary justification or equivalent man-days are not needed to justify damage prevention or mitigation measures. In view of this fact we trust that you will understand why we cannot comply with your request for monetary benefits of hunting resulting from the recommended wildlife management area.

We appreciate receiving your comments regarding the draft report. Ten copies of our report, dated March 22, 1961, are being transmitted under separate cover.

Sincerely yours,

John C. Gatlin

John C. Gatlin

cc: Executive Secretary, Texas Game and Fish Commission, Austin, Texas
Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Tulsa, Oklahoma

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

SOUTHWEST REGION
(REGION 2)
ARIZONA
COLORADO
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WYOMING

ADDRESS ONLY THE
REGIONAL DIRECTOR

April 11, 1961

AIRMAIL

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

On March 22, 1961, we provided your office with our report on the Sanders, Big Pine and Collier Creeks Project, Texas. A correction should be made in that report. The phrase "valued at $9,000" should be added at the end of the third complete sentence in the fourth paragraph on page 9. This value is attributed to the 9,000 fisherman-days downstream from the Pat Mayse (Sanders Creek) Reservoir site. We offer this correction so that your report may show the benefits anticipated from our request for a minimum instantaneous flow of 8 second-feet.

This omission was called to our attention by Mr. William T. Nallon of your staff, and he has been notified of our proposed correction.

Sincerely yours,

John C. Galtin

John C. Galtin
Regional Director

cc: Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Tulsa, Oklahoma

GAME AND FISH COMMISSION

AUSTIN, TEXAS

October 17, 1960

Colonel Thomas D. Quaid
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Quaid:

I am extremely sorry about the delay in answering your letter regarding the Sanders, Big Pine and Colliers Creeks projects. We are most indebted for the factual information which you have furnished us on these projects. The material has been reviewed by our Inland Fisheries and Wildlife Restoration Divisions.

The Game and Fish Commission does not plan any active participation in the projects other than offering its facilities to all agencies and individuals interested in the further development of the fisheries and wildlife resources of the project areas.

The survey and evaluations which you have requested are normally compiled and prepared by the Branch of River Basin Studies of the U. S. Fish and Wildlife Service with the cooperation and concurrence of the Game and Fish Commission. I am taking the liberty of sending their Tulsa office a copy of this correspondence.

Again may we thank you for providing us with information on the projects.

Very truly yours,

H. D. Dodgen
Executive Secretary

HDD:WHB:lf
cc - Mr. Forrest Romero, Field Supervisor, Branch of River Basin Studies, 916-17 Petroleum Building, Tulsa, Oklahoma

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SURVEY REPORT
ON
SANDERS, BIG PINE AND COLLIER CREEKS,
TEXAS

APPENDIX VI

ASSURANCES AND COMMENTS

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

RESOLUTION NO. 951 .

WHEREAS, under authority of a resolution, adopted May 21, 1957 by the Committee on Public Works, United States House of Representatives, the Corps of Engineers is investigating a reservoir site on Sanders Creek, Texas, for flood control, water supply, and related purposes; and,

WHEREAS, under the provisions of the Water Supply Act of 1958 (Title III of Public Law 85-500), water supply storage for municipal or industrial uses may be included in any reservoir project planned by the Corps of Engineers; provided that, before start of construction, State or local interests shall agree to pay the cost of such storage; and,

WHEREAS, the provisions of the Water Supply Act of 1958 are recognized as being applicable to the proposed Pat Mayse Reservoir; and,

WHEREAS, the City of Paris, Texas, considers the Pat Mayse Reservoir on Sanders Creek, Texas, as a desirable source of water supply; and,

WHEREAS, it is recognized that the securing of proper water rights from the State of Texas is the responsibility of the City of Paris;

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF PARIS, TEXAS:

1. That the City of Paris is fully cognizant of the provisions of the Water Supply Act of 1958 and the requirements for payment of the allocated costs of the water supply storage, including interest during construction and interest on the unpaid balance, annual operation and maintenance costs, and replacement costs.

2. That the City of Paris does hereby request the Corps of Engineers to include water supply storage in the Pat Mayse Reservoir to yield 55 million gallons per day at the project site for its water supply needs; it being understood that the City will be responsible for the conveyance of such water supply from the project to the City's intake works.

3. That the City of Paris recognizes the responsibility of repayment to the United States of all costs allocated to the requested water supply storage.

4. That prior to use of the requested water supply storage, the City of Paris will enter into a contract with the United States to pay for such storage in the reservoir within a period of time which will permit paying out the costs allocated to water supply within the life of the project, but in no event to exceed 50 years after the date on which the project is first used for the storage of water for future water supply purposes.

Passed and adopted this 25th day of January, A. D., 1961.

/s/ William C. Ragan
Mayor

ATTEST:

/s/ H. C. Greene
City Clerk

APPROVED AS TO FORM:

City Attorney.

THE STATE OF TEXAS |

COUNTY OF LAMAR |

I, H. C. Greene, the duly qualified and acting City Clerk of the City of Paris, Texas, do hereby certify that the above and foregoing resolution is a true and exact copy of the original resolution passed by the City Council of the City of Paris, Texas, on the 25th day of January, A. D., 1961.

Witness my hand and seal of office, this the 25th day of January, A. D., 1961.

City Clerk, City of Paris, Texas.

RESOLUTION

WHEREAS, under authority of a resolution, adopted May 21, 1957 by the Committee on Public Works, United States House of Representatives, the Corps of Engineers is investigating a reservoir site on Big Pine Creek, Texas, for flood control, water supply, and related purposes; and,

WHEREAS, under the provisions of the Water Supply Act of 1958 (Title III of Public Law 85-500), water supply storage for municipal or industrial uses may be included in any reservoir project planned by the Corps of Engineers; provided that, before start of construction, State or local interests shall agree to pay the cost of such storage; and,

WHEREAS, the provisions of the Water Supply Act of 1958 are recognized as being applicable to the proposed Big Pine Reservoir; and,

WHEREAS the City of Clarksville, Texas considers the Big Pine Reservoir as a desirable source of water supply; and,

WHEREAS, it is recognized that the securing of proper water rights from the State of Texas is the responsibility of the City of Clarksville;

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Clarksville, Texas:

1. That the City of Clarksville is fully cognizant of the provisions of the Water Supply Act of 1958 and the requirements for payment of the allocated costs of the water supply storage, including interest during construction and interest on the unpaid balance, annual operation and maintenance costs, and replacement costs.

2. That the City of Clarksville does hereby request the Corps of Engineers to include water supply storage in the Big Pine Reservoir to yield 26 million gallons per day at the project site for its water supply needs; it being

understood that the City will be responsible for the conveyance of such water supply from the project to the City's intake works.

3. That the City of Clarksville recognizes the responsibility of repayment to the United States of all costs allocated to the requested water supply storage.

4. That prior to use of the requested water supply storage, the City of Clarksville will enter into a contract with the United States to pay for such storage in the reservoir within a period of time which will permit paying out the costs allocated to water supply within the life of the project, but in no event to exceed 50 years after the date on which the project is first used for the storage of water for future water supply purposes.

IN WITNESS WHEREOF, the City Council of the City of Clarksville, Texas has adopted this resolution this 25 day of January, 1961.

Mayor

Attest:

City Clerk.

(Seal)

COMMENTS
ON
FIELD LEVEL REVIEW ON SURVEY REPORT ON
SANDERS, BIG PINE AND COLLIER CREEKS, TEXAS

SUMMARY

The draft of this report was submitted to other agencies on September 15, 1961 for field level review. Copies of all letters of comment received from other agencies are included in this appendix. The views of some of the agencies are, in effect, expressions of appreciation for the opportunity to review the report draft or expressions of being in general accord with the plans of improvement. Pertinent comments presented by certain reviewing agencies are summarized below.

a. U. S. Department of Agriculture.

(1) In letter dated October 17, 1961 from the River Basin representative, A-W-R Basins Office, Tulsa, Oklahoma, the views of the Temple, Texas SCS Office and the Regional Forester, U. S. Forest Service, are noted to constitute the field level comments of the Department of Agriculture. The October 3, 1961 memorandum from the Regional Forester states that the proposed projects will have no direct impact on Forest Service interests.

(2) The Soil Conservation Service states in their letter of October 13, 1961, that water supply storage contemplated in Big Pine Reservoir and in SCS Reservoir on Langford Creek appeared to duplicate water supply storage for Clarksville, Texas. Other suggestions were made concerning sediment requirements and economic data.

b. U. S. Department of Commerce.

(1) The Fort Worth Office of the Coast and Geodetic Survey in letter of October 2, 1961, expressed the view that sufficient horizontal and vertical control points are available to satisfy the projects under investigation.

(2) The Fort Worth, Texas, regional office of the Bureau of Public Roads in letter of October 6, 1961 offered no comments in addition to the comments contained in the Austin, Texas, Division Engineer's letter of October 5, 1961.

(3) The Austin, Texas, Division Office in letter of October 5, 1961 advised that the farm-to-market roads in the Big Pine Reservoir area, FM 195 and FM 410, are on the Federal-aid secondary system.

c. Department of Health, Education and Welfare. - The regional office in Dallas, Texas, in letter of September 28, 1961 stated that water supply requirements, quality and economic value of water supply storage are adequately covered in appendix IV of the report. They note that pollution abatement problems in the area may be expected with increase in population and industrial development.

d. U. S. Department of the Interior.

(1) The Bartlesville, Oklahoma, Office of the Bureau of Mines, in letter of September 19, 1961 stated that the proposed construction will have no adverse effect on mineral industries in the area.

(2) The Albuquerque, New Mexico, Office of Bureau of Sport Fisheries, Fish and Wildlife Service, in letter of October 6, 1961 re-emphasized some of the recommendations made in the Fish and Wildlife report and questioned the statement that lands now in Federal ownership are considered sufficient to compensate for wildlife losses.

(3) The Santa Fe, New Mexico, Office of the National Park Service in letter of September 29, 1961 was pleased to note that recreational benefits would result from the impoundments and that recreation is designated as a project purpose.

(4) The Tulsa, Oklahoma, Office of Southwestern Power Administration, by letter dated October 10, 1961 stated that the interests of the Southwestern Power Administration will not be affected by the proposed improvements.

(5) The Amarillo, Texas, Office of the Bureau of Reclamation, in letter of October 11, 1961 commented that the reservoir proposals do not develop the optimum yield of the streams. The Bureau questioned nonreimbursable costs for recreation and cost allocations for fish and wildlife. Other comments concerned economic and financial aspects of the projects.

e. Federal Power Commission. - The Fort Worth, Texas, Office of this agency, by letter of September 29, 1961 concurred in the report findings concerning power and concluded that facilities for the development of hydroelectric power should not be provided at the projects and operation of the proposed reservoirs will not affect any existing or potential hydroelectric resources.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AWR Basins Office
Agricultural Office Building, 15th and Quebec
Tulsa 12, Oklahoma

October 17, 1961

District Engineer
U. S. Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Sir:

According to our information, you have been furnished a letter of comments dated October 12, 1961, from Mr. H. N. Smith, State Conservationist, Texas, covering the field level review of draft report on Sanders, Big Pine and Collier Creek, Texas. Also relating to the review of the Department, we are enclosing a copy of a memorandum received from the Regional Forester, U. S. Forest Service.

The above mentioned letter directed to you from Mr. Smith and the enclosed memorandum from the Forest Service constitute the field level review comments of the Department of Agriculture. Thank you for the opportunity of reviewing and commenting on this report. We are returning copy No. 115 and with your permission are retaining copy No. 104 for our files.

Very truly yours,

John A. Short

John A. Short
River Basin Representative

Enclosures

U. S. Forest Service
50 Seventh St., N.E.
Atlanta 23, Georgia

UNITED STATES GOVERNMENT

MEMORANDUM

3520
DATE: October 3, 1961

TO : John A. Short, River Basins Representative,
Tulsa, Oklahoma

FROM : J. K. VESSEY, Regional Forester, By

SUBJECT: CIPP (COE)

We have reviewed the Survey Report on Sanders, Big Pine and Colliers Creeks, Texas, sent us with your memorandum of September 25.

The proposed projects are remote from the National Forests and will have no direct impact on them or upon Forest Service interests.

It appears that Big Pine Creek Watershed and the proposed reservoir are within an outlying portion of the Pine-Hardwood Forest Region of Texas. We find no indication in the report that the State Forester of Texas has been consulted regarding possible effects of the proposed projects upon the forest industry of Northeast Texas. The State Forester may have an interest in these projects, and we suggest that he be given an opportunity to comment, if this has not been done.

The report is returned herewith.

/s/ Baxter Reed

Attachment

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

P. O. Box 417
Temple, Texas
October 13, 1961

Colonel Howard W. Penney, District Engineer
U. S. Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

Your proposed survey report on Sanders, Big Pine and Colliers Creeks, Texas has been reviewed by technicians of this Service. The following comments and suggestions are offered for your consideration:

Page 2, paragraph d - As indicated in paragraph c, the investigation was coordinated with the Soil Conservation Service, as one of the interested Federal agencies. In view of the field surveys this Service has initiated on the Lamar County Pine Creek watershed, together with the application received for assistance on Sanders Creek, it is suggested that an elaboration be made at the appropriate place to state that further coordination, as needed, will be carried out during final design and construction phases. A statement along this line appears in Appendix I, page 20.

Page 12, paragraph 18a and 18b - Plans of improvement for Big Pine and Sanders Creeks are described to be primarily for flood control and water supply. Paragraph 18b states that 79,300 acre-feet of storage allocated to conservation would be for water supply - an estimated dependable yield of 26 Mgd. which would meet the needs indicated by the City of Clarksville. In paragraph 16c(3), (b) on page 8, it is pointed out that "...Clarksville has requested the Soil Conservation Service to include storage for municipal water supply in a small reservoir under consideration in a Public Law 566 project near the city." It also is stated that the city has contracted for storage sufficient to yield 1 Mgd. from the Soil Conservation Service reservoir. Since the report states that the City of Clarksville has indicated its need will be met by the Corps structure on Big Pine Creek, and in view of the contract the City has with the Langford Creek WCID for storage in the planned structure referred to above, it appears that there may be a duplication of water supply storage. It is noted also that paragraph 28a, page 20 states "The Public Health Service found no need for additional water supplies in the Big Pine Creek area."

Appendix I, page 17f. Sediment Requirements - The sediment storage capacity estimated for the Pat Mayse Reservoir (7,500 acre-feet) compares very favorably with the required 50-year sediment storage for this site (7,600 acre-feet) calculated using the Texas Board of Water Engineers Bulletin 5912. However, using TBWE Bulletin procedure for the Big Pine Reservoir, the estimated sediment storage is indicated to be 2,250 acre-feet, or about half the amount (4,600 acre-feet) estimated in the report.

It appears that the same sediment production rate was used for the drainage areas of both reservoirs, with some allowances for difference in watershed sizes. However, the Pat Mayse drainage area is about 50 percent Blackland Prairie area while the Big Pine drainage area is predominantly East Texas Timberlands Land Resource area, an area of lesser sediment production.

Appendix I, page 19 - The Clarksville request for 26 Mgd. municipal water supply from the Big Pine Reservoir, providing approximately 4,333 gallons per day per capita in the year 2010 appears to be excessive, especially in view of the 2010 requirement of 0.75 Mgd. estimated for Clarksville by the Department of Health, Education and Welfare (Appendix IV, page 2.) The request of Paris for 55 Mgd. from the Pat Mayse Reservoir seems to be consistent with previous estimates of needs for that city.

Appendix I, page 20, item m - As stated, the installation of floodwater retarding structures and land treatment measures undoubtedly would have a slight reducing effect on water yield during critical periods - probably about 10 percent. Based on experience to date, however, it is felt that evaporation from farm ponds is the major cause for the yield loss and not terracing as indicated in the draft.

As discussed in the meeting between members of your staff and representatives from this office for the purpose of coordinating planning activities on these watersheds, the lack of local interest and ability to complete the Sanders Creek project previously approved as feasible for assistance under Public Law 566 indicated that an upstream project should not be considered in determining storage requirements for your proposed reservoir. I am not aware of any change in the local interest aspect to date. The statement indicating further coordination between the two agencies following authorization of the Pat Mayse Reservoir appears adequate and provides for development of the most effective project possible for the watershed. We will keep you informed of any change in status regarding the local people's project under Public Law 566.

Appendix II, tables 3 and 4, pages 3 and 5 - Table 3 data show the crop value to be about $26 for oats, $42 for corn and $40 for tillable pasture. These relationships make it hard to understand why farmers would grow oats or corn if they could obtain the indicated return for pasture without entailing harvesting costs, and since it presumably is less susceptible to flood damage than the other crops.

Table 4 indicates that about two-thirds of the annual value of crop production in Big Pine is accounted for by pasture. However, the average annual crop damage amounts to almost 23 percent of the gross value of production. Pasture accounts for about one-fourth of the crop value on Sanders Creek and the annual flood damage is almost 32 percent of the value of production.

Paragraph 7 indicates $18,000 structural damage on Sanders Creek and $26,000 on Big Pine Creek from the largest flood on record. The average annual damages, exclusive of crop and rural supply losses, according to table 4 are $23,900 on Sanders and $23,760 on Big Pine Creek. In areas such as these our studies have indicated that a major flood such as the 1949 event ordinarily causes more damage to improvements than a number of small floods.

These comments relative to estimated losses in these predominantly agricultural areas are not intended to be suggestive of errors. They are made thinking that the report might be strengthened by inclusion of additional background information.

Appendix II, page 10, paragraph 15 - The second sentence refers to "the inflated value of land". It is suggested that this phrase be deleted since the use of a given price level, 1960 in this case, would indicate that all prices used were at that level. As long as support prices are in effect on agricultural products such as cotton, the price of these supported commodities also could be considered as "inflated".

Supplement A, page 23, 8. Agriculture - It is apparent that considerable investigation has gone into the collection of supplemental economic data. These data should provide valuable background. It is suggested that local information might be more applicable to these areas than that contained in "A 50-Year Look Ahead At U. S. Agriculture". While the Red River Basin was not included in the study area of the U. S. Study Commission - Texas, it is believed that yield projections developed for the Commission would be applicable to the project area and other areas of Texas in your district as well. Copies of the reports on the yield projections should now be available either at the Dallas Division Office or the two District Offices which participated in the Study Commission investigations.

It was the opinion of those who reviewed the survey report draft that it was a well prepared document containing ample data and information for three separate areas - a condition which adds to the complexity of presenting a clear and concise report.

Thank you for the opportunity to review the draft. It is hoped these comments will be useful in preparing the final survey report. The continued cooperation of your district in coordination of planning activities for the development of land and water resources is appreciated. If we can assist you in anyway, please let me know. Our copy of the report is enclosed.

Very truly yours,

H. N. Smith

H. N. Smith
State Conservationist

U. S. DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
FORT WORTH DISTRICT OFFICE
P. O. BOX 2195
FORT WORTH 1, TEXAS

October 2, 1961

The District Engineer
U. S. Army Engineer District Tulsa
Corps of Engineers
616 Boston
Tulsa 2, Oklahoma

Dear Sir:

I am writing in regards to your notice of 15 September 1961 concerning the proposed report on Sanders, Big Pine and Collier Creeks, Texas, reference SWP WR.

