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WALLISVILLE RESERVOIR, TRINITY RIVER, TEXAS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED APRIL 18, 1961, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON AN INTERIM REPORT ON WALLISVILLE RESERVOIR, TRINITY RIVER, TEXAS, REQUESTED BY RESOLUTIONS OF THE COMMITTEE ON RIVERS AND HARBORS, HOUSE OF REPRESENTATIVES, AND THE COMMITTEE ON PUBLIC WORKS, UNITED STATES SENATE, ADOPTED MARCH 31, 1944, FEBRUARY 28, 1945, AND JANUARY 20, 1958, RESPECTIVELY. IT IS ALSO IN PARTIAL RESPONSE TO THE RIVER AND HARBOR ACT APPROVED JULY 3, 1958, WHICH AUTHORIZED A SURVEY OF TRINITY RIVER, TEXAS.

JULY 24, 1961.—Referred to the Committee on Public Works and ordered to be printed with two illustrations.

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1961

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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C.

July 14, 1961

Honorable Sam Rayburn

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 18 April 1961, from the Acting Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on an interim report on Wallisville Reservoir, Trinity River, Texas, requested by resolutions of the Committee on Rivers and Harbors, House of Representatives, and the Committee on Public Works, United States Senate, adopted 31 March 1944, 28 February 1945, and 20 January 1958, respectively. It is also in partial response to the River and Harbor Act approved 3 July 1958, which authorized a survey of Trinity River, Texas.

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

The Bureau of the Budget states that standards for appraising the feasibility of water resources projects are currently under review at the request of the President. If the Wallisville Reservoir project is authorized by the Congress, the Bureau would expect that, prior to a request for funds to initiate construction of the project, the Corps of Engineers would reallocate the costs of the project to the extent necessary to conform to the water resources evaluation standards adopted by the administration.

The Bureau of the Budget also advises that there is no objection to the submission of the report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed

by the President's budgetary objectives as determined by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

Elvis J. Stahr, jr.

Elvis J. Stahr, jr.
Secretary of the Army

1 Incl
Rept w/accompg
papers & illus

COMMENTS OF THE BUREAU OF THE BUDGET

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

July 5, 1961

The Honorable
The Secretary of the Army

My dear Mr. Secretary:

Assistant Secretary Schaub's letter of May 3, 1961, submitted the proposed report of the Chief of Engineers on Wallisville Reservoir, Trinity River, Texas.

The Chief of Engineers recommends construction of a multiple-purpose dam and reservoir and appurtenant works near Wallisville, Texas, for salinity control, navigation, water supply, recreation, and fish and wildlife. The dam would have an overflow section with crest 4 feet above mean sea level and would be located at mile 3.9 on the Trinity River. The project is estimated to cost $9,162,000 for construction and $156,000 annually for maintenance and operation. All costs allocated to water supply and 50 percent of the cost allocated to salinity control are to be reimbursed by local interests. The Chief of Engineers also recommends that the proposed Wallisville Project incorporate the existing Federal projects designated as "Anahuac Channel, Texas", and "Mouth of Trinity River, Texas." The benefit-cost ratio for the combined project is stated to be 2.5.

It is noted that about $2.8 million, or 30 percent of the cost of the project, is tentatively allocated to recreation, including sports fishing and hunting, although the specific costs of recreational facilities are estimated to be only $399,100. As you are aware, standards for appraising the feasibility of water resources projects are currently under review at the request of the President. If the Wallisville Reservoir project is authorized by the Congress, we would expect that, prior to a request for funds to initiate construction of the project, the Corps of Engineers would reallocate the costs of the project to the extent necessary to conform to the water resources evaluation standards adopted by the administration.

I am authorized by the Director of the Bureau of the Budget to advise you that there would be nc objection to the submission of the report to the Congress. However, no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Sincerely yours,

Carl H. Schwartz, Jr., Chief
Resources and Civil Works Division

COMMENTS OF THE GOVERNOR OF TEXAS

EXECUTIVE DEPARTMENT
AUSTIN 11, TEXAS

PRICE DANIEL
GOVERNOR

June 10, 1960

AIRMAIL

Lt. Gen. E. C. Itschner
Chief of Army Engineers
U. S. Department of the Army
Washington 25, D. C.

Dear General Itschner:

This has further reference to your letter transmitting a copy of your proposed report on Wallisville Reservoir, Trinity River and Tributaries, Texas, and supplements my telegram of this date.

At my request, the Texas Board of Water Engineers reviewed this report pursuant to State law. Based on the Board's Order as evidenced by a certified copy hereto attached, I hereby advise that the project has been approved as to its feasibility, and I concur in the Board's findings.

Kindest personal regards.

Sincerely yours,

Price Daniel

Enclosure

BOARD OF WATER ENGINEERS

AN ORDER approving the feasibility of the United States Army Corps of Engineers Trinity River and Tributaries, Texas (Wallisville Reservoir), Project.

BE IT ORDERED BY THE BOARD OF WATER ENGINEERS OF THE STATE OF TEXAS:

Section 1. Statement of Authority. Article 7472e, Vernon's Annotated Civil Statutes of Texas, provides that upon receipt of any engineering report submitted by a Federal Agency seeking the Governor's approval of a Federal Project, the Board of Water Engineers shall study and make recommendations to the Governor as to the feasibility of the Federal Project. The Board 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 June 1, 1960, the Honorable Price Daniel, Governor of Texas, requested the Board of Water Engineers to review the report of the Chief of Engineers, United States Army, covering the Trinity River and Tributaries, Texas (Wallisville Reservoir), Project, entitled Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir), and to enter its order finding said project to be feasible or not feasible. (b) In accordance with Article 7472e, the Board caused a public hearing, after due notice by publication, to be held on June 10, 1960, at 10:00 o'clock a.m., in the

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offices of the Board of Water Engineers, 201 East 14th Street, Austin, Texas, on the Trinity River and Tributaries, Texas (Wallisville Reservoir), Project, and at which time all those interested or who may be affected should the project be initiated and completed were requested to come forward and give testimony.

Section 3. After fully considering all the evidence and exhibits presented by persons and groups who may be affected should the Federal Project be initiated and completed, including the matters set forth in Section 4 of Article 7472e, the Board finds that the project identified as Plan C in said Interim Review as recommended by the District Engineer, U. S. Army Engineer District, Galveston, Corps of Engineers, and concurred in by the Division Engineer, U. S. Army Engineer Division Southwestern, insofar as said Interim Review relates to providing for a multiple-purpose reservoir development at Wallisville, Texas, providing for salinity control, navigation, water conservation, fish and wildlife, and recreation, is feasible and that the public interest will be served thereby.

Section 4. That portion of said Interim Review dealing with recommendations by the District Engineer relating to the acquisition of 6,725 acres of land lying outside the area of the proposed Wallisville Reservoir for use by the Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, United States Department of the Interior, for a national wildlife refuge in connection with the multiple-purpose Wallisville Reservoir is considered to be outside the jurisdiction of the Board of Water Engineers and was not considered in determining the feasibility of the project described in Section 3 above.

Section 5. It is further ordered that a certified copy of this Order be transmitted to the Governor.

Section 6. This Order shall take effect and be in force on and after the 10th of June, 1960, the date of its passage, and it is so ordered.

SIGNED IN THE PRESENCE OF THE
BOARD OF WATER ENGINEERS

O.F. DENT Acting Chairman

ATTEST:

Ben F. Looney, Jr., Secretary

I certify that the foregoing order was adopted by the Board of Water Engineers of the State of Texas at a meeting held on the 10th day of June, 1960, upon motion of Member Dixon, Member Dent and Member Dixon voting aye, Member Manford being absent and excused.

Ben F. Looney, Jr., Secretary

STATE OF TEXAS
COUNTY OF TRAVIS

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

Given under my Hand and the Seal of the Board of Water Engineers of the State of Texas, this the 10 day of June, A.D. 1960.

Ben F. Looney, Jr., Secretary

LETTER TO THE GOVERNOR OF TEXAS

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

ENGCW-P 21 June 1960

Honorable Price Daniel
Governor of Texas
Austin, Texas

Dear Governor Daniel:

Reference is made to our letter dated 3 June 1960 inclosing for your review and comment an interim report on Trinity River and Tributaries, Texas, (Wallisville Reservoir) and to your letter reply dated 10 June 1960, inclosing an Order by the Board of Water Engineers of the State of Texas. Your letter points out that you approve the feasibility of the Wallisville Reservoir project and concur in the findings of the Board of Water Engineers.

It is noted in Section 4 of the Board's Order that the report recommendations relating to the acquisition of 6,725 acres of additional land lying outside the reservoir area for use as a National Wildlife Refuge in connection with the multiple-purpose reservoir are considered to be outside the jurisdiction of the Board and were not considered in determining the feasibility of the project. Accordingly, your letter of 10 June would be construed to constitute approval of the feasibility of the proposed reservoir project but would not necessarily indicate approval and concurrence in all of the report recommendations, particularly those pertaining to the acquisition of additional land for a National Wildlife Refuge.

In order that the report processing will not be delayed we would appreciate your further consideration and comment on the matter as soon as possible.

Sincerely yours,

/S/ E. C. ITSCHNER

E. C. ITSCHNER
Lieutenant General, USA
Chief of Engineers

EXECUTIVE DEPARTMENT
AUSTIN 11, TEXAS

PRICE DANIEL
GOVERNOR

August 12, 1960

Lt. Gen. E. C. Itschner
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Itschner:

This will acknowledge your letter of June 21 requesting my further consideration and comment on your interim report on Trinity River and Tributaries, Texas (Wallisville Reservoir).

You are correct in stating that my letter of June 10 transmitting the Order issued by the Texas Board of Water Engineers constituted general approval of the reservoir project but should not be construed to indicate approval of the acquisition of additional land for a national wildlife refuge. I believe the project is fully justified without the inclusion of high land for a wildlife refuge, which was not in the original proposals of the Trinity River Authority and the City of Houston. This small part of the plan is only incidental and unnecessary to the principal purposes of salinity control, navigation, and water conservation.

In order not to delay authorization, however, I recommend that the proposed report be transmitted to Congress for consideration. The State of Texas will interpose no objection to inclusion of the wildlife refuge at this time but reserves its right to request that this phase of the project be later changed or eliminated.

Sincerely yours,

Price Daniel

COMMENTS OF THE GOVERNOR OF TEXAS

TELEGRAM

15 June 1961

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MAJOR GENERAL KEITH R BARNEY, ACTING CHIEF OF ENGINEERS

U S ARMY CORPS OF ENGINEERS WASHDC

AS INDICATED BY MY REPLY OF MAY 2Ø TO YOUR LETTER OF MAY 9 ON WALLISVILLE RESERVOIR, TRINITY RIVER, TEXAS, I UNDERSTOOD THAT YOUR LETTER WAS FOR INFORMATION ONLY BUT IF COMMENT IS DESIRED, PLEASE BE ADVISED THAT PROPOSED REPORT MEETS WITH MY APPROVAL.

PRICE DANIEL GOVERNOR OF TEXAS.

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

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

June 30, 1960

Lieutenant General E. C. Itschner
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Itschner:

This is in reply to your letter of June 3 transmitting for our comments your proposed report, together with the reports of the Board of Engineers for Rivers and Harbors, and of the District and Division Engineers, on an interim report on Wallisville Reservoir, Trinity River, Texas.

The proposed development would not adversely affect any existing or authorized Bureau of Reclamation projects. The Bureau's plans for a coastal canal to carry surplus waters from eastern Texas basins to water-deficient areas to the westward as a part of the Bureau's Texas Basins Project are recognized, and it is indicated that the usefulness of the Wallisville Reservoir in connection with the Texas Basin Project will be considered further during the pre-construction planning phase. The Bureau will be glad to cooperate with the Corps of Engineers in accomplishing the necessary planning work prior to construction of the reservoir.

The U. S. Fish and Wildlife Service is pleased that its recommendations for inclusion of features for the conservation and development of fish and wildlife resources have been accepted. The Service recognizes that the proposed reservoir operation for waterfowl management could not be assured. However, the Service is gratified that the District Engineer considers the recommended operation generally feasible.

The opportunity of commenting on your report is appreciated.

Sincerely yours,

Fred H. Randall

Assistant Secretary of the Interior

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
WASHINGTON 25, D. C.

ADDRESS ONLY THE DIRECTOR,
BUREAU OF SPORT FISHERIES
AND WILDLIFE

February 3, 1961

Lt. Gen. E. C. Itschner
Chief of Engineers
Corps of Engineers
Department of the Army
Washington 25, D. C.

Dear General Itschner:

We have reviewed the testimony presented at the public hearing on the Wallisville Reservoir Project, Texas, held at Liberty, Texas, on December 16 and 17. In spite of the opposition to our proposal for a national wildlife refuge which was expressed at that meeting, we request that this proposal be made a part of your report and presented to the Congress for final decision as to whether it should be authorized. We shall be prepared to testify in behalf of the proposal if that is necessary. We request that you include our proposal for a refuge in your report. However, we now propose to reduce the amount of additional land requested by as much as two or three thousand acres. Particular attention will be given to excluding the more highly developed land of most concern to the local people. A supplement to our report of March 29, 1960, which will outline our latest thinking on this subject, will be provided to your District Engineer, Galveston, by our Regional Office in Albuquerque as soon as possible.

Our decision to continue to support establishment of a national wildlife refuge at the Wallisville Project was based primarily on the critical need for a refuge and feeding area in this section of Texas, particularly as a part of the overall management program for such waterfowl species as canvasback and red head ducks which are in short supply nationally. There are other cogent reasons for establishment of a refuge in this area, all of which can be presented in testimony before the Congress.

We are advising our Regional Office in Albuquerque of the above decision, and they in turn will notify your District Engineer in Galveston.

Sincerely yours,

Director

72814 O-61—2

DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D. C.

January 19, 1961

The Honorable
The Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Acting Chief of Engineers' letter of June 3, 1960, transmitting for our review and comment his proposed interim review survey report on the Trinity River and Tributaries, Texas, with respect to the Wallisville Reservoir.

The report recommends modification of the existing project for the Trinity River and Tributaries to provide for the construction of a multiple-purpose dam and reservoir at Wallisville. The proposed dam and reservoir will provide for salinity control, navigation, water supply, fresh-water fish and wildlife conservation and recreation.

Salinity control by prevention of salt water intrusion is the only project feature which will have a significant effect on agricultural resources and production. About 39,600 acres of land currently devoted to rice production would be affected by control of salt water intrusion afforded by the project. Two of the four irrigation companies providing water to the area would be benefited.

In 1951, nearly 79,000 acres of rice land were irrigated in the area. However, due to governmental programs lands used for rice production in 1958 had been reduced to 39,600 acres. Assuming that the Texas area would maintain its proportionate share of rice production in the United States, a production increase of about 25 percent would be required by 1975 in the area. Rice yields have been increased at a rate of more than 3 percent per year and it may be expected that this increase will continue at a similar rate in the immediate future. On this basis, an increase in acreage for this crop would probably not be required to meet projected production requirements. The report is not explicit in its treatment of these considerations in the analysis of future losses from salt water intrusion or expected benefits from the program.

The proposed improvements are all located at a considerable distance downstream from the nearest national forest lands and there would be very little effect upon nonforest land resources.

We appreciate the opportunity afforded us to review this report.

Sincerely ypurs,

C. M. Ferguson
Assistant Secretary

COMMENTS OF THE PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE — WASHINGTON 25, D. C.

BUREAU OF STATE SERVICES — Refer to:

July 29, 1960

Lieutenant General E. C. Itschner
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Itschner:

This is in reply to your letter of June 3, 1960 requesting comments on an interim report on the Wallisville Reservoir, Trinity River, Texas.

In Volume I, attachment, paragraph 16 the following statement is made, "The value of minerals was excluded from the appraised values of the reservoir lands, made in October 1959, on the basis that future oil explorations and developments within the reservoir area could be conducted without serious detriment to the reservoir purposes." This statement may be construed to mean oil or gas wells could be drilled within the water supply lake. In this event extraordinary precautions would be necessary if serious damage to the water supply is to be avoided.

Construction of the proposed 23,000 acre fresh water lake will obliterate many low areas along the Trinity River presently breeding mosquitoes. However, the reservoir itself is expected to have a high mosquito potential. The planned shallow water depth is likely to induce prolific aquatic plant growth and favor production of permanent water mosquitoes such as Anopheles, Culex and Mansonia. A rising pool into marginal vegetation during summer months would be followed by hordes of mosquitoes. Inasmuch as two recreational areas associated with the Wallisville Reservoir are planned, the following recommendations to protect the public health are made:

1. Postimpoundage entomologic inspections should be made routinely during the mosquito breeding season.

2. Major mosquito breeding areas located within 1 1/2 miles of the two planned recreational areas should be treated periodically with suitable larvicides.

3. For the temporary alleviation of annoyance caused by pest mosquitoes in recreational areas, the use of adulticidal space sprays would be advisable.

4. Infestations of obnoxious plants located within 1 1/2 miles of the recreational areas should be controlled by herbicides or other suitable methods.

Special attention is directed to the operating regimen proposed by the Bureau of Sport Fisheries and Wildlife, viz:

"That the reservoir be operated for water fowl management as follows: (a) During a 60-day period beginning April or May, lower the water level 6 inches with Plans B and C....; and (b) beginning in August or September, slowly raise the water level for 60 days to conservation pool elevation." The regimen is likely to induce large scale mosquito production. We recommend that plans be made to define more accurately mosquito problem areas. Upon request the Public Health Service (and the Texas State Department of Health) will be pleased to cooperate in conducting a postimpoundage mosquito survey.

We appreciate the opportunity to review the report and stand ready to assist the Corps of Engineers with the project in any way you may wish.

Sincerely yours,

Ralph H. Holtje

Ralph H. Holtje
Acting Chief, Technical Services Branch
Division of Water Supply and
Pollution Control

FEDERAL POWER COMMISSION
WASHINGTON 25

July 8, 1960

Lieutenant General Emerson C. Itschner
Chief of Engineers
Department of the Army
Washington 25, D. C.

Reference: ENGCW-P

Dear General Itschner:

This is in reply to the Acting Chief of Engineers' letter of June 3, 1960 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 an interim report on Wallisville Reservoir, Trinity River, Texas. The letter mentions the desirability of transmitting your report to Congress at an early date and requests the comments of the Commission as soon as possible.

The Commission has reviewed the reports of your Department and has considered the possibility of developing hydroelectric power at the Wallisville project in conjunction with salinity control, navigation, water supply, fish and wildlife, recreation, and other uses. As a result of its studies, the Commission concludes that because of the small releases from the reservoir and the low power head available it would be impracticable to develop power at the Wallisville project. It is the Commission's opinion that the recommended project would not affect any existing or potential water power developments.

Sincerely yours,

Jerome F. Kuykendall

Chairman

WALLISVILLE RESERVOIR, TRINITY RIVER, 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.

ENGCW-P

18 April 1961

SUBJECT: Wallisville Reservoir, Trinity River, Texas

TO: The Secretary of the Army

1. I submit for transmission to Congress the interim report of the Board of Engineers for Rivers and Harbors in partial response to resolutions of the Committee on Rivers and Harbors of the House of Representatives adopted 31 March 1944 and 28 February 1945, and the Committee on Public Works of the United States Senate adopted 20 January 1958, requesting the Board to review the reports on Trinity River and Tributaries, Texas, submitted in House Document Numbered 403, Seventy-seventh Congress, first session, and previous and subsequent reports, with a view to determining whether any modification of previous recommendations is advisable at this time. The report is also in review of interim reports on a survey of Trinity River, Texas, authorized by the River and Harbor Act of 1958. This report considers a salt-water barrier and navigation lock near the mouth of Trinity River for navigation and for other water-resource purposes. Several interim reports on Trinity River and Tributaries, Texas, have been previously submitted. A final report under the authorizations will be submitted later.

2. The District and Division Engineers report that modification of the project for the Trinity River and Tributaries, Texas, by construction of the Wallisville Dam and Reservoir at mile 3.9, for salinity control, navigation, water supply, fish and wildlife, including a national wildlife refuge, recreation, and other uses, is economically justified and advisable, subject to certain conditions of local cooperation. They estimate the benefit-cost ratio at 2.8 for the multiple-purpose reservoir.

3. The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. It notes, however, that successful operation of the proposed national wildlife refuge would require 4,000 acre-feet of water per year from the reservoir for which no specific provision is made for water rights. It believes that acquisition of, and settlement of any claims for, such water rights, in compliance with the laws of the State of Texas, must be accomplished by others than the Corps of Engineers. It is also of the opinion that a lock 56 feet wide and 400 feet long is

sufficient for existing and prospective commerce to Liberty. On the other hand, it believes that the Chief of Engineers should be authorized to construct a larger lock if, prior to construction of the Wallisville Reservoir, the studies presently underway for navigation above Liberty show that the larger lock is economically justified.

4. After full consideration of the reports of the District and Division Engineers, and in view of the opinions outlined in the preceding paragraph, the Board recommends modification of the existing project for Trinity River and Tributaries, Texas, in the interest of salinity control, navigation, water supply, fish and wildlife, recreation, and other uses, to provide for:

a. A multiple-purpose dam and reservoir at Wallisville, mile 3.9 on Trinity River, including an overflow section with crest 4 feet above mean sea level, a gate-controlled diversion channel to Trinity Bay, a navigation lock 56 feet wide and 400 feet long, and approach channel; all generally in accordance with the plans of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, including a larger lock if found justified; at an estimated cost of $9,162,000 for construction, and $156,200 annually for maintenance and operation; provided that, prior to construction, local interests agree to reimburse the United States in a manner satisfactory to the Secretary of the Army for a share of the construction costs and the maintenance, operation, and major replacement costs of the dam and reservoir allocated to certain project purposes as follows:

(1) Salinity control - 50 percent;
(2) Water supply - 100 percent;
(3) Recreation - 100 percent, less cost for minimum basic facilities and less costs equivalent to 15 percent of the total project cost; such reimbursements being presently estimated at $1,890,000 for construction and an average of $30,600 annually for maintenance, operation, and major replacements, provided that the latter payment may be made annually as a proportionate part of the actual costs incurred;

b. Incorporation of the existing Federal projects designated as "Anahuac Channel, Texas", and "Mouth of Trinity River, Texas".

5. The Board further recommends, in accordance with the recommendations of the Bureau of Sports Fisheries and Wildlife and the provisions of Public Law 85-624, Eighty-fifth Congress, approved 12 August 1958, that the Corps of Engineers be authorized to acquire 6,725 acres of additional land at an estimated cost of $1,136,000, and to make such land available, together with 10,730 acres within the Wallisville Reservoir, generally as shown on Plate 2 of the District Engineer's report, to the Secretary of the Interior for refuge use in accordance with an agreement to be made between the Secretary of the Army and the Secretary of the Interior as provided for in Section 3 of the Fish and Wildlife Coordination Act cited above; and that the Corps of Engineers be authorized to operate the Wallisville Reservoir in support of the refuge insofar as it does not conflict or interfere with operations for other project purposes; provided, that local interests furnish the necessary water rights for operation of the wildlife refuge.

6. The net cost to the United States for the recommended improvements is estimated at $7,272,000 for construction of the dam and reservoir and $125,600 annually for maintenance and operation, including major replacements; and $1,136,000 for the acquisition of additional land for the wildlife refuge.

7. Following my receipt of the report and recommendations of the Board, I received additional information indicating the desirability to give further consideration to the views and arguments of local people concerning the proposed national wildlife refuge. Accordingly, I requested the reporting officers to arrange for and conduct a local public hearing, jointly with representatives of the Bureau of Sports Fisheries and Wildlife, Department of the Interior, for the purpose of further developing the views and attitudes of all concerned local interests pertaining to the fish and wildlife aspects of the proposed reservoir project. The hearing was held at Liberty, Texas on 15-16 December 1960.

8. On the basis of information developed from the public hearing, the Bureau of Sports Fisheries and Wildlife made a further study of the proposal to establish a national wildlife refuge as part of the Wallisville reservoir project. As a result of such study, the Bureau recommended that the project be authorized to include a wildlife refuge that would embrace approximately 2,000 acres of land

outside the reservoir area in addition to certain of the lands which would be required for reservoir purposes. The Bureau estimates that the proposed 2,000 acres of additional land could be acquired at an estimated cost of $400,000 compared to a cost of $1,136,000 for the 6,725 additional acres proposed originally. The Bureau reports that the benefits of a wildlife refuge as proposed would be at least equal to the cost of land acquisition and development.

9. I have carefully considered the reports of the District and Division Engineers, the Board of Engineers for Rivers and Harbors, and the recommendations of the Bureau of Sports Fisheries and Wildlife, and have concluded that Wallisville Reservoir would provide an excellent opportunity for further development of the water resources of the area, but that the refuge as proposed by the Bureau of Sports Fisheries is a separable economic component which could be included or excluded from the overall development without affecting the justification for or the other purposes of the reservoir, and that the Fish and Wildlife Service and the Department of the Interior would be the agencies responsible for providing necessary detail and specific technical support for the refuge, as may be necessary.

10. The plan of improvement for Wallisville Reservoir only, exclusive of the 2,000 acres of additional land for the wildlife refuge, has an estimated first cost of $9,498,000, consisting of $9,410,000 for construction, of which $248,000 previously authorized, is for extending the navigation channel from its present ending about 1 mile below Anahuac to Wallisville Reservoir; $35,000 for preauthorization studies; and $53,000 for aids to navigation. Annual charges are estimated at $511,900, including $164,700 for maintenance and operation of the dam and reservoir, of which $8,500 would be for maintenance of aids to navigation. Average annual benefits creditable to the reservoir only, on the basis of present administrative policy separating fish and wildlife recreation and other recreation, are estimated as follows:

SUBJECT: Wallisville Reservoir, Trinity River, Texas

Project Purposes	Annual Benefits
Salinity control	$250,000
Navigation	376,000
Water Supply	149,300
Fish and Wildlife Conservation	29,000
Fish and Wildlife Recreation	184,000
Other Recreation	307,000
Total	$1,295,300

The benefit-cost ratio is 2.5.