The Coast and Geodetic Survey has an interest in this report to the extent that there is established adequate horizontal and vertical control in the project areas prior to the ground survey and construction phase and the preservation of these monuments during the construction phase.

It is believed that sufficient number of control points are available to satisfy the requirements of the projects under investigation.

If these data are not available in your office, please write direct to this office for your requirements.

Very truly yours,

William C. Russell

William C. Russell
CAPT, C&GS
District Officer

Enclosure: Sanders, Big Pine &
Collier Creeks Rpt.
(Ser No 117)

REGION SIX
ARKANSAS
LOUISIANA
OKLAHOMA
TEXAS

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
P. O. BOX 12037
FORT WORTH 16, TEXAS

October 6, 1961

IN REPLY REFER TO:
06-00.4

Colonel Howard W. Penney
District Engineer
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

Reference is made to your draft copy (Serial No. 118) of "Survey Report on Sanders, Big Pine and Colliers Creeks - Texas" dated September 16, 1961. Your office also furnished a draft copy of the report to our Texas Division Engineer.

We are enclosing the original signed copy of a letter to your office dated October 5, 1961, from our Texas Division Engineer, Mr. L. S. Coy. This office has no additional comments over those outlined in Mr. Coy's letter on your proposed report.

We appreciate the opportunity you have afforded the Division and Regional office to review and comment on the draft copy.

In accordance with your request we are returning the review draft copy, Serial No. 118, and we are requesting our Division Engineer to forward to your office their copy of the review draft (Serial No. 119). When the final report on Sanders, Big Pine and Colliers Creeks - Texas, is available, will you kindly furnish our Texas Division Office one copy (direct mailing) and send one copy to this office?

Sincerely yours,

C. T. Nitteberg
Acting Regional Engineer

Enclosure

cc:
Mr. L. S. Coy
Mr. S. E. Ridge

94758 O - 63 - 13

REGION SIX
ARKANSAS
LOUISIANA
OKLAHOMA
TEXAS

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
Austin, Texas

06-41

October 5, 1961

IN REPLY REFER TO:

Colonel Howard W. Penney
District Engineer
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

Your draft copy of "Survey Report on Sanders, Big Pine and Colliers Creeks, Texas" dated September 15, 1961 has been reviewed in this office.

In the allocation of costs for the two recommended projects, Sanders and Big Pine Reservoirs, it is noted that the highway relocation and protection work is considered to be a Federal project responsibility. Both of the farm to market roads in the Big Pine Reservoir area, FM 195 and FM 410, are on the Federal-aid Secondary system. None of the roads involved in the Sanders Creek (Pat Mayse) reservoir are on any Federal highway system.

We appreciate the opportunity to review and comment on your report.

Sincerely yours,

L. S. Coy
Division Engineer

By

W. Jack Wilkes
Division Bridge Engineer

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

Tenth Floor - 1114 Commerce Street
Dallas 2, Texas

PUBLIC HEALTH SERVICE

September 28, 1961

Colonel Howard W. Penney
District Engineer
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Attention: SWP WR

Dear Colonel Penney:

Copies of the proposed report "Survey Report on Sanders, Big Pine and Colliers Creeks, Texas (Serial Nos. 120, 121, 122) are being returned as requested in your transmittal letter.

The water supply requirements, quality of water and economic value of water supply storage in the project area are adequately covered in our report included as Appendix IV of your survey report.

Pollution abatement problems in the area may be expected with increases in population and industrial development. The provision of adequate treatment facilities, proper location of wastes discharges and regulation of wastes flows will need to be considered as these wastes develop to prevent serious pollution problems.

We appreciate the opportunity to review the proposed report.

Sincerely,

E. C. WARKENTIN
Associate Director for
Environmental Health Services

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
REGION IV

ROOM 206 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA

OFFICE OF
REGIONAL DIRECTOR

September 19, 1961

Colonel Howard W. Penney
District Engineer
U. S. Army Engineer District, Tulsa
P. O. Box 61
Tulsa 2, Oklahoma

File No. SWP WR

Dear Colonel Penney:

Thank you for sending the Bureau of Mines a copy of "Survey Report on Sanders, Big Pine and Collier Creeks, Texas", dated September 15, 1961, for our field level review. This review is given in three parts:

Sanders Creek Watershed: The proposed plan of improvement on the Sanders Creek Watershed, Fannin and Lamar Counties, Tex., provides for construction of Pat Mayse Reservoir. The proposed project has the primary purpose of flood control and water supply and a secondary purpose of recreation benefits and fish and wildlife conservation. The height of the dam will be 92 feet, drainage area 175 square miles, surface area of flood-control pool 7,950 acres, and total reservoir storage area 200,800 acre feet. The dam will be an earthfill structure with an uncontrolled concrete-lined chute spillway. The Texas Board of Water Engineers has proposed a similar reservoir for this watershed to be known as the Paris Reservoir. This proposal was only for water supply for the town of Paris, Tex., for a 98,860 acre-foot conservation pool which compares favorably with that proposed in the Pat Mayse Reservoir. The Paris Reservoir, therefore, would be about half as large as the overall Pat Mayse Reservoir. The Pat Mayse Reservoir is entirely within Lamar County. The Bureau of Mines in 1960 reported no mineral production in Lamar County; the only known mineral resources in the county are some structural and building chalk and limestone deposits about eleven miles south of the project near Paris, Tex.

Big Pine Creek Watershed: The proposed plan of improvement on Big Pine Creek Watershed, Lamar and Red River Counties, Tex., provides for construction of Big Pine Reservoir. The proposed project has the primary purpose of flood control and water supply and a secondary

purpose of recreation benefits and fish and wildlife conservation. Height of the dam will be 77 feet, drainage area 95 square miles, surface area of flood-control pool 6,400 acres, and total reservoir storage area 136,600 acre feet. The dam will be an earthfill structure with an uncontrolled concrete-lined chute spillway. The greatest part of the Big Pine Reservoir will be in Red River County. The Bureau of Mines reported in 1960 that Red River County had a mineral production value of $110,900, entirely from petroleum. Petroleum production is from two small oilfields about 15 miles south of the project. One abandoned oilfield is located about 2 miles south of the project. The only other known mineral resources in Red River County are some structural and building chalk and limestone deposits about 17 miles southeast of the project near Clarksville. There are also some known deposits of building clays about two miles east of Clarksville.

Collier Creek Watershed: The report shows that only initial studies were made on the Collier Creek Watershed in Red River County, Tex. These studies indicated unfavorable justification of a plan of improvement on Collier Creek. There was a proposed dam to be known as Acworth Damsite, but no further work is contemplated on the project. The same mineral values as stated for Red River County apply for this reservoir. Petroleum production from the two same oilfields is found about 12 miles southeast of the abandoned project. Other mineral deposits of building limestone and clays occur about 8 miles south of the abandoned project.

An office study of Bureau of Mines available records indicates that the proposed constructions will have no adverse effect on mineral industries in the area; therefore, the Regional Office of the Bureau of Mines has no objections to the proposed project. No field examination was made.

The survey report, serial No. 125, is herewith returned as requested.

Sincerely yours,

Peter Grandone

Peter Grandone
Acting Regional Director
Region IV

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

ADDRESS ONLY THE
REGIONAL DIRECTOR

SOUTHWEST REGION
(REGION 2)
ARIZONA
COLORADO
KANSAS
NEW MEXICO
OKLAHOMA
TEXAS
UTAH
WYOMING

October 6, 1961

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 61
Tulsa, Oklahoma

Dear Sir:

Reference is made to your undated letter received in this office on September 18, 1961, requesting our comments on a draft of a Survey Report on Sanders, Big Pine and Colliers Creek, Texas.

Our comments correspond to those discussed on pages 21, 22, and 23 of your report draft.

Recommendation No. 1 - No comment.

Recommendation No. 2. Fishery benefits presented in the report are based on a minimum of 8 public parking-access areas on Pat Mayse Reservoir and 6 on Big Pine Reservoir. Should these minimum requirements not be met, fishery benefits assigned will not be valid.

Recommendation No. 3. The spillway design and reservoir operation is based on a once in 50-year flood frequency; however, this spillage may occur at any time, possibly during the early years of impoundment. Should sizeable spillage occur shortly after treatment of the upstream watershed, to eradicate fish populations, and undesirable fish species manage to gain entrance into the reservoir over the spillway, the efforts and expenses of the Texas Game and Fish Commission to control fish populations in the reservoirs will be impaired.

Recommendation No. 4. - No comment.

Recommendation No. 5. Fishery benefits as presented in paragraph 5, page 9, of the Bureau of Sport Fisheries and Wildlife report were expected to occur if the stream channels were essentially unaltered, as we were led to believe they would be from the discussions with Corps personnel. The second paragraph on page 10, of the Bureau of Sport Fisheries and Wildlife

mentions that adjustments in evaluations of the fishery resources in conjunction with minimum instantaneous releases and proposed channel rectification will be made when definite plans are available.

Recommendation No. 6 - No comment.

Recommendation No. 7. The evaluation of wildlife resources and hunting opportunities necessary to mitigate losses resulting from the project were based on a state management area of 9,600 acres, which included 2,200 acres of non-federal land. An area of only 7,400 acres interspersed with private lands will present management problems which will make it difficult to properly mitigate the losses of big game-upland game habitat. We believe that we understand the Corps of Engineers' reluctance to become involved in the costs and legal problem associated with the purchase of the additional 2,200 acres of private land, and we do not intend to make an issue of the recommended purchase. We are puzzled, however, by the statement that lands now in Federal ownership are considered sufficient to compensate for wildlife losses. No reasons are offered to support this view. Furthermore it is at variance with the technical opinion of the fish and wildlife management agencies. If questions existed regarding the technical accuracy of our report we would have appreciated the opportunity to answer them prior to issuance of the draft.

In view of the foregoing observations we believe that the last three sentences of the third whole paragraph on page 22 of your proposed report should be deleted.

Your courtesy in providing us with an opportunity to comment upon your proposed report is appreciated.

Sincerely yours,

John C. Gatlin
Regional Director

cc: Executive Secretary, Texas Game and Fish Commission, Austin, Texas
Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Fort Worth, Texas

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

Region Three
Santa Fe, New Mexico

IN REPLY REFER TO:

L 7423

September 29, 1961

Howard W. Penney
Colonel, CE
District Engineer
U. S. Army Engineer District, Tulsa
Corps of Engineers
616 South Boston
Tulsa 2, Oklahoma

Dear Colonel Penney:

Thank you for the opportunity of reviewing the draft of your proposed report on Sanders, Big Pine, and Collier Creeks, Texas. We are pleased to note your recognition of the potential recreational benefits which would result from the impoundments to be created by construction of Pat Mayse and Big Pine dams, and that you are designating recreation as a project purpose.

Your draft, serial number 126, is being returned at your request.

Sincerely yours,

George W. Miller
Acting Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
SOUTHWESTERN POWER ADMINISTRATION
POST OFFICE DRAWER 1619
TULSA 1, OKLAHOMA

IN REPLY REFER TO:

October 10, 1961

District Engineer
U. S. Army Engineer District,
Tulsa
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

Thank you for your letter, file SWP WR, enclosing the proposed report on Sanders, Big Pine and Collier Creeks, Texas.

The interests of this Administration will not be affected by the proposed improvements. We appreciate being kept informed of the proposed improvements in your area. We are returning the copy of the report, serial number 129, as requested.

Very truly yours,

Douglas G. Wright
Administrator

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

REGIONAL OFFICE, REGION 5
P. O. BOX 1609
AMARILLO, TEXAS

IN REPLY
REFER TO: 5-730

October 11, 1961

Airmail

Col. Howard W. Penney, District Engineer
U. S. Army Engineer District, Tulsa
P. O. Box 61
Tulsa 2, Oklahoma

Dear Colonel Penney:

This is in response to your undated letter transmitting, for our field-level review and comment, your proposed report on Sanders, Big Pine, and Collier Creeks, Texas. That letter requested our comments by October 9, 1961, and the review of your report by this office and our Oklahoma City office has been expedited to meet that date to the extent practicable. It has not permitted the thorough review that your report proposals appear to merit. Consequently, the following comments may be supplemented at a later date when a more thorough review of the report has been accomplished. Our interest in your proposed report is primarily in connection with the water supply proposals advanced and our responsibilities for investigation and development of the land and water resource potentialities of the Reclamation area.

It is of interest that the Public Health Service, in accordance with an agreement between the Corps of Engineers and that agency, has prepared a report which is a part of your report, and which finds that the potential requirements for future municipal and industrial water supplies in the area of study do not support the water supply storage capacities proposed in your report. Further, the capacities proposed in your Pat Mayse and Big Pine reservoirs do not develop the optimum water yields of Sanders Creek and Big Pine Creek. Rather, they simply develop yields which are supported by expressions from the cities of Paris and Clarksville of willingness to contract for the costs which your report advances as potential reimbursable water supply obligations. Thus, the detailed studies of your cooperating agency, which are based on population and industrial growth forecasts, do not support either the water requirements or water supply benefits on which your project proposals are based.

In this connection, it is of interest that no information is presented in your report concerning the financial ability of the cities to pay the reimbursable project capital costs and related operation, maintenance, and replacement costs, or the costs of a conveyance system required to deliver water to the cities. Neither are details presented concerning the manner in which the required annual payments would be accomplished. It seems, in this circumstance, as in connection with other reports of your agency recently reviewed by this office, that your report would be strengthened by presentation of pertinent data pertaining to project repayment, such as payout period, interest rate, and payout schedule. It is believed that this would give a more realistic indication of the project costs to the potential water supply users, as it would involve inclusion of interest during construction and interest during repayment, and properly should include an appropriate share of the preauthorization costs. In this connection, it is noted that your report does not indicate the extent to which the project interests will be asked to contribute to the project costs for the increased land utilization benefits which are reflected in the estimates of total flood control benefits for each reservoir.

We note that the Separable Costs-Remaining Benefits method of cost allocation is used, but the allocation assumes that the cost of an alternative single-purpose fish and wildlife project would exceed the capitalized fish and wildlife benefits. Therefore, the justifiable expenditure for fish and wildlife is based on the evaluated fish and wildlife benefits. The magnitude of the capitalized benefits, which are about $3,200,000 for the Pat Mayse Reservoir and $2,800,000 for the Big Pine Reservoir, would appear to justify an appraisal of alternatives. Our agency, by requesting advice from the Fish and Wildlife Service as to the alternative single-purpose plan which would provide fish and wildlife benefits equivalent to those of the contemplated multiple-purpose reservoirs, has found that, generally, the single-purpose plan will involve costs considerably less than the evaluated fish and wildlife benefits; and the alternative single-purpose cost, therefore, will generally control the fish and wildlife allocation.

We note that the report proposes nonreimbursable allocations of joint reservoir costs to recreation, as well as costs of specific recreational facilities. We are unaware of any existing legislation or administrative direction which would permit nonreimbursable allocations of joint reservoir costs to recreation.

We also note that your cost estimates include allowances for cost of reservoir land acquisition and flowage easements. Thus, to some extent, the negative benefits which would result from inundation of reservoir lands are included on the cost side of your benefit-cost analyses. However, an evaluation of the loss of agricultural production, mineral values, and other resources which would result from reservoir inundation would be desirable to measure the adverse effects of reservoir construction and insure that they are fully recognized in your benefit-cost evaluations.

Your report advances identical benefit-cost ratios of 1.6 to 1 for the Pat Mayse and Big Pine reservoirs. However, it is doubtful if these favorable benefit-cost ratios would prevail if the water supply benefits were based upon satisfying the potential water requirements advanced by the Public Health Service instead of the adopted deliveries.

The above comments concern primarily the economic and financial aspects of the project proposals. We regret that time has not permitted more thorough review of the hydrologic and engineering aspects of the plan which are of concern to our agency.

We trust that the above comments can be recognized in any revisions of the report which may be undertaken by your office as a result of field-level comments received. Also, we hope that any further comments that our office may find appropriate through more thorough review can be furnished when the report of your agency is transmitted to the Department of Interior for formal comments at the Washington level.

We are retaining the copy of the report furnished this office for use in any further review undertaken.

Sincerely yours,

Acting Regional Director

FEDERAL POWER COMMISSION
100 NORTH UNIVERSITY DRIVE
FORT WORTH 7, TEXAS

September 29, 1961

The District Engineer
U. S. Army Engineer District, Tulsa
P. O. Box 61
Tulsa 2, Oklahoma

Dear Sir:

Reference is made to your letter of September (no date) 1961, (SWP WR) which inclosed for field-level review and comment a copy of your proposed report - "Survey Report on Sanders, Big Pine and Collier Creeks, Texas".

We have reviewed the report and the improvements recommended therein with attention to the effect of such improvements on existing or potential hydroelectric resources. The report proposes construction of Pat Mayse Reservoir on Sanders Creek and Big Pine Reservoir on Big Pine Creek for flood control and water supply purposes and concludes that improvements on Collier Creek are not justified at this time. We have considered the power possibilities of the recommended projects and we concur with the findings of the report that stream yields of Sanders and Big Pine Creeks are too small to support hydroelectric power plants at the dam sites and that installation of pump-back generating facilities around the reservoirs would be impractical because sufficient operating head would not be available. Accordingly, we conclude that facilities for the development of hydroelectric power should not be provided at the projects and that operation of the proposed reservoirs will not effect any existing or potential hydroelectric resources.

The opportunity to review the report and submit comments, which are prepared at field level and are not to be construed as those of the Federal Power Commission, is appreciated. The report is returned herewith in accordance with your request.

Sincerely yours,

Edgar S. Coffman
Regional Engineer

By Leonard B. Young
Acting

BOARD OF WATER ENGINEERS

JOE D. CARTER, CHAIRMAN
O. F. DENT
H. A. BECKWITH

BEN F. LOONEY, JR.
SECRETARY

P. O. BOX 2311
CAPITOL STATION
AUSTIN 11.TEXAS

513 STATE OFFICE BUILDING
201 EAST 14TH STREET

IN REPLY REFER TO

(DIVISION)

November 16, 1961

Colonel Howard W. Penney
U. S. Army Engineer District, Tulsa
P.O. Box 61
Tulsa 2, Oklahoma

Dear Colonel Penney:

In response to the request contained in your letter received on September 18, 1961, the Board of Water Engineers has reviewed the Corps of Engineers' Survey Report on Sanders, Big Pine, and Collier Creeks, Texas, and offers the following field level comments thereon. The review draft of the report was dated September 15, 1961.

SUMMARY

The limited number of sites for development of the waters of the Red River Basin downstream from Denison Dam requires consideration of the maximum practical conservation storage being developed on each of the tributaries to the main stem. Additional consideration should be given to increasing the size of conservation storage capacity of both the proposed Pat Mayse and Big Pine Reservoirs. If local interests cannot adequately finance such storage the Board of Water Engineers is authorized to negotiate for same under the provisions of the Texas Water Planning Act of 1957.

Additional consideration should be given to the hydrology studies with reference to the critical period yield and its method of determination.

Reference should be made in the report to the negotiation of a compact on the Red River.

A public hearing will be held by the Board of Water Engineers on the report when it is officially transmitted by the Corps of Engineers to the Governor for his comments.

The report shows justification for water supply and flood control projects on Sanders and Big Pine Creeks and proposes to construct Pat Mayse Reservoir on Sanders Creek and Big Pine Reservoir on Big Pine Creek with the City of Paris, Texas, sponsoring the water supply storage in Pat Mayse Reservoir and the City of Clarksville, Texas, the water supply storage in Big

Pine Reservoir. The report shows that there is not justification for flood control and water supply projects on Collier Creek at this time.

This office concurs in the need for planning multiple-purpose projects. It is the policy of this Board that water conservation storage be included in all major reservoir projects, including those proposed for flood control. Wherever water supply projects are planned, the Board gives consideration to the optimum development of each project.

As there do not appear to be any possible reservoir sites on the Red River downstream from Denison Dam, it is particularly important to obtain the largest possible development of the tributaries. The conservation storage proposed in the Pat Mayse and Big Pine Reservoirs leaves undeveloped a significant amount of the available resource. The development of this remaining water at other sites would be under conditions which would be most expensive. The projects as proposed would limit or prohibit later additional development on these tributaries, and lead to incomplete development of the water resources of these tributaries.

Therefore, it is desirable to consider the optimum development of the Pat Mayse and Big Pine Reservoir sites for possible future water conservation purposes. The Corps of Engineers' report shows that the Pat Mayse Reservoir could be planned to yield 65 mgd, when water supply storage in the amount of 172,000 acre-feet is provided, and that the Big Pine Reservoir could be planned to have a yield of 31 mgd, when 126,000 acre-feet of water supply storage is provided. However, this amount of water supply storage was shown in the Corps of Engineers' report as not practical for development, and Pat Mayse Reservoir was planned for a dependable yield of 55 mgd from 99,700 acre-feet of water supply storage, and Big Pine was planned with a dependable yield of 26 mgd from 79,300 acre-feet of water supply storage.

It is the view of the Board of Water Engineers that further consideration should be given to including additional conservation storage in the Pat Mayse and Big Pine Reservoirs above those amounts currently planned. If local interests cannot adequately finance such storage, the Board of Water Engineers is authorized to negotiate for same under the provisions of the Texas Water Planning Act of 1957.

In checking the hydrology for the Pat Mayse and Big Pine Reservoirs, a comparison was made of the results of the Corps' study with the results of a study on the Paris Dam and Reservoir on Sanders Creek by the consulting engineering firm of Forrest and Cotton, Incorporated, for the City of Paris. The Forrest and Cotton study showed a dependable yield of 43.22 mgd with a capacity of 98,860 acre-feet. The location of this reservoir and the amount of water supply storage is quite similar to your Pat Mayse Reservoir. Also, for the period January 1953, through December 1956, this agency has estimated monthly flows for Sanders Creek based on streamflow records of the North Sulphur River at the Cooper stream gage, proportioned according to the drainage area of Sanders Creek and North Sulphur River.

Attached hereto is a graph prepared by this agency showing the monthly

flows in acre-feet for the period of January 1953, through December 1956, given in each of the above three studies for the purpose of comparison. The same sheet also shows the rainfall by months for the Sanders Creek watershed based on an average of the Paris and Arthur City records for the same period. In comparing the monthly flows shown on this graph with the monthly rainfall estimate for Sanders Creek, the largest rainfall in the four-year period occurred in October 1954, and amounted to 10.44 inches. For this month, the report shows only 228 acre-feet of runoff for the Pat Mayse Reservoir site. On the other hand, excessively large monthly flows are shown for May 1954, May 1955, and February 1956.

The Board would also like to point out the unusual characteristics of the North Sulphur watershed above the Cooper gage which was used by you in computing the runoff for the period of study. The main stem channel of the river has been rectified and extensive realignment made. Also, the tributary streams are short and have steep gradients. For these reasons, this stream is not considered to have the same characteristics for producing runoff as Sanders or Big Pine Creeks. Further, it is not believed that the runoff from the main stem of the Red River is comparable to the runoff from these small watersheds.

A drought frequency curve is enclosed for your consideration in the hydrologic study for the Pat Mayse Reservoir. This curve was developed from graphs showing cumulative departures from long-time normals of rainfall at Paris, Clarksville, Arthur City, Sherman, and Sulphur Springs. The curve shows the drought from 1953 to 1958, the period which the Corps studied, to be the third most severe of those shown. It shows a 1908 to 1913 drought to be the second most severe and an 1895 to 1902 drought to be the most severe. This information is furnished so that the Corps may consider these droughts in determining the dependable yield of this reservoir. Similar information was not prepared for the Big Pine because the watersheds are adjacent. It is felt that the order of magnitude of the droughts on the Sanders and Big Pine would be the same and that these earlier droughts should be taken into consideration in determining the dependable yield of the Big Pine Reservoir.

From Board of Water Engineers' Bulletin No. 5912, the average sediment production in this area is given as 0.42 acre-feet per square mile and a sediment survey of Lake Crook gives the average annual sediment production as 0.96 acre-feet per square mile and a Lake Gibbons survey shows the average annual sediment production as 1.56 acre-feet per square mile. The 7,500 acre-feet allotment for sediment storage in Pat Mayse Reservoir and 4,600 acre-feet in Big Pine Reservoir is within the amount required at these rates and appears adequate for the sediment storage.

In comparing the benefits and estimated costs of the projects, it is noted that the computed benefits of the water supply feature for the Pat Mayse Reservoir are 39 percent of the total annual benefits; and, for the Big Pine Reservoir, the computed benefits of the water supply feature are 43 percent. Whereas, the allocated cost for the water supply features is 45 percent for Pat Mayse Reservoir and 49 percent for Big Pine Reservoir, which costs are somewhat higher than the proportional benefits.

A further comparison was made of the different methods used in the cost

allocation of water supply storage to the cities involved. The method adopted was "the separable costs-remaining benefit method", where the cost to the cities of Paris and Clarksville was higher than either of the other two methods shown. By this method, the cost amounted to $3,388,000 on Pat Mayse Reservoir and $4,150,000 on Big Pine Reservoir. By comparison, "the priority of use method" cost was lowest, amounting to $662,000 on Pat Mayse Reservoir and $1,157,000 on Big Pine Reservoir; and "the incremental cost method" cost was between the two, amounting to $2,069,000 on Pat Mayse Reservoir and $2,454,000 on Big Pine Reservoir. The report does not make clear the reason for adopting the highest cost.

There is no reference in the report to the Red River Compact which is now being negotiated. This agency believes that there should be a statement in the report to the effect that the hydrologic studies have not included consideration of any releases of flow from the reservoirs which may possibly be required by such a compact. It is also suggested that in the section of the report "Coordination with Other Agencies" reference be made to the Red River Compact negotiations now in progress.

A public hearing will be held by the Board of Water Engineers on the report when it is officially submitted by the Corps of Engineers to the Governor for his comments as required under the Flood Control Act of 1944 and under Article 7472e (Vernon's Civil Statutes).

Under separate cover one of the copies of the survey report is being returned. The other copy is being retained for reference in case there is correspondence between us or questions raised. If you wish that the retained copy be returned to you, it will be returned when the final report is released.

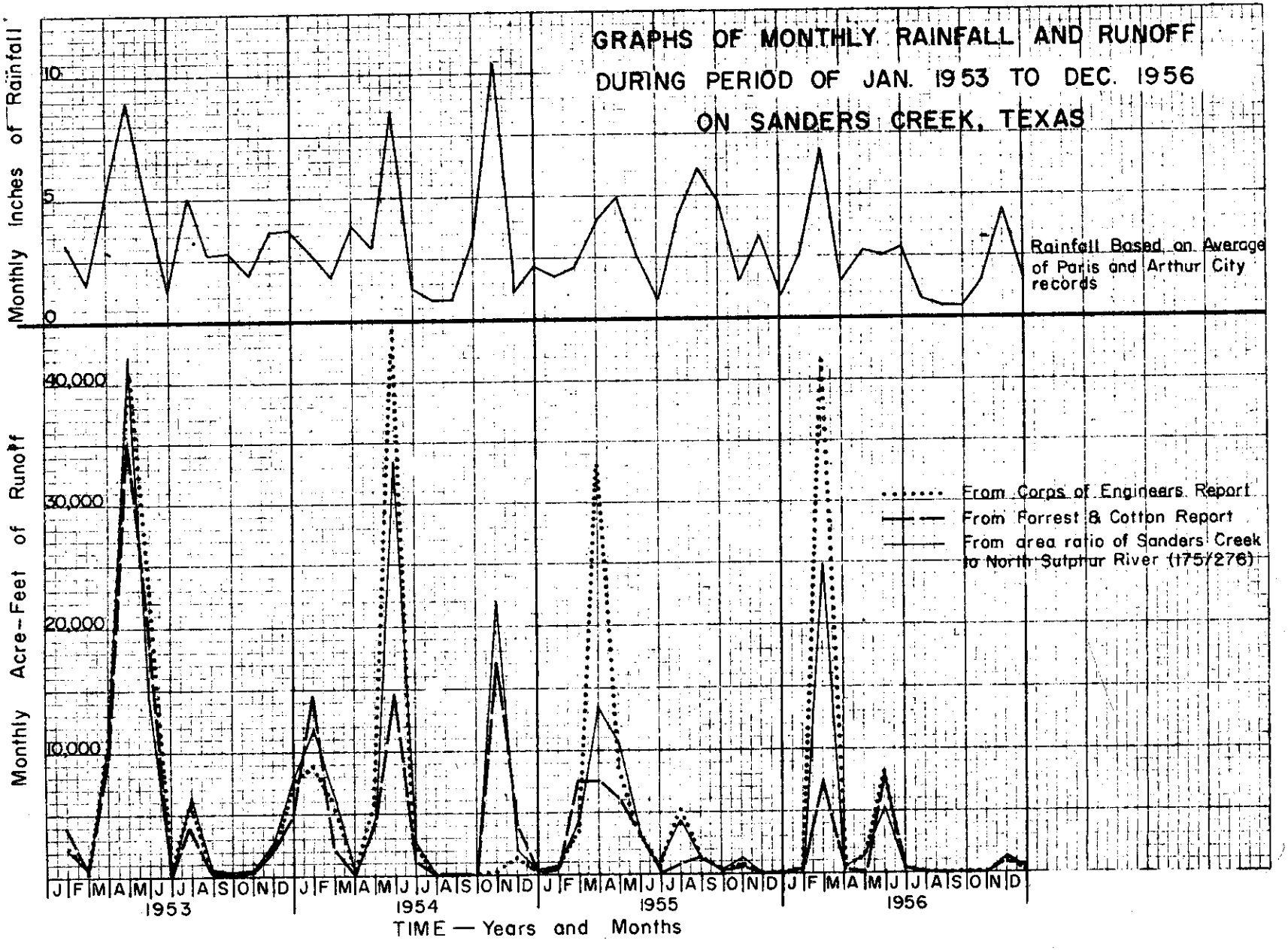
It is the agency's understanding that the proposed report has been transmitted to the Division office. It is requested that appropriate consideration of these comments be made by the Division Engineer in the preparation of his review and comments upon the District Engineer's report.

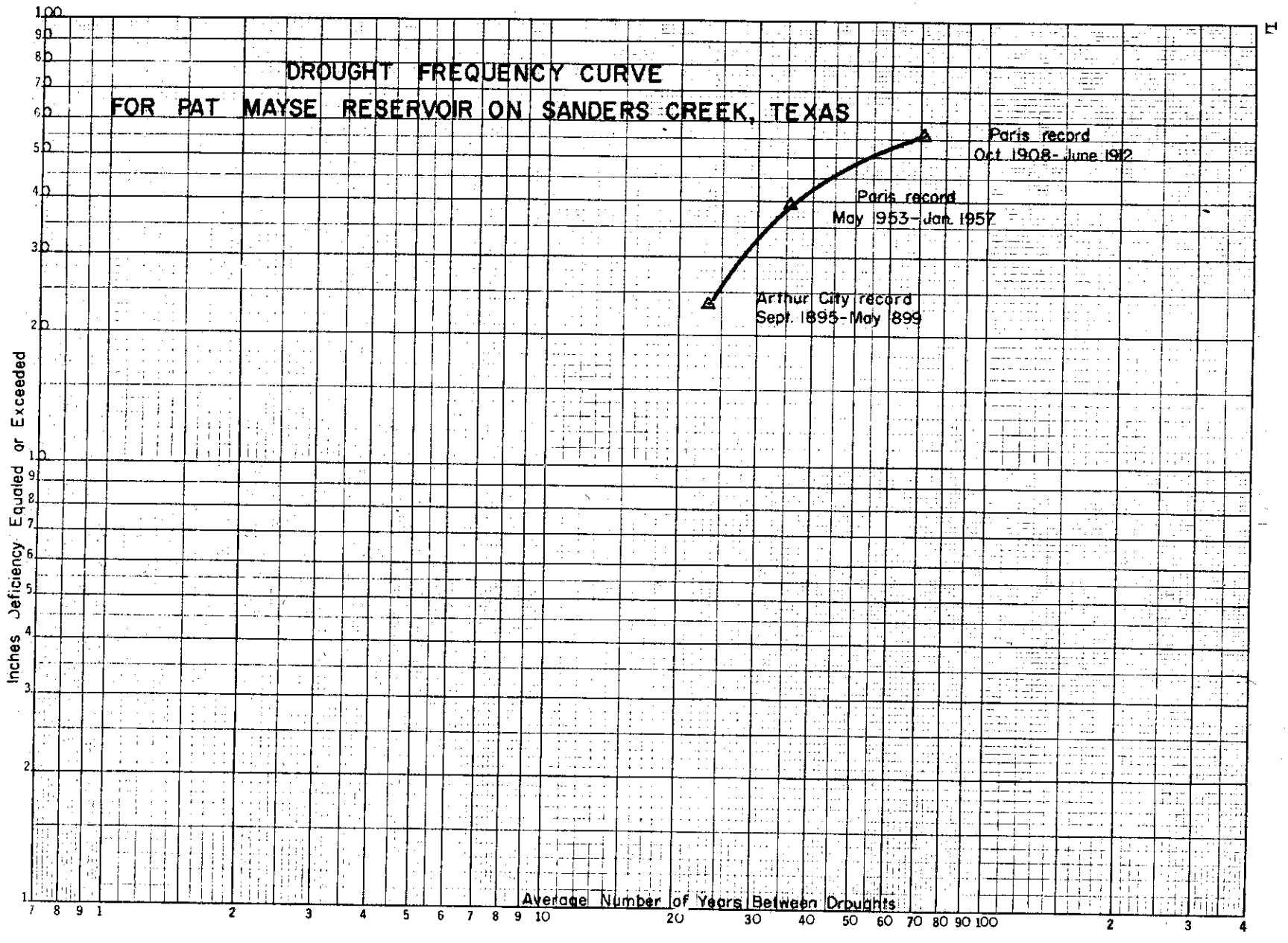
Our agency will appreciate your agency's advising us of contemplated modifications of your report.

Very truly yours,

BOARD OF WATER ENGINEERS

Joe D. Carter
Chairman


GRAPHS OF MONTHLY RAINFALL AND RUNOFF
DURING PERIOD OF JAN. 1953 TO DEC. 1956
ON SANDERS CREEK, TEXAS
Monthly Inches of Rainfall
10
5
0
Rainfall Based on Average of Paris and Arthur City records
Monthly Acre-Feet of Runoff
40,000
30,000
20,000
10,000
From Corps of Engineers Report
From Forrest & Cotton Report
From area ratio of Sanders Creek to North Sulphur River (175/276)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1953
1954
1955
1956
TIME — Years and Months


DROUGHT FREQUENCY CURVE
FOR PAT MAYSE RESERVOIR ON SANDERS CREEK, TEXAS
Paris record
Oct. 1908- June 1912
Paris record
May 1953-Jan. 1957
Arthur City record
Sept. 1895-May 899
Inches Deficiency Equaled or Exceeded
Average Number of Years Between Droughts

DROUGHT FREQUENCY TABLE
FOR PAT MAYSE RESERVOIR ON SANDERS CREEK, TEXAS
BASED ON PRECIPITATION RECORDS

Order of Magnitude	Time of Occurrence	Authenticated Station Record Used	Cumulative Departure from Normal Precipitation for Period (Inches Deficiency)	Period of Record	Years in Period	Average Number of Years
1	October 1908 - June 1912	Paris	56.17	1891-1961	71	71
2	May 1953 - January 1957	"	39.50	"	"	35.5
3	September 1895 - May 1899	Arthur City*	23.80	"	"	23.7

* From 1896 to 1904 (inclusive) the Paris precipitation record considered to be questionable.

ADDRESS REPLY TO:
DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, TULSA
P. O. BOX 61
TULSA 2, OKLAHOMA

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
616 SOUTH BOSTON
TULSA 2, OKLAHOMA

REFER TO FILE NO SWP WR

24 November 1961

Mr. Joe D. Carter, Chairman
Board of Water Engineers
P. O. Box 2311, Capitol Station
Austin 11, Texas

Dear Mr. Carter:

Receipt is acknowledged of the letter of 16 November 1961, containing the comments of the Board of Water Engineers on the review draft of the survey report on Sanders, Big Pine and Collier Creeks, Texas.

I appreciate having the views of the Board of Water Engineers regarding the desirability of the proposed reservoir projects, and note the desire for consideration of increasing the size of conservation storage capacity for maximum practical development of the two reservoirs. I also note the offer to assume sponsorship of water supply storage, in case local interests cannot adequately finance such storage.

The projects are, of course, subject to further study and firming up of hydrologic and engineering aspects after they become authorized for construction. Accordingly, the storages and water supply yields are subject to change from those shown in the report. Detailed planning of the project will also consider the requirements of such compact on Red River as may affect the operation of the reservoirs.

There is inclosed for your information a copy of my report as submitted to higher authority. Since it supersedes the review draft copy of the report, it is requested that the draft copy be returned to this office.

Sincerely yours,

HOWARD W. PENNEY
Colonel, CE
District Engineer

Incl
Sand-Bg Pine Rept
(Ser No 75)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE WASHINGTON 25, D.C.

Refer to:

January 24, 1962

The District Engineer
U. S. Army Engineer District, Tulsa
P. O. Box 61
Tulsa, Oklahoma

Dear Sir:

Reference is made to your "Survey Report on Sanders, Big Pine and Collier Creeks, Texas" in which a report of a study made by the Water Resources Section, Division of Water Supply and Pollution Control, Public Health Service, Region VII, on proposed reservoirs, dated November, 1960, is included as Appendix IV.