11. Allocation of costs to project purposes was computed on the basis of the foregoing estimated benefits. Apportionment of costs between Federal and non-Federal interests is in accordance with existing laws and administrative policies. The division of costs is tabulated below:

	Apportionment				Allocated Cost
	Federal	Percent	Non-Federal	Percent	
Construction					
Salinity control	$ 766,200	50	$ 766,200	50	$1,532,400
Navigation	4,019,900	100	700	--	4,020,600
Water supply	--	--	915,000	100	915,000
Fish and wildlife cons. & recreation	1,303,000	100	--	--	1,303,000
Recreation	1,727,000	100	--	--	1,727,000
Total	$7,816,100	82	$1,681,900	18	$9,498,000
Annual operation and maintenance					
Salinity control	$ 12,500	50	$ 12,400	50	$ 24,900
Navigation	72,100	100	--	--	72,100
Water supply	--	--	14,800	100	14,800
Fish and wildlife cons. & recreation	21,200	100	--	--	21,200
Recreation	31,700	100	--	--	31,700
Total	$ 137,500	83	$ 27,200	17	$ 164,700

12. After due consideration of all the foregoing, I concur generally in the views of the Board of Engineers. Accordingly, I recommend:

a. A multiple-purpose dam and reservoir at Wallisville, mile 3.9 on Trinity River, including an overflow section with crest 4 feet above mean sea level, a gate-controlled diversion channel to Trinity Bay, a navigation lock 56 feet wide and 400 feet long, and approach channel; all generally in accordance with the plans of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, including a larger lock if found justified; at an estimated cost of $9,162,000 for construction, and $156,200 annually for maintenance and operation; and in accordance with all the requirements of local cooperation set forth by the Board, with the exception that my estimates of the monetary reimbursements by local interests amount to $1,682,000 for construction and $27,200 annually for operation, maintenance and replacements.

b. Incorporation of the existing Federal projects designated as "Anahuac Channel, Texas", and "Mouth of Trinity River, Texas".

13. I further recommend that in the interests of comprehensive planning and development of the water resources of Trinity River, that the Congress give careful consideration to the recommendations of the Bureau of Sports Fisheries and Wildlife providing for authorization of Wallisville Reservoir to include a national wildlife refuge, and for acquisition of about 2,000 acres of additional land at an estimated cost of $400,000; and, should the wildlife refuge and acquisition of the additional lands be authorized, that the Corps of Engineers be authorized to operate the Wallisville Reservoir in support of the refuge insofar as it does not conflict or interfere with operations for other project purposes, and that local interests furnish the necessary water rights for operation of the wildlife refuge.

14. The net cost to the United States for the Wallisville Reservoir improvement exclusive of lands specifically for refuge purposes, is estimated at $7,480,000 for construction and $129,000 annually for maintenance and operation, including major replacements. The estimated

cost to the United States for acquisition of 2,000 acres of additional lands for purposes of a wildlife refuge is $400,000.

KEITH R. BARNEY
Major General, USA
Acting Chief of Engineers

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

ENGBR

6 May 1960

SUBJECT: Wallisville Reservoir, Trinity River, Texas

TO: Chief of Engineers, Department of the Army

1. Authority and scope.--This interim report is in partial response to the following resolutions adopted March 31, 1944, February 28, 1945, and January 20, 1958, respectively:

> Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors created under section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on the Trinity River and Tributaries, Texas, contained in House Document Numbered 403, Seventy-seventh Congress, First Session, with a view to determining whether any modifications should be made in the recommendations therein at this time with respect to works for navigation and local flood protection along the main stem and major tributaries of the Trinity River.

> Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors created under section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on the Trinity River and Tributaries, Texas, contained in House Document Numbered 403, Seventy-seventh Congress, 1st Session, with a view to determining whether any modifications should be made in the recommendations therein at this time with respect to works for navigation, flood control and allied purposes.

> Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on Trinity River and tributaries, Texas, submitted in House Document Numbered 403, Seventy-seventh Congress, First Session, and previous

and subsequent reports, with a view to determining whether any modification of previous recommendations is advisable at this time.

It is also in partial response to the River and Harbor Act of 1958 which authorized a survey of Trinity River. This report considers a salt-water barrier and navigation lock near the mouth of Trinity River for navigation and other water-resource purposes. Several interim reports on Trinity River and tributaries have been submitted. A final report under the authorizations will be submitted later.

2. Basin description.--The Trinity River rises in north-central Texas, and flows southeasterly for about 133 miles to Fort Worth; thence easterly about 53 miles to Dallas; and thence southeasterly about 506 miles to Trinity Bay, a northeast arm of Galveston Bay. The river drains 17,845 square miles. In the 41-mile tidal reach downstream from Liberty, the channel varies in width from 200 to 400 feet, and in controlling depth from 7 feet at the mouth to 4 feet at mile 30 and 2 feet at mile 38, with many pools considerably deeper. Bankfull channel capacity at Liberty is 20,000 cubic feet per second and at miles 12 and 4 somewhat less than 7,000 cubic feet per second. Floods may occur at any time of the year. A flood in 1942, the maximum since 1903, reached a peak flow of 114,000 cubic feet per second at Liberty. Low flows barely exceeding 100 cubic feet per second for several days occurred at Liberty in 1925, 1931, and 1956. In the reach downstream from Liberty the river follows a meandering course about twice the length of the valley axis through a low marshy area. The mean tidal range in Trinity Bay near the mouth of the river is 0.9 foot, although the bay at times is depressed by sustained northerly winds and raised by hurricanes as much as 1.5 feet below and 15 feet above mean low water, respectively.

3. Existing and planned improvements.--The three existing Federal navigation projects related to improvement of the lower Trinity River are:

a. Trinity River and tributaries, Texas - This provides for a sea-level channel 9 feet deep and 150 feet wide, extending from the Houston Ship Channel near Red Fish Bar in Galveston Bay to Smith Point, thence along the eastern shore of Trinity Bay to Anahuac, and thence generally following the river channel to and including a turning basin near the town of Liberty, Texas, a distance of 48.9

miles; with a protective spoil embankment on the bay side from Smith Point to Anahuac, and a log boom at the head of the Anahuac Channel. The part of the project extending from the Houston Ship Channel to mile 23.2, 1 mile south of Anahuac, is complete. Local interests object to further extension of the channel to Liberty without positive protection against salt water intrusion in the Trinity River.

b. Mouth of Trinity River, Texas - A project was adopted in 1871 to provide a 5-foot depth for navigation from the head of Galveston Bay to Liberty. The project was modified on three occasions, the last in 1905. Work consisted of dredging, pile jetties, pile breakwaters, and snagging. No funds have been expended on the project since 1921. It has been considered inactive since 1935.

c. Anahuac Channel, Texas - A project, with no dimensions specified, was adopted in 1905 to provide a navigation channel from Trinity Bay to Anahuac. A channel 6 feet deep, 80 feet wide, and 28,000 feet long was dredged and subsequently maintained.

The Soil Conservation Service, Department of Agriculture, is administering an active authorized program of runoff and waterflow retardation and soil-erosion prevention on the Trinity River watershed. Plans provide for a large number of detention structures upstream from the mouth of Long King Creek at river mile 117.6, of which many have been constructed. Existing improvements by non-Federal interests consist mainly of off-river reservoirs for irrigation and mining purposes, small levees along Cotton Bayou and Old River, and a ring levee having a grade about 10 feet above mean sea level for flood protection of the Lost Lake oilfield west of river mile 9. The city of Houston and the Trinity River Authority of Texas have jointly obtained a permit from the Texas State Board of Water Engineers to construct the Livingston Reservoir on the main stem of the Trinity River at about mile 129 and a salt-water barrier at about mile 4. These improvements are planned to operate as a unit for storing and diverting Trinity River water, largely for municipal and industrial use in the metropolitan area of Houston, and for irrigation.

4. Tributary area and commerce.--The area which may contribute to waterborne commerce south of Liberty is roughly confined to Chambers and Liberty Counties. In 1950 the 2 counties had a total population of 34,600, of which 15,980 resided in urban areas. The predominant activity of the area is agriculture. Principal crops are rice, cotton, corn, and miscellaneous truck crops. Dairying, raising of beef cattle, and poultry farming are extensive in the area.

Industrial activity consists of processing agricultural and forest products, sulphur mining, and processing of petroleum products. Of the 40 producing oilfields in the 2 counties, 4 in the river valley south of the town of Liberty produced 5,289,000 barrels of crude petroleum in 1958. Existing commerce on the lower river consists of sulphur, seashells, and minor amounts of oilfield equipment and clay products. In the 9-year period 1950-58, commerce on the lower river averaged more than 500,000 tons. In 1958, vessels, including barges, made 1,223 trips into the river and 1,283 out of the river. About 30 percent of the vessels had drafts of 7 to 9 feet, inclusive, and the remainder, less than 7 feet.

5. Water conservation.--In 1959 four canal companies were using Trinity River water downstream from river mile 27, mostly for irrigation of rice. Their aggregate water rights provide for irrigation of about 116,000 acres and they actually irrigated about 79,000 acres annually prior to 1952. Under the present-day farm program about 40,000 to 50,000 acres are irrigated annually. The total area under the irrigation systems amounts to over 300,000 acres, of which only about 90,000 acres can be planted to rice annually because of the necessity of allowing rice land to lie fallow for 2 of each 3 years, and because the existing sources of irrigation water are sufficient for only about 90,000 acres of rice annually. Intrusion of salt water to the pump intakes of the rice irrigation systems during periods of low flow in the river has been a problem for a number of years. During the irrigation seasons of 1952 and 1954, the problem became critical to the extent that local interests constructed a temporary barrier in the river at mile 12. The need for additional water supply is general throughout the lower Trinity River Basin and adjacent areas, including the city of Houston. The Trinity River Authority of Texas has prepared a master plan for developing the water resources of the Trinity River Basin, providing for present and future use of all the runoff. The Public Health Service, Department of Health, Education and Welfare, has determined that the present requirements for domestic and industrial water in 21 principal cities of the 4.5 county potential service area are 136 million gallons per day. Based on population projections, availability of adequate water supplies, and certain limiting factors, the Public Health Service estimates the domestic and industrial water supply needs of the area at 650 MGD in 1965 and 3,874 MGD in 2010.

6. Improvements desired.--Navigation interests desire the improvement of the Trinity River to Liberty to provide an adequate and dependable channel for existing and prospective commerce. They contend that the resources of the area can support an industrial complex, a necessary adjunct to water transportation, and that availability of adequate water supplies is necessary for such industrial development. Irrigation interests request that in any navigation project through the lower river provision be made for positive protection against salt-water intrusion. They state that preservation of the fresh water supply for the rice crop, with an annual gross revenue of over $10,000,000, is of major importance to the economy of the area. Responsible officials of the city of Houston, the Trinity River Authority of Texas, and the Chambers-Liberty Counties Navigation District (irrigators) have requested that a water conservation reservoir be investigated in conjunction with studies for a salt-water barrier and navigation lock in the lower river. During the investigations for this report, the Bureau of Sports Fisheries and Wildlife, Fish and Wildlife Service, Department of the Interior, participated in the studies for all plans considered. For the selected plan they recommend establishment of a national wildlife refuge embodying 17,455 acres, of which 6,725 acres would adjoin the reservoir on the northwest, and 10,730 acres would be in the reservoir. They also recommend that 4,000 acre-feet of water, an average of 3.6 MGD, be made available for the growing of feed and forage on the refuge. Local interests are willing and able to meet the requirements of local cooperation for the improvement.

7. Improvements considered.--The District Engineer reports that prospective commerce to and from Liberty is not sufficient at this time to warrant construction of the authorized navigation channel above Moss Bluff, mile 21. He finds that the most suitable plan for meeting the water-resource needs of the area would consist of a multiple-purpose reservoir at mile 3.9 on the Trinity River. The reservoir would have a normal pool elevation of 4 feet above mean sea level and would have a total capacity of 55,700 acre-feet and a total area of 23,200 acres. It would be formed by an earth dam 33,900 feet long, of which 20,100 feet would be a paved overflow section with crest 4 feet above mean sea level, and 13,500 feet would be a non-overflow structure with crest 8 feet above mean sea level. The remaining 300 feet would consist of a navigation lock 84 feet wide and 600 feet long, with gate sills 16 feet below mean sea level, and a river diversion control structure consisting of four tainter

gates 40 feet long. The reservoir is designed to operate jointly with the Livingston Reservoir at mile 129, which is planned by the city of Houston for early construction. Using October 1959 prices, the District Engineer estimates the total first cost of the improvement at $9,498,000, consisting of $9,410,000 for construction, of which $248,000, previously authorized, is for extending the navigation channel from its present ending about 1 mile below Anahuac to the Wallisville Reservoir; $35,000 for preauthorization studies; and $53,000 for aids to navigation. Annual carrying charges are estimated at $511,900, including $164,700 for maintenance and operation of the dam and reservoir, of which $8,500 would be for maintenance of aids to navigation. Average annual benefits are estimated as follows:

Project purposes	Annual benefits	Percent of total
Salinity control	$ 250,000	18
Navigation	376,000	27
Water supply	140,500	10
Fish and wildlife	104,300	7
Recreation	538,300	38
Total	$1,409,100	100

The benefit-cost ratio is 2.8.

8. Cost allocation and apportionment.--Allocation of costs for the five project purposes is computed in accordance with the separable costs-remaining benefits procedure. Apportionment of costs between Federal and non-Federal interests is in accordance with law for navigation, water supply, and fish and wildlife purposes; in accordance with administrative policy for recreation; and in accordance with findings of cause and effect for salinity control. The division of costs is tabulated below:

SUBJECT: Wallisville Reservoir, Trinity River, Texas

	Apportionment				Allocated cost
	Federal	Percent	Non-Federal	Percent	
Construction					
Salinity control	$ 860,450	50	$ 860,450	50	$1,720,900
Navigation	4,200,200	100	700	--	4,200,900
Water supply	--	--	967,000	100	967,000
Fish and wildlife	715,600	100	--	--	715,600
Recreation	1,830,800	97	62,800	3	1,893,600
Total	$7,607,050	80	$1,890,950	20	$9,498,000
Annual operation and maintenance					
Salinity control	$ 13,950	50	$ 13,950	50	$ 27,900
Navigation	75,000	100	--	--	75,000
Water supply	--	--	15,700	100	15,700
Fish and wildlife	11,700	100	--	--	11,700
Recreation	33,400	97	1,000	3	34,400
Total	$ 134,050	81	$ 30,650	19	$ 164,700

The District Engineer recommends modification of the existing project for the Trinity River and Tributaries, Texas, to provide for the Wallisville Reservoir at mile 3.9 on Trinity River substantially in accordance with his plan, subject to certain requirements of local cooperation. He further recommends that the existing Federal projects designated as the "Anahuac Channel, Texas", and "Mouth of Trinity River, Texas", be incorporated in the existing project "Trinity River and Tributaries, Texas". In addition, he recommends that:

a. In accordance with the recommendations of the Bureau of Sports Fisheries and Wildlife, a Federal project providing for a national wildlife refuge be established in connection with the Wallisville Reservoir under the provisions of Public Law 85-624, Eighty-fifth Congress, approved August 12, 1958;

b. The Corps of Engineers be authorized to acquire about 6,725 acres of additional land for the national wildlife refuge, at an estimated first cost of $1,136,000; and

c. The Corps of Engineers be authorized to transfer to the Secretary of the Interior the 6,725 acres of additional refuge lands and about 10,730 acres of the Wallisville Reservoir as requested by the Bureau of Sports Fisheries and Wildlife. The Division Engineer concurs.

9. Public notice.--The Division Engineer issued a public notice stating the recommendations of the reporting officers and affording interested parties an opportunity to present additional information to the Board. Several communications were received from proponents of the project under consideration.

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 reservoir will serve the growing water conservation needs of the area and permit completion of the upstream portion of the authorized navigation project and subsequent construction of the proposed Livingston Reservoir. The plan is economically justified and the requirements of local cooperation are appropriate. The Board notes that the recommended lock, 84 feet wide and 600 feet long, is the same as that now being investigated for navigation to Fort Worth. It is of the opinion that such a lock cannot be justified by the existing and prospective commerce to Liberty only, and that a lock, 56 feet wide and 400 feet long, should be recommended, provided that the Chief of Engineers be authorized to construct the larger lock if, prior to construction of the Wallisville Reservoir, studies of prospective commerce above Liberty show it to be economically justified.

11. The Board agrees with the Bureau of Sports Fisheries and Wildlife that the project site is favorably located for establishment of a national wildlife refuge, and that the project facilities

are adaptable for development of such a refuge. The Board notes that successful operation of the refuge will require 4,000 acre-feet of water per year from the reservoir for the growing of forage and feed crops in the refuge area, for which no specific provision is made for water rights. It believes that acquisition of, and settlement of any claims for, such water rights, in compliance with laws of the State of Texas, must be accomplished by others than the Corps of Engineers.

12. Recommendations.--Accordingly, the Board recommends modification of the existing project for Trinity River and Tributaries, Texas, in the interest of salinity control, navigation, water supply, fish and wildlife, recreation, and other uses, to provide for:

a. A multiple-purpose dam and reservoir at Wallisville, mile 3.9 on Trinity River, including an overflow section with crest 4 feet above mean sea level, a gate-controlled diversion channel to Trinity Bay, a navigation lock 56 feet wide and 400 feet long, and approach channel; all generally in accordance with the plans of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, including a larger lock if found justified; at an estimated cost of $9,162,000 for construction, and $156,200 annually for maintenance and operation; provided that, prior to construction, local interests agree to reimburse the United States in a manner satisfactory to the Secretary of the Army for a share of the construction costs and the maintenance, operation, and major replacement costs of the dam and reservoir allocated to certain project purposes as follows:

(1) Salinity control - 50 percent;
(2) Water supply - 100 percent;
(3) Recreation - 100 percent, less cost for minimum basic facilities and less costs equivalent to 15 percent of the total project cost; such reimbursements being presently estimated at $1,890,000 for construction and an average of $30,600 annually for maintenance, operation, and major replacements, provided that the latter payment may be made annually as a proportionate part of the actual costs incurred;

b. Incorporation of the existing Federal projects designated as "Anahuac Channel, Texas", and "Mouth of Trinity River, Texas".

13. The Board further recommends, in accordance with the recommendations of the Bureau of Sports Fisheries and Wildlife and the provisions of Public Law 85-624, Eighty-fifth Congress, approved August 12, 1958, that the Corps of Engineers be authorized to acquire 6,725 acres of additional land at an estimated cost of $1,136,000, and to make such land available, together with 10,730 acres within the Wallisville Reservoir, generally as shown on Plate 2 of the District Engineer's report, to the Secretary of the Interior for refuge use in accordance with an agreement to be made between the Secretary of the Army and the Secretary of the Interior as provided for in Section 3 of the Fish and Wildlife Coordination Act cited above; and that the Corps of Engineers be authorized to operate the Wallisville Reservoir in support of the refuge insofar as it does not conflict or interfere with operations for other project purposes; provided, that local interests furnish the necessary water rights for operation of the wildlife refuge.

14. The net cost to the United States for the recommended improvements is estimated at $7,272,000 for construction of the dam and reservoir and $125,600 annually for maintenance and operation, including major replacements; and $1,136,000 for the acquisition of additional land for the wildlife refuge.

FOR THE BOARD:

/S/ W. K. WILSON, JR.

W. K. WILSON, JR.
Major General, USA
Chairman

INTERIM REVIEW OF REPORTS ON TRINITY RIVER AND TRIBUTARIES, TEXAS (WALLISVILLE RESERVOIR)

SYLLABUS

This report comprises the results of an investigation to determine the advisability of providing a multiple-purpose reservoir for salinity control, navigation, water supply, fish and wildlife conservation, and recreation on the lower Trinity River near Wallisville, Texas. The report also presents data concerning the advisability of providing a national wildlife refuge as recommended by the United States Fish and Wildlife Service. It is found that:

a. There is an immediate and urgent need for construction of a multiple purpose reservoir development at Wallisville and that the most feasible plan for achieving this objective would be the construction of a multiple-purpose reservoir with dam located at about river mile 3.9, providing storage to elevation 4.0 above mean sea level, generally as described under plan C in this report.

b. The estimated annual benefits to be afforded by the Wallisville reservoir considered in plan C would exceed the estimated annual charges, showing a favorable ratio of 2.8.

c. The local interests should reimburse the United States for a share of the first cost of construction and annual cost of maintenance and operation and major replacements of the Wallisville reservoir in accordance with the provisions outlined herein.

d. The Wallisville reservoir, plan C, would provide outstanding opportunities for the development of a national wildlife refuge which could be achieved by the purchase of additional lands adjacent to the reservoir for the growing of feed and forage crops and protection of the migratory birds.

e. The estimated annual benefits to be afforded by the national wildlife refuge as considered in this report would exceed the estimated annual charges, showing a favorable ratio of 1.2.

Accordingly, it is recommended that the existing project for the Trinity River and Tributaries, Texas, be modified to provide a multiple purpose reservoir on the lower Trinity River with dam located at river mile 3.9 providing storage to elevation 4.0 above mean sea level. The estimated first cost to the United States is at $9,162,000 with $164,700 estimated for annual maintenance, operation and major replacements. The recommendation is subject to the condition that local interests reimburse the United States for a share of the first costs of construction and for a share of the annual costs of maintenance and operation. The share of

first cost to local interests is presently estimated to be $1,890,000 with $30,600 estimated as the share of the annual estimated cost of maintenance and operation.

It is further recommended:

a. That, in accordance with recommendations of the Bureau of Sport Fisheries and Wildlife, a Federal project be adopted providing for the establishment of a national wildlife refuge in connection with the Wallisville reservoir, plan C, in accordance with the Fish and Wildlife Coordination Act, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.

b. Acquisition by the Corps of Engineers be authorized for additional lands of about 6,725 acres for the national wildlife refuge at an estimated first cost of $1,136,000.

c. The Corps of Engineers be authorized to transfer to the Secretary of the Interior the 6,725 acres of additional refuge lands to be purchased by the Corps of Engineers and about 10,730 acres of the Wallisville reservoir as requested by the Bureau of Sport Fisheries and Wildlife in this report.

It is further recommended that the existing Federal projects for navigation, "Channel to Anahuac, Texas", and "Mouth of Trinity River, Texas", be incorporated into the existing project "Trinity River and Tributaries, Texas".

U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS
April 6, 1960

SUBJECT: Interim review of reports on the Trinity River and Tributaries, Texas, (Wallisville Reservoir)

TO: Chief of Engineers, Department of the Army,
Washington, D. C., through
Division Engineer, U. S. Army Engineer Division
Southwestern, Dallas, Texas

AUTHORITY

1. Authority.- This interim review of reports on the Trinity River and tributaries, Texas, covering the Wallisville Reservoir is submitted in partial response to the following four Congressional authorizations:

a. Resolution by the Committee on Rivers and Harbors of the House of Representatives, United States, adopted March 31, 1944.

> "Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on the Trinity River and Tributaries, Texas, contained in House Document Numbered 403, Seventy-seventh Congress, First Session, with a view to determining whether any modifications should be made in the recommendations therein at this time with respect to works for navigation and local flood protection along the main stem and major tributaries of the Trinity River."

b. Resolution by the Committee on Rivers and Harbors of the House of Representatives, United States, adopted February 28, 1945.

> "Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on the Trinity River and Tributaries, Texas, contained in House Document Numbered 403, Seventy-seventh Congress, 1st Session, with a view to determining whether any modifications should be made in the recommendations therein at this time with respect to works for navigation, flood control, and allied purposes."

c. Resolution by the Committee on Public Works of the Senate adopted January 20, 1958.

> "Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on Trinity River and tributaries, Texas, submitted in House Document Numbered 403, Seventy-seventh Congress, First Session, and previous and subsequent reports, with a view to determining whether any modification of previous recommendations is advisable at this time."

d. Public Law 85-500, Eighty-fifth Congress, S. 3910, Title I Rivers and Harbors.

> "Section 112. The Secretary of the Army is hereby authorized and directed to cause surveys to be made at the following named localities and subject to all applicable provisions of section 110 of the River and Harbor Act of 1950.
>
> ******
>
> Trinity River, Texas . . . ."

2. Submission of this interim report is also in response to the directive of the Chief of Engineers in 4th Indorsement, dated October 29, 1952, subject "Lower Trinity River Navigation Project, Texas," authorizing the preparation of an interim report of survey scope to cover adequate investigation of the salt water aspect of the authorized navigation project for the preservation of the quality of water available for irrigation. The assignment calling for an interim report on the proposed Wallisville reservoir near the mouth of the Trinity River, as requested by local interests, was made by the Division Engineer, Southwestern Division in letter to the Chief of Engineers, dated April 2, 1959, subject: "Preparation of Interim Report - Lower Trinity River."

3. Extent of investigation.- The reach of river pertinent to the study of the Wallisville reservoir extends from the mouth of the river at Anahuac, Texas, to about river mile 32.0, near Liberty, Texas. The town of Anahuac is on the northeast side of Trinity Bay about 34 airline miles from Galveston, Texas. Wallisville, Texas, is located adjacent to the left bank of the Trinity River about 6 miles upstream from the mouth. Liberty is about 25 miles north of Anahuac, at river mile 40.3. The reach of river under consideration and the surrounding features are shown on plate 1.

4. This interim report gives consideration to the advisability of providing a multiple purpose reservoir near the mouth of the Trinity River in the interest of advancing the authorized navigation channel to Liberty,

of providing storage for municipal and industrial water needs of the local and adjacent communities and cities, or preventing salt water intrusion in the fresh water supply of the Trinity River, and of developing the fish, except marine fisheries, wildlife and recreational resources of the area.