It is noted that the Plan of Improvement calls for construction of Pat Mayse Reservoir with a water supply yield of 55 mgd, and Big Pine Reservoir with a like yield of 26 mgd. This Plan is based on Resolution No. 951 from the City of Paris, Texas, asking the Corps to include storage in Pat Mayse Reservoir for water supply purposes in the amount of 55 mgd and a Resolution from the City of Clarksville, Texas, asking the Corps to include storage in Big Pine Reservoir for water supply purposes in the amount of 26 mgd. By letter dated November 16, 1961 to you over the signature of Joe D. Carter, Chairman, The Texas Board of Water Engineers, supported these Resolutions.

Although the detailed water resources study made by the Public Health Service indicated that water supply demands of Clarksville for the next 50 years can be met by presently available or firmly committed sources and that no demands on Big Pine Reservoir could be foreseen within that period of time, the Public Health Service supports as reasonable the construction of both reservoirs at the stated yield for the following reasons:

At the time of the original study, legislation was not clear whereby storage for the regulation of flows for water quality control could be provided. Passage of Public Law 87-88 in July 1961 changes this situation -- such storage may now be included in multipurpose, Federally constructed reservoirs. The need for water for municipal, industrial, and water quality control purposes in the Dallas-Fort Worth area has been more clearly defined in the months since the Public Health Service study was originally made. It seems reasonable that available water from either or both the subject reservoirs may be used to meet part of these demands. The absence of detailed studies on these points

prevents estimates of specific demands but does not mitigate the opinion of this Department that the best interests of the area with respect to the optimum development of its water resources will be served by the construction of both reservoirs as proposed by the Corps.

Sincerely yours,

J. H. Svore

Regional Program Director, Region VII
Division of Water Supply
and Pollution Control

SUPPLEMENT A

SUPPLEMENTAL ECONOMIC DATA

SURVEY REPORT
ON
SANDERS, BIG PINE AND COLLIER CREEKS,
TEXAS

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

SANDERS, BIG PINE AND COLLIER CREEKS, TEXAS

SUPPLEMENTAL ECONOMIC DATA

1. INTRODUCTION

The purpose of this supplement is to summarize the studies of the four-county area of Bowie, Fannin, Lamar, and Red River, in which the Sanders, Big Pine, and Collier Creeks Basins are located, and to present an analysis of those basins and the adjacent region from the standpoint of economic characteristics, developments, past trends and future growth projections.

2. SUMMARY OF FINDINGS

a. The 1960 population of Fannin, Lamar, and Red River Counties is considerably less than reported in the census of 1940 and 1950. The population of Bowie County experienced a steady gain through 1950, while the 1960 census count indicates a decline of 3.2 percent over the 1950 census.

b. Census reports since 1880 evidence continuing growth of Texarkana, Arkansas-Texas metropolitan area. Bonham, in Fannin County, Texas, has grown steadily since its founding.

c. The following urban centers have shown a variable growth trend: Paris, in Lamar County, Texas, has had a steady population growth until the 1960 census report. Comparison of the 1960 count with the 1950 census indicates a decline in population of 3.1 percent; however, it is expected that Paris will again grow and that related economic activities will keep pace with the population growth. A similar expectancy is forecast for Clarksville, Red River County, which experienced an 11.6 percent decrease in population in 1960 when compared to the 1950 census; however, its growth is expected to be at a lesser rate.

d. Population projections have been made for the counties, the Texarkana, Texas-Arkansas metropolitan area, and the major urban centers in the counties. Middle projections of a series indicate growths will occur in populations of the counties and the urban centers.

e. Agriculture will continue to play an important role in the region. Farm incomes for the larger farm units will tend to increase. Under proper management, soils are productive in the Red River and tributary valleys. In the region studied, cotton has decreased in importance as a crop, but other farm products have increased because of favorable soil and growing season and its favorable location near urban centers. This includes the metropolitan areas of Dallas, Fort Worth, Texarkana and Tyler, where a market exists for fresh vegetables and poultry products.

f. Irrigation in the area will be possible only by obtaining a supplemental water supply. The Bureau of Reclamation has found that the most economical source of irrigation water is the Red River and could be obtained by pumping.

g. Metropolitan and urban areas are expected to increase in population, industrialization being the prime factor in such growth.

h. Navigation systems on Red River are under study. From Paris, Texas, the nearest operational navigation system is at Camden, Arkansas, (on Ouachita River) 188 rail miles distant.

i. Because of the physical limitations of topography and lack of sufficient stream-flow, hydroelectric power generation is not practical.

j. Commercial timber will become more important when improved management practices and cooperative agreements are initiated among diversified landowners. The best possibilities for development of timber resources exist in Red River and Bowie Counties.

k. Manufacturing establishments increased during the 1954-1958 period. Payrolls reported by the 1954-1958 census of manufacturers are calculated to approximate $21 million annually. However, during that same period the number of employees engaged in manufacturing decreased due to increased productivity resulting from efficiency improvements and automation of plant facilities. Value added by manufacture has increased considerably since 1947 and added to the area economic base.

l. Deposits of refractory and semi-refractory clays, limestone, chalk, lignite, sand and gravel are present in commercial quantities. Red River and Bowie Counties produce petroleum, natural gas and natural gas liquids.

m. Surface water supplies are suitable for area water supply needs. Available ground water supplies are slightly saline and have total dissolved solids ranging from 1,000 to 3,000 parts per million. The economics of deep water well recovery are beyond the scope of this report.

n. Frequent flooding in the area makes crop production uncertain; however, future long-term domestic demands and foreign exports of farm and agricultural products will cause an increased growth on an assumed straight-line basis without flood protection in the area.

o. An ample labor force is available in the area for current and future needs.

p. Bank deposits and assets of both State and National banks have continued to increase during the 1950-1959 period. These gains in deposits indicate continued economic growth despite population loss.

3. GENERAL

a. Study area locations and drainage area relationships. As shown on plate 1, the four northeast Texas Counties of Bowie, Fannin, Lamar, and Red River comprise the major area studied in this report.

(1) Sanders Creek watershed, approximately 190 square miles in area, is located principally in Lamar County, Texas. Headwater drainage begins near Honey Grove, Texas, near the eastern boundary of Fannin County. The project under study is known as Pat Mayse Reservoir, with the dam site located on Sanders Creek at mile 4.4, approximately two miles southwest of Arthur City, Texas.

(2) Big Pine Creek watershed, comprising approximately 170 square miles, is located principally in Red River County, Texas. Its headwater drainage begins in the northeast section of Lamar County. The project under study is known as Big Pine Reservoir, with the dam site located on Big Pine Creek (mile 13.2), two and one-half miles northwest of Manchester, Texas.

(3) Collier Creek watershed is approximately 36 miles in area and is located in Red River County; drainage is to the east of the Big Pine Creek watershed. The project under study is known as Acworth Reservoir, with dam site located on Collier Creek at mile 3.9, four miles northeast of Negley, Texas.

(4) Sanders, Big Pine, and Collier Creeks are intermittent streams with high flood frequencies. Channels follow a northeasterly course and each stream flows into Red River.

b. Economic history and recent events of area.

(1) Settlement of the four-county area began soon after 1800. By 1850, the area was extensively developed for agriculture. Population of the four-county area in 1850 was approximately 14,500; 80,800 in 1880; 157,000 in 1900; 169,000 in 1930; and 134,000 in 1960. Cotton planting was extensive and important by 1880. Timber cutting was on the increase soon after 1880. As the building of railroads became increasingly important after 1880, timber cutting increased and reached its maximum from 1895 to 1910. With the advent or railroads and timber clearing, the number of farms increased rapidly, doubling between the years 1890 and 1910.

(2) By 1880, lands had been farmed to an extent that some croplands had been abandoned; considerable "damage by gullies and washing" was reported by the 1880 Census of Agriculture. After

having expanded until the early 1920's, acreage planted to cotton declined sharply. Changes in the areas primarily agricultural environment began in the 1930's when oil production and other non-farming activities began to expand.

(3) Migration from farms to cities has been steady since 1900. From 1940 to 1960, the trend continued; and agricultural labor now represents approximately 25 percent of the labor force, compared to 70 percent in 1930. Industrial and other nonfarm employment opportunities in the general area have continued to increase. Farming has changed from small cash-crop farms to small size livestock and poultry farms. Reforestation and changed crop practices (such as the introduction of wheat, sesame seed, tomatoes, pecans and peanuts) have added considerable value to the agriculture of the area.

(4) The area has important military installations. The Red River Arsenal and Lone Star Ordnance plants of the U. S. Army are located in Bowie County, Texas. Camp Maxey, a World War II training camp (now excess for military purposes) is located several miles north of Paris, Texas. Some of this area has been made available for industrial sites with trackage connections. Junior colleges are located in Paris and Texarkana, Texas. Central Airlines has recently expanded its operations from Paris, Texas. The Campbell Soup Company is keenly interested in the farm area near Paris as a potential source of growing tomatoes for processing. The Campbell Soup Company's share of the tomato soup market in the United States is about 85 to 89 percent. Growing and canning facilities in this area would permit appreciable savings in transportation and facilitate distribution.

c. Navigation.

(1) Red River, Louisiana, Arkansas, Texas, and Oklahoma. Navigation has been practiced on the river in past years. Cotton and other commodities have been shipped from various points on the upper portion of the river; however, under present conditions, navigation is not practical due to hazards along the watercourse. Present-day navigation is intermittent and limited to the lower reach. A 9-foot navigation channel from Shreveport to the confluence with the Black River (river mile 35) has been authorized for construction. Studies are currently under way to determine the feasibility of navigation on the Red River below Denison Dam.

(2) Ouachita and Black Rivers, Arkansas and Louisiana. This is a functional navigation system at the present time. Authorized in 1871 and subsequent acts through 1945, it provides a navigable depth of six and one-half feet at low water from the mouth of Black River, Louisiana to Arkadelphia, Arkansas, a distance of 417 miles. In the future, the existing channel will probably be modified to provide a 9-foot by 100-foot navigation channel on the Ouachita River to Camden, Arkansas, as presently authorized. Paris is 170 miles rail distance from Arkadelphia and 188 miles from Camden.

d. Hydroelectric power. Hydroelectric power generation at Pat Mayse and Big Pine Reservoirs is not practical, due to inflow and topographical limitations at the site.

e. Recreation. Prospects for recreational use of the reservoir impoundments are good, as the area is close to urban centers which are developing rapidly.

f. Irrigation. Supplemental irrigation can fill an important need over a widespread area in the Sanders and Big Pine Creeks watersheds, according to statements presented at the public hearing. While the average annual rainfall is about 42 inches, the rainfall distribution during the growing season is frequently inadequate for crop production and therefore a need exists for supplemental irrigation in order to improve the crop yields. These areas have fine, deep fertile soils but would require surface drainage relief systems if irrigated. The Bureau of Reclamation found very limited acreage suitable for irrigation according to their criteria in the Sanders and Big Pine areas. This area could possibly be economically supplied with water pumped from the nearby Red River. In studies of the adjacent land areas in the Red River valley, the Bureau of Reclamation estimates that approximately 15,000 acres, along both sides of the river, would be suitable for irrigation. They are also of the opinion that all of these lands (15,000 acres) will prove more economical for development by stream-bank pumping from the Red River, rather than by irrigation storage from the proposed reservoirs.

4. PERTINENT DATA SHEETS

Included herewith as exhibit 1 are a series of pertinent data sheets summarizing the activities, physical features and important towns for the four counties of Boxie, Fannin, Lamar, and Red River.

5. POPULATION

a. General. Trends in population (studied for the four-county area) are discussed in the following paragraphs and summarized in accompanying tables 1 through 4:

TABLE 1

CURRENT AND PAST POPULATIONS AND PERCENT CHANGE BY COUNTIES
(Period 1930-1960)

County	Land Area in Square Miles	County Population 1930	County Population 1940	Change in Population Percent	County Population 1940	County Population 1950	Change in Population Percent	County Population 1950	County Population 1960	Change in Population Percent
Bowie	921	48,563	50,208	+3.4	50,208	61,966	+23.4	61,966	59,971	-3.2
Fannin	906	41,163	41,064	-0.2	41,064	31,253	-23.9	31,253	23,880	-23.6
Lamar	906	48,529	50,425	+3.9	50,425	43,033	-14.7	43,033	34,234	-20.4
Red River	1,033	30,923	29,769	-3.7	29,769	21,851	-26.6	21,851	15,682	-28.2
Total	3,766	169,178	171,466	+1.4	171,466	158,103	-7.8	158,103	133,767	-15.4

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TABLE 2

1960 URBAN-RURAL POPULATION DISTRIBUTION

County	Population	Urbanized Areas, Over 2,500 Population				Rural Areas, Under 2,500 Population		
		Total Urban	Percent of Total Pop.	Metro-politan	Other Urban	Total Rural	In towns of 1,000 to 2,500	Other Rural
Bowie	59,971	35,822	59.7	33,049	2,773	24,147	4,090	20,059
Fannin	23,880	7,357	30.8	-	7,357	16,523	3,188	13,335
Lamar	34,234	20,977	61.3	-	20,977	13,257	-	13,257
Red River	15,682	3,851	24.6	-	3,851	11,831	1,112	10,719

b. Bowie County. (Population 59,971 - 1960 census) has shown a strong growth during the period 1930-1950, with a small decrease in population for the decade 1950-1960. Bowie County experienced an increase of 11,758 or 23.4 percent in population during the decade 1940-1950. During the past decade, the county population decreased 1,995 or 3.2 percent. The urban population of the county in 1960 was 35,882 or 59.7 percent with the main concentration in the City of Texarkana, Texas, (Population 30,218 - 1960 census). The 1960 rural population was 24,419. The county has experienced this migration of population due to increased employment opportunities provided by industry in the urban areas. The 1958 census of manufactures shows a slight decrease in the value added by manufactures, and this may in part account for the slight loss in population.

c. Fannin County. (Population 23,880 - 1960 census) reported a population loss of 9,811 or 23.9 percent in the decade 1940-1950. The county had an additional loss in population of 7,373 or 23.6 percent in the 1950-1960 decade. The urban population of the county in 1960 was 7,357 or 20.8 percent, with the concentration being in the City of Bonham, Texas. The rural population in the county, reported in 1960, was 16,523.

d. Lamar County. (Population 34,234 - 1960 census) reported a population loss of 7,392 or 14.7 percent in the decade 1940-1950. The county had an additional loss in population of 8,799 or 20.4 percent in the past decade, 1950-1960. The urban population of the county in 1960 was 20,977 or 61.3 percent, with this concentration being in the City of Paris, Texas. The rural population in the county, reported in 1960, was 13,257.

e. Red River County. (Population 15,682 - 1960 census) reported a population loss of 7,917 or 26.6 percent in the decade 1940-1950. The county had an additional loss in population of 6,169 or 28.2 percent in the past decade, 1950-1960. The urban population of the county in 1960 was 3,851 or 24.6 percent, with concentration in the City of Clarksville, Texas. The total rural population in the county for 1960 was 11,831.

f. Rural trends. The populations of Fannin, Lamar and Red River Counties have experienced a decrease since 1920. In contrast to this decline in population, Bowie County has shown a strong growth from 1930 to 1950 and a small decrease in the decade 1950-1960. The four counties combined have a reported decrease in population of 7.8 percent for the decade 1940-1950 and 15.4 percent decrease for the decade 1950-1960. These population changes are due to complex interrelated economic factors. The most evident factors are that Bowie, Fannin, Lamar and Red River Counties have experienced these net migrations due partly to advanced technology in agricultural production and increased employment opportunities in the urban areas.

g. Population of principal cities and towns. Tabulation presented in table 3 shows the population of the principal towns and cities in the four counties of Bowie, Fannin, Lamar and Red River.

TABLE 3

POPULATION - CITIES AND TOWNS 1930-1960
AND PERCENT CHANGE 1950-1960

County - City	1930	1940	1950	1960	Percent Change 1950-60
Bowie County:	(48,563)	(50,208)	(61,966)	(59,971)	-3.2
Texarkana(Texas)	16,602	17,019	24,753	30,218	+18.1
Wake Village	(1)	(1)	1,066	1,140	+6.5
Hooks	(1)	(1)	2,319	2,048	-11.7
New Boston	945	1,111	2,688	2,773	+3.1
DeKalb	1,023	1,287	1,928	2,042	+5.6
Nash City	(1)	(1)	(1)	1,124	-
Maud City	(1)	(1)	713	915	+25.1
Fannin County:	(41,163)	(41,064)	(31,253)	(23,880)	-23.6
Bonham	5,655	6,349	7,049	7,357	+4.2
Honey Grove	2,475	2,456	2,340	2,071	-11.5
Leonard	1,131	1,331	1,211	1,117	-7.8
Ladonia	1,199	1,279	1,104	890	-19.4
Trenton	490	634	603	712	+15.4
Lamar County:	(48,529)	(50,425)	(43,033)	(34,234)	-20.4
Paris	15,649	18,678	21,643	20,977	-3.1
Blossom	650	858	780	545	-30.2
Deport	819	787	(2) 708	(2) 639	-9.8
Red River County:	(30,923)	(29,769)	(21,851)	(15,682)	-28.2
Clarksville	2,952	4,095	4,353	3,851	-11.6
Bogata	(1)	800	936	1,112	+15.9
Detroit	(1)	1,064	679	576	-15.2
Annona	426	446	492	369	-25.0
Avery	(1)	477	442	343	-30.3

(1) Not Incorporated
(2) Includes part of Deport in Red River County

(1) Texarkana, the principal city of Bowie County has shown a constant population growth trend since 1880. Its twin city, Texarkana, Arkansas, (population 19,788 - 1960 census) has also experienced a constant rate of growth since 1880. The Texarkana, Texas-Arkansas urban area has recently been designated by the Census Bureau as one of 21 new

"Standard Metropolitan Statistical Areas", in the United States (SMSA). A comparison of the Texarkana population for the years 1950 and 1960 is shown below:

	Population	
	1950	1960
Bowie County	61,966	59,971
Miller County	32,614	31,686
Texarkana Texas-Arkansas SMSA Total Population	94,580	91,657
Texarkana, Texas	24,753	30,218
Texarkana, Arkansas	15,875	19,788
Within City Limits	40,628	50,006
Outside City Limits	53,952	41,651

The Texarkana metropolitan area had a decrease of 2,923 in population during the decade 1950-1960. The central city, however, had an increase during that same period of 9,378.

(2) Bonham, Texas, is the county seat and the principal city in Fannin County. Bonham has grown steadily since 1930 and experienced a gain of 308 people or 4.2 percent during the past decade.

(3) Paris, Texas, is a major metropolitan center and the county seat of Lamar County. Paris has experienced a steady population growth up to the 1950 census count. The 1960 census indicates a decrease of 666 persons or 3.1 percent for the city since 1950.

(4) Clarksville, Texas, is the county seat and principal city in Red River County. Clarksville has experienced a decrease in population of 502 or 11.6 percent during the past decade. Clarksville had its maximum population count (4,353) in 1950.

h. Population projections.

(1) Population projections for the four-county area, the Texarkana metropolitan area and other principal cities and towns were adapted from State population projections as obtained from "Population Projections and Economic Assumptions, Select Senate Committee on National Water Resources", Committee print number 5, March 1960, based on data furnished by U. S. Census Bureau and the Resources for the Future. These projections represent middle projections of a series. The growth rates of population appear to be reasonable and have been used for planning purposes. Table 4 presents the projections for the above areas.