5. Preliminary investigation was made of the advisability of providing flood storage in the multiple purpose reservoir. The upper site for the Wallisville reservoir considered in this report crosses the Trinity River at river mile 8.6, just upstream of Wallisville. The flood plain below the damsite has a total area of about 19,000 acres including the large delta area at the mouth of the river. The flood plain contains many small lakes, bayous and sloughs of shallow depth. The land areas in general have elevations of one to two feet above mean sea level with some areas having a maximum elevation of five feet, all of which are classified as marshy wet bottom lands. The principal vegetation on the land areas is reed grass, marsh millet, and some large areas of swamp trees and brush. The higher land areas are occasionally used for the grazing of cattle but the frequent flooding of the area by floods limits the extent of the lands used for grazing purposes. The area affords some fishing, hunting or migratory birds and trappings of muskrats. The town of Wallisville is partly within the limit of the maximum highwater flood plain. State Highway 73, a limited access, four-lane highway to Houston, crosses the flood plain on earth embankments with crown of roadway at elevation 16 above flood stage. The preliminary investigation clearly revealed that protection to the area by flood storage in the Wallisville reservoir would not be economically justified. Accordingly, studies relating to the control of floods by the Wallisville reservoir are excluded from this report.

6. Field investigations made in connection with the preparation of this report consisted of a subsurface investigation of the Wallisville damsite including laboratory testing of the soil samples; a salinity survey of the waters in the Trinity River delta area including office study of the occurrence and extent of the salt water intrusion in the lower Trinity River; gross appraisal real estate surveys and economic surveys of the reservoir areas under consideration; inspection surveys of the structures, roads and other facilities that would require modification or relocation. Reconnaissance of the area was made by the District Engineer. The United States Department of Health, Education and Welfare Service made a survey of the municipal and industrial water needs of the local and adjacent communities and cities including a determination of the monetary value of water in the Wallisville reservoir. The Bureau of Sport Fisheries and Wildlife made a survey of the fresh-water fish and wildlife resources of the area and evaluated the fresh-water fish and wildlife aspects of the reservoir. The marine fishery will be evaluated when the Bureau of Commercial Fisheries has had an opportunity to make adequate studies. A number of conferences and discussions were held with the local interests, a summary of which is given in paragraphs 40 through 46. The views of Federal, State and other agencies are presented in paragraph 96.

7. This interim report is presented in 2 volumes. Volume 1, Text; and Volume 2, Appendixes. In addition to the text of the report, Volume 1 contains copies of pertinent letters from other agencies, the reports of the United States Public Health Service and the Bureau of Sport Fisheries and Wildlife, designated as exhibits 1 through III, respectively, and a report called for by Senate Resolution 148, 85th Congress, adopted January 28, 1958 as an attachment. Volume 2 contains the following appendixes: Appendix I - Hydrology; Appendix II - Engineering Data; Appendix III - Economic Data; and, Appendix IV - Statement of local interests.

8. Reports reviewed.- The only reports on the Trinity River submitted subsequent to House Document No. 403, 77th Congress, 1st session, that are pertinent to the current investigation, are those contained in House Document No. 634, 79th Congress, 2d session. In the report of that document, the Chief of Engineers recommended modification of the existing project for the Trinity River and tributaries, so as to locate the section of navigation channel below Anahuac adjacent to the eastern shore of Trinity Bay, the relocated channel to have a depth of 9 feet, a width of 150 feet, and a prospective embankment on the bay side, with such changes as in the discretion of the Secretary of the Army and the Chief of Engineers may be advisable. The recommended modification was authorized by the River and Harbor Act approved July 24, 1946.

9. Information on other prior reports on the Trinity River is given in House Document 403. The prior reports relate to preliminary examinations and surveys of the Trinity River in the interest of flood control and navigation made prior to 1935, and are not pertinent to the present study of the Wallisville reservoir.

10. House Document No. 403, 77th Congress, 1st session, which is being reviewed in this report, contains reports on the Trinity River and tributaries, Texas, for flood control, navigation and allied purposes. The reports gave consideration to five existing reservoirs and 15 proposed reservoirs on headwater tributary streams and to one on the main river at river mile 348.2 near Palestine, Texas, for flood control and water conservation. The reports also gave consideration to a plan of improvement for canalization of the Trinity River to Fort Worth providing for a channel 9 feet deep and 150 feet wide from the Houston Ship Channel in Galveston Bay to Fort Worth with 26 navigation locks in the river to overcome a total lift of 496 feet. The Chief of Engineers recommended "approval of the comprehensive plan of improvement * * * * and construction at this time of Benbrook, Little Elm, and Grapevine Reservoirs, the modification of Garza Dam, and the improvement of the levees and floodways at Fort Worth and Dallas for flood protection and water conservation in the Trinity River Basin, and provision of a navigable channel from the Houston Ship Channel to Liberty, with project depth of 9 feet, 200 feet wide in Galveston Bay and 150 feet wide in the river section, and with a turning basin at Liberty"; all subject to certain specified conditions of local cooperation. Improvement of the Trinity River and its tributaries in accordance with the plans recommended by the Chief of Engineers was authorized by the River and Harbor Act approved March 2, 1945. The portion of the project through Galveston Bay was subsequently modified by the River and Harbor Act approved July 24, 1946, as described in paragraph 8.

11. Description.- The Trinity River, one of the major rivers of Texas, is located in the east central portion of the state. The main headwaters of the river rise in Archer County in north central Texas at an elevation of about 1,250 feet above mean sea level. From its source, the Trinity River flows in a southeasterly direction for about 133 miles to Fort Worth, thence easterly about 53 miles to Dallas, thence in a general southeasterly direction for about 506 miles, and empties through its delta distributaries into Trinity Bay, the northeast portion of Galveston Bay. The main stream below Fort Worth has a total length of about 559 miles and a total fall of about 508 feet. The watershed of the Trinity River has an area of 17,845 square miles.

12. Throughout its entire length, the Trinity River follows a meandering course across its valley and below Liberty its meandering is about twice the length of the general axis of the valley. The river valley varies from two to six miles in width. Tidewater extends up the river about 41 miles to Liberty, thence the low-water slope of the river averages about 0.60 foot per mile for 344 miles. Tidal influence at extreme low stages extends upstream to about mile 50, approximately 5 airline miles above Liberty. Between its mouth and Liberty, the width of the river channel varies from about 400 to 200 feet. Depths in the river channel from the mouth to mile 29 vary from a controlling depth of about 7 feet at the mouth of the river to a maximum depth of about 30 feet in pools. Above mile 29, the controlling depth decrease rapidly to 4 feet at about mile 30 and 2 feet at about mile 38, while maximum depths decrease to about 20 feet. The channel banks vary in height from about one foot at the mouth to two feet at mile 10, eight feet at mile 24 and 22 feet at mile 40 near Liberty.

13. Below mile 12 the low marshy land subject to frequent overflow contains lakes, bayous and sloughs that are only a few feet deep and have normal water surface elevations at about mean sea level. The land areas are covered with marsh grasses including considerable growths of dense swamp trees and brush. Between river mile 12 and Liberty the surface of the valley rises gradually and is intersected by small streams and sloughs in abandoned river channels. The area is largely covered with bottomland type of trees and brush.

14. The Trinity River empties into the Anahuac Channel near the town of Anahuac, Texas, thence the flows traverse the navigation channel a distance of about 5.3 miles to the outlet in Trinity Bay. Extensive mud flats adjoin the delta area of the Trinity River and the Anahuac Channel, and the mud flats are being extended constantly into Trinity Bay by deposition of sediment from the Trinity River. Trinity Bay is a shallow coastal bay extending northeast of Galveston Bay and has maximum depths of about eight feet at mean low tide in its central area and depths of six feet over a large portion of the bay area. The mean diurnal tidal

range in Trinity Bay in the vicinity of Anahuac is about 0.9 feet. The water surface is affected to a considerable extent by winds and may be depressed as much as 1.5 feet below mean low tide by strong winds in the winter season and raised as much as 15 feet above mean low tide by hurricanes during the summer and fall seasons. The Trinity and Galveston Bay areas are shown on plate 1 and the United States Coast and Geodetic Survey chart No. 1282.

15. Elevations given hereinafter refer to the U. S. Coast and Geodetic Survey mean sea level datum, unless otherwise stated, which is 1.0 foot above Corps of Engineers datum of mean low tide, at Anahuac, Texas.

16. The Trinity River below Liberty is a source of water for irrigation of extensive areas in rice cultivation located on uplands adjacent to the river valley. At present, four companies obtain water from the Trinity River for the irrigation of rice. The Richmond Irrigation Co. and the Devers Canal Co. have pumping plants on the Trinity River at mile 26.9 and 20.7, respectively, which, with necessary booster pumps, raise the water about 50 feet for delivery into the main canals. The Southern Canal Co. diverts water from the Trinity at about river mile 15.2 by gravity flow through a diversion channel leading to Pickett Bayou, thence via the cutoff to Old River, where a temporary dam, backs the water into Old River a distance of about 3.3 miles to the company's pump intake on the south bank of Old River, where the water is raised about 38 feet to the main delivery canal. The Chambers-Liberty Counties Navigation District diverts water from the mouth of the Trinity River and from Lake Anahuac by means of gate controlled diversion channels extending to a pumping plant located near the east bluff at Anahuac which raises the water about 20 feet to the main canal. Lake Anahuac was formerly an arm of Trinity Bay, known as Turtle Bay. The Chambers-Liberty Counties Navigation District obtained ownership of Turtle Bay from the State of Texas, and created a fresh water reservoir of about 5,000 acres and 5 feet of vertical drawdown storage by construction of a levee along the east bank of the Trinity River including an overflow spillway and appurtenant facilities for obtaining fresh water from the Trinity River at about river mile 3.6.

17. There are four oil fields within the Trinity River valley below Liberty. Two fields designated Liberty-South field and Dayton-South field extend over a large portion of the Trinity River Valley from about river mile 30 to Liberty, Texas. The Liberty-townsite field is located within and adjacent to the city of Liberty. The Lost Lake field located opposite river mile 9.0, upstream of State Highway 73, is protected against river floods by an encircling earth levee. A new field has been developed in the lower southwest portion of the valley near the north shore of Trinity Bay. There are 12 through pipelines ranging from 3 to 30 inches in diameter crossing the valley more or less parallel to State Highway 73. In addition, 13 through pipelines cross the valley between river mile 13.0 and Liberty, several of which have connections with extensive gathering lines from the oil fields.

18. Economic development.- The immediate area adjoining the proposed Wallisville reservoir consisting of Chambers and Liberty Counties has an area of 1,791 square miles of coastal prairie land and constitutes a fertile agricultural region. The principal farm crops consist of rice, cotton, corn and miscellaneous truck crops. It is one of the principal rice producing areas in the State. Livestock are raised extensively in the area and include a large number of beef cattle and well-developed dairy herds. Poultry raising is also an important pursuit. The area is noted for its excellent fishing in the coastal bays and fresh water lakes. A large number of geese, ducks and other migratory waterfowl spend the winter season in the marshes and rice fields and afford excellent waterfowl hunting. According to the 1950 census the two counties had a population of about 34,600, of which 15,980 resided in communities, towns and cities. The population of the 2 counties based on 1957 estimates is now about 41,000.

19. The principal industrial developments in Chambers and Liberty Counties are industries engaged in processing agricultural and forest products, in mining sulfur, and producing and processing petroleum products. The irrigation companies have water rights appropriated by the State Board of Water Engineers for the irrigation of 116,000 acres and actually irrigated an average of 79,000 acres annually prior to 1952. Under the present-day farm program about 40,500 to 50,000 acres are being irrigated annually. The total area under the irrigation systems amounts to over 300,000 acres. The rice irrigation season is generally from April through September, with the peak pumping during July and August, when the maximum rate of pumping is attained almost continuously. The total application of water to the crop is about 3.5 acre-feet per acre. Under the practice of allowing land to lie fallow for two years between cultivation of rice crops, the lands now under canals are sufficient to maintain an average cropping program of about 90,000 acres annually. There are also other adjacent lands which are suitable for rice culture and it is reported that several companies plan to expand their canal systems at some future date. A deterent factor to expansion is the lack of sufficient water supply necessary for the irrigation of more than 90,000 acres, annually.

20. The Texas Gulf Sulphur Company, in 1948, opened a new sulfur mine located about 5 miles northeast of Wallisville and about 3 miles east of the Trinity River. The sulfur is transported in the molten state through pipelines from the mines to a terminal on the Trinity River. Representatives of the company state that the production of the field is expected to be 400,000 to 500,000 tons of sulfur annually.

21. Oil production has increased rapidly in both Chambers and Liberty Counties, and a total of about 40 fields are now in production. The oil fields within the proposed Wallisville reservoir area produced a total of about 5,289,000 barrels of crude petroleum in 1958, of which 5,273,176 barrels was reported as being produced from the combined Liberty-South and Dayton-South fields, 5,108 barrels from the Liberty townsite field and 10,772 barrels from the Lost Lake field.

22. A system of improved highways and county roads serve the tributary area. Rail connections are provided by a branch line of the Atchison, Topeka and Santa Fe Railroad on the east, the main line of the Southern Pacific Railroad which crosses the area through Liberty, the Missouri Pacific crossing the area just north of Liberty, and the main line of the Atchison, Topeka and Santa Fe Railroad crossing the north portion of the area.

23. The Wallisville reservoir would be centrally located to the large industrial and commercial cities of Houston, Texas City and Galveston, about 40 to 70 miles southwest, and Beaumont, Port Arthur and Orange, about the same distances eastward. These cities have large metropolitan areas of which several are highly industrialized. The combined total population of the counties containing these cities, Harris and Galveston on the southwest and Jefferson and Orange on the east, was estimated in 1957 at about 1,600,000.

24. Climate.- The lower Trinity River and adjacent areas are located in a mild humid region having warm summers and moderate winters. Freezing temperatures and snowfall are experienced occasionally with the passage of cold high-pressure air masses from the northwestern polar regions and the continental western highlands. The mean annual temperature in the area is about 63 degrees, Fahrenheit. Temperatures at Liberty have ranged from a maximum of 108 degrees to a minimum of 8 degrees.

25. Precipitation.- The mean annual precipitation over the lower Trinity River based on the record of the Weather Bureau station at Liberty is about 51 inches. Extremes in annual precipitation at Liberty have ranged from a maximum of 85.08 inches in 1919 to a minimum of 29.82 inches in 1917.

26. Evaporation.- The mean annual evaporation rate from a free water surface in the Wallisville reservoir would be about 44 inches, based on records of evaporation at the Beaumont station. A study of the average monthly evaporation rates and recorded monthly rainfall during the critical drought period, 1953 to 1957, shows that there would be an excess of precipitation over evaporation of about one inch per year.

27. Runoff.- The runoff of the Trinity River pertinent to this study is reflected by the records of stream gaging stations at Liberty, river mile 40.3; Romayor, river mile 94.2, and Riverside, river mile 182.4. The Liberty and Riverside gaging stations were established January 1, 1903, and the Romayor gage on June 1, 1924. The discharge of the Trinity River is affected by regulation by reservoirs above Dallas and by Lavon reservoir on the East Fork of the Trinity River.

28. Runoff data for the Liberty gaging station indicate that the average annual runoff of the Trinity River is about 6.4 inches. The annual runoff has varied from a minimum of 0.8 inches to a maximum of 14.1 inches. The runoff data for the Liberty gage were estimated from United States Weather Bureau gage heights and a rating curve constructed from

discharge measurements made by the United States Geological Survey. Table 1 shows runoff data for the Riverside, Romayor and Liberty stream gaging stations.

TABLE 1

RUNOFF DATA - LOWER TRINITY RIVER

Item	Station		
	Riverside	Romayor	Liberty
Miles above mouth	182.5	94.2	40.3
Drainage area, (sq. mi.)	15,619	17,192	17,539
Period of record	1903-1957	1924-1957	1903-1957
Discharge (sec-ft)			
Peak	121,000(1)	111,000(1)	114,000(1)
Minimum	70(2)	102(3)	--

(1) May 1942
(2) Observed August 20 through 26, September 8 through 13, 1925, and September 29 through October 4, 1931.
(3) Observed August 24, 25, 1956.

29. Low flows.- Low flow stages on the Trinity River at the Liberty gaging station are generally affected by the tides in Galveston Bay and the nearest stream gaging stations recording unaffected low flows are located at Romayor and Riverside approximately 54 and 142 miles, respectively, above Liberty. In the 88-mile reach between Riverside and Romayor, there is a definite make-up or increase in the low-water flow. Based on records of the Riverside and Romayor gaging station during the low flow period of September-October 1931, the increase amounted to about 70 second feet. However, during the most critical drought period on the lower river, 1953-1957, the records for August 1956 indicate an increase of 15 second feet. The increase in low flow is further augmented in the reach from the Romayor gage to river mile 12.9, based on data obtained during August-November 1952. During this period, a temporary dam was placed in the Trinity River at river mile 12.9 to prevent salt water intrusion to three upstream pumping stations. Data on river flow, during that period indicate that the pumping rates, after the water surface became steady, exceeded the river discharge by an average of about 153 second-feet for a period of 25 days. This make-up probably is supplied by return flow from ground water along the river channel and from drainage of the lakes and sloughs in the flood plain.

30. Floods.- The records of the gages on the lower Trinity River indicates that floods occur at all seasons of the year. The maximum high water for the year usually occurs during the months of April, May and June. Along the main stem of the Trinity River below Liberty the major floods are relatively broad crested and of long duration. Floods in this reach overtop

the banks, thus retarding the flow, flattening the peak discharge, and prolonging the flood periods. The maximum flood of record on the lower Trinity River occurred in May 1942. This flood produced a peak stage of 29.38 feet on the Liberty gage and had a peak discharge of 114,000 second-feet. The frequency of the maximum flood of record is estimated at once in 35 years. Flood stage at Liberty is 24.0 feet on the gage, or 21.8 feet above mean sea level, at which stage the river has a discharge of 20,000 second-feet. Flows of 7,000 second feet exceed bankfull stage of 2 feet at river miles 12 and 4.

31. Existing Corps of Engineers' project.- The only existing Corps of Engineers project on the lower Trinity River, is the Trinity River and tributaries, Texas, project which provides for navigation to Liberty, Texas. This project was modified by the River and Harbor Acts of March 2, 1945 and July 24, 1946. The project provides for a sea-level channel, 9 feet deep and 150 feet wide, extending from the Houston Ship Channel along the east shore of Trinity Bay to Anahuac, thence generally following the natural river channel to and including a turning basin near the town of Liberty, Texas, a distance of about 48.9 miles, with a protective spoil embankment on the Trinity Bay side of the channel between Smith Point, mile 6.0, and Anahuac, mile 24.3, and a log boom at the head of the Anahuac Channel. The project was authorized subject to such future modification thereof as in the discretion of the Secretary of the Army and the Chief of Engineers may be advisable, and to prescribed requirements of local cooperation. The total cost of the existing project to June 30, 1958 was $1,294,255, of which $1,042,660 was for new work and $251,595 was for maintenance.

32. The lower portion of the project channel, extending from the Houston Ship Channel along the east shore of Trinity Bay to mile 23.2, about one mile below Anahuac, Texas, was completed to project dimensions, including the protective spoil embankment, in July 1950. During planning studies for further advancement of the channel to Liberty, local interests objected to construction of the channel upstream of its present ending without positive protection against salt water intrusion in the Trinity River. The advisability of providing auxiliary works of improvement for the prevention of salt water intrusion in the river and for further advancement of the channel to Liberty, is considered in this report.

33. The existing project was authorized subject to the conditions that local interests furnish necessary rights-of-way and suitable areas for disposal of dredged material, make necessary changes in utilities crossing the natural river channel below Liberty, give assurances satisfactory to the Secretary of the Army that they will provide adequate terminal and transfer facilities on the waterway, and hold and save the United States free from claims for damages that may result from construction and operation of the improvements. Local interests have not complied with the conditions of local cooperation for the portion of the channel from Anahuac to Liberty, but have fully complied with the conditions of local cooperation for the completed portion of the channel below Anahuac by furnishing necessary rights-of-way free of cost to the United States and by furnishing the "hold and save" assurances.

34. Related projects.- There are several existing navigation projects in the vicinity of Anahuac which would be affected by completion of additional portions of the authorized channel to Liberty. These projects are: Mouth of Trinity River, Texas, and Anahuac Channel, Texas. Information concerning these projects is given in paragraphs 35 through 37.

35. Mouth of Trinity River, Texas.- A previous project for improving the Trinity River to obtain 5-foot depth for navigation from the head of Galveston Bay to Liberty, adopted in 1871 and modified in 1873, provided for a pile breakwater and dredging at the mouth of Middle Pass, for removal of a bar in the Trinity River about 4½ miles below Liberty, and for the removal of snags and overhanging trees between the mouth and Liberty. The project was modified in 1889 to provide for parallel timber jetties at the mouth of Middle Pass and for closing of two other principal passes by submerged dams to effect a deepening of the channel to 6 feet on the bar. A total of $75,900 had been expended on the project prior to adoption of the existing project in 1905.

36. The River and Harbor Act approved March 3, 1905 added the work of this project to others covered by the appropriation for "Improving West Galveston Bay Channel, Double Bayou, and mouths of adjacent streams, Texas." Work was continued at Middle Pass until September 1907, when it was stopped and improvement of Browns Pass was undertaken to provide a channel 7 feet deep and 80 feet wide from Anahuac Channel through Browns Pass to deep water in the Trinity River, a distance of 6,700 feet. The total cost of this project to June 30, 1921 was $14,511 of which $3,640 was for new work, and $10,871 was for maintenance. Subsequent to June 30, 1921 no funds have been expended for new work or maintenance and since 1935 the project has been considered as an inactive project.

37. Anahuac Channel, Texas.- The existing project for Anahuac Channel, Texas, was authorized by the River and Harbor Act approved March 3, 1905, but no definite dimensions were specified. In 1905 the Department dredged a channel 6 feet deep and 80 feet wide from Trinity Bay to the wharves at Anahuac, a distance of about 16,000 feet and these dimensions have since been considered as the project dimensions. The existing project was completed in 1906 and is now being maintained to project depth of 6 feet and a width of 80 feet throughout a length of 28,000 feet to 6-foot depth in Trinity Bay. The total cost of the project to June 30, 1959, was $717,289, of which $5,975 was for new work and $711,314 was for maintenance.

38. Improvement by other Federal agencies.- No improvements for flood control or beneficial use of water have been constructed by other Federal agencies on the lower Trinity River. However, the Soil Conservation Service, Department of Agriculture, has been authorized by Congress to undertake a program of runoff and waterflow retardation and soil-erosion prevention on the Trinity River watershed. Plans provide for a large number of detention structures on the watershed upstream of the mouth of Long King Creek at river mile 117.6. Approximately 246 of 1,330 planned floodwater retarding structures have been constructed on the watershed.

39. Improvements by non-Federal agencies.- The existing improvements for water conservation by non-Federal interests consist mainly of off-river reservoirs for irrigation and mining purposes. Lake Anahuac reservoir near the mouth of the river is the largest reservoir providing for storage of fresh water from the Trinity River for irrigation purposes including some diversion for municipal purposes. The Texas Gulf Sulphur Company has two reservoirs located on the uplands about 4.5 miles from Wallisville, which store fresh water used for mining of sulfur. The water is transported by canals extending from a pumping station on the east bank of the Trinity River at river mile 20.9. In addition the four canal companies have several reservoirs on the uplands providing emergency storage for irrigation purposes. There are no organized levee improvement districts on the Trinity River below Liberty. However, private interests have recently constructed a small levee on the east side of Cotton Bayou and are rehabilitating the old levee south of Old River Lake to protect the fresh water areas from salt water intrusion in the interest of hunting and trapping.

IMPROVEMENTS DESIRED

40. Improvements desired.- Public hearings were held in Liberty, Texas, on May 2, 1946, and February 2, 1950, to determine the nature and extent of the improvements desired by the local interests and to afford interested parties an opportunity to express their views concerning the proposed improvements. Subsequent to the hearing numerous conferences were held with the representatives of navigation and irrigation interests at which various plans for improvements of the channel from Anahuac to Liberty were considered in an effort to arrive at a plan that would satisfy the irrigation interests and at the same time provide a satisfactory navigation channel.

41. The navigation interests desire the improvement of the Trinity River to Liberty to provide an adequate and dependable channel for existing and prospective commerce. In support of the requested improvement the navigation interests state that the location of the adjacent area together with the natural resources that are so readily available to the area are conducive factors for a tremendous industrial development which is a necessary adjunct to water transportation. They also point out that the industrial development is, to a great measure, dependent upon the availability of fresh-water supply in the lower reaches of the river. These interests state that the Anahuac Channel, which is the only existing waterway to the Trinity River, has not sufficient depth and width to permit economical operation of modern barge traffic; that the channel shoals frequently due to the sediment load of the Trinity River which discharges into the inner end of the channel, and that some shoals exist in the Trinity River above its mouth, all of which impede economical barge transportation.

42. The irrigation interests request that any project for improvement of the Trinity River below Liberty provide positive protection against the upstream intrusion of salt water and damage to the fresh water supply in the river channel. In support of the request for protection from salt water intrusion, they point out that the agricultural industries in the immediate area that have been built upon this fresh-water supply must be protected; that rice growing is of major importance to the economy of the tributary area, with an annual gross revenue of over $10,000,000, and that loss of the rice production because of salt water intrusion in the water supply is a serious economic loss to the area.

43. They state that from observation of other navigation developments on the Neches River, Texas, and the Calcasieu River, Mermentau River, and other bayous intersected by deep and shallow draft navigation channels in Louisiana, they are very fearful that salt water will intrude into the Trinity River more quickly and more often than it has done in the past because of deepening the channel and cutting through the bar at the mouth of the river and shoals in the river. The Chairman of the Chambers-Liberty Counties Navigation District states that the Lone Star Canal Company which started operation in 1901 experienced no difficulty from salt water intrusion until the development of the Houston Ship Channel. He further states

that the company found that the salt water moved up the Houston Ship Channel and spread along the west side of Trinity Bay to the western passes into the Trinity River which necessitated a temporary stoppage of irrigation pumping until the "block" of salt water was passed out of the river. He alleges that such intrusion also reached the pumping plant of the Old River Canal Co., (now the Southern Canal Company) and that the continued deepening and widening of the Houston Ship Channel has constantly increased the salt water intrusion. He further states that this condition would have prevailed even if no improvement of any kind had been made on the Anahuac Channel. Local irrigators allege that during the greater part of previous years, the high discharge of the Trinity River created a fresh water "pool" along the east shore of Trinity Bay from the mouth of the river southward and that it is this pool that delayed salt water intrusion in the river during periods of low flow. They state that construction of the Houston Ship Channel, the navigation channel along the bay shore and the recent maintenance dredging of the Anahuac Channel has virtually destroyed the fresh water pool and has aggravated the intrusion of salt water into the river channel. Information concerning the foregoing conditions furnished by the chairman of the navigation district is given in appendix IV.

44. Based on interviews with the local interests several plans of improvement for extending the navigation channel above Anahuac were developed and discussed with the local interests. These plans provided for a lateral navigation canal from Anahuac to Liberty; for a navigation channel in the Trinity River from Anahuac to Moss Bluff and thence to Liberty in a lateral canal protected from river overflows; for a gate control structure in the navigation channel located either below or above Anahuac; for a multiple-purpose reservoir storage by dams across the Trinity River valley at Moss Bluff (river mile 20) and at the Lake Liberty site about 11 miles upstream of Liberty; and for a diversion dam across the Trinity River at mile 3.9 with a gate controlled river diversion channel to Trinity Bay, and a navigation lock in a cutoff channel.

45. In March 1958, the Trinity River Authority of Texas and the Trinity River Improvement Association requested that an investigation be made of the feasibility of providing conservation storage in connection with the improvements considered for advancement of the navigation channel to Liberty and for prevention of salt water intrusion in the lower river. They proposed construction of the Wallisville reservoir as envisioned in the Trinity River Authority's "Master Plan for the Trinity River and Tributaries," to be located just upstream of the town of Wallisville. The reservoir would have a normal water surface at elevation 20, a surface area of about 49,000 acres, and a storage of about 535,000 acre-feet. They state that the conservation storage contemplated in the proposed reservoir is an essential element in any long range plan for the maximum development of the water resources of the Trinity River.

46. Subsequently, in March 1959 the Chairman of the Chambers-Liberty Counties Navigation District proposed that provision be made to provide for three to five feet of storage in connection with the previously considered diversion dam at river mile 3.9 including the gate controlled river diversion channel and navigation lock. The proposed storage to be obtained by means of a levee extending westward from the gate controlled diversion structure across the Trinity River valley to high ground.

WATER PROBLEMS AND SOLUTIONS CONSIDERED

47. Water problems.- In summary of the desires of local interests it is apparent that the principal water problems on the lower Trinity River relate to the prevention of salt water intrusion that would result from the completion of the navigation channel upstream of Wallisville and to the need of providing storage of water for conservation purpose in addition to providing for the further advancement of the navigation project.

48. The intrusion of salt water to the pump intakes of the rice irrigation systems during periods of low flow in the Trinity River has been a problem for a number of years. The intrusion of salt water in damaging proportions has never been reported to have reached the intake of the Richmond Irrigation Co., mile 26.9, and has seldom been reported at the intake of the Devers Canal Co., river mile 20.7. However, excessive salinities have often reached the Chambers-Liberty Counties Navigation District's intake at the mouth of the river and the Southern Canal Co's. intake on Old River which is supplied by diversion from the Trinity River at mile 15.2.

49. A study was made of the salinity records to determine whether any relation existed between the factors of stream flow, pumpage, wind and tide at the several stations. It appears that the stream flow as given by the Romayor gage and the rate of pumpage by the several canal companies are the factors that have most influence on the salinity in the lower Trinity River. From the study of these records, it appears that the water resources in the lower Trinity River during extreme low flow are insufficient to meet the demand for rice irrigation and to prevent intrusion of salt water in the lower river upstream to the intake of the Devers Canal Co. This situation is often aggravated during the late summer when continued strong north winds lower the water surface in Galveston Bay and in the lower river, and subsequent south winds fill the bay and river channel with highly saline water from the lower bay areas. The Chambers-Liberty Counties Navigation District has recourse, during low flows when excessive salinity reaches its river intakes, to water stored in Lake Anahuac. In the past this storage has prevented full loss of rice crops but has not prevented damage from salinity. The upstream canal companies have no recourse except to temporarily dam the river channel below their pump intakes to stop the upstream intrusion of salt water as was done in 1952. Information concerning the study of salinity intrusion in the lower Trinity River is given in Appendix I.

50. The need for additional water supply is general throughout the lower Trinity River basin and adjacent areas including the city of Houston, Texas. The Trinity River Authority of Texas has made a study of the Trinity River basin and proposes a plan for developing the water resources of the basin for all beneficial purposes, including barge navigation from the Houston Ship Channel to Fort Worth, and for additional flood control improvements. The Authority's report states that "a basic premise

in the development of the plan proposed herein is that all of the runoff of the Trinity River and tributaries that can be regulated economically will be required in future years for development in the watershed." The proposed Wallisville multiple-purpose reservoir with storage to elevation 20 is proposed as a unit in the comprehensive plan providing 21 major reservoirs on the water shed, and is the lowermost proposed reservoir.

51. The city of Houston, Texas, has made investigations of the feasibility of constructing a large conservation reservoir on the Trinity River at about river mile 129 and a salt water barrier dam on the lower Trinity River at river mile 4, for the purpose of diverting waters of the Trinity River to meet the present and future industrial water supply needs of the city and adjacent areas. The city of Houston and the Trinity River Authority have been granted a permit by the Texas State Board of Water Engineers to construct the proposed water supply facilities. Officials of the city of Houston have expressed a great interest in the reservoir improvements under consideration in this report and a willingness to participate with the Trinity River Authority and the Chambers-Liberty Counties Navigation District as may be required.

52. A major factor in the economy of the area tributary to the lower Trinity River is the availability of an adequate supply of fresh water to meet the needs of agriculture and industrial expansion which would be afforded by storage in the vicinity of Wallisville. In addition the reservoir storage would be of major importance in affording development of the fish, exclusive of marine fisheries, wildlife and recreational resources of the area.

PLANS OF IMPROVEMENT

53. Plans investigated.- The most feasible plan to meet only the needs of navigation and prevention of salt water intrusion in the lower Trinity River is the plan previously developed in collaboration with the local interests. This plan, referred to as plan A, is reconsidered to show the minimum feasible development for navigation and control of salinity intrusion. Investigation reveals; however, that it would be feasible to provide improvements for navigation and salinity control in combination with the conservation storage reservoirs proposed by the local interests. The development of minimum storage at Wallisville could be accomplished by providing a low dam extending across the Trinity River valley below Wallisville, generally as proposed by the Chambers-Liberty Counties Navigation District. Whereas, the development of larger amounts of storage would be most feasible by higher dams extending across the valley just upstream of Wallisville, as proposed by the Trinity River Authority. Because of site limitations at river mile 3.9 below Wallisville, investigations were made of two plans of reservoir development, designated plans B and C, providing storage to elevation 3 and 4, respectively. The proposed dam upstream of Wallisville at river mile 8.6 is limited by physical site features to a maximum full development providing for reservoir storage to elevation 20. In addition to determining the feasibility of providing maximum development of the site, investigation was made of partial development providing for reservoir storage to elevation 10 and elevation 15. The plans of improvement providing for reservoir storage to elevations 10, 15 and 20 are referred to hereinafter as plans D, E and F, respectively. All plans providing for reservoir storage also provide for extending the authorized navigation channel from its present ending below Anahuac to Moss Bluff including a lock to overcome the vertical lift at the reservoir dam.

54. The salient features of the six plans of improvement investigated are as follows:

Plan A.- For navigation and salinity control. Consists of a navigation lock, a navigation cutoff channel, a river diversion dam and a gate-controlled river diversion channel to provide water storage to elevation 1.0, mean sea level within the banks of the river. At the site below Wallisville.

Plan B.- For navigation, salinity control, water conservation, fish and wildlife, and recreation purposes. Consists of same features as plan A, plus a low overflow spillway dam extending across the flood plain to provide water storage to elevation of 3 feet above mean sea level. At the site below Wallisville.

Plan C.- For navigation, salinity control, water conservation, fish and wildlife, and recreation purposes. Same as plan B, but with water storage to elevation of 4 feet above mean sea level. At the site below Wallisville.

Plan D.- For navigation, salinity control, water conservation, fish and wildlife, and recreation purposes. Consists of a navigation lock, a gated and overflow spillway and a non-overflow dam, with storage to elevation 10 feet above mean sea level. At the site above Wallisville.

Plan E.- Same as plan D, but with water storage to elevation 15 feet above mean sea level. At the site above Wallisville.

Plan F.- Same as plan D, but with only a gated spillway and with water storage to elevation 20 feet above mean sea level. At the site above Wallisville.

55. Considerations in project development.- The development of a multi-purposed reservoir at Wallisville is premised in part on the following:

a. That the Livingston reservoir at river mile 129.2, as proposed by the city of Houston will be constructed.

b. During the critical drought period for determining reservoir yield, there would be no releases of water from Livingston reservoir, and the inflow to the Wallisville reservoirs would be derived solely from the uncontrolled drainage area below the Livingston dam site.

c. The yield of conservation water to be derived from the several reservoirs would be based on the most severe drought period in the lower river, which occurred during the period June 1953 to April 1957.

d. The sediment load entering the Wallisville reservoir would amount to 819 acre-feet per year which would be derived from the uncontrolled drainage area below the Livingston dam including an outflow of about 7 percent of the sediment load entering the Livingston reservoir. This rate of sedimentation in the Wallisville reservoir is based on a study and analysis of the sedimentation factors of the various portions of the Trinity River watershed, which study is given in appendix I.

e. The spillway design flood would be the standard project flood with a discharge of 200,000 cubic feet per second, which is greater than the experienced 35-year flood (114,000 c.f.s.) and about 50 percent of the theoretical maximum probable flood. This is premised on the fact that the locations of the dam sites are near the mouth of the river and the undeveloped area below the site would experience very little damage and probably no loss of life from the occurrence of a greater flood discharge, or in the event of failure of the dam.

f. The plans of improvement under investigation for this report provide for a navigation lock that would serve the authorized channel to Liberty, with a lock basin 84 feet wide and 600 feet long, clear dimensions. In addition the plans of improvement for the three large Wallisville reservoirs provide for a small craft lock having clear basin dimensions of 20 feet wide and 70 feet long for the lockage of pleasure, sports and other small craft through the dam in order to save considerable amounts of water that would be lost by operation of the larger lock for passage of small craft through the dam.

g. A minimum water surface of one foot above mean sea level should be maintained in the river channel above the navigation lock below Wallisville to prevent salt water intrusion upstream through lock operations.

56. The analysis of the six plans of improvement given in paragraphs 78 thru 81 on project formulation results in a determination that plan C offers the most practicable and economic means of providing the present and prospective needs by a reservoir at the lower Wallisville site. This plan meets in full the needs of navigation, salinity control, fresh-water fishery and wildlife conservation, and recreation, and provides for the project to serve its function in an integrated water supply plan. Details of the six plans of improvement are given in appendix II and pertinent features of the facilities provided in plan C are described in the following paragraphs. The location and typical views of the proposed structures are shown on plate 2.

57. Plan C.- Plan C proposes the construction of a dam providing storage to elevation 4.0 mean sea level. The dam would have a total length of 33,900 feet, or about 6.4 miles, of which 13,500 would be non-overflow section with crest at elevation 8.0, and 20,400 feet would consist of a combination gated and overflow spillway section. The non-overflow section would consist of an 8,400 foot long earth embankment extending from high ground in Wallisville to and including a 600-foot long earth diversion dam across the Trinity River at river mile 3.9, a navigation lock, having a paved earth basin 84 feet wide by 600 feet long clear dimensions adjoining the west side of the diversion dam; and an earth (spoil) embankment about 4,400 feet long paralleling the east side of the river diversion channel from the upper gates of the navigation lock to the river diversion control structure. The spillway section would consist of a river diversion control structure about 300 feet long, containing four tainter gates each 40 feet wide and of sufficient height to provide one foot of freeboard above normal reservoir elevation, and a concrete covered earth embankment overflow spillway about 20,100 feet long with crest at elevation 4.

58. A river diversion channel would extend from the Trinity River at about river mile 4.0 southward for a total distance of about 10,000 feet to the north shore of Trinity Bay. The channel would be 275 feet wide throughout its full length with bottom at elevation (-)16 in the approach channel to the gate control structure and the discharge channel would slope upwards from elevation (-)16 at the control structure to elevation (-)9 at Trinity Bay. The control structure would be located about 4,400 feet from the upper gates of the navigation lock, which would permit construction of the overflow spillway generally on natural ground in lieu of locating the spillway across Old River Lake.

59. Plan C would provide a reservoir with a total area of 23,200 acres and a capacity of 55,700 acre-feet. The plan provides for relocating the existing fresh water intake structure at mile 3.6 to a location about one mile upstream of the lock structure and the construction of a delivery canal from the new intake to a connection with the existing canal in Big Hog Bayou, which transports water from the Trinity River to the pump station at Lake Anahuac. The plan also provides for an embankment access road to the Lost Lake Oil field, and, an 18-foot wide bituminous surfaced access road extending on the non-overflow section of the dam from Wallisville to the office building at the lock site including adjoining surface roads to the diversion control structure and to the proposed boat house, and for a recreation area located near State Highway 73 on both sides of the reservoir.

60. Subsurface borings made along the river indicate that it would not be advisable to locate the diversion dam and lock structure in the delta area downstream of the proposed location. Based on available subsurface data it is concluded that the subsurface materials at the lock and dam site consist generally of about five to eight feet of dark grayish silt and clay top soil overlying about 20 feet of fine waterbearing sand. These materials are underlain by a hard blue sandy jointed clay varying in thickness from about 20 to 40 feet, below which exists fine waterbearing sand at least 15 feet thick. The available data indicate that the proposed structures would be bedded in the lower portion of the upper sand strata and that the foundation piles would be based in the hard blue clay strata.

61. Estimated reservoir yields.- The maximum yields to be derived from storage in the several Wallisville reservoirs under investigation were based on a determination of river flows from the uncontrolled drainage area extending between the Livingston and Wallisville Dam sites for the period from 1953 through 1957. There are no records of river flows at either dam site, however, the inflow to the Wallisville reservoir was determined on a drainage area basis from the records of stream flow at the Riverside and Romayor gaging stations at river miles 182.5 and 96.3, respectively.

62. Based on the computed inflows to the Wallisville reservoir, a preliminary determination of the yield from each reservoir was made from the mass curve of inflow. Subsequently, a hypothetical regulation of each reservoir was made for the period September 1940 through September 1958 to substantiate the preliminary evaluation of the yields from the reservoir. Details of this study are given in appendix I and the results are summarized in table 2.

TABLE 2

ESTIMATED YIELDS FROM STORAGE
IN WALLISVILLE RESERVOIRS

Plan of reservoir improvement	Conservation storage (acre-feet)	Estimated yield from reservoir		
		Total yield (MGD)	Use for navigation (MGD)(1)	Net yield (MGD)
A	0	(2)		
B	19,800	48.5	8	40.5
C	42,900	67.8	11	56.8(3)
D	133,800	109.8	2.9	106.9
E	298,000	151.9	3.6	148.3
F	525,300	181.0	3.7	177.3

(1) Net requirements for lockage of commercial navigation and small craft through the reservoir, including salvage from commercial lock operation.

(2) No yield from storage, but would prevent salinity pollution of natural flow.

(3) Includes supply for national wildlife refuge estimated in paragraph 67 as 3.6 m.g.d.

RECREATIONAL DEVELOPMENT

63. The Wallisville reservoir would be centrally located in a complex industrial and agricultural area in the southeast portion of the state of Texas. According to the 1950 census, about 1,485,000 people resided within a radius of 100 miles of the Wallisville reservoir site in the State of Texas. Within this area there are 12 existing major fresh water reservoir lakes having capacities greater than 5,000 acre-feet and 52 smaller reservoirs. Most of the reservoirs are privately owned and do not afford recreational facilities for the general public use. The two largest reservoir lakes, namely Dam B reservoir on the Neches River and Lake Houston on the San Jacinto River, are popular fishing, hunting and boating areas open to the public.

64. Dam B reservoir, constructed and operated by the Corps of Engineers, is located about 80 miles northeast of Wallisville. The reservoir at normal level has a surface area of about 13,700 acres, and provides several public camp and park areas and a boat launching ramp for public use. The management of fish and wildlife resources on the reservoir is being conducted in cooperation with the Texas Game and Fish Commission. An average of 620,000 persons visited Dam B reservoir annually during the last 5-year period. Lake Houston, constructed and operated by the city of Houston, is located about 30 miles west of the Wallisville reservoir. The reservoir has a normal surface area of about 12,800 acres. There are several boat launching ramps and boat trailer parks on the lake, but public parks and camp sites are not provided as much of the lake shore property is privately owned. The lake is a popular fishing and boating area, but no record is available regarding visitor-day attendance at the lake. Within a 100-mile radius of the Wallisville reservoir, there are a number of prospective large storage reservoirs. Of these one is proposed by the City of Houston, eight by the San Jacinto River Authority and two others have been authorized by Congress to be constructed by the Corps of Engineers. Of these last two, one would be located at Ferguson on the Navasota River east of College Station. The other, which is now under construction, is located at McGee Bend on the Angelina River, just north of Jasper. These eleven reservoirs will have a total water surface area estimated at about 520,000 acres.

65. The foregoing indicates that several large existing and proposed storage reservoirs will provide additional recreational areas in the 100-mile zone. However, in view of the prospective population of about 10 million people by the year 2010, it is believed that the recreational opportunities to be afforded by the Wallisville reservoir and its proximity to the large population in the city of Houston would be attractive to a large number of these people, and development of the recreational potential of the reservoir would be of considerable interest to the general public. Two recreational areas are proposed in conjunction with the reservoir development proposed under plan C. The estimates of use of the reservoir area for recreation are given in appendix III.

NATIONAL WILDLIFE REFUGE

66. The report of the Bureau of Sport Fisheries and Wildlife, appended hereto as exhibit III, shows that the proposed Wallisville reservoir site is favorably located with respect to major waterfowl wintering grounds, and that it would be feasible to develop selected portions of the project land and water areas for waterfowl management in the interest of conservation of waterfowl in the Central Flyway. The Bureau of Sport Fisheries and Wildlife recommends that a national wildlife refuge be provided in conjunction with the reservoir development considered in plan C of this report. The proposed refuge would have a total area of about 17,455 acres, of which about 10,730 acres would be within the Wallisville reservoir as shown on plates 1 and 2 accompanying this report. The area of the refuge outside of the reservoir area of approximately 6,725 acres consists of 3,560 acres of lowlands adjoining the north limits of the reservoir, bounded on the east and north generally by the authorized (uncompleted) navigation channel, and 3,165 acres of uplands adjoining the west side of the reservoir and bounded on the west by State Farm to Market highways 565 and 1409. The south portion of the refuge would be bounded generally by State Highway 73.

67. It is reported that the additional lands are required for buffer zone to provide protection for the waterfowl wintering on the refuge and to provide for the growing of feed and forage crops for the ducks and geese. It is proposed that storage of 4,000 acre-feet of water annually or an average of 3.6 m.g.d. be provided from the Wallisville reservoir for use in the growing of feed crops, and that the reservoir be operated for waterfowl management by maintaining a reservoir drawdown of six inches during the summer months. Development of the refuge would provide for a general headquarters area consisting of several residences, service building with office, equipment storage building, shop and associated utility facilities and structures; for fencing and posting of the refuge area; for construction of roads and trails as may be required, minimum recreational facilities; and for food production areas, green tree reservoir areas and marsh areas including control structures.

68. All lands and water areas within the refuge boundary would be made available to the Secretary of the Interior under 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. Development of the refuge including the annual cost of maintenance and operation would be assumed by the Bureau of Sport Fisheries and Wildlife. It is recommended that the Federally owned land and project waters of the Wallisville reservoir be open to free use for hunting and fishing except for sections reserved for waterfowl management, safety, efficient operation, and protection of public property. Additional detailed studies of the fish and wildlife resources of the project area would be conducted by the United States Fish and Wildlife Service and the Texas Game and Fish Commission after the project is authorized, and any proposed modification of the project would be subject to agreement by the Secretary of the Interior, the Executive Secretary of the Texas Game and Fish Commission and the Chief of Engineers, United States Army.

ESTIMATES OF FIRST COST

69. First cost - Wallisville reservoirs.- Detailed estimates of first cost have been prepared for each of the six plans of reservoir improvement considered in this report. The unit prices used in the estimates of first cost are based on the experienced costs of similar work in the district during October 1959, adjusted for differentials due to location of the improvements. A summary of the total estimated first cost, including contingency cost, of the principal features of each improvement, is shown in table 3. The cost of acquisition of reservoir lands shown in table 3 reflects the productivity value of the lands, less mineral rights, under present and expected future development during the life of the improvements. The extent of work to be done by Federal and non-Federal interests regarding the plan of improvement recommended in this report are set forth in paragraphs 90 and 91.

70. First cost - national wildlife refuge.- The total first cost of the national wildlife refuge recommended by the Bureau of Sport Fisheries and Wildlife is estimated at $2,458,000, details of which are given in table 4, appendix II, which are summarized as follows:

Refuge lands outside of the Wallisville reservoir	$1,136,000
Refuge development	612,000
Subtotal, refuge outside of Wallisville reservoir	1,748,000
Refuge area common to Wallisville reservoir (1)	710,000
Total first cost of national wildlife refuge	2,458,000

(1) The first cost of these lands is also included in the total first cost of the Wallisville reservoir given in table 3 for plan C only, and is included in the cost of the refuge for the purpose of determining the economic justification of the refuge.

TABLE 3

ESTIMATED FIRST COSTS

COVERING SIX INVESTIGATED PLANS OF IMPROVEMENT

WALLISVILLE RESERVOIR

(OCTOBER 1959 PRICE LEVEL)

	ITEM	PLANS INVESTIGATED					
		PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F
Estimated first cost							
(01.0)	Lands and damages	$ 34,900	$1,235,400	$1,480,800	$ 2,470,800	$ 3,531,300	$ 5,036,200
(02.0)	Relocations	68,700	127,600	140,900	5,527,900	8,868,100	18,548,300
(03.0)	Reservoir clearing	-	-	-	351,000	362,000	662,000
(04.0)	Dams	-	379,300	478,200	8,700,900	8,843,000	14,601,000
(05.0)	Locks	2,981,500	2,981,500	2,981,500	7,178,500	7,800,100	8,901,100
(08.0)	Roads, railroads and bridges	272,400	282,700	282,700	431,700	456,100	470,700
(09.0)	Channels and canals	963,500	991,600	991,600	692,600	609,600	893,400
(14.0)	Recreation	-	350,000	350,000	1,191,500	1,410,400	1,371,500
(15.0)	Floodway control and diversion structures	1,234,100	1,552,400	1,589,200	-	-	-
(19.0)	Buildings, grounds and utilities	151,500	151,500	151,500	149,000	149,000	149,000
(20.0)	Operating equipment for reservoir	-	-	-	5,000	5,000	5,000
(29.0)	Preauthorization studies	35,000	35,000	35,000	35,000	35,000	35,000
(30.0)	Engineering and design	340,300	409,000	417,900	1,442,400	1,698,900	2,725,000
(31.0)	Supervision and administration	455,800	548,000	545,700	1,897,200	2,234,300	3,431,000
	Subtotal (Items 01.0 thru 31.0)	6,537,700	9,044,000	9,445,000	30,073,500	36,002,800	56,829,600
	U. S. Coast Guard	-	53,000	53,000	53,000	64,000	64,000
	Total estimated first costs	6,537,700	9,097,000	9,498,000	30,126,500	36,066,800	56,893,600

ESTIMATES OF ANNUAL CHARGES

71. Annual charges - Wallisville reservoir.- The detailed estimates of investment and annual charges for each of the six investigated plans of improvement are summarized in table 4. The investment costs are based on an interest rate of 2.5 percent for one-half the construction period given in table 4 for each improvement. The annual charges for each improvement are based on a useful life of 50 years. The annual cost of operation for the navigation lock is based on 24-hour operation throughout each day of the year. The annual cost of maintenance and operation of the structures considered in the various investigated plans were based on experienced costs of similar existing reservoir projects of the Corps of Engineers in Texas.

72. Annual charges - national wildlife refuge.- The annual charges for the national wildlife refuge are estimated at $195,700, details of which are given in table 5, appendix II. In determining the annual charges, the investment costs are based on a 3-year construction period and an interest rate of 2.5 percent for one-half the construction period, which is the same basis for construction of the Wallisville reservoir considered in plan C. The annual charges are based on a useful life of 50 years. The annual cost of maintenance and operation of the refuge is based on data given in the Bureau of Sport Fisheries and Wildlife report, appended hereto as exhibit III. The gross investment and annual charges for the national wildlife refuge is as follows:

a. Investment cost

(1) Estimated first cost of national wildlife refuge----------	$2,458,000
(2) Interest during construction ($2,458,000 x 2.5% x 18 mos.)---	92,200
(3) Total gross investment----------	2,550,200

b. Estimated annual charges

(1) Interest on total gross investment ($2,550,200 @ 2.5%)----------	$ 63,800
(2) Amortization of total gross investment ($2,550,200 @ 1.03%) ------	26,200
(3) Estimated cost of maintenance and operation of refuge ----------	105,700
(4) Total estimated annual charges for refuge (1) ----------	195,700

(1) This includes charges for the portion of the refuge area within the reservoir as given in table 4 for plan C only, and is included in the cost of the refuge for the purpose of determining the economic justification of the refuge.