(2) The Texarkana metropolitan area is defined in 1960 as Bowie County, Texas, and Miller County, Arkansas. The projected total population in the year 2010 for the two counties would be 220,000.

(3) Paris, Texas, principal city of Lamar County has a projected population in the year 2010 of 95,000.

(4) Bonham, Texas, principal city of Fannin County has a projected population in the year 2010 of 27,000. Honey Grove, Texas, and Leonard, Texas, also located in Fannin County, have a projected population for the year 2010 of 6,000 and 2,500, respectively.

(5) Clarksville, Texas, the principal city in Red River County has a projected population for the year 2010 of 19,000.

(6) These population projections agree substantially with the Public Health Service projection for the City of Paris, Texas, as shown in Appendix IV. The studies indicate a more favorable growth for the Cities of Bonham, and Clarksville, Texas, than indicated by the Public Health Service. Population projections were also made for the metropolitan area of Texarkana, Texas-Arkansas.

TABLE 4

I. POPULATION PROJECTIONS FOR COUNTIES

County	1960	1970	1980	1990	2000	2010
Bowie	59,971	72,305	85,000	102,000	124,000	160,000
Fannin	23,880	28,693	33,500	40,000	49,000	58,500
Lamar	34,234	41,317	52,000	64,000	80,000	109,000
Red River	15,682	18,363	21,500	25,500	30,000	33,000
Miller, Arkansas	31,686	33,800	37,000	42,000	48,200	60,000

II. POPULATION PROJECTIONS FOR URBAN CENTERS

City or Town	1960	1970	1980	1990	2000	2010
Texarkana, Texas (1)	30,218	46,000	64,500	86,000	112,000	140,000
Texarkana, Ark. (2)	19,788	25,800	30,000	36,000	43,000	52,000
Paris, Texas (3)	20,977	31,000	43,000	57,000	74,000	95,000
Clarksville, Texas (4)	3,851	5,450	7,800	11,800	15,800	19,000
Bonham, Texas (5)	7,357	9,700	13,000	17,100	21,800	27,000
Honey Grove, Texas (5)	2,071	3,100	3,300	4,800	5,100	6,000
Leonard, Texas (5)	1,117	1,310	1,590	1,900	2,200	2,500

(1) Bowie County, Texas
(2) Miller County, Arkansas
(3) Lamar County
(4) Red River County
(5) Fannin County

(7) Other sources of information considered in determination of population projections are as follows:

a. Readings in Economics, from Fortune. Revised Edition, Edited by Richard E. Mulcahy, University of San Francisco.

b. Texas Almanac, 1961-62 edition.

c. National Economic Projections, National Planning Association, 1959.

d. Historical statistics of the United States, Colonial Times to 1957.

e. Census of Population - Final Population Counts, Texas and Arkansas.

f. East Texas Economic Index, East Texas Chamber of Commerce, July 1959.

g. Sanders, Big Pine, Acworth Reservoir Study; Sanders, Big Pine, and Collier Creeks, Texas. Department of Health, Education, and Welfare, Public Health Service, Region VII, 1960.

h. Communications with various Chambers of Commerce.

i. Directory of Texas Manufactures, 1961.

j. Area development bulletin, U. S. Department of Commerce, Volume VI, 1955-1960.

i. Total bank deposits and total assets. Reference is made to table 5, showing total assets and total deposits for the years 1950, 1954, and 1959. Total assets have shown an increase during the period 1950 to 1959 in all counties. Total bank deposits have also increased during the period 1950-1959. These increases are indicative of a strengthening economy for the four counties although a considerable loss in population has been experienced.

TABLE 5

TOTAL BANK DEPOSITS AND ASSETS
DECEMBER 31, 1950, 1954, AND 1959
(Thousands of Dollars)

County	TOTAL ASSETS			TOTAL DEPOSITS		
	Dec 31 1950	Dec 31 1954	Dec 31 1959	Dec 31 1950	Dec 31 1954	Dec 31 1959
	$	$	$	$	$	$
Bowie	33,962	39,875	41,682	32,178	37,471	32,129
Fannin	13,083	15,692	17,171	11,897	14,241	15,513
Lamar	21,230	20,899	23,564	19,742	19,303	21,617
Red River	5,812	6,163	7,715	5,213	5,461	6,826

j. Total labor force and unemployment in Texas by counties. Table 6 shows the status of the labor force as reported by Texas employment commission as of December 31, 1959. The population and labor force are dynamic segments of the area economy and the figures below represent a point in time only.

TABLE 6

TOTAL LABOR FORCE AND UNEMPLOYMENT IN TEXAS
BY COUNTIES

County	Labor Force					
	Total Population	Total Employment	Un-employment	Nonfarm	Manufac-turing	Farm
Bowie	59,971	26,650	1,650	22,500	(2,800)	2,500
Fannin	23,880	11,550	650	6,400	(1,650)	4,500
Lamar	34,234	16,500	950	10,550	(2,000)	5,000
Red River	15,682	6,850	400	2,950	(450)	3,500
Total	133,767	61,550	3,650	42,350	(6,900)	15,500

6. VALUE ADDED BY MANUFACTURE

a. Value added by manufacture by county.

TABLE 7

VALUE ADDED BY MANUFACTURE FOR THE FOUR COUNTIES OF BOWIE, FANNIN, LAMAR & RED RIVER, TEXAS

County	1947	1954	% Gain or Loss: 1947-54	1954	Prelim Census of Mfg: 1958	% Gain or Loss: 1954-58
	$	$		$	$	
Bowie	8,719,000	22,793,000	+161.4%	22,793,000	16,370,000	-28.2%
Fannin	2,338,000	2,885,000	+23.4%	2,885,000	8,700,000	+201.5%
Lamar	4,743,000	13,608,000	+186.9%	13,608,000	12,970,000	-4.7%
Red River	812,000	942,000	+16.0%	942,000	1,508,000	+60.0%
Total	16,612,000	39,228,000	+142.7%	39,228,000	39,548,000	+.8%

(1) As shown in table 7, value added by manufacture in Bowie County has shown a strong increase for the period 1947-54, of $14,074,000 or 161.4%. For the period 1954-58, value added by manufacture decreased $6,423,000 or 28.2%. Bowie County, however, maintains its top rank in value added by manufacture for the four-county area. Fannin County has shown a remarkable gain in value added by manufacture with $547,000 or a 23.4% gain in the period 1947-54. In the 1954-58 period, a $5,815,000 or 201.5% gain in value added by manufacture was reported. Lamar County had a rapid rise in value added by manufacture in the 1947-54 period, showing an increase of $8,865,000 or 186.9%. The county experienced a decline of $638,000 or 4.7% in the period 1954-58. It maintained its second-place position with respect to the four counties. Red River County had a small gain of $130,000 or 16.0% during the period 1947-54. The county showed an increase of $566,000 or 60.0% increase in the period 1954-58.

(2) The four counties show $320,000 or .8% net increase in value added by manufacture for the period 1954-58. The previous period, 1947-54, had an increase of $22,616,000 or 142.7% increase in total value added by manufacture. These increases in value added by manufacture do not take into consideration the decrease in dollar value caused by inflation for the periods compared. Value added by manufacture alone is not the complete answer to area gain in the manufacturing industry. Other factors which must be considered are the number of employees, manufacturing payroll, and capital expenditures.

(3) Table 8 compares the number of manufacturing employees, total payroll (all forms of compensation) and number of establishments operating for the years 1954 and 1958 in the four counties of Bowie, Fannin, Lamar and Red River. Bowie County has experienced a decline of 1,565 manufacturing employees; this was due in part to cyclical movement of manufacturing activity and reflects temporary conditions which existed during the 1957-58 recession. By July 1960, employment in manufacturing was reported as 3,990, which was slightly below the level reported in the 1954 census. The manufacturing industries of the four counties have experienced a steady growth in number with a slight decrease in number of employees and in total annual payroll as evidenced by the 1954 and 1958 census of manufactures.

(4) A comparison of total capital expenditures for manufacturing firms is shown in table 9 for the years 1954 and 1958. This compares figures for the periods specified and does not include the expenditures for the interval years.

TABLE 8

COMPARISON OF MANUFACTURING EMPLOYEES, PAYROLLS AND ESTABLISHMENTS, PERIOD 1954-1958

County	Manufacturing Employees		Payroll ($1000)		Establishments	
	1954	1958	1954	1958	1954	1958
			$	$		
Bowie	4,279	2,714	14,094	9,586	59	63
Fannin	907	1,251	2,308	3,746	21	31
Lamar	1,713	2,012	4,654	6,785	42	45
Red River	224	409	471	897	26	25
Total	7,123	6,386	21,527	21,014	148	164

TABLE 9

COMPARISON OF NEW CAPITAL EXPENDITURE, PERIOD 1954-1958

County	Year 1954	Year 1958
	$	$
Bowie	2,144,000	694,000
Fannin	637,000	498,000
Lamar	599,000	541,000
Red River	48,000	132,000
Total	3,428,000	1,865,000

b. Value added by manufacture for the east Texas region (71 counties).

(1) According to the U. S. Census of Business (1954), east Texas counties had at that time a total of 5,148 manufacturing plants. This concentration of industry was 57.7% of the State total of 8,594 plants in 1954.

(2) Value added by manufacture in 1940 was $307,637,000 for the 71-county region, compared to $1,099,593,000 in 1947. Value added by manufacture in 1954 was reported as $2,228,800,000. Percentage gain in dollars added, 1940-47, was 257.4%. Percentage gain 1947-54 was 102.7%. This drop in percentage gain did not mean that manufacturing fell off in volume but that, for the first time, other sections of the State of Texas were becoming industrialized, thus distributing the gain.

(3) As reported in the 1954 census, east Texas cities were first in the State in value added by manufacture. Houston led in all major factory statistics, with Dallas second. Houston had 1,421 factories; Dallas had 1,386. Houston had 79,038 employees; Dallas had 74,793. In factory payrolls, Houston reported $368,444,000 for 1954; Dallas, $297,705,000. In capital investments, Houston ranked first with $90,529,000; Beaumont-Port Arthur, second with $66,990,000; and Dallas, third with $20,427,000.

(4) Recent reports do not show by county units the values added by manufacture. However, as reported in the "Area Development Bulletin", December 1959 - January 1960, Texas has experienced a gain of 67,000 manufacturing employees. Thus, Texas showed a 16-percent gain in manufacturing employment during the period 1954-58. Oklahoma

and Arkansas also shared by gaining one percent and 15 percent, respectively, in manufacturing employment.

(5) The regional picture thus shows an increase being experienced in manufacturing industry. The four northeastern counties of Bowie, Fannin, Lamar, and Red River will have gained some small percentage of the manufacturing industry, which has been added to the region. Along with this added local industry, an increased demand is being experienced for goods and services throughout the region, thereby creating even more employment for people in these nonmanufacturing industries.

c. Manufacturing plants by counties and type of products. The following list of products manufactured was extracted from the 1961 edition of the Directory of Texas Manufactures, published by the Bureau of Business Research. All subsequent lists are also from this source. The number of firms is indicated in parentheses.

BOWIE COUNTY, TEXAS: In Texarkana, Texas, 61 manufactures are listed, with the major products as follow:

Commercial printing (4)
Millwork (2)
Batteries (1)
Oil well drilling mud (1)
Neon signs (2)
Sheet metal (4)
Dairy products (3)
Pickles (1)
Soft Drink (5)
Bakery products (2)
Canvas products (1)
Meat packing plants (4)
Boats (1)
Automobile products (1)
Sewer pipes (1)
Mixed fertilizers (1)
Mattress (3)
Ready mixed concrete (2)
Not-mixed asphalt (1)
Coffee and spice products (1)
Household drugs and chemicals (1)
Timber products and wood preserving (3)
Surgical appliances (1)
Truck bodies (1)
Mobile homes (1)
Red River Arsenal - U.S. Army Ordnance(1)
Machine Shop (1)
Caskets (1)
Concrete Blocks (1)
Texarkana Gazette - newspaper (1)
Stage equipment (1)
Paddles and boat oars (1)
Foundry (1)
Iron works and welding (1)

In Dekalb, Texas: Dekalb News, newspaper; in Nash, Texas: Lumber and hardwoods; in New Boston, Texas: Fiberglass boats.

FANNIN COUNTY, TEXAS: In Bonham, Texas, 21 manufactures are listed, with the major products as follow:

Commercial printing (1)
Clothing, fabric and yarn(4)
Mattress (2)
Brooms and mops (1)
Newspapers (1)
Dairy products (1)
Pumps and compressors (1)
Mobile homes (1)
Lawn mowers and wheels (1)
Wire and cable reels (1)
Soft drink bottling (1)
Communication cables (1)
Feeds (1)
Fertilizer, insecticides and sprayers (1)
Meat packing and processing (2)
Welding and storage tanks (1)

In Honey Grove, Texas: Power transformers and other electrical equipment, Honey Grove Signal-Citizen, Ladonia News and Wolfe City Sun - newspapers, livestock feed mill; in Leonard, Texas: Leonard Graphic - newspaper; in Trenton, Texas: Trenton Tribune - newspaper.

LAMAR COUNTY, TEXAS: In Paris, Texas, 38 manufactures are listed, with the major products as follow:

Waxed paper and cellophane products (1)
Metal product - boilers (1)
Dairy products (2)
Reprocessed grease and bones (1)
Boots (1)
Soft drinks (4)
Fruits and vegetable crates (1)
Reflective glass beads and blasting and cleaning compounds (1)
Candy (1)
Brassieres (1)
Plywood boats (1)
Bakery products (2)
Cotton oil mill products (2)
Lamar County Echo - Paris News, newspapers (2)
Concrete pipe and products (2)
Meat packing and processing (2)
Clothing (1)
Ready-mix concrete (1)
Stock and poultry feed (1)
Tread rubber factory (1)
Furniture and chairs (2)
Sesame seed processing (1)
Paperboard folding boxes (1)
Apple juice vinegars, powdered pectin (1)
Dressed poultry (1)
Business stationery forms (1)
Brass and aluminum lamp bases, wires, and filaments (1)
Commercial printing (1)

In Deport, Texas: Deport Times - newspaper.

RED RIVER COUNTY, TEXAS: In Clarksville, Texas, 8 manufactures are listed, with the major products as follow:

Women's clothing (2)
Clarksville Times - newspaper (1)
Soft drinks (1)
Machine shop jobbing and repair (1)
Bath tubs, sinks and lavatories for house trailers (1)
Hardwood lumber, industrial brushes (1)
Boats (1)

In Annona, Texas: Louver and screen doors and millwork; in Bagwell, Texas: Pine and hardwood lumber; and in Bogata, Texas: Hardwood lumber.

7. NATURAL RESOURCES AND AREA METAL INDUSTRY

a. Minerals available in four-county area.

(1) The table below shows the value of mineral production for the years 1953-1958 for Bowie, Fannin, Lamar, and Red River Counties, Texas.

TABLE 10

VALUE OF MINERAL PRODUCTION
BOWIE, FANNIN, LAMAR & RED RIVER COUNTIES, TEXAS

County	1953	1957	1958	Minerals Produced in 1958 In Order of Values
	$	$	$	
Bowie	1,309,831	369,399	336,343	Sand, gravel, petroleum, natural gas, natural gas liquids
Fannin	(1)	(1)	(1)	--
Lamar	(1)	34,961	(1)	--
Red River	(1)	45,000	47,400	Petroleum

(1) No value of production reported.

(2) In Bowie County, sand and gravel extractive industries are operating. In 1958, Gifford Hill and Company, Inc., produced sand and gravel for building and paving, ready-mixed concrete, and asphaltic concrete. Oil, gas and natural gas liquids are also produced in the county. Several raw materials of possible commercial value which are located in the county are as follow:

Refractory - Clay and Semirefractory Clay
Limestone
Chalk
Lignite and Brown Coal

(3) During 1958, Fannin County, no value of mineral production was reported. However, limestone and chalk of possible commercial value are available in the county. The limestones have qualities which make them adaptable for structural and building uses.

(4) During 1957, Lamar County reported $34,961 as the value of mineral production. In 1958, no value of mineral production was reported. Limestones having qualities for structural and building purposes are available. Lignite and Brown Coal deposits have been recently discovered in northeastern Lamar County.

(5) During 1958, Red River County reported $47,400 as the value of mineral production. This value was principally from petroleum products. Several raw materials of possible commercial value located in the county are as follow:

Clay - Structural and Building
Clay - Refractory and Ceramic Production
Limestone - Structural and Building

b. Area mineral and metal industry.

(1) Morris and Cass Counties, which lie to the south of Bowie and Red River Counties, have active iron ore mines. In Cass County, Sheffield Steel Division of Armco Steel Corporation mined brown iron ore from open pits.

(2) In Morris County, Lone Star Steel Company completed most of their eight-million-dollar expansion program, which included a sixth open-hearth furnace, a new stretch-reducing mill, and a rod mill. Basic annual still capacity of the Lone Star Works was raised to 800,000 tons. Brown iron ore was mined from open pits near Lone Star, Texas, by Lone Star Steel.

(3) In addition to the iron ore mining, Cass and Morris Counties currently produce petroleum, natural gas, and natural gas liquids.

(4) Of the other Texas counties directly adjacent to the study area, Franklin County produced petroleum, natural gas liquids and natural gas valued at approximately 11.3 million in 1957 and approximately 11.7 million in 1958.

(5) In Delta and Titus Counties, no value of mineral production was reported. Hunt County reported the value of sand, gravel, and petroleum production for the year 1957, as $49,100. The values for the year 1958 were withheld to avoid disclosing individual company data. Collin County reported a value of $107,567 in 1957, with no information as to kind of minerals produced.

(6) Grayson County, which is the bordering county to the east of Fannin County, produced petroleum, natural gas liquids, stone, sand and gravel, and natural gas. The 1957 value was approximately $29.8 million and the 1958 value approximately $23.8 million.

c. Major ground water supplies for the four counties.

(1) The Blossom sand of Late Cretaceous age outcrops in a narrow west-trending belt in Red River, Lamar, and Fannin Counties in northeast Texas. The Blossom sand consists of brown sandy beds, interlaminated with thin clay layers. The formation dips toward

the south and supplies soft, slightly saline water to the City of Clarksville, in Red River County, from wells about 600 feet deep. The analysis of the water from a well reported to be yielding 650 g.p.m. at Clarksville, Texas, indicates 1,030 p.p.m. dissolved solids, with chloride concentration being 326 p.p.m. Similar quantities of saline water could be obtained from this formation in the south-central portion of these counties.

(2) The Nacatoch sand of the Navarro group of Late Cretaceous age outcrops in a narrow belt extending westward across Bowie, Red River, and Lamar Counties, Texas. The formations consist largely of sands and clays. The areas of effective water supply are located in southern Red River and Bowie Counties. The Nacatoch sand furnishes moderate quantities of fresh water to public-supply wells at Bogata in Red River County. Yields of 335 g.p.m. have been reported from the wells in this formation. The City of Talco in Titus County draws slightly saline water from a well tapping the Nacatoch in Red River County. The Nacatoch is known to occur in the subsurface throughout a large area in northeast Texas and is probably capable of yielding quantities of saline water to wells in the area.