TABLE 4

ESTIMATED INVESTMENT COSTS AND ANNUAL CHARGES

COVERING SIX INVESTIGATED PLANS OF IMPROVEMENT

WALLISVILLE RESERVOIR

(OCTOBER 1959 PRICE LEVEL)

ITEM	PLANS INVESTIGATED					
	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F
1. Investment cost						
(a) Construction period, months	36	36	36	60	60	60
(b) Estimated first cost	$6,537,700	$9,097,000	$9,498,000	$30,126,500	$36,066,800	$56,893,600
(c) Interest during construction	245,200	324,200	339,200	1,794,900	2,149,900	3,454,600
(d) Gross investment	6,782,900	9,421,200	9,837,200	31,921,400	38,216,700	60,348,200
2. Estimated annual charges						
(a) Interest (2½%) on gross investment	169,600	235,500	245,900	798,000	955,400	1,508,700
(b) Amortization (1.026)	69,900	97,000	101,300	328,800	393,600	621,600
(c) Maintenance and operation (including replacement of parts)	136,200	161,100	161,100	182,900	170,800	203,200
(d) Advanced replacement of aids to navigation	-	3,600	3,600	3,600	4,300	4,300
3. Total - Estimated annual charges	375,700	497,200	511,900	1,313,300	1,524,100	2,337,800

ESTIMATES OF BENEFITS

73. Investigation reveals that the five reservoir improvements considered in this report as plans B through F, would provide benefits attributable to navigation, salinity control, water supply, fish and wildlife, and recreation. Plan A would provide benefits attributable to navigation and salinity control. The annual benefits attributable to the several project purposes to be provided by the investigated improvements were evaluated on the following basis:

a. Navigation - The navigation benefits are based on the savings in transportation costs that would be realized by transporting the prospective commerce of 650,000 tons annually in fully loaded barges on the 9-foot project channel to its connection with the Houston Ship Channel near Red Fish Bar in lieu of transporting the commerce in partially loaded barges via the existing 6-foot Anahuac Channel, thence across Trinity and upper Galveston Bays to a connection via Five-Mile Cut with the Houston Ship Channel.

b. Salinity control - The salinity control benefits are based on preventing the loss of rice yield and grade that results from the use of irrigation water from the Trinity River that has been polluted by intrusion of salt water from Galveston Bay.

c. Water supply - The measure of the water conservation benefits creditable to the several Wallisville reservoir improvements is based on the value of 6.75 mills per 1000 gallons determined by the United States Public Health Service, in its study of the municipal and industrial water needs of the area served by the Wallisville reservoir. The benefits to water supply also include a reduction in pumping costs resulting from the decrease in pumping head to be provided by the several reservoirs at the proposed city of Houston's pumping plant, and for the three larger reservoirs, the value of lock waste water salvaged by means of sluice gates through the lock wall discharging into an adjoining storage reservoir.

d. Fish and wildlife - The benefits to fish and wildlife considered in this report relate to the fresh-water commercial fisheries aspect of the investigated reservoir improvements and to the conservation of wildlife on the portions of the reservoir considered in plan C that would be common to the proposed national wildlife refuge. The values of these benefits are based on the findings of a study of the Wallisville reservoirs made by the Bureau of Sport Fisheries and Wildlife. Fish and wildlife benefits from the standpoint of increased hunting and fishing are considered to be recreational benefits and are included under item e "Recreation".

e. Recreation - Recreation benefits are those derived from use of the project areas by the public for sport fishing, hunting, picnicking, water sports and other outdoor activities. The benefits of a facility for recreation are based on a value for one user-day times the total number of user-days. The differences in the benefits under unimproved conditions and under improved conditions for each proposed plan are considered to be the benefits of the improvement. The estimates of the value of one user-day and the number of user-days for sport hunting and fishing and other recreational activities based on available records of attendance at existing reservoirs in Texas, are given in appendix III. The recreation benefits of the reservoir under plan C include an increment of benefits from the wildlife refuge proposed by the Bureau of Sport Fisheries and Wildlife.

74. Detailed information concerning the analyses and methods used in determining and evaluating the annual benefits creditable to the reservoir improvements under investigation is given in appendix III. A summary of the estimated annual benefits is given in table 5.

TABLE 5

SUMMARY OF ESTIMATED ANNUAL BENEFITS
WALLISVILLE RESERVOIRS

Type of benefit	Estimated annual benefits in $1,000 units (1)					
	Plan A	Plan B	Plan C	Plan D	Plan E	Plan F
Navigation	376.0	376.0	376.0	376.0	376.0	376.0
Salinity control	250.0	250.0	250.0	250.0	250.0	250.0
Water supply	-	105.0	140.5	289.5	408.9	491.8
Fish & Wildlife(2)	-	30.0	104.3	(-)7.0	(-)8.0	(-)9.0
Recreation (3)	-	473.0	538.3	591.0	767.0	852.0
Total	626.0	1234.0	1409.1	1499.5	1793.9	1960.8

(1) The annual benefits given in table 5 for plans A, B, D, E and F do not include refuge area wildlife management benefits.

(2) Conservation fresh-water commercial fishery type benefits.

(3) Includes hunting and fishing benefits.

75. Benefits of wildlife refuge.- The report of the Bureau of Sport Fisheries & wildlife, exhibit III, points out that the benefits which will accrue from a waterfowl refuge are impossible to evaluate monetarily, for in addition to the improved waterfowl hunting locally, the refuge will provide a much-needed wintering area for waterfowl in the Central Flyway.

76. The report evaluates the benefits from waterfowl hunting on the Wallisville reservoir considered in plan C without the additional refuge lands and developments at $89,000 and with the proposed refuge at $150,000 annually. It is therefore considered that the proposed refuge would result in an increase of $61,000 annually in the benefits attributable to the local waterfowl hunting on the combined areas of the Wallisville reservoir and the refuge lands adjoining the reservoir. On an areal basis for distribution of these benefits the refuge is credited with $35,600. The Wallisville reservoir is credited with an additional $47,300 annually in increased hunting benefits that could result from the refuge.

77. The conservation benefits of the national wildlife refuge are said to be at least equal to the total cost of refuge and on this basis would total $195,700 annually, as shown in appendix III. Distribution of these benefits on a first cost of refuge land basis would credit the reservoir with an additional $75,300 annually in increased wildlife conservation benefits that would result from the refuge. The total combined benefits attributable to the wildlife refuge is estimated at $231,300. A comparison of the estimated annual benefits of $231,300 with the estimated annual charges of $195,700 shows that the national wildlife refuge has a favorable benefit-cost ratio of 1.2.

78. Comparison of costs and benefits.- The average annual benefits, the annual charges, the annual benefits in excess of annual charges, and the ratio of benefits to charges for the six investigated plans of improvement at the Wallisville site, based on October 1959 price level, are summarized in table 6. The comparison in table 6, shows that each investigated improvement except plan F has a favorable benefit-cost ratio on an overall project basis. On the basis of the estimates of benefits and costs in this report, plan C affords a maximum excess of benefits over costs and has the maximum benefit to cost ratio.

TABLE 6

SUMMARY OF ECONOMIC JUSTIFICATION
(In thousands of dollars)

Item	Investigated plans of improvement					
	Plan A: 1.0(1)	Plan B: 3.0(1)	Plan C: 4.0(1)	Plan D: 10.0(1)	Plan E: 15.0(1)	Plan F 20.0(1)
Annual benefits	626	1,234	1,409	1,499	1,794	1,961
Annual charges	376	497	512	1,313	1,524	2,338
Benefits in excess of cost	250	737	897	186	270	(-)377
Ratio of benefits to charges	1.7	2.5	2.8	1.1	1.2	0.8

(1) Reservoir storage to elevation above mean sea level.

79. A comparison of the excess of benefits over charges for the six investigated improvements and the incremental excess benefits of the several plans are given in table 7. The data in table 7 indicate that the cost of adding the last increment of one foot in the scale of development to plan C nearly equals the added benefits resulting from that increment. At this point of development, the incremental benefits still exceed incremental costs. Extension of the scale of development from the four-foot storage contemplated under plan C to the development under plan D would require expenditures in excess of the benefits added and such extension, on a purely evaluated monetary basis, would not be economically justified.

TABLE 7

COMPARISON OF EXCESS OF BENEFITS
VERSUS INCREMENTAL BENEFITS
(In thousands of dollars)

Plan of improvement	Benefits in excess of costs	Incremental excess benefits
Plan A (storage to 1 foot)	250	250
Plan B (storage to 3 feet)	737	487
Plan C (storage to 4 feet)	897	160
Plan D (storage to 10 feet)	186	(-)711
Plan E (storage to 15 feet)	270	84 (1)
Plan F (storage to 20 feet)	(-)377	(-)647

(1) Equivalent to (-) 620 when compared to plan C.

80. The multiple purpose reservoirs investigated for this report would provide functional facilities for navigation, salinity control, water supply, fresh-water fish and wildlife conservation and recreation. A portion of the project reservoir considered in plan C would also serve in conjunction with the proposed national wildlife refuge. Analysis of the benefits and separable costs for each of the project purposes under plan C shows that the separable costs are economically justified. A comparison of the annual benefits and separable costs on an annual basis of plan C, which is summarized from table 15, appendix III, is given in table 8.

TABLE 8

COMPARISON OF BENEFITS AND SEPARABLE COSTS
OF PROJECT PURPOSES IN THE
WALLISVILLE RESERVOIR, PLAN C
(In thousands of dollars)

Project purposes	Annual Benefits	Annual equivalent separable costs
Salinity control	250.0	0
Navigation	376.0	71.0
Water supply	140.5	0
Fish and wildlife	104.3	0
Recreation	538.3	24.1
Total	1409.1	95.1

81. Pertinent information regarding the economic analysis of plan C including detailed data concerning allocation of project costs by the separable costs remaining benefits method are given in appendix III. In view of the foregoing economic analysis, plan C is considered to be the most economical plan for development of a multiple purpose reservoir at the Wallisville site. Accordingly, plan C is recommended for Federal construction in this report.

82. The officials of the Trinity River Authority and the Chambers-Liberty Counties Navigation District, who would be responsible for local cooperation, have agreed that the multiple purpose reservoir proposed for construction in accordance with plan C would meet their present needs and requirements, and propose that plan C be recommended for adoption as a Federal project.

LOCAL COOPERATION

83. Proposed local cooperation.- The requirements of local cooperation for construction of the multiple-purpose Wallisville reservoir as considered in plan C, are based on present Federal policies regarding local cooperation. The proposed reservoir and dam are considered for construction by the Federal Government subject to local cooperation consisting of a contribution of a portion of the first cost and annual maintenance cost. The local share of first cost, based on the separable cost remaining benefit method of cost allocation; as outlined in paragraphs 87 through 91, is presently estimated at $1,890,000. The local share of annual maintenance and operation cost is presently estimated at $30,600 annually.

84. For the improvement of the navigation channel, exclusive of the reservoir features, the local interests are required to furnish the items of local cooperation in the authorized channel to Liberty, which are specified in House Document No. 403, 77th Congress, 1st session, and House Document No. 634, 79th Congress, 2nd session.

85. The city of Houston, Trinity River Authority, and the Chambers-Liberty County Navigation District by letter dated February 18, 1960, have agreed to provide all proposed items of local cooperation. A copy of the letter of intent signed jointly by the responsible officials of these agencies is presented in exhibit I. Subsequent to receipt of the referenced letter, the local interests were advised that their share of the first cost and the annual maintenance, operation and major replacements costs required for the multiple-purpose Wallisville reservoir given in the referenced letter would be increased as recommended in this report. The local interests stated that the costs given in their letter were considered as preliminary costs, and that they would provide for the total costs apportioned to the local interests in accordance with this report. Accordingly, it is considered that the local political bodies are willing and financially able to provide the proposed cooperation.

ALLOCATION OF COSTS AMONG PURPOSES

86. The first cost and annual maintenance, operation and major replacement costs of the multiple purpose Wallisville reservoir proposed under plan C is estimated at $9,498,000, and $164,700 respectively. The total costs of the project have been allocated between the following purposes: salinity control, navigation, water supply, fish and wildlife and recreation in accordance with the separable costs-remaining benefits method. Detailed data concerning the allocation of project costs to the several purposes are given in table 18, appendix III, which are summarized in table 9.

TABLE 9

ALLOCATION OF PROJECT COSTS

PLAN C

Purpose	Allocated first cost	Allocated annual maintenance operation and replacement cost
Salinity control	$1,720,900	$27,900
Navigation	4,200,900	75,000
Water supply	967,000	15,700
Fish and wildlife	715,600	11,700
Recreation	1,893,600	34,400
Total	9,498,000(1)	164,700

(1) Includes preauthorization cost of $35,000.

APPORTIONMENT OF COST AMONG INTERESTS

87. The costs of the multiple purpose Wallisville reservoir as considered in plan C are apportioned between the Federal Government and non-Federal interests on the principal of utility and in accordance with existing policies. All Federal costs of the proposed multiple purpose reservoir are apportioned to the Corps of Engineers except the cost of aids to navigation which are apportioned to the U. S. Coast Guard. The maintenance and operation of the proposed reservoir would be the responsibility of the Corps of Engineers, but the cost of such maintenance and operation would be apportioned to Federal and non-Federal interests in accordance with the apportionment of allocated costs.

88. The apportionment of costs is made on the following basis:

a. Salinity control.- The cost allocated to salinity control is apportioned equally to the United States and the local interests on the grounds that salinity intrusion in the lower Trinity River is caused by the navigation improvements in the local and adjacent waters and by the natural conditions in Galveston Bay and adjacent waters. As discussed in paragraph 64, appendix III the Livingston Reservoir to be constructed by the local interests will afford a natural benefit in salinity control on the lower Trinity River, and accordingly an equitable share of the cost of the Wallisville reservoir, which would realize the remaining benefits from salinity control, should be borne by the United States. It is considered that equal shares of the costs allocated to salinity control should be apportioned to the Federal Government and the local interests.

b. Navigation.- The cost of lands and rights-of-way for navigation purposes outside of the reservoir and dam is apportioned to the non-Federal interests, and the remaining allocated costs to navigation would be borne by the Federal Government of which the United States Coast Guard would provide for the cost of necessary aids to navigation.

c. Water supply.- The total allocated cost of water supply is assigned to the non-Federal interests.

d. Fish and wildlife.- The Federal Government would provide for the total allocated first cost for conservation of fish and wildlife.

e. Recreation.- The apportionment to the Federal Government of the allocated first cost of recreation would be limited to the separable cost of the minimum recreation facilities plus a portion of the joint project costs equal to 15 percent of the total project costs, as shown in the separable cost remaining benefits method of cost allocation. Apportionment of the allocated first cost of the recreation purposes to the non-Federal interests would equal the total allocated first cost of the recreation purpose minus the amount apportioned to the Federal Government.

89. Based on the proposed apportionment set forth in the above paragraph, the apportionments of the allocated first costs and the estimated annual cost of maintenance and operation of the multiple-purpose project in plan C, are shown in table 10.

TABLE 10

APPORTIONMENT OF ALLOCATED FIRST COSTS AND ANNUAL MAINTENANCE AND OPERATION COSTS
PLAN C

Purpose	Allocated total cost	Federal Government: Corps of Engineers	Federal Government: U.S. Coast Guard	Non-Federal interests
FIRST COST				
Salinity control	$1,720,900	$860,450	-	$860,450
Navigation	4,200,900	4,147,200	$53,000	700
Water supply	967,000	-	-	967,000
Fish and wildlife	715,600	715,600	-	-
Recreation	1,893,600	1,830,800	-	62,800
Total	9,498,000	7,554,050	53,000	1,890,950
ANNUAL COST OF MAINTENANCE AND OPERATION				
Salinity control	$27,900	13,950	-	13,950
Navigation	71,400	66,500	4,900	-
Water supply	15,700	-	-	15,700
Fish and wildlife	11,700	11,700	-	-
Recreation	34,400	33,400	-	1,000
Total	161,100	125,550	4,900	30,650
ANNUAL COST OF MAJOR REPLACEMENT				
Salinity control	-	-	-	-
Navigation	3,600	-	3,600	-
Water supply	-	-	-	-
Fish and wildlife	-	-	-	-
Recreation	-	-	-	-
Total	3,600	-	3,600	-

90. The total first cost of the Wallisville reservoir project considered in plan C is estimated at $9,498,000, which includes $35,000 preauthorization cost, $53,000 for aids to navigation apportioned to the United States Coast Guard, and $248,000 of previously authorized new work for the navigation channel. The cost of $248,000 covers the portion of the authorized navigation channel considered in this report for advancement of the navigation project upstream of its present ending about one mile below Anahuac to the Wallisville reservoir. The new work involved from one mile below Anahuac to the Anahuac Channel was authorized by the River and Harbor Act of July 24, 1946 (H.D. 634, 79th Cong., 2d Sess.).

The portion of the channel from the Anahuac Channel upstream to Liberty was authorized by the River and Harbor Act of March 2, 1945 (H.D. 403, 77th Cong., 1st Sess.). The cost of the authorized new work is included in the total cost considered in this report for economic analysis of the Wallisville reservoir, but is excluded in determining the additional first cost recommended for authorization. The Federal first cost of additional work to be performed by the Corps of Engineers, as recommended in this report, is $9,162,000, excluding $35,000 for preauthorization studies, $53,000 for navigation aids and $248,000 for previously authorized new work on the authorized navigation channel. The cost of maintenance and operation apportioned to the United States amounts to $130,450 of which $125,500 is assigned to the Corps of Engineers and $4,900 is assigned to the U. S. Coast Guard. The Federal first cost of maintenance and operation to be performed by the Corps of Engineers as recommended in this report is $156,200 which includes the share of local cost of $30,650 and excludes $4,900 to be done by the Coast Guard. The cost of major replacements for renewal of aids to navigation apportioned to the United States amounts to $3,600 annually which is assigned to the U. S. Coast Guard. The total annual cost to be borne by the U. S. Coast Guard is $8,500 of which $4,900 would be for maintenance and operation of aids to navigation and $3,600 for replacement of aids to navigation.

91. The first cost share to be repaid by local interests totals $1,890,950, which includes $700 for lands for navigation improvements outside of the dam and reservoir. The cost of $700 is the estimated cost to local interests for the requirements of local cooperation in the advancement of the authorized navigation project. The cost of $700 is included in the total cost considered in this report for economic analysis of the Wallisville reservoir, but is excluded in determining the first cost of $1,890,250 to be repaid by the local interests as an item of local cooperation in the Wallisville reservoir project. The share of the annual costs for maintenance and operation to be repaid by the local interests totals $30,650.

COORDINATION WITH OTHER AGENCIES

92. Federal, State and local agencies, business and industrial concerns, and others known to have an interest in the improvement of the lower Trinity River were notified of the public hearings held at Liberty, Texas. They were invited to be present at the hearing and to present their views and desires regarding the improvements they advocated and to file for the record any briefs on proposals in connection therewith.

93. In the preparation of this interim report, procedures for coordination with other interested Federal agencies have been followed. In August 1959 a letter was addressed to each regional office of the Federal Inter-Agency River Basin Committee having jurisdiction covering any part of the Galveston District, advising the regional agency of the status of the Wallisville reservoir investigations and requesting a statement of the interest the agency had in the investigations. The following agencies indicated an interest in the Wallisville reservoir investigations: The Bureau of Sport Fisheries and Wildlife and the Bureau of Commercial Fisheries of the U. S. Fish and Wildlife Service, U. S. Public Health Service, Bureau of Reclamation, Bureau of Mines, Southwest Field Committee, Region SIX, U. S. Geological Survey, Federal Power Commission, Soil Conservation Service, Forest Service-Southern Region, and the Game and Fish Commission of Texas.

94. The Regional Office of the Bureau of Sport Fisheries and Wildlife was requested to prepare a report on the fresh-water fisheries and wildlife resources in relation to the Wallisville reservoirs under investigation which accompanies this report as exhibit III. The Bureau of Sport Fisheries and Wildlife finds that the proposed reservoir would be beneficial to fish and wildlife resources of the area and recommends that a national wildlife refuge be provided in conjunction with the Wallisville reservoir project. The findings and recommendations of the Bureau of Sport Fisheries and Wildlife have been incorporated in this report.

95. The U. S. Public Health Service prepared a report on the need for municipal and industrial water in the nearby Beaumont-Port Arthur-Houston, Texas City and Galveston areas, and the value of water supply that could be provided by storage in the Wallisville reservoir. A copy of the U. S. Public Health Service report on the Wallisville reservoir is presented in exhibit II of this volume. The findings of the U. S. Public Health Service have been incorporated in this report.

96. Copies of this report have been forwarded to the interested Federal and State agencies at regional level for their formal views and comments. These views and comments and the District Engineer's answers thereto are presented in toto in exhibit I of this volume. The views and comments of the other agencies concerning this report are summarized briefly as follows:

a. National Park Service.- The Assistant Regional Director, by letter dated April 1, 1960 advises that they nave no comments to offer regarding this interim report.

b. Department of Health, Education and Welfare.- The Regional Program Director, Water Supply and Pollution Control, by letter dated April 1, 1960, suggested rewording of a sentence in paragraph 56 of the text of this interim report and amending paragraph 71 of appendix III. These suggestions have been incorporated in this report.

c. Federal Power Commission.- The Regional Director, by letter dated March 31, 1960, advises that upon consideration of the comparatively low power head that would be provided by the project and the relatively nominal water yield that would be available for power purposes from uncommitted storage to be impounded by the reservoir, there appears to be little opportunity for an economical power development as an adjunct to the proposed project. Also, the project would not affect any existing or potential hydro power resource. He advises that his comments are not to be construed as those of the Federal Power Commission.

d. Bureau of Mines, Region IV.- The Regional Director, by letter dated March 29, 1960, advises that it appears that the Corps of Engineers has carefully considered the mineral industries of the area, and proposes, under plan C, adequate protecitve measures to prevent damages to mineral resources. It is further stated that the development of the project will provide water that may be useful to the mineral industry.

e. Bureau of Reclamation.- The Acting Regional Director, by letter dated April 1, 1960, advises that the proposed reservoir would not adversely affect any existing or authorized Bureau of Reclamation project, that the report recognizes the plans for a coastal canal to deliver water supplies from eastern Texas basins to western areas of water deficiency, and that the Bureau offers to cooperate in the necessary planning for incorporation of the Wallisville reservoir in the coastal canal plan prior to construction of the Wallisville reservoir.

f. U. S. Study Commission - Texas.- The Executive Director by letter dated April 4, 1960, advises that the interim report bears on matters specifically under consideration by the Commission. However, project planning studies have not as yet been initiated, and in view thereof no comments on the subject report can be made at this time.

g. Bureau of Commercial Fisheries.- The Laboratroy Director, Biological Laboratory, by letter dated March 30, 1960, advises their comments on the subject interim report would be incorporated in the combined comments representing the views of the U. S. Fish and Wildlife Service.

h. Bureau of Sport Fisheries and Wildlife.- The Acting Regional Director, by letter dated April 8, 1960, comments on a number of proposed revisions to the subject interim report considered necessary to reflect the revised previous information on the national wildlife refuge and to clarify reference and data in the report relating to fish and wildlife. The proposed revisions have been incorporated in this report. The Director states that the report of the Bureau of Sport Fisheries and Wildlife, appended as exhibit III, is confined only to the fresh-water fishery and wildlife aspects, and does not reflect effects of the project upon the marine fisheries. The Acting Regional Director states that the Bureau of Commercial Fisheries

advises that no investigation has been made of the marine commercial fishers relative to the Wallisville reservoir, however, it is proposed to make adequate study of this phase of the reservoir project when funds become available.

i. Soil Conservation Service.- The River Basin Representative, by letter dated April 12, 1960, advises that the letter from the State Conservationist, Texas, constitutes the comments of the Department of Agriculture on the subject interim report, and that the Forest Service indicated it has no comments on the report. The State Conservationist in letter dated April 6, 1960, comments on phases of the subject report relating to hydrology, sedimentation, economics, drainage and irrigation and suggests minor revision to paragraph 38 of the text of subject report. With respect to hydrology the State Conservationist states that no consideration was given to the possibility that floodwater retarding structures might be constructed above the Wallisville reservoir, that four of the structures may be constructed between the Wallisville and Livingston reservoirs, and that the tentative data for the four structures show that the total effect of these structures on the operation of the Wallisville reservoir would be negligible.

Regarding sedimentation, the State Conservationist advises that the estimates of sediment delivered to the Livingston and Wallisville sites, as given in the interim report appear to be reasonable and in close agreement with the findings of the Soil Conservation Service. Comments on the storage allocated to sediment in the Wallisville reservoir project are based on the assumption that such storage was determined without considering the Livingston reservoir in place and it is contemplated that the remaining sediment storage in the Wallisville reservoir will be utilized for irrigation or other beneficial purposes following construction of the Livingston reservoir.

The comments on economics questions the advisability of excluding the net benefit from irrigation storage in the selection of the project reservoir, plan C, which is concluded to equal or exceed the benefit of storage for municipal and industrial supply, and proposes that the net worth of irrigation storage be evaluated. It is stated that the interim report does not indicate that the irrigation needs of agriculture have been provided for adequately; information is presented regarding the presently irrigated cropland in Chambers, Jefferson and Liberty Counties and it is concluded that the projected irrigation requirements will be considerably greater by the year 2010. It is suggested that adjustment of storage allocations for conservation and irrigation purposes be considered to provide for future needs. It is further suggested that consideration should be given to the needs of water users upstream as well as those downstream of the project whereby the subject interim report would aid the State Board of Water Engineers to make a realistic allocation of water rights.

With respect to drainage and irrigation, the State Conservationist advises that it appears that there will be no adverse effects to the major drainage outlets in the Lower Trinity Soil Conservation District as a result of the Wallisville reservoir project. Regarding irrigation it is concluded that the present quality of irrigation water would be maintained and salt water intrusion would be prevented with installation of the salt water barrier. Also, the minimum pumping level during low flows would be raised to the level of the reservoir lake, thus reducing pumping costs.

The State Conservationist has been advised regarding his comments on the interim report as per copy appended to exhibit I, and the proposed revisions have been incorporated in this report.

97. This report considers the feasibility of developing improvements that would provide positive protection against the upstream intrusion of salt water in the Trinity River that would accompany the further completion of the authorized navigation channel upstream from its present ending about one mile below Anahuac, Texas, and for reservoir storage to meet the urgent need for additional water-conservation facilities in the local and adjacent areas. Investigation and studies for this report show that it is feasible to provide a multiple-purpose reservoir at Wallisville, Texas, which would provide for salinity control, navigation and water supply and in addition would afford opportunities for the development of fish and wildlife resources of the area and for recreation.

98. A suitably located reservoir in the lower Trinity Valley may have additional potential value to facilitate the intracoastal distribution of water in Texas. Studies of the future water needs of Texas indicate that future economic expansion of the south and west coastal areas will require large additional water supplies; provision of needed supplies by storage is expensive and will become more so as the demand increases in the future. The eastern section of the State has more abundant supplies for current use and the easterly rivers, the Sabine and Neches, will have water resources that will exceed local interbasin demands, at least for a long time. Although current studies will have to be carried further to give a full answer, it appears that future demands may require the intracoastal transportation of water from the eastern part of the State southwestward to the regions deficient in supply. In such a diversion system a reservoir at Wallisville could receive in storage the water moved westward from the Neches River and serve as a pondage area for the pumps that would move the water on westward toward the deficient areas. Moreover, it would take the place of some alternate means of crossing the Trinity Valley by canal or siphon. The evaluation of the usefulness of the Wallisville reservoir in such a future system of water transportation is not possible at this time. However, if so used, the Wallisville project would have economic value over and above that shown in this report. It is expected that current studies of the various agencies concerned, coordinated through the U. S. Study Commission for Texas, will result in definite conclusions relative to the desirability of a future East-West diversion prior to the time the Wallisville project could be put under construction. Therefore, this aspect can be considered further during the pre-construction planning phase and included if appropriate.

99. The economics of completing the authorized navigation channel to Liberty were not considered in the investigations made for this report. At present there is very little commerce to and from Liberty, Texas, and the demand of prospective commerce is not sufficient at this time to warrant construction of the channel above Moss Bluff. Accordingly, the economic analysis in this report is limited to a study of the feasibility

of extending construction of the authorized project from its present ending about one mile below Anahuac to Moss Bluff, a distance of about 20 miles. A study of the existing and prospective vessel traffic on the channel to Moss Bluff indicates that a navigation lock having dimensions of 84 feet wide by 600 feet long would adequately serve the needs of existing and prospective navigation on the lower Trinity River.

100. Studies and investigations are being made regarding the feasibility of providing a canalized waterway via the Trinity River from Liberty to Fort Worth, Texas. A lock size of 84 feet wide by 600 feet long is tentatively under study for canalization of the river. The findings of these studies will be incorporated in the pending comprehensive review of reports on the Trinity River and Tributaries, Texas. In the event that the comprehensive report findings indicate that a lock size other than 84 X 600 is justified for the canalized Trinity River waterway, it is considered that a similar lock for the multiple purpose Wallisville reservoir, considered in plan C, could be incorporated in the final design of the reservoir without any appreciable differences in the economic justification of the reservoir project.

101. The city of Houston, Texas, and the Trinity River Authority of Texas, have been granted a permit by the Texas State Board of Water Engineers to construct the Livingston reservoir on the main stem of the Trinity River at about river mile 129.2 near Livingston, Texas, and a salt water barrier on the lower Trinity River at about river mile 4 below Wallisville. The Livingston reservoir and the salt water barrier would serve as a unit to provide for the storage and diversion of water from the Trinity River largely for use of municipal and industrial supply in the metropolitan area of Houston, Texas. A large pumping station would be provided at about river mile 26.9 for the diversion of water from the Trinity River. With respect to construction of these facilities, the agreement between the city of Houston, Texas, and the Trinity River Authority of Texas contains the following statement.

"Sec. 7. Upon receipt of the necessary permits and the authority to construct the Livingston project in a form satisfactory to the City and the Authority, the City will promptly proceed with the design and construction of that project and will provide the funds necessary therefor". ***** "Upon receipt of the necessary permits and authority to construct the salt water barrier project in a form satisfactory to the City and to the Authority, the City will either proceed promptly and in no event later than September 1, 1963 with that project or the City and the Authority will enter into a contract or contracts with the United States of America for construction of the project by the Corps of Engineers in which the City will either provide the funds or obligate itself to make payments required of the local sponsoring agency for the non-Federal cost of the project".

102. In view of the foregoing, studies of the Wallisville reservoir presented in this report are predicated on the basic assumption that the proposed Livingston water storage reservoir would be constructed, and that conservation storage in the Wallisville reservoir would be derived from the uncontrolled drainage area between the Livingston and Wallisville dam sites without any release of storage from the Livingston reservoir.

103. Six plans of improvement were investigated in detail in connection with this report of which plan A provided minimum development principally for salinity control and navigation without reservoir storage. The other five plans provided for reservoir storage varying in capacity from minimum to maximum site development involving project purposes for salinity control, navigation, water supply, fish and wildlife resources and recreation. The economic analysis of the estimates of benefits and costs of the investigated reservoir improvements present in this report shows that plan C offers a maximum excess of benefits over costs. Officials of the Trinity River Authority of Texas and the Chambers-Liberty Counties Navigation District, who would be responsible for local cooperation, have agreed that the multiple-purpose reservoir constructed in accordance with plan C would meet their present needs and requirements for a salt water barrier dam and propose that plan C be recommended for adoption as a Federal project.

104. The Wallisville multiple-purpose reservoir project, plan C, is considered for construction by the Federal Government subject to the conditions that the local interests would contribute a share of the project first cost and annual maintenance and operation cost. Based on the apportionment of costs set forth in paragraphs 88 thru 91, the local share of the first cost and the annual cost of maintenance and operation is presently estimated at $1,890,000 and $30,600 respectively. It is considered that the local interest be required to enter into a contract with the Federal Government to pay for their share of the cost of the project including maintenance and operation costs based on the separable cost-remaining benefits method of cost allocation. In addition to contributing a share of the project costs, the local interests are required to furnish the items of local cooperation in the authorized channel to Liberty, which are specified in House Document No. 403, 77th Congress, 1st session, and House Document No. 634, 79th Congress, 2d session. The officials of the Trinity River Authority of Texas and the Chambers-Liberty Counties Navigation District, who would be responsible for the local cooperation, have agreed to provide all proposed items of local cooperation. The local political bodies are willing and financially able to provide the proposed cooperation.

105. The investigations and studies for this report show that the Wallisville reservoir provides for the project to serve its function in an integrated water supply plan, and would be an element in a comprehensive plan of improvement on the Trinity River basin. The study of the water needs in the area by the United States Public Health Service indicates that full utilization of all potential sources of water supply will be required within the next fifty years to

meet the predicted growth of population and industry, and that in deciding the time sequence of utilization of the several sources, construction of the Livingston-Wallisville reservoirs can be given early priority.

106. The authorized navigation channel on the Trinity River, after completion of the channel as proposed in plan C, would cross the inner end of the existing Federal project: "Anahuac Channel", near Anahuac, Texas, and enter the Trinity River through the existing project: "Mouth of Trinity River, Texas." The Anahuac Channel would serve as a feeder channel to the channel for traffic moving to and from Trinity Bay to terminals on the Trinity River. The reports in House Document No. 634, 79th Congress, 2d session, proposed that after completion of the project channel, the Anahuac Channel would be maintained only to the extent necessary to assist in diverting the flows of the Trinity River into Trinity Bay and provided for such partial maintenance of the channel at $5,000 annually. The works of improvement proposed by plan C would divert all Trinity River floods via the river diversion channel to Trinity Bay at a location 5 miles north of the outer end of the Anahuac Channel. Accordingly, the portion of the authorized navigation channel in the Trinity River and the Anahuac Channel below the lock site would not be subject to the flood flows of the Trinity River and would not require maintenance of the Anahuac Channel for a floodway as considered in House Document No. 634. Investigations made for this report indicate that there is a need to maintain the Anahuac Channel for navigation after further completion of the authorized channel. In view of the slack water conditions to prevail on the Anahuac Channel, it is considered that maintenance of the channel to project dimensions of 6 feet deep and 80 feet wide would cost about $5,000 annually. Since the Anahuac Channel would serve as a feeder channel to the channel on the Trinity River, it is proposed that the existing project for the "Anahuac Channel, Texas" be incorporated in the existing project for the "Trinity River and Tributaries, Texas."

107. Construction of the project channel, as proposed in plan C, would also obviate the need for the existing project, "Mouth of the Trinity River, Texas". The latest full report on this project was made in 1928. The project has served its useful purposes and there are no foreseeable reasons for further use of the project. It is proposed that this project be incorporated in the existing project for the "Trinity River and Tributaries, Texas".

108. The Bureau of Sport Fisheries and Wildlife in its report on the Wallisville reservoir project, exhibit III, evaluates the annual wildlife and fresh-water fishery gain that would result from the reservoir project, and points out that the project would provide an outstanding opportunity for development of migratory waterfowl resources. The report recommends that additional detail studies of the fish and wildlife resources, including studies of effects upon the estuarine fishery, be conducted as necessary by the United States Fish and Wildlife Service and the Texas Game and Fish Commission after the project is authorized in accordance with the Fish and Wildlife Coordination Act, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq., and that any proposed modification

of the project would be subject to agreement by the Secretary of the Interior, the Executive Secretary of the Texas Game and Fish Commission and the Chief of Engineers, United States Army. The report further recommends that a national wildlife refuge be provided in conjunction with the Wallisville reservoir, plan C, having a total area of 17,455 acres of which about 10,730 acres would be within the Wallisville reservoir and 6,725 acres would adjoin the west and north limits of the reservoir. The refuge area would provide for the growing of feed and forage crops for ducks and geese and for protection of the waterfowl wintering on the refuge. The cost of refuge lands outside of the project reservoir is estimated at $1,136,000 and refuge development costs are estimated at $612,000. The cost of maintenance and operation of the refuge is estimated at $105,700 annually. The total first cost of the refuge including the cost of the lands within the reservoir is estimated at $2,458,000 and the total annual charges is estimated at $195,700. The annual benefits including conservation benefits and increase of waterfowl hunting are estimated from evaluations furnished by the Fish and Wildlife Service at $231,300 giving an overall ratio of benefits to cost of 1.2.

109. In addition to the acquisition of additional lands for the refuge, the Bureau requests and recommends that the 10,730 acres of the refuge that would be within the Wallisville reservoir, with an estimated first cost of $710,000, be made available on a non-reimbursable basis to the Secretary of the Interior as provided for under existing law, that storage of 4,000 acre-feet of water annually, or an average of 3.6 million gallons daily, be provided from the Wallisville reservoir for use in th growing of crops, and that the reservoir be operated for waterfowl management by maintaining a reservoir drawdown of six inches during the summer months. It further recommends that the Federally owned land and project waters of the Wallisville reservoir be open to free use for hunting and fishing except for sections reserved for waterfowl management, safety, efficient operation and protection of public property.

110. Investigation reveals that it would be feasible to assign the 10,730 acres of the Wallisville reservoir as delineated on plate 2 to the Secretary of the Interior and provide the requested 4000 acre-feet of storage annually without detriment to the reservoir project. It is further considered that the proposed operation of the reservoir would generally be feasible from the standpoint of the proposed water conservation and navigation uses as considered in this report. However, the proposed reservoir operation could not be assured because the lower Trinity River is subject to floods occurring during the period from May to September and the small capacity occupied by the six inches in the reservoir would be filled during almost any flood on the river. The operation of the reservoir to provide the required six inches of drawdown for the waterfowl refuge would be subject to the primary operation of the reservoir for water conservation.

111. Additional information on recommended and alternate projects called for by Senate Resolution 148, 85th Congress, adopted January 28, 1958, is contained in an attachment to this report.

CONCLUSIONS

112. Based on the findings of this investigation it is concluded that:

a. There is an immediate and urgent need for construction of a multiple-purpose reservoir for salinity control, navigation, water supply, fish and wildlife, and recreation on the lower Trinity River near Wallisville, Texas.

b. The most feasible plan for a multiple-purpose reservoir development at Wallisville, Texas, providing for salinity control, navigation, water supply, fresh-water fish and wildlife conservation and recreation is plan C as generally described in paragraph 57 through 59 of this report, at a total estimated cost of $9,498,000, including preauthorization study cost of $35,000, U. S. Coast Guard costs of $53,000, and previously authorized navigation improvement cost of $248,000. The total annual operation and maintenance costs are estimated at $161,100, including $4,900 of U. S. Coast Guard cost. The annual cost of major replacements is estimated at $3,600 for renewal of aids to navigation.

c. The estimated annual benefits to be afforded by plan C would exceed the estimated annual charges, the estimated benefit-cost ratio being 2.8.

d. The first cost to the Corps of Engineers for plan C is estimated at $9,162,000 and the annual operation and maintenance cost to the Corps of Engineers is estimated at $156,200.

e. The local interests should be required to reimburse the Federal Government for a share of the construction, maintenance and operation costs of the multiple-purpose reservoir, in accordance with provisions outlined herein, presently estimated at a first cost of $1,890,000 and an annual cost of $30,600.

f. The local interests are required to furnish the items of local cooperation in the authorized channel to Liberty, which are specified in House Document No. 403, 77th Congress, 1st session, and House Document No. 634, 79th Congress, 2nd session.

g. The existing Federal projects for navigation, namely, "Anahuac Channel, Texas," and "Mouth of the Trinity River, Texas," should be incorporated into the existing Federal project "Trinity River and Tributaries, Texas."

113. It is further concluded, based on the findings and recommendations of the Bureau of Sport Fisheries and Wildlife, that:

a. The Federal Government should adopt a project for a national wildlife refuge in connection with the multiple-purpose Wallisville reservoir, in accordance with the Fish and Wildlife Coordination Act, approved August 12, 1958.

b. Funds should be provided to the Corps of Engineers for the purchase of additional 6,725 acres of refuge lands, adjoining the Wallisville reservoir, plan C, estimated at a cost of $1,136,000.

c. Authority be provided to the Corps of Engineers to transfer the 6,725 acres of additional refuge lands and 10,730 acres of the Wallisville reservoir, plan C, as specified by the Bureau of Sport Fisheries and Wildlife and shown on plate 2 of this report, to the Secretary of the Interior on a non-reimbursable basis for operation of the proposed national wildlife refuge.

d. Storage in the amount of 4,000 acre-feet, or an average of 3.6 million gallons daily be provided in the Wallisville reservoir, plan C, and made available to the Secretary of the Interior on a non-reimbursable basis for the operation of the proposed wildlife refuge.

114. Accordingly, it is recommended that the existing project for the Trinity River and Tributaries, Texas, be modified to provide for a multiple-purpose reservoir, designated as the Wallisville reservoir, in the navigation channel below Liberty, substantially as described under plan C in this report with such changes therein as in the discretion of the Secretary of the Army and the Chief of Engineers may be advisable, at an estimated first cost to the United States of $9,162,000 with $156,200 annually for maintenance and operation.

115. The foregoing recommendations shall be subject to the conditions that prior to initiation of construction, local interests shall enter into a contract or contracts, satisfactory to the Secretary of the Army, whereby the local interests will reimburse the Federal Government for a share of the construction, maintenance, operation and major replacements costs of the multiple-purpose reservoir outlined herein and summarized below:

a. Make reimbursement to the United States for a share of the first cost of the Wallisville reservoir project determined on the following basis: (a) Fifty percent of that part of the total first cost allocated to salinity control; (b) one hundred percent of that part of the total first cost allocated to water supply; and (c) the total first cost allocated to recreation minus the cost apportioned to the United States consisting of the first cost of minimum facilities for recreation and fifteen percent of the total project cost; all presently estimated at $1,890,000.

b. Enter into a contract with the United States to provide annual payments for a share of the annual cost of maintenance, operation and major replacements of the Wallisville reservoir project, determined on the following basis: (a) Fifty percent of the total allocated maintenance and operation cost to salinity control; (b) one hundred percent of the total allocated maintenance and operation cost to water supply; and (c) the remaining cost of the total annual cost of maintenance and operation allocated to recreation minus the allocated cost for maintenance and operation of the minimum facilities for recreation and the proportional amount of the remaining allocated maintenance and operation costs based on the ratio of apportioned first cost to Federal and non-Federal interests, all presently estimated at $30,600.

116. It is further recommended that the existing Federal projects designated as the "Anahuac Channel, Texas," and "Mouth of Trinity River, Texas," be incorporated in the existing project, "Trinity River and Tributaries, Texas."

117. It is further recommended:

a. That in accordance with recommendations of the Bureau of Sport Fisheries and Wildlife, a Federal project providing for a national wildlife refuge be established in connection with the Wallisville reservoir in accordance with the Fish and Wildlife Coordination Act, approved August 12, 1958.

b. Acquisition by the Corps of Engineers be authorized for additional land of about 6,725 acres for the national wildlife refuge, at an estimated first cost of $1,136,000.

c. The Corps of Engineers be authorized to transfer to the Secretary of the Interior the 6,725 acres of additional refuge lands to be purchased by the Corps of Engineers and about 10,730 acres of the Wallisville reservoir as requested by the Bureau of Sport Fisheries and Wildlife and shown on plates 1 and 2 of this report.

E. A. HANSEN
Colonel, CE
District Engineer

5 Incl
1. Exhibits I thru III
2. Attachment
3. Print of plate 1
4. Print of plate 2
5. Volume 2 of 2 (under sep cov)

[First endorsement]

SUBJECT: Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir)

United States Army Engineer Division, Southwestern, Dallas, Texas, April 6, 1960

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

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

WM WHIPPLE
Brigadier General, USA
Division Engineer

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

INFORMATION CALLED FOR BY
SENATE RESOLUTION 148, 85TH CONGRESS,
ADOPTED JANUARY 28, 1958

1. Authority.- The following information is furnished in response to Senate Resolution 148, 85th Congress, adopted January 28, 1958.

2. Project description and economic life.- The plan of improvement for the Wallisville reservoir which is recommended for Federal adoption provides for a multiple purpose reservoir with a dam located across the Trinity River at mile 3.9, about 1.8 miles below Wallisville, Texas. The proposed dam would have a total length of 33,900 feet, consisting of 13,500 feet of non-overflow section with crest at elevation 8.0 above mean sea level, a gated river diversion control structure about 300 feet long containing four tainter gates each 40 feet wide by 21 feet high and a concrete covered earth embankment overflow spillway about 20,100 feet long with crest at elevation 4.0 above mean sea level.

3. The plan provides for an 84-x 600-foot navigation lock adjacent to the earth dam across the Trinity River with a cut-off navigation channel adjoining the Trinity River, and a river diversion channel 275 feet wide at a bottom elevation of (-) 16.0 extending from the Trinity River at about mile 4.0 southward for a distance of 10,000 feet to the north shore of Trinity Bay with a gated river control structure located about 4,400 feet from the upper lock gates. The plan provides also for a non-overflow spoil embankment between the upper lock gates and the river control structure, an access road from Wallisville to the lock with crest at elevation 8.0 above mean sea level, an access road to the river control structure with a bascule bridge across the lock, appurtenant lock facilities, residences, office and storage building and associated utility facilities, two recreational parks with boat launching ramps, and an access road from State Highway 73 to the Lost Lake oil field.

4. The proposed reservoir would have a normal surface area of 23,200 acres and a capacity of 55,700 acre-feet. At elevation 4.0 above mean sea level the reservoir would provide 42,900 acre-feet of water supply storage between elevation 1.0 and 4.0 mean sea level. The net yield of water supply to be provided by the project reservoir is estimated at 56.8 million gallons daily. A detailed description of the physical features of plan C, the recommended plan, is given in paragraphs 20 through 43 of appendix II of the report.

5. The economic life of the Wallisville reservoir, plan C, is estimated to be 50 years.

6. The United States Fish and Wildlife Service in their report on the Wallisville reservoir, exhibit III of the text of the subject interim report, recommends that a national wildlife refuge be provided in

conjunction with the Wallisville reservoir project recommended for Federal adoption. The refuge would have a total area of 17,455 acres of which about 10,730 acres would be within the Wallisville reservoir. The area of the refuge adjoining the reservoir would be about 6,725 acres consisting of 3,560 acres of low-lands adjoining the north limits of the reservoir and 3,165 acres of uplands adjoining the west limits of the reservoir. The cost of the 6,725 acres of refuge lands outside of the reservoir is estimated at $1,136,000. Development of the refuge is estimated at $612,000 and the cost of maintenance and operation of the refuge is estimated at $105,700. The ratio of estimated annual benefits versus the estimated annual charges for the recommended wildlife refuge is 1.2.

7. Project costs.- The first cost of constructing the Wallisville reservoir in accordance with plan C, based on October 1959 prices is estimated at $9,162,000 and the annual additional operation and maintenance cost for the Corps of Engineers is estimated at $156,200, as discussed in paragraph 90 of the text of the subject interim report. A detailed estimate of the first cost and of the maintenance and operation cost of the project is given in table 3 of appendix II. The annual costs of maintenance and operation are estimated on the basis of prevailing costs as of October 1959 for both 50- and 100-year project life analyses considered hereinafter.

8. The local interests would be required to reimburse the Federal Government for a share of the construction and operation cost presently estimated at $1,890,000 and $30,600, respectively.

9. Benefit-cost ratios.- The total annual primary benefits to be afforded by the recommended project is estimated at $1,409,100, details of which are given in appendix III of the subject interim report. The secondary benefits have not been evaluated. Information relative to tax revenue enhancement and tax revenues foregone by development of the recommended multiple purpose project reservoir is given in paragraph 16. The total annual costs, based on October 1959 prices, for both 50- and 100-year project life are estimated at $511,900 and $433,300, respectively, as shown in table 1, inclosed. The overall benefit-cost ratio is 2.8 for a 50-year project life and 3.2 for a 100-year project life. The following tabulation shows a comparison of the estimated investment costs, annual costs, benefits and benefit to cost ratio on the basis of 50- and 100-year project life.

Item	Project life	
	50 years	100 years
Estimated total investment	$9,837,200	$9,837,200
Estimated annual charges:		
Interest on total investment	245,900	245,900
Amortization of total investment	101,300	22,700
Maintenance, operation and major replacements	164,700	164,700
Total annual charges	511,900	433,300
Estimated total direct benefits	1,409,100	1,409,100
Benefit to cost ratio	2.8	3.2

10. Intangible project effects.- Development of the multiple-purpose reservoir as recommended would produce direct benefits attributable to the following purposes: Salinity control, navigation, water supply, fish and wildlife, and recreation. The intangible project effects relating to the project purposes are discussed in the following subparagraphs.

a. Salinity control.- The control of salinity intrusion in the lower Trinity River as would be accomplished by the multiple-purpose reservoir would obviate the objections of the local rice irrigation companies relative to the further advancement of the authorized navigation channel upstream in the Trinity River. Investigation reveals that the cost of providing a single purpose project for advancement of navigation in the Trinity River would be considerably greater than the apportioned cost of providing for navigation in the multiple-purpose reservoirs. It is also considered that the control of salinity intrusion in the lower river is a basic requirement for further development of additional rice culture in the local area. It is reported that lands now under canals are sufficient to maintain an average cropping program of about 90,000 acres annually or about 100 percent more than presently under cultivation. There are also other lands adjacent to the lands under canals which are suitable for rice culture. The deterrent factors to expansion of the local rice growing industry are the present day Government agriculture controls of the rice crop and the lack of sufficient water supply during low flows on the river. Should the national economy require abandonment of the Government controls, expansion of the local rice culture would be feasible. With the assurance that the water supply in the river would not be contaminated by salt water intrusion, the local irrigation companies could arrange for additional water supply from upstream reservoirs as may be required, and the national economy would be benefited by the additional lands devoted to rice culture.

b. Navigation.- The prevention of salt water intrusion in the lower river would permit the advancement of the authorized and partly constructed navigation channel from its present ending one mile

below Anahuac. An expenditure of about one million dollars was made in 1950 for construction of the navigation channel from the Houston Ship Channel to one mile below Anahuac. The cost of providing the channel is presently considered as a "sunk investment" until such time as the salinity control problem is solved, which would materialize on completion of the project reservoir. In addition to obtaining the beneficial use of the completed channel to Anahuac, the traffic using the waterway would be benefited by traversing the protected channel afforded by the protective spoil embankment extending for a distance of about 17 miles below Anahuac on the bay side of the channel in lieu of traversing the open bay waters as now required.

c. Water supply.- In addition to the water supply benefits evaluated in appendix III of the interim report, which cover only the costs of an alternative single-purpose reservoir project, additional benefits will accrue as the true value of the water supply exceeds the alternative costs. In addition it is considered that the water supply to be provided by the Wallisville reservoir project would result in increases in annual income and employment which would be of widespread benefit to the local, state and national economy.

d. Fish and wildlife.- The evaluated benefits attributable to the project purpose relating to fish and wildlife represent only the increased catch in commercial fishing from the project reservoir. Intangible benefits to the project from commercial fishing would include the economic gains resulting from the manufacturing, transportation and purchasing of the associated needs for the increased commercial fishing. Intangible economic benefits would also result from construction of the national wildlife refuge, and particularly from its maintenance and operation which is estimated to cost $104,200 annually. This annual expenditure would produce sizeable economic gains to the various interests that provided for the associate needs of maintaining and operating the refuge.

e. Recreation.- Recreation included as one of the project purposes includes sport hunting and fishing, picknicking, camping, water sports and other activities on the reservoir area. Many intangible benefits would accrue as a result of providing the reservoir and the recreational facilities, which would be attractive to a large number of the people residing within about 100-miles of the project reservoir. The intangible benefits of recreation not evaluated include the economic gains resulting from previsitation expenditures, such as the purchase of boats, water sports equipment, hunting and fishing equipment and supplies, licenses, and expenditures enroute for food, gasoline and associated items. Intangible benefits would result from the development of the national wildlife refuge, and would include the value of the refuge as a wintering area for waterfowl, and the expenditures of visitors to the refuge to observe the waterfowl. Benefits would also accrue to the general well being, health and mental condition of people resulting from their recreation experience at the project reservoir.