(3) The Woodbine sand of Late Cretaceous age is one of the chief aquifers in northeast Texas. In our area of study, the Woodbine outcrops in a narrow belt roughly parallel to the Red River, extending nearly to the Arkansas State line and lying in Fannin, Lamar and Red River Counties, Texas. The majority of the area in the four counties under study in this report have access to a water supply from this source; of course, this does not take into consideration the economics of deep wells needed for water recovery. This formation also outcrops to the west in Grayson, Cooke, Denton, Tarrant, Johnson, Hill, and McLennan Counties, Texas. The formation is a broad wedge of sand and sandy clay which thins southeastward, underlies the surface 120 miles east and west and 150 miles north and south over an area of at least 18,000 square miles. The amounts of chlorides and dissolved solids in the water increase gradually downdip from the northwest to the southeast. A contour interval some 40 miles downdip from the outcrop shows the chloride content of the water to be about 2,500 p.p.m. An objection to the use of Woodbine water is that the fluoride concentration generally exceeds 1.5 p.p.m. Excessive amounts discolor the teeth.

(4) Another source of ground water exists in southern Bowie County, Texas. This is from the Wilcox Group of Eocene age. The water yield varies with the lithology encountered. The dissolved solids concentration in saline water from the Wilcox Group ranges from about 1,000 to nearly 7,000 p.p.m. This concentration increases with the dip.

(5) Considerable amounts of ground water are available in the four counties from the above-mentioned formations. However, if

quality is considered, then, by standards established by the Public Health Service, the majority of the ground water supply must be classed as slightly saline with dissolved solids, ranging from 1,000 to 3,000 parts per million.

d. Quality of surface water supply. Water quality, as reported by the Public Health Service, is suitable for most domestic and industrial use with the exception of a high iron and manganese concentration in the surface water supply than presently indicated.

8. AGRICULTURE

a. Agriculture in the State of Texas. For the State of Texas, the estimated 1960 cash income for farmers and ranchers amounted to $2,209,219,000, down 3.2 percent from 1959. Income from livestock was up 2.7 percent, but this was not enough to offset the 7.6 percent decrease from all crops. Income from all crops in 1960 amounted to $1.2 billion, while income from livestock totaled $1.0 billion. A smaller cotton crop, lower prices, and a shifting marketing pattern in 1960 were all contributing factors to a decreased farm cash income of about 15 percent for the cotton crop. Cotton constituted slightly more than one half of all crop income. Cotton, sorghum grain, and wheat exceeded three quarters of the total value of all principal crops produced in Texas in 1960. Marketings of sorghum grain in 1960 were similar to those of 1959, but about six percent lower prices in 1960 caused farm income from sorghum grain to decrease from $207,479,000 in 1959 to $194,968,000 in 1960. Volume of wheat marketing was much higher in 1960 than 1959, while the price remained about the same. Income from wheat in 1960 was $135,475,000, compared to $106,205,000 in 1959. The larger wheat, sorghum, peanut, and hay crops offset lower production of corn and cotton to help make 1960 a high level year in Texas agriculture. For 1961, the general stability of farm prices, farm cost rates, and farm incomes of 1959 and 1960 may be expected to continue. The price outlook for 1961 does not indicate much change from current levels, although larger marketings of livestock products may help to lower prices later in 1961. Agricultural incomes and trends in Bowie, Fannin, Lamar, and Red River Counties are directly related to the over-all State income in proportion to agricultural production in each county and the magnitude of the operation.

b. Soils in four-county area. Soils in the four-county area have wide variations in texture, structure, permeability, productivity and frequency of flooding. They generally fall into three main groups roughly designated as Blackland Prairie soils, soils of the Middle and Upper Coastal Plains, and soils of the Southern Alluvial Plains. Table 11 shows the representative soil series, great soil groups, profile characteristics, county in which located, and topography for the soils of Bowie, Fannin, Lamar, and Red River Counties.

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TABLE 11

SOILS OF BOWIE, FANNIN, LAMAR, AND RED RIVER COUNTIES

Representative Series	Great Soil Groups	Profile Characteristics	Location & Topography
(a) Miller (b) Yahola (c) Portland	Alluvial	(a) Calcareous - Well-drained clays, (b) Calcareous - Well-drained silt and sandy loams, (c) Slightly Acid to Neutral - Imperfectly drained clay and clay loams.	Arkansas and Red River Valleys. Red River County.
(a) Yahola (b) Miller	Alluvial	Calcareous - Well-drained infrequently flooded sandy loams to clay loams with subsoils of (a) stratified sandy loam and (b) clay.	Stream bottoms of Red River in Rolling Plains. Fannin, Lamar, Red River Counties.
(a) Kantman (b) Trinity	Alluvial	(a) Slightly Acid to Neutral and (b) Calcareous frequently flooded imperfectly to poorly drained clays.	Stream bottoms in Blackland Prairie and Forested Coastal Plain. Fannin, Lamar, Red River, Bowie Counties.
Bowie Boswell Ruston	Red-Yellow Podxolic	Sandy loams, mainly with sandy clay loam subsoils, but some with clay subsoils; all from interbedded Coastal Plains acid sands and clays.	Coastal Plains, Undulating and rolling uplands. Fannin, Lamar, Red River, Bowie Counties.
(a) Lufkin (b) Ivanhoe	Planosols	Silt loams to clay loams with clay pans from alkaline Coastal Plains and alluvial clays.	Coastal Plains, Level to Undulating uplands. Fannin, Red River, Bowie Counties.
Wilson Crockett	Reddish Prairie	Sandy loams to clay loams with clay pen subsoils over weakly Calcareous clays and sandy clays.	Blackland Prairies, Undulating uplands. Fannin, Lamar, Red River Counties.

TABLE 11 (CONT'D)

Representative Series	Great Soil Groups	Profile Characteristics	Location & Topography
Houston Black Hunt	Rendzina	Calcareous and Neutral to slightly acid granular clays with firm clay subsoils over Calcareous clay (Marl) or chalk.	Blackland Prairies, Undulating uplands. Fannin, Red River Counties.
(a) Houston (b) Sumter	Rendzina (b)Lithosol	Strongly Calcareous granular clays over Calcareous clay (Marl); (a) Moderately deep and shallow.	Blackland Prairies, Rolling uplands. Fannin County.

c. Agriculture trends in four-county area. The size and nature of the agricultural economy in each county and for the four-county area is indicated in table 2 as derived from the U. S. Census Data. Several noteworthy items are evident from an examination of table 12.

TABLE 12

AGRICULTURE - BOWIE, FANNIN, LAMAR, AND RED RIVER COUNTIES, TEXAS

Item - County	Yr	Bowie	Fannin	Red River	Lamar	Totals
FARMS, ACREAGE & VALUE						
Farms, Number	59	1,814	2,246	1,446	2,088	7,594
	54	2,440	2,953	2,360	2,529	10,282
Reduction in number of farms due to change in definition 1954 to 1959		347	94	112	155	708
Approx land area:						
Acres	59	589,400	579,840	660,480	579,840	2,409,600
Percent in farm	59	59.6	80.9	64.0	85.6	72.5
Land in farms -						
Acres	59	351,142	469,289	423,589	496,627	1,740,647
	54	375,904	489,816	458,041	471,792	1,795,553

TABLE 12 (CONT'D)

Item - County	Yr:	Bowie	Fannin	Red River:	Lamar	Totals
Avg size of farm - acres	59:	193.6:	208.9:	292.9:	237.8:	233.3
	54:	154.1:	165.9:	194.1:	186.6:	175.2
Value of land & bldgs. avg per farm - $	59:	16,009:	22,464:	17,945:	20,315:	19,183
	54:	9,761:	12,293:	8,991:	13,230:	11,069
avg per acre - $	59:	94.00:	110.80:	71.55:	94.52:	92.72
	54:	63.79:	75.99:	47.20:	77.30:	64.57
Cropland, harvested, acres	59:	40,504:	162,198:	58,074:	115,001:	375,777
	54:	45,380:	198,216:	79,019:	147,744:	470,359
Cropland, used only for pasture, acres	59:	65,304:	42,364:	61,926:	53,145:	222,739
	54:	52,379:	37,820:	50,134:	58,349:	198,682
Cropland, not harvested and not pastured, acres	59:	17,128:	38,292:	16,302:	36,152:	107,874
	54:	10,389:	22,223:	11,990:	24,611:	69,123
Woodland, pastured, acres	59:	101,351:	31,344:	100,754:	74,352:	307,801
	54:	138,731:	44,483:	112,723:	59,289:	335,226
Woodland, not pastured, acres	59:	19,501:	5,054:	16,667:	11,246:	52,468
	54:	14,370:	8,268:	19,829:	8,376:	50,843
Other pasture, acres	59:	96,542:	175,002:	163,376:	191,854:	626,774
	54:	106,601:	156,510:	174,232:	160,354:	597,697
Irrigated land-farms, acres	59:	1,963:	963:	35:	445:	3,406
	54:	1,978:	124:	180:	106:	2,388
Proportion of Tenancy - %	59:	9.7:	29.1:	12.6:	23.3:	18.7
	54:	14.2:	38.5:	24.4:	33.5:	27.6
Tractors on farms, No. (including garden tractor)	59:	1,189:	2,809:	1,114:	2,154:	7,266
	54:	988:	2,924:	1,304:	1,997:	7,213

TABLE 12 (CONT'D)

Item - County	Yr	Bowie	Fannin	Red River	Lamar	Totals
MAJOR FARM EXPENDITURES						
Feed for Livestock & Poultry - $	59	2,256,027	846,233	1,223,114	1,951,190	6,276,564
	54	962,510	850,417	1,167,466	764,871	3,745,264
Purchase of Livestock & Poultry - $	59	1,299,365	663,256	469,270	1,047,600	3,479,941
Machine Hire - $	59	193,839	1,022,998	258,611	663,608	2,139,056
	54	107,363	643,119	161,244	457,151	1,368,877
Hired Labor - $	59	724,022	888,315	489,252	1,154,862	3,256,451
	54	549,516	1,372,868	635,280	1,130,233	3,687,897
Gasoline & Other Petr Fuel & Oil for Farm Business - $	59	381,478	678,611	274,438	544,539	1,879,066
	54	203,522	677,679	282,918	465,827	1,629,946
Seeds, Bulbs, Plants and Trees - $	59	95,931	255,588	31,181	125,795	508,495
LIVESTOCK & POULTRY ON FARMS						
Cattle and Calves - No.	59	48,769	49,154	31,176	62,150	191,249
	54	50,522	49,092	31,801	47,868	179,283
Milk Cows - No.	59	5,429	3,458	1,274	3,540	13,701
	54	6,192	5,929	1,996	5,047	19,164
Hogs & Pigs - No.	59	7,432	8,249	4,502	6,938	27,121
	54	8,135	9,198	5,764	5,402	28,499
Sheep & Lambs - No.	59	611	1,824	2,229	4,726	9,390
	54	370	3,359	631	4,904	9,264
Chickens, 4 Mos Old & Over	59	132,643	66,198	35,550	142,308	376,699
	54	83,357	122,281	67,886	72,679	346,103
LIVESTOCK & POULTRY PRODUCTS SOLD						
Cattle, except calves, sold alive - No.	59	7,996	9,401	4,780	5,833	28,010
	54	5,912	7,093	7,125	4,772	24,902

TABLE 12 (CONT'D)

Item - County	Yr	Bowie	Fannin	Red River	Lamar	Totals
Hogs and pigs sold alive	59	7,572	8,244	4,176	6,565	26,557
	54	6,335	8,115	4,022	4,463	22,935
Sheep & lambs sold alive	59	1,070	2,630	1,531	2,914	8,145
	54	394	2,886	281	2,694	6,255
Chickens sold, including broilers - No.	59	2,243,225	41,642	1,219,314	863,157	4,367,338
	54	251,825	142,829	436,220	137,927	968,801
Milk & cream sold - $	59	1,122,250	555,095	493,280	1,013,775	3,184,000
	54	684,075	448,503	215,782	579,282	1,927,642
Wool shorn - Pounds	59	4,180	10,430	10,576	28,091	53,277
	54	1,629	9,356	1,946	34,536	47,467
Chicken eggs sold - Doz.	59	1,241,329	295,676	175,253	1,156,577	2,868,835
	54	331,244	365,995	166,738	152,497	1,016,474
Turkeys, ducks, geese, misc. poultry & their eggs sold - $	59	4,043	2,120	1,018	3,403	10,584
	54	7,464	7,834	3,818	1,491	20,607

The number of farms in the four-county area decreased from 10,282 in 1954 to 7,504 in 1959, due in part to change in definition of farm size by census bureau which accounted for 708 farms. At the same time, the average size of these farms increased from 175.2 acres in 1954 to 233.3 acres in 1959. Total acreage in farms declined from 1,795,533 acres in 1954 to 1,740,647 acres in 1959. Cropland harvested also decreased from 470,359 acres in 1954 to 375,777 in 1959. In this period the average value of land and buildings per farm increased from $11,069 in 1954 to $19,183 in 1959. Tenancy declined from 27.6 percent average for the four counties in 1954 to only 18.7 percent in 1959. Major farm expenditures increased greatly except for hired labor expense which declined somewhat from 1954 to 1959. The number of milk cows declined from 19,164 in 1954 to 13,701 in 1959, but the value of milk and cream rose from $1,927,642 to $3,184,400 for the same years. There was a large increase in chickens sold, including broilers: 968,801 in 1954, compared to 4,367,338 in 1959. Egg sales in 1959 were 2,868,835 dozens, compared

to 1954 sales of 1,016,474 dozen from farms in the four-county area. The value of farm products sold by counties in 1954 is shown in table 13. The downward trend in cotton production is indicated in table 14 showing bales of cotton ginned in various years from 1916 to 1959. It is anticipated that there will be a continued decrease in numbers and increase in size of farms as mechanization continues to spread and increase. If the anticipated domestic demand for farm products continues to expand in the next 50 years in response to population growth and rising living standards, the agricultural production of the four-county area will be expected to keep pace in milk, meat, poultry products, and vegetables in particular.

TABLE 13

VALUE OF FARM PRODUCTS SOLD IN 1954
(In 1,000 dollars)

County	Total	All Crops	Livestock & Livestock Products	Dairy Products	Poultry & Poultry Products
	$	$	$	$	$
Bowie	3,754	1,535	1,207	684	307
Fannin	8,075	5,789	1,621	449	215
Lamar	6,190	4,104	1,352	579	142
Red River	4,080	2,164	1,327	216	348
Total	22,099	13,592	5,507	1,928	1,012

TABLE 14

BALES OF COTTON GINNED

County	1916	1947	1949	1952	1953	1954	1958
Bowie	26,556	9,113	9,054	4,369	3,304	5,965	6,065 (1)
Fannin	71,369	47,008	55,877	32,054	53,833	23,013	24,928 (1)
Lamar	71,078	40,740	39,954	23,158	29,882	17,511	16,233 (1)
Red River	40,936	18,224	19,200	12,151	14,648	11,451	5,831 (1)
Total	209,939	115,085	124,085	71,732	101,667	57,940	47,226 (1)

(1) Preliminary, 1958, Census of Agriculture.

9. FUTURE GROWTH AND DEVELOPMENT

Any potential flood control project should be analyzed on the basis of the future conditions expected to prevail over the economic life of the project. In making the forecast, care was exercised to insure that developments which might be brought about specifically by the flood control project would not be included. The estimates of damages from future floods are, therefore, on the basis of growth and technological developments which may occur in relation to probable agricultural production which would take place without the project. It is assumed that the agricultural acreage under study in the Sanders, Big Pine, and Collier Creeks flood plains will undergo negligible future development for urban or highway use and therefore will remain predominantly in use for agricultural purposes.

A recent publication entitled "A 50-Year Look Ahead at U. S. Agriculture" by the various research divisions of the United States Department of Agriculture furnished a new insight into the potential agricultural needs of our growing population. This publication furnishes various quantitative forecasts for the nation in the year 2010. Of particular interest is the forecast of crop yields per harvested acre. National percentage increases, based on a 1951-53 average crop yield per harvested acre, are projected for major crops grown. The following tabulations compare the United States Department of Agriculture projected increase in yields above the 1951-53 yields for the year 2010 in the United States and the projected percentage increases in the Sanders and Big Pine Basins for the major crops grown in their respective flood plains.

COMPARISON OF PROJECTED INCREASE OF CROP YIELDS PER HARVESTED ACRE WITH ASSUMED INCREASES FOR THE SANDERS CREEK FLOOD PLAIN ACREAGE

Crops Sanders Creek Flood Plain Acreage	USDA Projected % Increase in Yield By Year 2010 In U. S.	Projection of % Increase in Yield By Year 2010 Sanders Flood Plain
Cotton lint) Cottonseed)	177%	25%
Corn	118%	40%
Oats	30%	10%
Alfalfa	57%	3%
Grain Sorghum	122%	40%
Tillable Pasture	47%	20%
Woods Pasture	-	-

COMPARISON OF PROJECTED INCREASE OF CROP YIELDS
PER HARVESTED ACRE WITH ASSUMED INCREASES
FOR THE BIG PINE CREEK FLOOD PLAIN ACREAGE

Crops Big Pine Creek Flood Plain Acreage	USDA Projected % Increase in Yield By Year 2010 In U. S.	Projection of % Increase in Yield By Year 2010 Big Pine Flood Plain
Corn	118%	40%
Alfalfa	57%	3%
Tillable Pasture	47%	25%
Woods Pasture	-	-

Factors considered in the above analysis are existing conditions of the cropland, flood frequency, present and potential land use, and proximity to urban centers and transportation systems. The cultivated acreage in the Sanders and Big Pine flood plains is small in comparison to total acreage under cultivation in the United States. However, the acreage is generally first-class bottom land, and the production yields per acre would exceed the national average but are reduced by frequent flooding. For these reasons, the forecasts of percentage increases in yields are estimated conservatively to be 22 percent in the year 2010 for the Sanders and 30 percent for the Big Pine on a constant dollar basis. It has been assumed that the increase factor for crops is indicative of a parallel trend in vulnerable physical property development, and this factor has been applied to structural losses prevented to derive the future physical property flood reduction benefits. The estimated 22 and 30 percent respective increases in flood losses prevented at the fiftieth year in the Sanders and Big Pine flood plains are adjusted by application of the straight-line growth curve factor at the rate of 2-5/8 percent interest for a 50-year period. The adjusted average annual equivalent percentage increase for the growth in the Sanders and Big Pine flood plains for the 50-year period amounts to 9 and 12 percent, respectively. Using the same rate of growth for a second 50-year period as discussed above, the increase in yields at the end of 100 years would be 44 and 60 percent for Sanders and Big Pine Creeks, respectively. Applying the straight-line growth factor at 2-5/8 percent interest for a 100-year period, the adjusted average annual equivalent percentage increase becomes 14 percent for Sanders Creek and 19 percent for Big Pine Creek. The future flood reduction benefits based on these percentages for the 100-year period are used for analysis in appendix II.

PERTINENT DATA - BOWIE COUNTY, TEXAS

POPULATION: 59,971 (1960 census) AREA: 921 sq. mi.

GENERAL: In East Texas pine area, in northeast corner of state deriving income from crops and livestock, manufacturing, rail and highway commerce, and large military installations. Established in 1840 and organized in 1841 from Red River County. Named for James Bowie, Alamo hero.

CITIES AND TOWNS: Texarkana, Texas (30,218 population, 1960 census; 24,753 population, 1950 census.) Texarkana, Texas and Texarkana, Arkansas (50,006 population in 1960, and 40,628 population in 1950.) Manufacturing centers, with large paper mill proposed for construction. Texarkana Junior College. Large area of Red River Arsenal, Lone Star Ordnance plants of U. S. Army located 10 miles east of Texarkana. Four modern hospitals. Boston (100 population, 1960 census). Bowie County seat. New Boston (2,773 population, 1960 census). Rural commercial city, centrally located. Hooks (2,048 population, 1960 census), De Kalb (2,042 population, 1960 census), and Wake Village (1,140 population, 1960 census) are other important commercial centers.

CLIMATIC CONDITIONS: Annual rainfall 44.30 inches. Temperature averages: January - 45 degrees; July - 84 degrees; mean annual - 65 degrees. Growing season 234 days.

PHYSIOGRAPHY: Altitude 250-400 feet. Hilly timbered surface with pine on uplands, hardwoods in valleys. Bounded by Red River on the north and Sulphur River on the south.

SOILS: Sandy and clay soils on uplands; rich alluvial soils in bottoms.

MINERALS AND LUMBER RESOURCES: Mineral: Oil (1954) - 25,788 bbls. Lignite and clay available. Lumber: Commerical timber from pine, white oak and gum. More than four million pine seedlings planted in county within recent years.

AGRICULTURAL PRODUCTION: Crops: Cotton (6,065 bales - 1958), corn, alfalfa, grain sorghums, soy beans, sweet potatoes, melons, peaches, strawberries, and peanuts. Some hybrid seed corn and rice being grown. Livestock: Beef cattle raising; also dairying, poultry, hogs. Much activity in pasture improvement.

RAIL TRANSPORTATION: St. Louis Southwestern Railway, Missouri Pacific Railroad, Texas and Pacific Railway and Kansas City Southern Lines.

HIGHWAYS: U. S. Highways 59, 67, 71, 82. State Highways 8, 26, 98. (Proposed Interstate Route 30 of National Defense Highway System). Farm and Ranch Highways 44, 559, 561, 911, 990, 992, 989 and 2253.

AIRPORTS: The Texarkana Municipal Airport is located in Arkansas with a 4,000-foot paved runway. Cranfill Airport has a 2,260-foot turf runway; Macks Airport has a 1,800-foot turf runway.

AIRLINES: Braniff Airways to New Orleans, Oklahoma City and Kansas City. Trans-Texas Airways to Dallas and Memphis.

TRUCK OR MOTOR FREIGHT LINES: Interstate Truck or Motor Freight Lines - from Texarkana, Texas:

Arkansas - Best Freight System, Inc.
East Texas Motor Freight
Strickland Transportation Company
Red Ball Motor Freight
Southwestern Transportation Company
Kansas City Southern Transport
Missouri Pacific Transport Co.
Texas and Pacific Transport Co.
T. G. Hunter Freight Lines

BUS LINES: Local, Texarkana, Texas, Arkansas. 13 vehicles and 54 miles of route. From Texarkana, Texas: Arkansas Trailways, Continental Dixie Lines, Continental Trailways, Crown Coach Company, Jordan Bus Company, Lone River Bus Company, Midwest Trailways, and Southwestern Greyhound Lines.

RADIO AND TV STATIONS: Texarkana - 3 AM stations - CKMC, KOSY, KTFS; 1 FM station - KCMC; 1 TV - KCMC - Ch. 6.

RECREATION AREAS: Small game hunting of duck, quail, dove, squirrel, rabbit and deer in season. Fishing in rivers and lakes. Lake Texarkana on Sulphur River, multiple purpose project. Fishing, water skiing, boating and picnicking facilities available. Annual Events: At Texarkana, Texas - Four State Fair in fall of year.

UTILITIES: Electric: Southwestern Electric Power Company and REA cooperatives. Natural Gas: Lone Star Gas Company and Arkansas-Louisiana Gas Company. Telephone: Southwestern Bell Telephone.

TRADE HOUSING AND COMMERCIAL INFORMATION:

Retail sales (millions of dollars)	$ 53.1	(1958)
	64.5	(1959)
Number of households, Bowie County estimate - 1959	20,100	
Number of households Texarkana, Texas (1960 preliminary census)	10,926	
Bank deposits (1958)	38,017,249	
Net effective buying income (millions of dollars)	82.2	(1958)
	84.9	(1959)
Buying income per household	4,094	(1958)
Buying income per capita	1,210	(1958)
Value of all urban construction in county	2,894,796	(1958)

PERTINENT DATA - FANNIN COUNTY, TEXAS

POPULATION: 23,880 (1960 census) AREA: 906 sq. mi.

GENERAL: Established in 1837 and organized in 1838 from Red River County. Named for James W. Fannin. A farming and livestock county with supplementary income from industry. County is located on the Red River, with three definite soil groups, the southern and major portion being Blackland type of the Central plains, the central portion of county being middle and upper coastal plains and the northern portion being alluvial bottom lands of the Red River.

CITIES AND TOWNS: Bonham (7,357 population, 1960 census; 7,049 - 1950 census), the county seat, is county's principal commercial center with a number of industries and manufacturing plants. Three hospitals plus a U. S. Veterans Hospital. Honey Grove (2,071 population, 1960 census), located in cotton growing area. Has cotton gins, cottonseed oil mill, and compress. Leonard (1,117 population, 1960 census), agricultural center. Ladonia (890 population, 1960 census) and Trenton (712 population, 1960 census) in southeast part and Savoy (493 population, 1960 census) and Ector (519 population, 1960 census) in west are other commercial centers.

CLIMATIC CONDITIONS: Annual rainfall 39.51 inches. Temperature averages, January 43 degrees, July 83 degrees, mean annual temperature 63 degrees. Growing season 227 days.

PHYSIOGRAPHY: Altitude 500 - 700 feet. About three-fourths of county in Blackland prairies with gently rolling surface. Northern fringe in Red River sandy land.

SOILS: Gray loam, sandy and black waxy in south; reddish-brown alluvials in river valley.

MINERALS AND LUMBER RESOURCES: Minerals: Brick clay and limestone deposits; Lumber: Hardwoods, oak and bois d'arc sold commerically. Other timber blackjack, hackberry, hickory, walnut, and pecan. Some experimentation with pine tree growing.

AGRICULTURAL PRODUCTION: Crops: A leading diversified farming and livestock county with 270,000 acres in cropland in 1955. Cotton (24,928 bales - 1958), wheat (396,000 bu. - 1958), corn, peanuts, pecans, clover, alfalfa, prairie hay, oats, rye, watermelons, castor beans, sesame, and truck garden crops. County area has Northeast Texas Land Utilization Project with 17,000 acres in 4-phase program of grazing and soil conservation, reforestation and recreation. Livestock: Small ranches and stock farms devoted to beef cattle. County has Sam Rayburn model Hereford Ranch. Dairying on large scale. Some sheep. Commercial chicken and turkey raising.

RAIL TRANSPORTATION: Texas and Pacific Railway, Santa Fe Railway, Gulf, Colorado, St. Louis-Southwestern Railway, Missouri-Kansas Texas Railway.

HIGHWAYS: U. S. Highway 82. State Highways 34, 78, and 121. Farm and Ranch Highways 64, 68, 79, 100, 271, 273, 814, 816, 824, 896, 1281, 1396, 1550, and 1753.

AIRPORTS: At Bonham, Texas, Jones Field - one 5,000-foot concrete runway. Private Fields: Falks - one 1,900-foot runway. Henington - one 2,200-foot runway.

INTRASTATE AND INTERSTATE TRUCK AND MOTOR FREIGHT LINES: From Bonham, Texas: Texas and Pacific Motor Transport, Central Freight Lines, and Red Ball Motor Freight.

BUS LINES: From Bonham, Texas: Continental Trailways (Dixie) System.

RADIO AND TV STATIONS: At Bonham, one AM radio station KFYN. No local TV station.

RECREATION AREAS: Bonham State Park, with 65-acre lake. Offers swimming, boating, and fishing. Lake Fannin is 16 miles northeast of Bonham and is part of a 15,000-acre conservation program begun several years ago by the U. S. Soil Conservation Service. On the lake are modern individually owned cabins and a large lodge, all built of native logs and stone. Swimming, boating, picnicking, fishing and horseback riding. Lake Davey Crockett, 12 miles north of Honey Grove, and 30 miles northeast of Bonham has 500 acres of good fishing water together with fourteen-room ranch style lodge which offers all hotel conveniences. Lake Coffee Mill has 700 acres of water with bait and boat facilities available.

ANNUAL EVENTS: At Bonham, Texas, Fannin County Fair in September and Annual Rodeo July 27-30.

UTILITIES: Electric: Texas Power and Light Company. Natural Gas: Lone Star Gas Company. Telephone: Southwestern Bell Telephone.

TRADE, HOUSING AND COMMERCIAL INFORMATION:

Retail sales (millions of dollars)	$ 17.7	(1958)
	20.1	(1959)
Number of households (county estimate 1959)	7,100	
Number of households Bonham, Texas (Corps of Engineers estimate October 1960)	2,000	
Bank deposits	15,947,688	(1958)
Net effective buying income (millions of dollars)	26.1	(1958)
	25.1	(1959)
Buying income per household	3,676	(1958)
Buying income per capita	1,130	(1958)

Value all urban construction in county (1958). Not reported.

PERTINENT DATA - LAMAR COUNTY, TEXAS

POPULATION: 34,234 (1960 census) AREA: 906 sq. mi.

GENERAL: Established in 1840 and organized in 1841 from Red River County. Named for Mirabeau B. Lamar, second president of Texas Republic. This industrial and commercial county at the north end of the Blacklands soils belt also has diversified agriculture and the county has a wildlife sanctuary and feeding grounds.

CITIES AND TOWNS: Paris: (20,977 population, 1960 census; 21,643, 1950 census), Lamar County seat. Paris is an attractive, centrally located city, with Paris Junior College, modern hospitals and medical centers, a good park system and many churches. Paris is a manufacturing center which has 61.3 percent of total population in the urban area. There are also five small rural commercial centers with populations less than 1,000. They are Roxton, Brookston, Deport, Arthur City and Blossom.

CLIMATIC CONDITIONS: Annual rainfall 40.30 inches; temperature averages, January 44 degrees, July 83 degrees, mean annual 63.9 degrees; growing season 241 days.

PHYSIOGRAPHY: Altitude 400 - 600 feet. Rolling topography, Blackland Prairie over all of county except southeast corner and fringe along Red River which are in Post Oak Timber Belt.

SOILS: Soils range from red chocolate loam in Red River Valley to rich black loam in the south; some black waxy and gray sandy soils.

MINERALS AND LUMBER RESOURCES: Minerals: Minerals include deposits of brick clay, gravel, shale, and silica sands. Lumber: Oak, ash, post oak, cottonwood, some pine, water oak, elm, bois d'arc.

AGRICULTURAL PRODUCTION: Crops: Cotton (16,233 bales - 1958), hybrid corn, grain, sorghum, wheat, oats, barley, prairie hay, alfalfa, legumes, vetch hay and seed. A variety of truck crops are grown for home use and market, including tomatoes, sweet potatoes, beans, cucumbers, watermelons, peanuts and peaches. A development of 1953-1955 has been the increase in irrigated acreage for truck production with water coming from tributaries and lagoons along Red River. Livestock: Rapid development of the livestock industries in recent years. A leading dairying county with 105 Grade A dairies and more than 300 Grade B milk producers. Large broiler and egg production. Also honey.

RAIL TRANSPORTATION: St. Louis San Francisco Railway (Frisco), Southern Pacific Lines, Gulf, Colorado and Santa Fe Railway (Santa Fe Lines) and Texas and Pacific Railway.

HIGHWAYS: U. S. Highways 82 and 271. State Highway 24. Farm and Ranch Roads 38, 79, 137, 195, 196, 197, 1497, 1498, 1503, and 2352.

AIRPORTS: Cox Field at Paris, has three concrete 4500-foot runways.

AIR LINES SERVICE: Present Central Airlines - To Dallas, Paris, Fort Smith. Proposed Central Airlines - To Paris, Hot Springs.

RADIO AND TV STATIONS: At Paris - two AM radio stations, KFTV and KPLT. No local TV station.

INTRASTATE AND INTERSTATE TRUCK OR MOTOR FREIGHT LINES: From Paris, Texas: Texas and Pacific Transport Company, Southern Pacific Transport, Red Ball Motor Freight, Strickland Motor Freight Company and Paris and Mt. Pleasant Transport.

BUS LINES: From Paris, Texas: Continental Trailways Bus System and Jordan Bus Lines.

RECREATION AREAS: Small game hunting with quail, wild duck, dove, squirrel and rabbit in season. Fishing in Red River, Lake Crook and local farm ponds. Water skiing, boating and picnicking are popular at Lake Crook and Lake Gibbons. Other recreational facilities are available to the public in Paris, Texas, the county's major city.

ANNUAL EVENTS: At Paris, Texas, Red River Valley Exposition in October.

POINTS OF HISTORIC INTEREST: Lafayette and Mount Vernon, former county seats. Site of Fulton's trading post at Fulton Crossing on Red River. George Wright and other homes in Paris.

UTILITIES: Electric: Texas Power and Light Company. Natural Gas: Lone Star Gas Company. Telephone: Southwestern Bell Telephone Company.

TRADE, HOUSING AND COMMERCIAL INFORMATION:

Retail sales (millions of dollars)	$ 34.1	(1958)
Retail sales (millions of dollars)	36.4	(1959)
Number of households (county estimate - 1959)	12,900	
Number of households, Paris, Texas (1960 preliminary census)	7,817	
Bank deposits	21,007,306	(1958)
Net effective buying income (millions of dollars)	48.8	(1958)
Net effective buying income (millions of dollars)	47.8	(1959)
Buying income per household	3,759	(1958)
Buying income per capita	1,128	(1958)
Value of all urban construction in county	2,044,390	(1958)

PERTINENT DATA - RED RIVER COUNTY, TEXAS

POPULATION: 15,682 (1960 census) AREA: 1,033 sq. mi.

GENERAL: A pioneer northeast Texas county established in 1836 and organized in 1837. Crop and livestock raising in the county at the upper end of Blackland and Post Oak belts. Predominantly rural population with economy primarily based on agriculture with supplemental income from industry and trade.

CITIES AND TOWNS: Clarksville (Population 3,851 - 1960 census; 4,353 - 1950 census;) county seat; geographic and commercial center of the county; commercial center of productive farming and livestock-raising area; local manufacturing center; Red River County Hospital. Bogata (Population 1,112 - 1960 census). Serves productive farming area. Location of a regional power plant. Detroit (Population 576 - 1960 census). Commercial center in western part of county.

CLIMATIC CONDITIONS: Altitude 250-500 feet. Annual rainfall 47.92 inches. Mean annual temperature 65 degrees. 234-day growing season.

PHYSIOGRAPHY: Rolling central upland with gentle slope to Red River on the north and Sulphur River on the south. A strip of the cross timbers extends into the northwest part of the county. Along the Red River are alluvial bottom lands. Black lands soils of the coastal plain cover southwestern part of county. The Postoak Belt extends into southeast part of county.

SOILS: Some 39 soil types - black, waxy, gray loams, sandy loams and sands, alluvials.

MINERALS AND LUMBER RESOURCES: Minerals: Brick clay, sand, limestone and some oil production. Lumber: Commerical lumber from pine, oak, gum, ash and bois d'arc.

AGRICULTURAL PRODUCTION: Crops: Recent trend toward increased acreage of legumes and small grains. 40,000 acres of legumes in year 1954-55. Top grade hay crop. Cotton (5,831 bls. - 1958), corn, wheat, sorghum, alfalfa, tomatoes, watermelons, cucumbers, peanuts, castor beans, fruits and pecans. Pasture improvement program and some grass seed production. Livestock: Beef cattle production is a leading pursuit; also swine and sheep raising; dairying; poultry with large broiler production.

RAIL TRANSPORTATION: Texas and Pacific Railway.

HIGHWAYS: U. S. Highways 82 and 271. State Highway 37. Farm and Ranch Roads 44, 114, 195, 410, 411, 909, 911, 2118, 2583.

AIRPORT: At Clarksville, Texas, reports landing strip which will handle two-motor airplanes. (Not indicated on August 1958 aeronautical chart).

INTRASTATE AND INTERSTATE TRUCK AND MOTOR FREIGHT LINES: From Clarksville, Texas: Continental Trailways Bus System.

RADIO AND TV STATIONS: At Clarksville - 1 AM radio station KCAR. No local TV station.

RECREATION AREAS: Small game hunting of quail, wild duck, dove, squirrel and rabbits in season. Fishing in Red River and local farm ponds.

ANNUAL EVENTS: At Clarksville, Texas, Red River County Fair and Livestock Show in September. Andrews Rodeo in June. At Bogata, Annual Bogata Rodeo in June.

UTILITIES: Electric: Texas Power and Light Company. Natural Gas: Lone Star Gas Company. Telephone: Southwestern Bell Telephone Company.

TRADE, HOUSING AND COMMERCIAL INFORMATION:

Retail sales (millions of dollars)	$ 10.1	(1958)
	13.5	(1959)
Number of households (county estimate - 1959)	4,900	
Number of households, Clarksville, Texas, Clarksville Chamber of Commerce	1,800	(1960)
Bank deposits - county	6,833,121	(1958)
Net effective buying income (millions of dollars)	16.8	(1958)
	18.3	(1959)
Buying income per household	3,441	(1958)
Buying income per capita	1,004	(1958)
Value of all urban construction in county	180,200	(1958)

SURVEY REPORT
ON
SANDERS, BIG PINE AND COLLIER CREEKS,
TEXAS

SUPPLEMENT B

INFORMATION CALLED FOR BY
SENATE RESOLUTION 148, 85TH CONGRESS
ADOPTED JANUARY 28, 1958

U. S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

SANDERS, BIG PINE AND COLLIER CREEKS, TEXAS
RED RIVER BASIN

INFORMATION CALLED FOR BY
SENATE RESOLUTION 148, 85TH CONGRESS
ADOPTED JANUARY 28, 1958

1. INTRODUCTION

Preliminary studies were made of three dam sites on Sanders Creek and one site each on Big Pine and Collier Creeks, in the interest of flood control, municipal and industrial purposes, water supply, and other uses. A very preliminary study was made of a water supply pipeline from the Hugo and Boswell Reservoirs to Paris and Clarksville, Texas. Consideration was also given to flood control by levees, channel improvement and stream diversion. An initial plan, consisting of Pat Mayse and Big Pine Reservoirs, was selected for more detailed study.

2. PROJECT DESCRIPTION AND ECONOMIC LIFE

a. General. The plan of improvement for Sanders and Big Pine Creeks consists of a dam and reservoir on each stream for flood control and water supply. No alternate plans were studied.

b. Pat Mayse Reservoir. The dam would be located 4.4 miles above the mouth of Sanders Creek, a tributary of Red River, and about 12 miles north of Paris, Texas. The proposed project consists of an earthfill embankment with a total length of 7,010 feet and a maximum height of 92 feet above the streambed. The uncontrolled spillway would be 200 feet wide and would be located in the right abutment. The flood control outlet works consists of a 5.5-foot-diameter conduit and drop inlet located near the center of the embankment. The total capacity of the reservoir would be 200,800 acre-feet, of which 91,600 acre-feet are for flood control, 101,700 acre-feet for water conservation, and 7,500 acre-feet for sediment reserve. Pertinent data are shown in table 1.

c. Big Pine Reservoir. The dam would be located 13.2 miles above the mouth of Big Pine Creek, a tributary of Red River, and about 22 miles northwest of Clarksville, Texas. The proposed project consists of an earthfill embankment with a total length of 5,390 feet and a maximum height of 77 feet above the streambed. The uncontrolled spillway would be 200 feet wide and would be located in the right abutment. The flood control outlet works consist of a 4-foot-diameter conduit and drop inlet located near the right abutment. The total capacity of the reservoir would be 138,600 acre-feet, of which 53,600 acre-feet are for flood control, 80,400 acre-feet for water conservation, and 4,600 acre-feet for sediment reserve. Pertinent data are shown in table 1.

TABLE 1

PHYSICAL FEATURES AND ENGINEERING DATA
PAT MAYSE AND BIG PINE RESERVOIRS

Feature	Reservoir	
	Pat Mayse	Big Pine
Stream	Sanders Creek	Big Pine Creek
Miles above mouth	4.4	13.2
Drainage area, square miles	175	95
Purposes	Flood Control, Water Supply, Recreation & Fish & Wildlife	
General elevations, ft, msl:		
Top of dam	487.0	451.0
Top of flood control pool	462.0	430.0
Top of conservation pool	448.0	420.0
Reservoir area, acres:		
Top of flood control pool	7,950	6,400
Top of conservation pool	5,450	4,640
Reservoir storage, acre-feet:		
Flood control	91,600	53,600
Water supply	99,700	79,300
Sediment	7,500	4,600
Inactive	2,000	1,100
Total	200,800	138,600
Dam:		
Type	Earthfill	Earthfill
Gross length, ft	7,010	5,390
Maximum height, ft	92	77
Crown width, ft	28	28
Spillway:	Right abutment	Right abutment
Type	Uncontrolled	Uncontrolled
Width	200	200
Crest elevation, feet, msl	462.0	430.0
Capacity at maximum pool, cfs	55,400	41,400
Outlet works:		
Flood control	5.5' drop inlet	4' drop inlet
Low flow	36" pipe	24" pipe
Water supply	1-42" pipe	1-30" pipe
Channel capacity at dam site, cfs:		
Existing	500	300
Rectified	1,300	800
Water supply yield, mgd	55	26

d. Economic life. The sediment storage allowances included in the reservoirs are designed to be filled in 50 years, so that at the end of that time the storage of sediment would be encroaching on the conservation and flood control pools. Since 50 years' sedimentation is only about 3.7 and 3.3 percent of the capacity of the Pat Mayse and Big Pine Reservoirs, respectively, it is apparent that the economic lives of the projects are far in excess of 100 years.

3. PROJECT COSTS

a. Estimates of first costs are based on average bid prices for similar work in the same general area, adjusted to 1960 price levels. All estimates include allowances for contingencies and costs for engineering and overhead. The investment includes the project first cost, plus interest during construction for one-half of the construction period.

b. Annual charges given in the report are based on annual interest rates of 2-5/8 percent for Federal costs, with amortization of the project costs distributed over a 100-year period. Allowances for maintenance and operation and major replacement costs are based on past experience for similar projects.

c. Table 2 shows a comparison of the annual charges and benefits for the recommended projects, based on 50- and 100-year periods of analysis.

4. BENEFIT-COST RATIOS

The benefit-cost ratios, calculated by using tangible benefits and costs for 50- and 100-year periods, are shown in table 2.

TABLE 2

RECOMMENDED PLAN
COMPARISON OF ANNUAL CHARGES AND BENEFITS
BASED ON 50- AND 100-YEAR ECONOMIC PERIODS OF ANALYSIS

Item	Project First Cost	Annual Charges	Annual Benefits	Benefit-Cost Ratios
Pat Mayse Reservoir:				
50- year	7,590,000	361,000	487,900	1.4
100- year	7,590,000	301,000	490,400	1.6
Big Pine Reservoir:				
50- year	8,590,000	387,000	502,200	1.3
100- year	8,590,000	319,000	506,200	1.6

5. INTANGIBLE PROJECT EFFECTS

Intangible benefits are those benefits which are difficult to evaluate, or for which no satisfactory method of evaluation has been established. Construction of Pat Mayse and Big Pine Dams would relieve the anxiety of the flood-plain residents downstream from the reservoirs by reducing the dangers accompanying floods and the threat of epidemics which follows. Other intangible benefits include: reduction of pollution of water supplies; elimination of interruption of normal transportation services which often causes appreciable loss from delayed shipment of livestock, perishable fruits and vegetables and seasonal merchandise; and reduction of interruptions to the normal social processes of the valley. While these unevaluated intangible benefits and other benefits (such as the increase in value of non-Federal recreational developments) are not utilized in the computation of the benefit-cost ratio, it is apparent that they add to the desirability of the project and provide a better economic climate for the orderly development of the valley.

6. PHYSICAL FEASIBILITY AND COST OF PROVIDING FOR FUTURE NEEDS

Because of the limited supply of ground water in the area, surface water storage must be depended on for water supplies. Irrigation is not practiced to any large extent in the region. On the average, there is ample surface water of satisfactory quality. However, because of extreme variation in flow, stream regulation is essential to assure a dependable water supply to meet present needs, as well as those estimated for the future. Future power needs in the region will be supplied from thermal units. The Public Health Service found there is need for additional municipal and industrial water supplies of 26 mgd in the Sanders Creek area, and existing sources in the Big Pine area could be expanded to meet future needs of that area. In keeping with the requests of the Cities of Paris and Clarksville, Texas, storage with firm yields of 55 and 26 mgd are included in Pat Mayse and in Big Pine Reservoirs, respectively. The allocated first cost for the water supply storage in the Pat Mayse Reservoir is $3,388,000 (1960) and $4,150,000 (1960) for Big Pine Creek Reservoir, based on the separable costs-remaining benefits method of cost allocation for a 100-year period of analysis.

7. ALLOCATION OF COST

Cost allocations for Pat Mayse and Big Pine Reservoirs, based on the separable costs-remaining benefits, priority of use, and incremental cost methods, are presented in tables 3, 4 and 5.

TABLE 3

FIRST COST, ANNUAL CHARGES AND BENEFITS
ALLOCATED BY SEPARABLE COST-REMAINING BENEFIT METHOD
(In Thousands of Dollars)

Project and Item	50-Year Period of Analysis					100-Year Period of Analysis				
	Flood Control	Water Supply	Recreation	Fish & Wldlf	Total	Flood Control	Water Supply	Recreation	Fish & Wldlf	Total
	$	$	$	$	$	$	$	$	$	$
Pat Mayse Reservoir:										
First cost	1,676.0	3,335.0	1,127.0	1,452.0	7,590.0	1,823.0	3,388.0	1,054.0	1,325.0	7,590.0
Investment	1,720.0	3,422.0	1,152.0	1,487.0	7,781.0	1,871.0	3,477.0	1,076.0	1,357.0	7,781.0
Annual charges:										
Interest and amortization	62.1	123.6	41.6	53.7	281.0	53.2	98.9	30.6	38.6	221.3
Operation and maintenance	21.0	21.6	18.6	17.6	78.8	22.2	22.1	17.9	16.6	78.8
Major replacements	0.3	0.6	0.1	0.2	1.2	0.3	0.4	0.1	0.1	0.9
Total annual charges	83.4	145.8	60.3	71.5	361.0	75.7	121.4	48.6	55.3	301.0
Annual benefits	88.6	189.4	92.5	117.4	487.9	91.1	189.4	92.5	117.4	490.4
Benefit-cost ratio	1.1	1.3	1.5	1.6	1.4	1.2	1.6	1.9	2.1	1.6

TABLE 3 (Contd)

Project and Item	50-Year Period of Analysis					100-Year Period of Analysis				
	Flood Control	Water Supply	Rec-rea-tion	Fish & Wldlf	Total	Flood Control	Water Supply	Rec-rea-tion	Fish & Wldlf	Total
	$	$	$	$	$	$	$	$	$	$
Big Pine Reservoir:										
First cost	2,093.0	4,121.0	999.0	1,377.0	8,590.0	2,269.0	4,150.0	925.0	1,246.0	8,590.0
Investment	2,148.0	4,229.0	1,020.0	1,410.0	8,807.0	2,329.0	4,259.0	944.0	1,275.0	8,807.0
Annual charges:										
Interest and amortization	77.5	152.6	36.8	50.9	317.8	66.1	120.9	26.8	36.2	250.0
Operation and maintenance	18.0	19.9	15.0	15.4	68.3	19.3	20.3	14.4	14.3	68.3
Major replacements	0.2	0.4	0.1	0.2	0.9	0.2	0.3	0.1	0.1	0.7
Total annual charges	95.7	172.9	51.9	66.5	387.0	85.6	141.5	41.3	50.6	319.0
Annual benefits	105.0	220.0	75.0	102.2	502.2	109.0	220.0	75.0	102.2	506.2
Benefit-cost ratio	1.1	1.3	1.4	1.5	1.3	1.3	1.6	1.8	2.0	1.6

TABLE 4

FIRST COSTS, ANNUAL CHARGES AND BENEFITS
ALLOCATED BY PRIORITY OF USE METHOD
(In Thousands of Dollars)

Project and Item	50-Year Period of Analysis					100-Year Period of Analysis				
	Flood Control	Water Supply	Rec-rea-tion	Fish & Wldlf	Total	Flood Control	Water Supply	Rec-rea-tion	Fish & Wldlf	Total
	$	$	$	$	$	$	$	$	$	$
Pat Mayse Reservoir										
First cost	1,800.0	1,754.0	1,448.0	2,588.0	7,590.0	2,278.0	662.0	1,481.0	3,169.0	7,590.0
Investment	1,847.0	1,800.0	1,481.0	2,653.0	7,781.0	2,338.0	679.0	1,515.0	3,249.0	7,781.0
Annual charges: (1)										
Interest and amortization	66.7	65.0	53.5	95.8	281.0	66.5	19.3	43.1	92.4	221.3
Operation and maintenance	21.4	17.7	18.4	21.3	78.8	24.2	11.3	18.6	24.7	78.8
Major replacements	0.5	0.3	0.1	0.3	1.2	0.4	0.1	0.1	0.3	0.9
Total annual charges	88.6	83.0	72.0	117.4	361.0	91.1	30.7	61.8	117.4	301.0
Annual benefits	88.6	189.4	92.5	117.4	487.9	91.1	189.4	92.5	117.4	490.4
Benefit-cost ratio	1.00	2.3	1.3	1.00	1.4	1.00	6.2	1.5	1.00	1.6

TABLE 4 (Contd)

Project and Item	50-Year Period of Analysis					100-Year Period of Analysis				
	Flood Control	Water Supply	Rec-reation	Fish & Wldlf	Total	Flood Control	Water Supply	Rec-reation	Fish & Wldlf	Total
	$	$	$	$	$	$	$	$	$	$
Big Pine Reservoir										
First cost	2,276.0	2,395.0	1,583.0	2,336.0	8,590.0	2,935.0	1,157.0	1,614.0	2,884.0	8,590.0
Investment	2,336.0	2,458.0	1,619.0	2,394.0	8,807.0	3,012.0	1,187.0	1,652.0	2,956.0	8,807.0
Annual charges: (1)										
Interest and amortization	84.3	88.7	58.4	86.4	317.8	85.5	33.7	46.9	83.9	250.0
Operation and maintenance	20.3	17.2	15.1	15.7	68.3	23.3	11.7	15.2	18.1	68.3
Major replacements	0.4	0.3	0.1	0.1	0.9	0.2	0.2	0.1	0.2	0.7
Total annual charges	105.0	106.2	73.6	102.2	387.0	109.0	45.6	62.2	102.2	319.0
Annual benefits	105.0	220.0	75.0	102.2	502.2	109.0	220.0	75.0	102.2	506.2
Benefit-cost ratio	1.00	2.1	1.02	1.00	1.3	1.00	4.8	1.2	1.00	1.6

(1) Annual cost (excluding specific cost) assigned to recreation limited to 15 percent of total annual cost of project.

TABLE 5

FIRST COST ANNUAL CHARGES AND BENEFITS
ALLOCATED BY INCREMENTAL COST METHOD
(In Thousands of Dollars)

Project and Item	50-Year Period of Analysis					100-Year Period of Analysis				
	Flood Control	Water Supply	Rec-rea-tion	Fish & Wldlf	Total	Flood Control	Water Supply	Rec-rea-tion	Fish & Wldlf	Total
	$	$	$	$	$	$	$	$	$	$
Pat Mayse Reservoir:										
First cost	5,212.0	2,063.0	194.0	121.0	7,590.0	5,206.0	2,069.0	194.0	121.0	7,590.0
Investment	5,349.0	2,117.0	194.0	121.0	7,781.0	5,343.0	2,123.0	194.0	121.0	7,781.0
Annual charges:										
Interest and amortization	193.3	76.5	6.9	4.3	281.0	151.8	60.3	5.7	3.5	221.3
Operation and maintenance	49.6	11.4	11.0	6.8	78.8	49.6	11.4	11.0	6.8	78.8
Major replacements	0.8	0.4	-	-	1.2	0.6	0.3	-	-	0.9
Total annual charges	243.7	88.3	17.9	11.1	361.0	202.0	72.0	16.7	10.3	301.0
Annual benefits	88.6	189.4	92.5	117.4	487.9	91.1	189.4	92.5	117.4	490.4
Benefit-cost ratio	0.4	2.1	5.2	10.6	1.4	0.5	2.6	5.5	11.4	1.6

TABLE 5 (Contd)

Project and Item	50-Year Period of Analysis					100-Year Period of Analysis				
	Flood Control	Water Supply	Rec-reation	Fish & Wldlf	Total	Flood Control	Water Supply	Rec-reation	Fish & Wldlf	Total
	$	$	$	$	$	$	$	$	$	$
Big Pine Reservoir:										
First cost	5,810.0	2,467.0	188.0	125.0	8,590.0	5,823.0	2,454.0	188.0	125.0	8,590.0
Investment	5,962.0	2,532.0	188.0	125.0	8,807.0	5,976.0	2,518.0	188.0	125.0	8,807.0
Annual charges:										
Interest and amortization	215.2	91.4	6.7	4.5	317.8	169.4	71.4	5.5	3.7	250.0
Operation and maintenance	46.1	7.4	8.9	5.9	68.3	46.1	7.4	8.9	5.9	68.3
Major replacements	0.7	0.2	-	-	0.9	0.5	0.2	-	-	0.7
Total annual charges	262.0	99.0	15.6	10.4	387.0	216.0	79.0	14.4	9.6	319.0
Annual benefits	105.0	220.0	75.0	102.2	502.2	109.0	220.0	75.0	102.2	506.2
Benefit-cost ratio	0.4	2.2	4.8	9.8	1.3	0.5	2.8	5.2	10.6	1.6

8. EXTENT OF INTEREST IN PROJECT

Testimony at public hearings held at Paris, Texas, on December 9, 1957, and at Clarksville, Texas, on December 10, 1957, indicated local interests desire the development of a reservoir on Sanders, Big Pine and Collier Creeks for flood control and conservation storage. Interest was also expressed in the potential recreational, waterfowl and fishery management aspects of reservoirs in the locality. At the hearing, a number of cities expressed interest in obtaining water supplies and the Cities of Paris and Clarksville, Texas, have furnished formal assurances of intent for sponsorship of water supply capacity in the Pat Mayse and Big Pine Reservoirs, respectively.

9. REPAYMENT SCHEDULES

The costs allocated to water supply are reimbursable to the United States. These costs include construction, operation and maintenance, replacement, and interest costs. Local interests will be given the option of: (1) paying the costs allocated to water supply in a lump sum, plus annual payments for operation and maintenance costs and for payment of replacement costs when incurred; or (2) for annual payments for the construction costs, including interest during construction and interest on the unpaid balance, plus annual payments for operation and maintenance costs and payment of replacement costs when incurred. In accordance with the provisions of the Water Supply Act of 1958, as amended by Section 10 of Public Law 87-88, local interests will be required to arrange for repayment of the allocated water supply costs in excess of 30 percent of the total project cost, beginning on completion of construction. Repayment of the remaining water supply costs may be deferred until such time as storage is needed for future water supply. The entire amount of the construction costs (including interest during construction) for water supply storage contracted for shall be repaid within the life of the project, but in no event, to exceed 50 years after the date on which such storage is first used for water supply purposes. When one user contracts for both immediate and future water supply, different repayment periods may apply to each portion contracted for. No interest will be charged on costs allocated to future water supply until use of the storage is initiated, but such interest-free period shall not exceed 10 years from the time the project is completed. The repayment requirements are subject to modification in conformity with any amendments to the Water Supply Act of 1958, which may be in effect at time of repayment negotiations.

10. EFFECT OF PROJECT ON STATE AND LOCAL GOVERNMENTS

a. The construction of Pat Mayse and Big Pine Dams should not result in any increased cost in State and local government services.

b. The loss of local and State taxes on lands which would be inundated was not computed, since the increased taxes from private

development and use of the reservoir areas for recreational purposes would provide new privately-financed facilities and new tax revenues that should more than offset the loss in taxes from the inundation of the reservoir lands.

11. ALTERNATE PLANS

Other means of flood control, such as levees, channel improvement and stream diversion were considered on a reconnaissance basis. Specific studies of such plans were not made, since the development of a reservoir in accordance with desires of local interests is more adaptable to the needs of the area. Very preliminary studies of an alternate plan of obtaining water supply by pipeline from the Boswell and Hugo Reservoirs were made. The pipe sizes and pumping requirements used in the estimate were based on supplying 81 mgd, of which 55 mgd would be for Paris, Texas (in lieu of Pat Mayse Reservoir) and 26 mgd for Clarksville, Texas (in lieu of Big Pine Reservoir). As the cost of obtaining water from Hugo and Boswell Reservoirs is indicated to be about four times higher than the cost of water supply in Pat Mayse and Big Pine Reservoirs, no detailed cost estimates were made of the alternate plan.