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11. Physical feasibility and cost of providing for future needs.- The Wallisville reservoir would be an element in a comprehensive plan of development on the Trinity River basin. A study of the water needs in the area by the United States Public Health Service indicates that full utilization of all potential sources of water supply will be required within the next fifty years to meet the predicted growth of population and industry, and that in deciding the time sequence of utilization of the several sources, construction of the Livingston-Wallisville reservoirs can be given early priority. The city of Houston, Texas, and the Trinity River Authority of Texas were granted a permit by the Texas State Board of Water Engineers for construction of a large storage reservoir on the main stem of the Trinity River at about mile 129.2 near Livingston, Texas, and a salt water barrier on the lower Trinity River at about mile 4.0 below Wallisville. The Livingston reservoir and the salt water barrier would serve as a unit to provide for the storage and diversion of water from the Trinity River largely for use of municipal and industrial supply in the metropolitan area of Houston. A large pumping station would be provided at about mile 26.9 for the diversion of water from the Trinity River. The project reservoir recommended in this report would obviate construction of the salt water barrier. The city of Houston approves and recommends the construction of the project reservoir. Accordingly the project reservoir would serve as a unit in the plan providing for the municipal and industrial needs of Houston. In addition the city of Houston proposes to provide the water supply by releases from the Livingston Reservoir as may be required by the local four irrigation companies, who now withdraw water from the Trinity River by means of pumping stations located adjoining the project reservoir. Additional water is to be made available from the Livingston reservoir that would be diverted from the project reservoir for the use of local industry that may develop in the near future. In view of the foregoing it is considered that the recommended reservoir project and the Livingston storage reservoir would provide for satisfaction of anticipated future needs. In considering the development of a larger project reservoir the local interests expressed the view that at this time there was no foreseeable need for greater storage at Wallisville and that they would not be able to provide the local cooperation required for a larger development of reservoir storage.

12. Allocation of costs.- A summary of the allocations of project investment costs and annual maintenance and operation costs to the several project purposes as determined by (a) the Separable Costs - Remaining Benefits Method, (b) the Priority of Use Method, and (c) the Incremental Cost Method, using an interest rate of 2.5 percent for both the 50-year and 100-year project life analysis, is presented in table 2. Data given in table 2 regarding the Separable Costs-Remaining Benefits Method- 50 year analysis is summarized from table 18, appendix III of the interim report. Details of the allocation of costs by the Priority of Use Method and the Incremental Cost Method for a 50-year project life are given in tables 3 and 4, respectively. Details of the allocation of costs by the three methods (a), (b) and (c) for a 100-year project life are given in tables 5, 6 and 7, respectively.

TABLE 2

SUMMARY OF ALLOCATIONS OF PROJECT COSTS
TO THE SEVERAL PROJECT PURPOSES
(THOUSAND OF DOLLARS)

Project purpose	Investment costs : 50-year	Investment costs : 100-year	Annual costs(1) : 50-year	Annual costs(1) : 100-year
Separable costs-remaining benefits method				
Salinity control	1785.0	1508.8	28.8	28.6
Navigation	4357.6	4768.0	72.3	71.3
Water supply	1003.0	956.8	16.2	18.1
Fish and wildlife	742.3	712.1	12.4	13.4
Recreation	1949.3	1891.5	35.3	33.5
Total	9837.2	9837.2	164.7	164.7
Priority of use method				
Salinity control	158.4	0.0	2.2	0.0
Navigation	7174.3	7248.0	123.5	123.6
Water supply	0.0	0.0	0.0	0.0
Fish and wildlife	2105.1	2189.8	29.0	31.1
Recreation	399.4	399.4	10.0	10.0
Total	9837.2	9837.2	164.7	164.7
Incremental cost method				
Salinity control	0.0	0.0	0.0	0.0
Navigation	9437.8	9437.8	154.7	154.7
Water supply	0.0	0.0	0.0	0.0
Fish and wildlife	0.0	0.0	0.0	0.0
Recreation	399.4	399.4	10.0	10.0
Total	9837.2	9837.2	164.7	164.7

(1) Includes annual costs of maintenance, operation and major replacements.

13. Extent of interest in project.- Officials of the city of Houston, Texas, Trinity River Authority of Texas, and the Chambers-Liberty Counties Navigation District, who would be responsible for local cooperation, have agreed that the multiple-purpose reservoir recommended for construction would meet their present needs and requirements, and proposed that it be adopted as a Federal project. The United States Fish and Wildlife Service have expressed an interest in project reservoir relative to the fish and wildlife resources of the area and the need for a national wildlife refuge adjoining the project reservoir, as given in the Service's report appended to the text of the interim report.

14. Repayment schedules.- The Wallisville multiple-purpose reservoir project is recommended for construction by the Federal Government subject to the conditions that the local interests shall enter into a contract or contracts satisfactory to the Secretary of the Army, whereby the local interests will reimburse the Federal Government for a share of the first cost of construction and for a share of the annual cost of maintenance, operation and major replacements required for the reservoir project.

15. The local interests consisting of the city of Houston, Texas, the Trinity River Authority of Texas, and the Chambers-Liberty Counties Navigation District by jointly signed letter, appended in exhibit 1 of text of interim report, have offered to provide the items of required local cooperation, satisfactory to the Secretary of the Army that they will:

a. Obtain all the necessary water rights.

b. Prior to construction agree to pay that portion of the cost of construction allocated to local interests payments to begin when space is used for water supply and not later than 15 years from the time storage is available for water supply. The costs allocated to local interests include interest from the date of completion, such costs to be repaid within the economic life of the project but in no event to be more than 50 years after the project is available for the storage of water for water supply.

c. Agree to contribute the portion of the annual cost of maintenance, operation and replacements allocated to the local interests, payable annually.

d. In the event that any of the costs of the facilities are properly allocable to navigation costs the Trinity River Authority will assume such costs.

16. Effect of project on state and local governments.- The construction of the Wallisville multiple-purpose reservoir should not result in any increased cost in State and local governmental services. The lands required for the Wallisville reservoir are in general undeveloped, low-lying coastal marsh lands having considerable grass coverage with some brush and small trees, and are subject to frequent overflows from the Trinity River. Grazing and hunting are considered to be the highest use of the lands. State, county and school taxes on the lands are estimated to be about 25 to 30 cents an acre per year. The tax loss incurred by the proposed reservoir would be offset by the increased economy of the area resulting from hunting, fishing and recreation afforded by the reservoir. The market values of lands to be acquired for the Wallisville reservoir, as used in the estimate of land costs, are much greater than the capitalized net income therefrom. Accordingly, no allowance need be made for loss of productivity as an economic cost. The value of minerals was excluded from the appraised values of the reservoir lands, made in October 1959, on the basis that future oil explorations and developments within the reservoir area could be conducted without serious detriment to the reservoir purposes.

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

TABLE 1

DETAILED ESTIMATES OF ANNUAL CHARGES
WALLISVILLE RESERVOIR PROJECT FOR
ECONOMIC LIFE OF 50 YEARS AND 100 YEARS

Item	Economic life	
	50 years	100 years
1. Estimated investment		
a. Estimated first cost of project (1)	$ 9,498,000	$ 9,498,000
b. Interest during construction (3-year period) on estimated first cost of project excluding recreational facilities ($399,100) and aids to navigation ($53,000) (2) ($9,498,000 - 452,100) @ 2½% for 18 months	339,200	339,200
c. Total investment	9,837,200	9,837,200
2. Estimate of annual charges		
a. Interest on total investment $9,837,200 @ 2½%	245,900	245,900
b. Amortization of total investment $9,837,200 @ 1.03%	101,300	-
$9,837,200 @ 0.231%	-	22,700
c. Maintenance, operation and major replacements(3)	164,700	164,700
d. Total estimated annual charges	511,900	433,300

(1) Based on October 1959 prices and detailed estimate of first cost given in table 3, appendix II of subject interim report.

(2) The construction of recreational facilities and installation of aids to navigation can be accomplished in less than 1 year.

(3) Data regarding the estimated costs of maintenance and operation are given in paragraphs 46 through 55 of appendix II of the subject interim report.

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

TABLE 3

COST ALLOCATION - WALLISVILLE RESERVOIR
PRIORITY OF USE METHOD - 50 YEAR PROJECT LIFE

(Thousands of dollars)

Item	Purpose					
	Salinity control	Navigation	Water supply	Fish and Wildlife	Recreation	Total
1. Allocation of annual costs						
a. Justifiable expenditure	250.0	375.7	140.5	104.3	241.9	511.9
b. Specific costs	0	71.0	0	0	24.1	95.1
c. Remaining justifiable expenditure	250.0	304.7	140.5	104.3	217.8	416.8
d. Assignment of remaining costs to non-reimbursable purposes	7.8	304.7	-	104.3	-	416.8
e. Total allocated annual costs	7.8	375.7	0	104.3	24.1	511.9
2. Allocation of Operation & Maintenance Costs						
a. Specific costs	0	35.0	0	0	10.0	45.0
b. Allocated joint costs	2.2	84.9	0	29.0	0	116.1
c. Total allocated O&M	2.2	119.9	0	29.0	10.0	161.1
3. Allocation of major replacements						
a. Specific costs	0	0	0	0	0	0
b. Allocated joint costs	0	3.6	0	0	0	3.6
c. Total allocated Maj. Replacement costs	0	3.6	0	0	0	3.6
4. Allocation of investments						
a. Specific annual investment cost	0	36.0	0	0	14.1	50.1
b. Allocated joint annual investment	5.6	217.2	0	74.3	0	297.1
c. Total allocated annual investment	5.6	253.2	0	74.3	14.1	347.2
d. Allocated investment	158.4	7174.3	0	2105.1	399.4	9837.2
5. Allocation of construction expenditures						
a. Specific investment	0	1019.2	0	0	399.1	1418.3
b. Investment in joint use facilities	158.4	6155.1	0	2105.1	0.3	8418.9
c. Interest during construction on joint-use facilities	5.7	221.1	0	75.6	0	302.4
d. Construction expenditure in joint-use facilities	152.7	5934.0	0	2029.5	0.3	8116.5
e. Percent of construction expenditures in joint-use facilities	1.88	73.11	0	25.01	0	100
f. Construction expenditures in specific facilities	0	982.4	0	0	399.1	1381.5
g. Total construction expenditures	152.7	6916.4	0	2029.5	399.4	9498.0

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

TABLE 4

COST ALLOCATION - WALLISVILLE RESERVOIR
INCREMENTAL COST METHOD - 50 YEAR PROJECT LIFE

(Thousands of dollars)

Item	Purpose					
	Salinity control	Navigation	Water supply	Fish and Wildlife	Recreation	Total
1. Allocation of annual costs						
a. Justifiable expenditure	250.0	375.7	140.5	104.3	241.9	511.9
b. Specific costs	0	71.0	0	0	24.1	95.1
c. Remaining justifiable expenditure	250.0	446.7	140.5	104.3	266.0	416.8
d. Assignment of remaining costs to basic Federal purpose	0	416.8	0	0	0	416.8
e. Total allocated annual costs	0	487.8	0	0	24.1	511.9
2. Allocation of Operation & Maintenance costs						
a. Specific costs	0	35.0	0	0	10.0	45.0
b. Allocated joint costs	0	116.1	0	0	0	116.1
c. Total allocated O&M	0	151.1	0	0	10.0	161.1
3. Allocation of major replacements						
a. Specific costs	0	0	0	0	0	0
b. Allocated joint costs	0	3.6	0	0	0	3.6
c. Total allocated major replacement costs	0	3.6	0	0	0	3.6
4. Allocation of investment						
a. Specific annual investment cost	0	36.0	0	0	14.1	50.1
b. Allocated joint annual investment	0	297.1	0	0	0	297.1
c. Total allocated annual investment	0	333.1	0	0	14.1	347.2
d. Allocated investment	0	9437.8	0	0	399.4	9837.2
5. Allocation of construction expenditures						
a. Specific investment	0	1019.2	0	0	399.1	1418.3
b. Investment in joint-use facilities	0	8418.6	0	0	0.3	8418.9
c. Interest during constr. on joint-use facil.	0	302.4	0	0	0	302.4
d. Constr. expenditure in joint-use facilities	0	8116.2	0	0	0.3	8721.3
e. Percent of constr. expenditures in joint-use facilities	0	100	0	0	0	100
f. Constr. expenditures in specific facilities	0	982.4	0	0	399.1	1381.5
g. Total construction expenditures	0	9098.6	0	0	399.4	9498.0

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

TABLE 5

COST ALLOCATION - WALLISVILLE RESERVOIR
S.C.R.B. METHOD - 100-YEAR PROJECT LIFE

(Thousands of dollars)

Item	Specific Costs							Alternate Purpose					Single Purpose				
	Salinity Control	Navigation	Water Supply	Fish & Wildlife	Recreation	Joint Use	Total	Nav. W. S. F. & W. Rec.	S. C. W. S. F. & W. Rec.	S. C. Nav. F. &W. Rec.	S. C. Nav. W. S. Rec.	S. C. Nav. W. S. F. & W.	Salinity Control Only	Nav. Only	Water Supply	Fish & W. L.	Recreation
FIRST COST:																	
Federal First Cost	0	982.4	0	0	399.1	8,116.5	9,498.0	9,498.0	6,925.7	9,498.0	9,498.0	9,098.9	4,575.5	6,537.7	6,526.6	6,526.6	4,733.7
Construction Period (Years)	0	3.0	0	0	0.5	0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.5
Interest during construction	0	36.8	0	0	0	302.4	(1) 339.2	(1) 339.2	(1) 242.7	(1) 339.2	(1) 339.2	(1) 339.2	171.6	245.2	(2) 242.8	(2) 242.8	(3) 135.5
Federal Investment	0	1,019.2	0	0	399.1	8,418.9	9,837.2	9,837.2	7,168.4	9,837.2	9,837.2	9,438.1	4,747.1	6,782.9	6,769.4	6,769.4	4,869.2
ANNUAL CHARGES:																	
Interest on Investment (0.025)	0	25.5	0	0	10.0	210.4	245.9	245.9	179.2	245.9	245.9	236.0	118.7	169.6	169.2	169.2	121.7
Amortization on Investment (0.00231)	0	2.4	0	0	0.9	19.4	22.7	22.7	16.6	22.7	22.7	21.8	11.0	15.7	15.6	15.6	11.2
Operation and Maintenance	0	35.0	0	0	10.0	116.1	161.1	161.1	116.1	161.1	161.1	151.1	91.2	136.2	126.1	126.1	70.0
Major Replacement	0	0	0	0	0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	0	0	3.6	3.6	0
Total	0	62.9	0	0	20.9	349.5	433.3	433.3	315.5	433.3	433.3	412.5	220.9	321.5	314.5	314.5	202.9
ANNUAL BENEFITS:																	
Salinity Control	250.0	0	0	0	0	0	250.0	0	250.0	250.0	250.0	250.0	250.0	0	0	0	0
Navigation	0	376.0	0	0	0	0	376.0	376,0	0	376.0	376.0	376.0	0	376.0	0	0	0
Water Supply	0	0	140.5	0	0	0	140.5	140.5	140.5	0	140.5	140.5	0	0	140.5	0	0
Fish & Wildlife	0	0	0	104.3	0	0	104.3	104.3	104.3	104.3	0	104.3	0	0	0	104.3	0
Recreation	0	0	0	0	537.0	0	537.0	537.0	537.0	537.0	537.0	0	0	0	0	0	537.0
Total	250.0	376.0	140.5	104.3	537.0	0	1,407.8	1,157.8	1,031.8	1,267.3	1,303.5	870.8	250.0	376.0	140.5	104.3	537.0
B/C Ratio							3.25						1.13	1.17	0.45	0.33	2.65

(1) Excludes interest on two recreation facilities ($399,100) and aids to navigation ($53,000).
(2) Excludes interest on aids to navigation ($53,000) required to mark channel through reservoir..
(3) Excludes interest on two recreational facilities ($399,100)

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)
(TABLE 5 (Cont'd)

COST ALLOCATION - WALLISVILLE RESERVOIR
S.C.E.S. METHOD - 100-YEAR PROJECT LIFE
(Thousands of dollars)

Item	Salinity Control	Navigation	Water Supply	Fish & Wildlife	Recreation Total	Recreation Federal	Recreation Non-Federal	Total
1. ALLOCATION OF ANNUAL COST:								
a. Benefits	250.0	376.0	140.5	104.3	537.0		0	1,407.8
b. Alternate cost	220.9	321.5	314.5	314.5	202.9		0	1,374.3
c. Benefits limited by alternate cost	220.9	321.5	140.5	104.3	202.9		0	990.1
d. Separable cost	0	117.8	0	0	20.8	20.8	0	138.6
e. Remaining benefits (Distribution ratio as percent of remaining benefits)	220.9	203.7	140.5	104.3	182.1	0	0	851.5
f. Allocated joint cost	76.5	70.5	48.6	36.1	63.0	63.0	0	294.7
g. Total allocation, project cost	76.5	188.3	48.6	36.1	83.8	83.8	0	433.3
h. Benefit to Cost Ratio	3.27	2.00	2.89	2.89	6.41			3.25
2. ALLOCATION OF OPERATION AND MAINTENANCE COST:								
a. Separable cost	0	45.0	0	0	10.0	10.0	0	55.0
b. Allocated joint cost (in proportion to 1a)	27.5	25.4	17.5	13.0	22.7	22.7	0	106.1
c. Total allocation O&M	27.5	70.4	17.5	13.0	32.7	32.7	0	161.1
d. Specific cost	0	35.0	0	0	10.0	10.0	0	45.0
e. Allocated joint-use cost	27.5	35.4	17.5	13.0	22.7	22.7	0	116.1
f. Ratio for allocation for joint use O&M	0.2369	0.3049	0.1507	0.1120	0.1955	0	0	1.0000
3. ALLOCATION OF MAJOR REPLACEMENTS:								
a. Separable cost	0	0	0	0	0	0	0	0
b. Allocated joint cost (in proportion to 1e)	0.9	0.9	0.6	0.4	0.8	0.8	0	3.6
c. Total allocation major replacements	0.9	0.9	0.6	0.4	0.8	0.8	0	3.6
4. ALLOCATION OF INVESTMENT:								
a. Annual investment cost	48.1	152.0	30.5	22.7	60.3	60.3	0	313.6
b. Allocated investment	1,508.8	4,768.0	956.8	712.1	1,891.5	1,891.5	0	9,837.2
5. ALLOCATION OF CONSTRUCTION EXPENDITURES:								
a. Specific investment	0	1,019.2	0	0	399.1	399.1	0	1,418.3
b. Investment in joint-use facilities	1,508.8	3,748.8	956.8	712.1	1,492.4	1,492.4	0	8,418.9
c. Interest during construction on joint-use facilities	54.2	134.7	34.3	25.6	53.6	53.6	0	302.4
d. Construction expenditures in joint-use facilities	1,454.6	3,614.1	922.5	686.5	1,438.8	1,438.8	0	8,116.5
e. Percent of construction expenditures in joint-use facilities	17.92	44.53	11.36	8.46	17.73	17.73	0	100.00
f. Construction expenditures in specific facilities	0	982.4	0	0	399.1	399.1	0	1,381.5
g. Total construction expenditures	1,454.6	4,596.5	922.5	686.5	1,837.9	1,837.9	0	9,498.0

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

TABLE 6

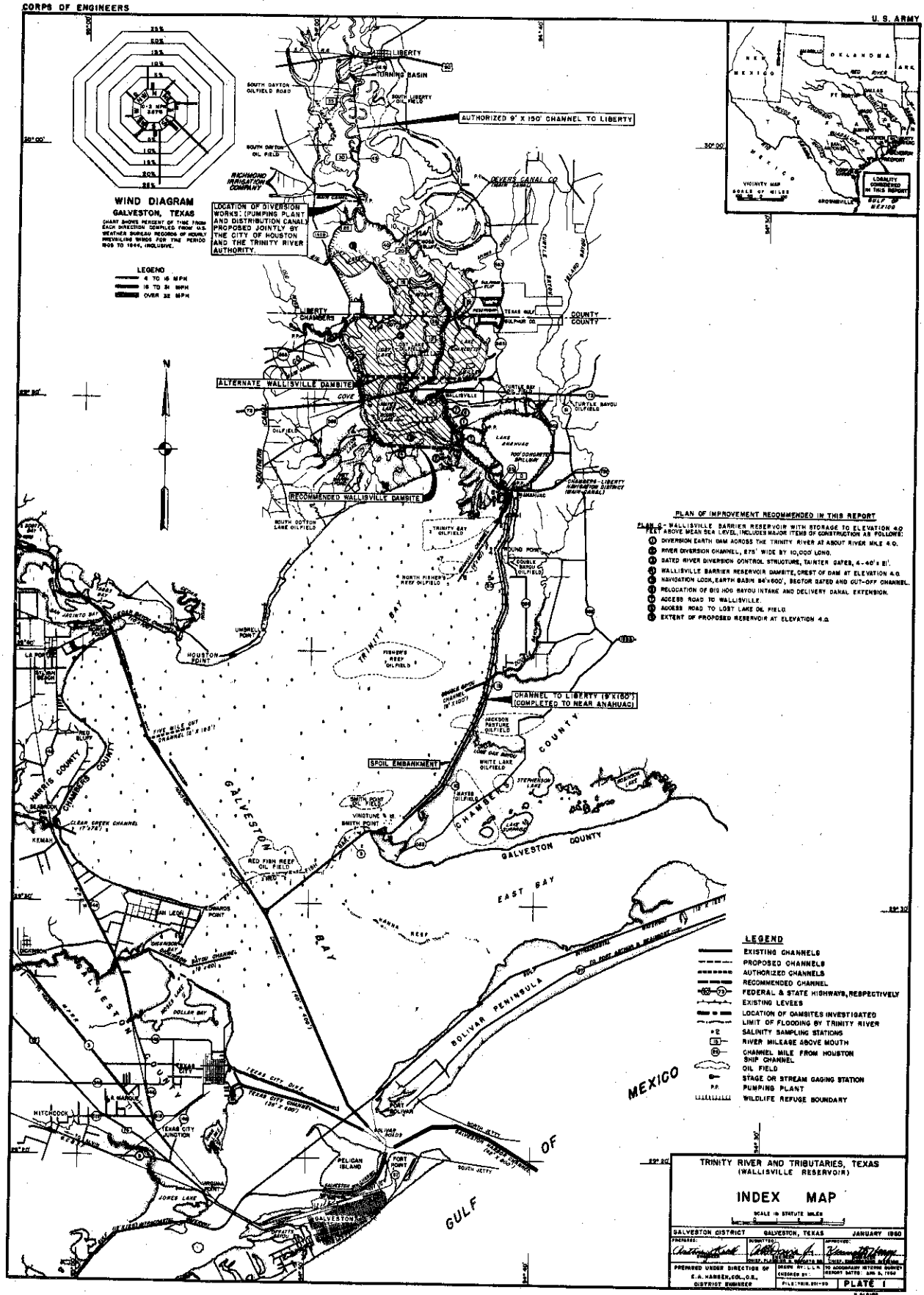
COST ALLOCATION - WALLISVILLE RESERVOIR
PRIORITY OF USE METHOD - 100 YEAR PROJECT LIFE
(Thousands of dollars)

Item	Purpose					
	Salinity control	Navigation	Water supply	Fish and Wildlife	Recreation	Total
1. Allocation of annual costs						
a. Justifiable expenditure	220.9	321.5	140.5	104.3	202.9	433.3
b. Specific costs	0	62.9	0	0	20.9	83.8
c. Remaining justifiable expenditures	220.9	258.6	140.5	104.3	182.0	349.5
d. Assignment of remaining costs to non-reimbursable purposes	0	258.6	0	90.9	0	349.5
e. Total allocated annual costs	0	321.5	0	90.9	20.9	433.3
2. Allocation of Operation and Maintenance costs						
a. Specific costs	0	35.0	0	0	10.0	45.0
b. Allocated joint costs	0	85.9	0	30.2	0	116.1
c. Total allocated O & M	0	120.9	0	30.2	10.0	161.1
3. Allocation of major replacements						
a. Specific costs	0	0	0	0	0	0
b. Allocated joint costs	0	2.7	0	0.9	0	3.6
c. Total allocated major repairs	0	2.7	0	0.9	0	3.6
4. Allocation of investments						
a. Specific annual investment cost	0	27.9	0	0	10.9	38.8
b. Allocated joint annual investment	0	170.0	0	59.8	0	229.8
c. Total allocated annual investment	0	197.9	0	59.8	10.9	268.6
d. Allocated investment	0	7248.0	0	2189.8	399.4	9837.2
5. Allocation of construction expenditures						
a. Specific investment	0	1019.2	0	0	399.1	1418.3
b. Investment in joint-use facilities	0	6228.8	0	2189.8	0.3	8418.9
c. Interest during construction on joint use facilities	0	223.7	0	78.7	0	302.4
d. Construction expenditure in joint-use facilities	0	6005.1	0	2111.1	0.3	8116.5
e. Percent of construction expenditures in joint use facilities	0	73.99	0	26.01	0	100.00
f. Construction expenditures in specific facilities	0	982.4	0	0	399.1	1381.5
g. Total construction expenditures	0	6987.5	0	2111.1	399.4	9498.0

INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

COST ALLOCATION - WALLISVILLE RESERVOIR
INCREMENTAL COST METHOD - 100 YEAR PROJECT LIFE
(Thousands of dollars)
TABLE 7

Item	Purpose: Salinity control	Navigation	Water supply	Fish and Wildlife	Recreation	Total
1. Allocation of annual costs						
a. Justifiable expenditure	220.9	321.5	140.5	104.3	202.9	433.3
b. Specific costs	0	62.9	0	0	20.9	83.8
c. Remaining justifiable expenditure	220.9	258.6	140.5	104.3	182.0	349.5
d. Assignment of remaining costs to basic Federal purpose	0	349.5	0	0	0	349.5
e. Total allocated annual costs	0	412.4	0	0	20.9	433.3
2. Allocation of Operation & Maintenance costs						
a. Specific costs	0	35.0	0	0	10.0	45.0
b. Allocated joint costs	0	116.1	0	0	0	116.1
c. Total allocated O & M	0	151.1	0	0	10.0	161.1
3. Allocation of major replacements						
a. Specific costs	0	0	0	0	0	0
b. Allocated joint costs	0	3.6	0	0	0	3.6
c. Total allocated major replacement costs	0	3.6	0	0	0	3.6
4. Allocation of investment						
a. Specific annual investment cost	0	27.9	0	0	10.9	38.8
b. Allocated joint annual investment	0	229.8	0	0	0	229.8
c. Total allocated annual investment	0	257.7	0	0	10.9	268.6
d. Allocated investment	0	9437.8	0	0	399.4	9837.2
5. Allocation of construction expenditures						
a. Specific investment	0	1019.2	0	0	399.1	1418.3
b. Investment in joint-use facilities	0	8418.6	0	0	0.3	8418.9
c. Interest during construction on joint-use facilities	0	302.4	0	0	0	302.4
d. Construction expenditure in joint-use facilities	0	8116.2	0	0	0.3	8116.5
e. Percent of construction expenditures in joint-use facilities	0	100.00	0	0	0	100.00
f. Construction expenditures in specific facilities	0	982.4	0	0	399.1	1381.5
g. Total construction expenditures	0	9098.6	0	0	399.4	9498.0



TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

INDEX MAP

SCALE IN STATUTE MILES

GALVESTON DISTRICT — GALVESTON, TEXAS — JANUARY 1960

PREPARED UNDER DIRECTION OF E.A. HARDEN, COL., O.D., DISTRICT ENGINEER

DRAWN BY: L.L.R. TO ACCOMPANY HYDRO ENGINEER REPORT DATED: JAN. 5, 1960

TRACED BY:

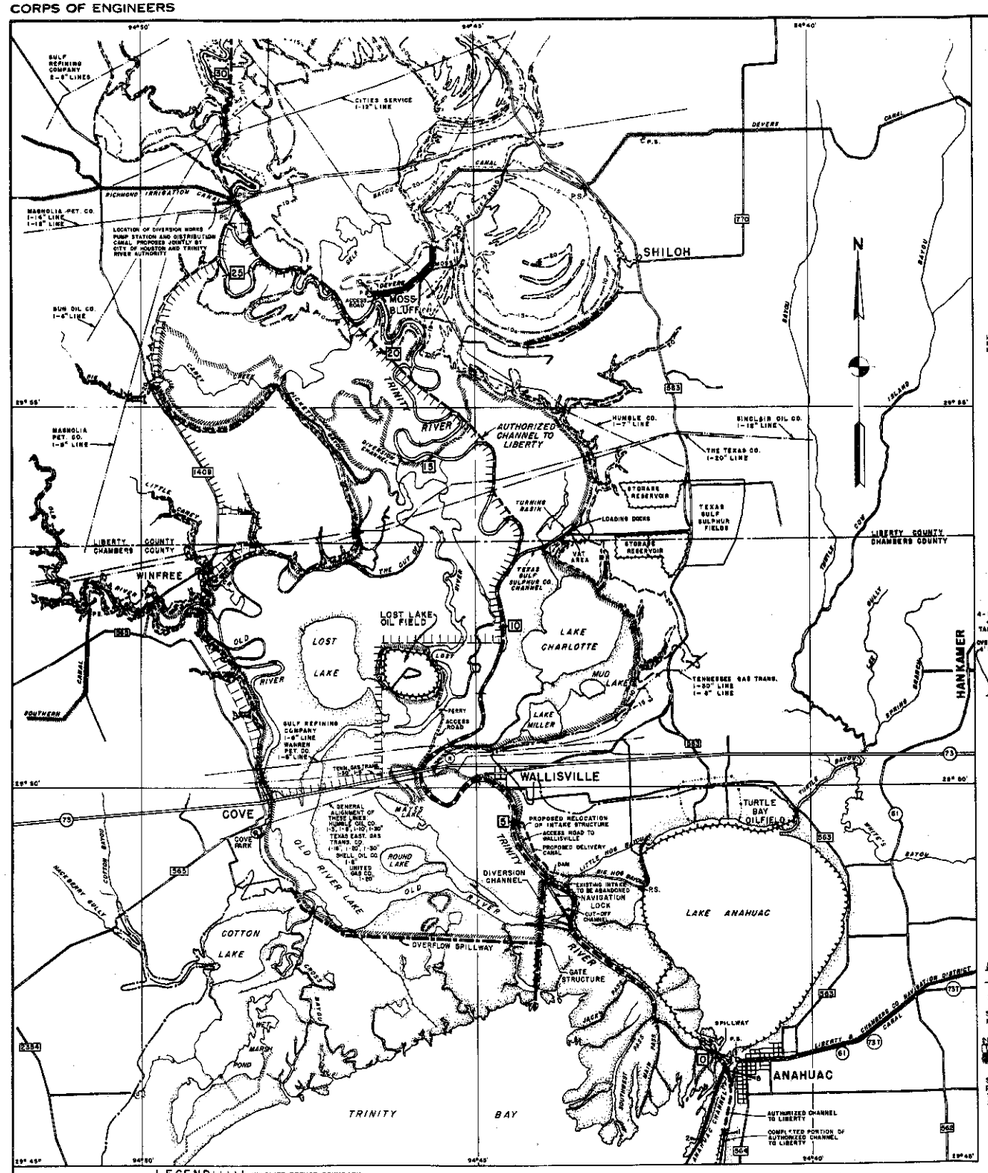
CHECKED BY:

FILE: TRIN. 201-20

PLATE 1

CORPS OF ENGINEERS

U. S. ARMY



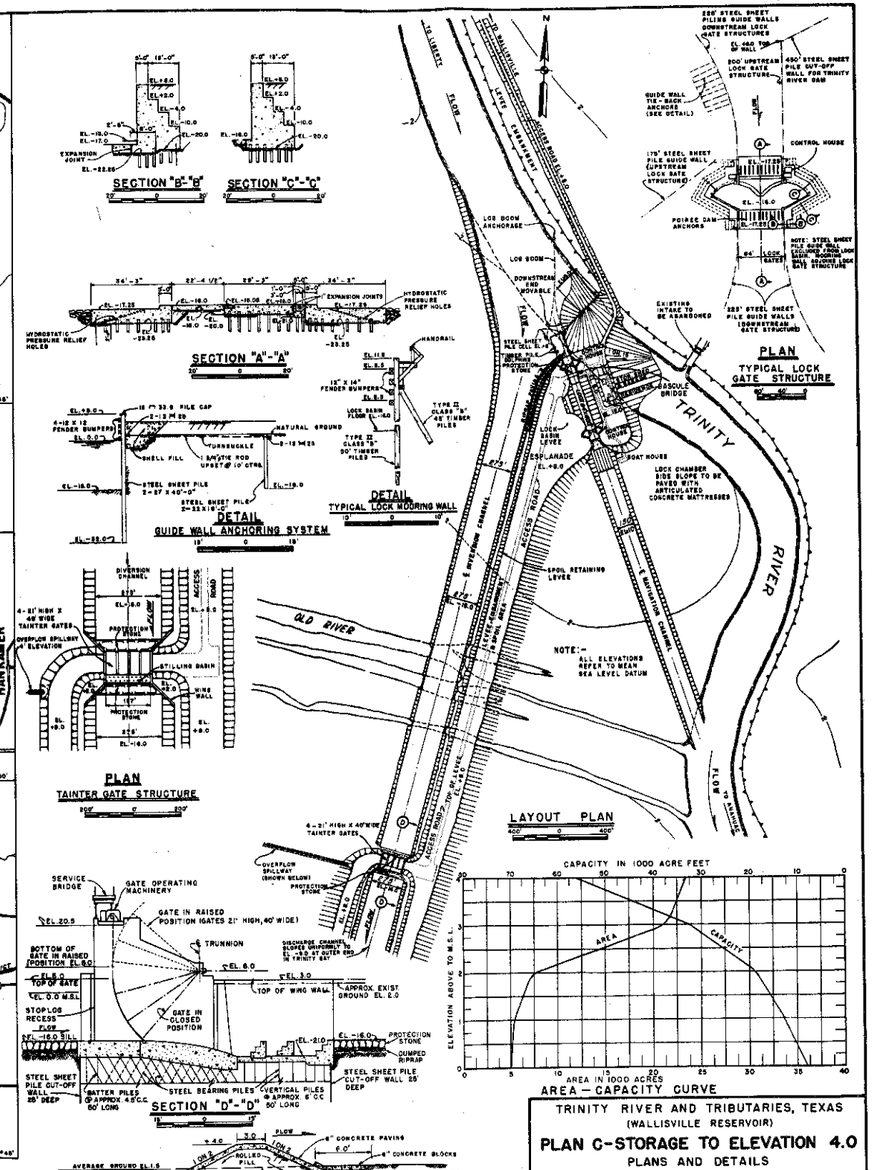
LEGEND

- LOCATION OF DAMSITE INVESTIGATED
- FARM TO MARKET ROAD
- STATE HWY.
- RIVER MILES (INTERMEDIATE MILES SHOWN BUT NOT NUMBERED)
- EXISTING LEVEE
- PROPOSED LEVEE
- EXISTING CHANNEL
- AUTHORIZED CHANNEL
- PROPOSED CHANNEL
- WILDLIFE REFUGE BOUNDARY
- RECREATION PARKS
- ACCESS ROAD
- EXISTING PIPELINES
- LIMIT OF FLOODING BY TRINITY RIVER
- SALINITY SAMPLING STATIONS
- EXISTING PUMPING STATION
- 10' CONTOUR
- 15' CONTOUR
- 20' CONTOUR
- LIMIT OF 4' RESERVOIR

GENERAL PLAN

SCALE OF FEET 3000' 0 6000' 12000' 18000'

SCALE OF MILES 4 0 4



NOTE: ALL ELEVATIONS REFER TO MEAN SEA LEVEL DATUM

TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

PLAN C-STORAGE TO ELEVATION 4.0

PLANS AND DETAILS

SCALE AS SHOWN

GALVESTON DISTRICT	GALVESTON, TEXAS	JANUARY 1960
PREPARED:	SUBMITTED:	APPROVED:
	CHIEF, PLANNING & REPORTS BR.	CHIEF, ENGINEERING DIVISION
PREPARED UNDER DIRECTION OF E.A. HANSEN, COL., C.E. DISTRICT ENGINEER	DRAWN BY: C.L.R.	TO ACCOMPANY INTERIM REPORT DATED: APR. 6, 1950
	CHECKED BY: P.N.B.	
	FILE TRIN 201-50	PLATE 2 4-4-6-50

INTERIM REPORT

TRINITY RIVER AND TRIBUTARIES, TEXAS

(WALLISVILLE RESERVOIR)

EXHIBIT I

LETTERS FROM OTHER AGENCIES

NOTE: The following letter dated February 18, 1960 is based on data furnished to the signatories prior to final determinations of the share of first costs and maintenance costs to be provided by the local interests as set forth in this copy of the interim report on the Wallisville reservoir.

February 18, 1960

Colonel E. A. Hansen
District Engineer
Corps of Engineers, United States Army
Galveston, Texas

Dear Colonel Hansen:

Receipt is acknowledged with thanks of your estimates of cost to local interests for the construction and maintenance of water conservation facilities in the Wallisville Dam on the Trinity River, Texas.

We are pleased to inform you that the Trinity River Authority and the City of Houston have jointly entered into an agreement concerning the development of this project and will jointly give assurance satisfactory to the Secretary of the Army that they will: (a) obtain all the necessary water rights; (b) prior to the construction agree to pay that portion of the cost of construction allocated to local interests which cost is presently estimated to be sixteen percent (16%) of presently estimated total cost of $9,450,000 or approximately $1,500,000, payments to begin when space is used for water supply and not later than 15 years from the time storage is available for water supply. The costs allocated to local interests include interest from the date of completion, such costs to be repaid within the economic life of the project but in no event to be more than 50 years after the project is available for the storage of water for water supply; (c) agree to contribute the portion of the annual cost of maintenance, operation, and replacements allocated to the local interests, payable annually which amount is presently estimated to be $19,700; and (d) in the event any of the costs of the facilities are properly allocable to navigation costs the Trinity River Authority will assume such costs.

We appreciate the opportunity to cooperate with the Federal Government in this worthwhile project.

Very truly yours,

For Trinity River Authority — /s/ Joe E. Butler, President

For City of Houston — /s/ Lewis Cutrer, Mayor

For Chambers-Liberty Counties Navigation District — /s/ Guy C. Jackson, Jr., Chairman

IN REPLY REFER TO:
L7423

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

Region Three
Santa Fe, New Mexico

April 1, 1960

Corps of Engineers
Galveston District
606 Santa Fe Building
Galveston, Texas

Dear Sirs:

In reply to your correspondence of March 23, your reference SWNGW-4, regarding the draft of the interim report on the Trinity River and Tributaries, Texas (Wallisville reservoir), field level review number 28, we have reviewed the report and have no comments to offer regarding it. We are returning the report with our reply as requested.

We would like to have a copy of the final report when available.

Sincerely yours,

George W. Miller

George W. Miller
Assistant Regional Director

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

Ninth Floor - 1114 Commerce Street
Dallas 2, Texas

PUBLIC HEALTH SERVICE

April 1, 1960

District Engineer
U. S. Army Engineer District, Galveston
Corps of Engineers
606 Santa Fe Building
Galveston, Texas

Reference: SWNGW-4

Dear Sir:

This refers to your letter of March 23, 1960, transmitting a draft copy of the Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir).

The copy of subject report is returned herewith, and the following comments are offered for consideration.

Paragraph 56, page 21, states that Plan C "...provides sufficient water supply to meet the forseeable demand." Reference to the graph of projected water requirements in our appended report will indicate that the Livingston - Wallisville development will meet only part of the expected future need of the potential market area. It is suggested that the wording of the above-quoted phrase be changed to read, "...provides for the project to serve its function in an integrated water supply plan."

Paragraph 71 of Appendix III presents additional benefits which would accrue from the reduction of pumping head. It seems desirable to clarify the point that the saving in pumping cost would accrue not only to the net yield of water from Wallisville storage, but also to the (much greater) yield of Livingston reservoir, whose water is released for pickup from the Wallisville Lake.

Sincerely yours,

Jerome H. Svore

Jerome H. Svore
Regional Program Director
Water Supply and Pollution Control

FEDERAL POWER COMMISSION
REGIONAL OFFICE
300 WEST VICKERY BOULEVARD - SUITE 2127
FORT WORTH 4, TEXAS

March 31, 1960

Colonel E. A. Hansen
District Engineer
U. S. Army Engineer District, Galveston
Corps of Engineers
P. O. Box 1229
Galveston, Texas

Dear Colonel Hansen:

Reference is made to your letter of March 23, 1960 forwarding a draft copy of your Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir) for field level review and comments.

The Federal Power Commission has a continuing interest in the development of water resources of rivers and streams for hydroelectric power purposes, and our examination of the principal features of the project related to those aspects that might lend themselves to these purposes.

Upon consideration of the comparably low power head that would be provided by the project and the relatively nominal water yield that would be available for power purposes from uncommitted storage to be impounded by the reservoir, there appears to be little opportunity for an economical power development as an adjunct of the proposed project. Also, the project will not affect any existing or potential hydro power resource.

We appreciate the opportunity to review the project report at its interim stage. It is to be noted that our field level views as expressed herein are not to be construed as those of the Federal Power Commission. As requested, the report comprised of volumes 1 and 2 is returned herewith.

Sincerely yours,

Edgar S. Coffman

Edgar S. Coffman
Regional Engineer

Enclosure No. 49850:
As stated above

72814 O-61—8

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
REGION IV

ROOM 206 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA

DIVISION OF
MINERAL RESOURCES

March 29, 1960

AIR MAIL

Colonel E. A. Hansen, CE
District Engineer
U. S. Army Engineer District
Galveston Corps of Engineers
P. O. Box 1229
Galveston, Texas

Your reference: SWNGW-4

Dear Colonel Hansen:

Your letter of 23 March 1960 together with "Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir), volumes 1 and 2 of 2", have been received for field level review.

I wish to thank you for the three large-scale maps of the proposed Wallisville Reservoir at elevations of 10, 15, and 20 feet that you sent us 28 August 1959. Our preliminary study of these maps facilitated our field level review of the report.

We note that six plans were investigated during the project studies, as follows: Plan A, with water storage and an elevation of 1 foot above mean sea level; plan B, water storage at 3 feet; plan C, water storage at 4 feet; plan D, water storage at 10 feet; plan E, water storage at 15 feet; and plan F, water storage at 20 feet. Plan C, with the benefit to cost ratio of 2.8 to 1.0, was selected as the best.

The multi-purpose reservoir (plan C), recommended in the report, would provide functional facilities for navigation, salinity control, water supply, fish and wildlife conservation, and recreation. The dam would have a total length of 33,900 feet and a total estimated cost of $9,498,000, with $161,100 annually for maintenance and operation.

Copy to: Leon W. Dupuy, Special Assistant for Mineral Resource Studies of River Basins, Washington, D. C.
Wm. Whipple, Brigadier General, U. S. Army

There are 4 oilfields within the Trinity River valley below Liberty that are mentioned on page 6 of the report, and which we have checked on our oilfield maps. The Liberty-South field, the Daton-South field, and the Liberty-Townsite field, would have been inundated or partially inundated by a reservoir with the water elevation at 20 feet (plan F). We note that the Lost Lake oilfield will be protected by a levee, and that an elevated access road will be constructed to this oilfield (plan C). The Texas Gulf Sulphur Company property is outside the area that will be inundated by the proposed reservoir.

There are 15 pipelines, that vary in size from 3 to 30 inches, crossing the proposed reservoir. The pipelines crossing the Trinity River were installed under permits issued by the Secretary of the Army at elevations of about minus 26 feet, as required for navigation purposes. All pipelines were installed with the knowledge that they would be inundated by 4 to 6 feet of water, for periods of 60 to 90 days, during the passage of major floods. In the event that pipeline repairs or the installation of new lines would be required, it would be feasible to temporarily lower the reservoir pool to permit the necessary pipeline work. Hence, relocation or modification of the existing pipelines is considered unnecessary and none is proposed in plan C.

From a review of the report, it appears that the Corps of Engineers have carefully considered the mineral industries of the area and propose, under plan C, adequate protective measures. The development of the project will provide water that may be useful to the mineral industry and the proposed protection should prevent damage to mineral resources. This review was based on information available in the Regional Office; a field reconnaissance was not made.

Under separate cover we are returning Serial No. 45 of the Wallisville Reservoir report to your office. After this report has been completed, please send a final copy to us.

Sincerely yours,

Robert S. Sanford
Division of Mineral
Resources, Region IV

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

April 1, 1960

Airmail

Brigadier General William Whipple
Division Engineer
U. S. Army Engineer Division, Southwestern
Corps of Engineers
1114 Commerce Street
Dallas 2, Texas

Dear General Whipple:

This is in response to your March 25, 1960, letter concerning the report of your Galveston District Engineer, entitled "Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir)" This report was transmitted by the District Engineer by letter dated March 23, 1960. The requirement that our comments be submitted by April 5, 1960, has precluded detailed review of the report. Following are the joint comments of this office and our Austin Development Office. Any additional comments indicated appropriate as the result of subsequent detailed review of the report will be submitted to our Commissioner of Reclamation for consideration when formal comments on your report are requested at Departmental level.

The proposed reservoir would not adversely affect any existing or authorized Bureau of Reclamation project. We note with pleasure that your report recognizes plans for a coastal canal to deliver water supplies from eastern Texas basins to westward water deficiency areas. Such plans have been developed by our agency, and will be considered by the U. S. Study Commission. Also, we note that your report contemplates that necessary planning involved in incorporation of the Wallisville Reservoir in such plans would be accomplished prior to construction of the reservoir. We will be glad to cooperate in this matter.

We note that your report finds that a substantially larger water supply could be developed at the Wallisville site than would result

from the reservoir proposed in your report, which you consider would, in conjunction with other reservoirs, meet foreseeable water supply demands. Consideration of this matter in connection with other water supply plans being developed for Texas may be appropriate prior to construction.

We will appreciate transmittal of copies of your final report to this office and our Austin Development Office. The opportunity to review your report is appreciated.

Sincerely yours,

J. R. Douglass

Regional Director

U. S. STUDY COMMISSION—TEXAS

FOR
NECHES, TRINITY, COLORADO, SAN JACINTO, BRAZOS, SAN ANTONIO, GUADALUPE AND NUECES RIVERS AND INTERVENING AREAS
980 M&M BUILDING
HOUSTON 2, TEXAS

EXECUTIVE DIRECTOR
CHARLES D. CURRAN
EXECUTIVE SECRETARY
H. E. TOBEY, JR.

TELEPHONE:
CAPITOL 4-9778
CAPITOL 2-7201

April 4, 1960

Colonel E. A. Hansen
District Engineer
U. S. Army Engineer District, Galveston
Corps of Engineers
P. O. Box 1229
Galveston, Texas

Dear Colonel Hansen:

This is in reference to your letter of March 23, 1960, file SWNGW-4, which forwarded to us for field-level review and comment a draft copy of your recently completed INTERIM REVIEW OF REPORTS ON TRINITY RIVER AND TRIBUTARIES, TEXAS (WALLISVILLE RESERVOIR).

The report bears on matters specifically under consideration by this Commission and, therefore, is of considerable interest to us. Our activities to date have been concerned primarily with data collection in the eight river basins and intervening areas in Texas under study by this Commission, and we have not as yet initiated the phase of study involving project planning. It will probably be late this calendar year or possibly early in calendar year 1961 before the first results of our project studies become apparent. In view thereof I am obliged to advise you that I have no comments to offer on your report at this time.

I understand that the current review is at field level and that further opportunity for review and comment will be afforded when the Chief of Engineers at some future date requests agency review at the Washington level. It may be that our studies will be sufficiently advanced at that time to provide pertinent information which I will be pleased to furnish to the Corps of Engineers.

I appreciate having the opportunity of reviewing your Wallisville Reservoir report. As requested in your letter, the draft copy serial No. 48 is being returned. When the final report becomes available I would like a copy for our files and use.

Sincerely yours,

Charles D. Curran

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES
P. O. Box 3098
Galveston, Texas

March 30, 1960

District Engineer
U. S. Army Engineer District, Galveston
Corps of Engineers
606 Santa Fe Building
Galveston, Texas

Dear Colonel Hansen:

The Bureau of Commercial Fisheries' field level comments on the draft of the Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir), were submitted to the Fort Worth office, Branch of River Basin Studies, on 30 March 1960. The River Basins Branch is charged with reporting effects of federal water development programs upon fish and wildlife resources. It is expected the combined comments representing the views of the U. S. Fish and Wildlife Service will be forwarded to your office by the River Basins staff as soon as possible.

Enclosed are volumes 1 and 2, serial number 43, of the Wallisville Reservoir Interim Report as requested. We would greatly appreciate a copy of the final report when available.

Sincerely,

George A. Rounsefell
Laboratory Director
Biological Laboratory

Encl.

cc: Division Engineer
U. S. Army Engineer Division, Southwestern
Corps of Engineers
1114 Commerce Street
Dallas 2, Texas

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
2-RBS

April 8, 1960

AIRMAIL

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1229
Galveston, Texas

Dear Sir:

Your letter of March 23 and General Whipple's letter of March 25, 1960, requested that we review and comment on the draft of the "Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir)." We do so herein.

Most of our comments pertain to sections of the report related to fish and wildlife. Our letter of March 29, 1960, which constitutes our report on this project, revised previous information on the national wildlife refuge, primarily land acquisition resulting from revision of the proposed boundary. You probably will wish to revise your data to reflect these changes. We are pleased that our recommendations are included in your report.

Following are our comments on the report:

Volume 1 of 2

Syllabus, page a, first paragraph, line 6. "United States Fish and Wildlife Service" should be changed to "Bureau of Sport Fisheries and Wildlife." This same change should be made to this reference and also to Fish and Wildlife Service as follows: page 3, paragraph 6; page 4, paragraph 7; page 25, paragraph 66; page 28, paragraph 72; page 30, paragraph 73, (d) and (e); page 31, paragraph 75; page 40, paragraph 94; page 46, paragraph 108; page 48, paragraph 113; page 48, paragraph 113 (c); page 51, paragraph 117, (c); Volume 2, Appendix III, page 28, paragraph 68; page 31, paragraphs 73 and 74; and page 33, paragraphs 75, 76, and 77.

Syllabus, page a, paragraph (e). The estimated annual benefits to be afforded by the national wildlife refuge show a favorable ratio of 1.17. Whether this is a justifiable expression of benefits, we do not know. As you know, our Bureau does not justify national wildlife refuges by a benefit-cost ratio. The justifications are formed in various pieces of Federal legislation which recognize the need for such refuges.

Syllabus, page b, recommendation (a). It would be preferable to cite "Public Law 85-624" as the "Fish and Wildlife Coordination Act, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq."

Syllabus, page b, recommendation (b) should be revised to 6,725 acres and $1,135,500. (cf. my memorandum of today to your office on this subject.)

Page 3, paragraph 4. Our report analyzed effects of the project on the fresh-water fishery and on the wildlife resources. The marine fishery aspects have not been evaluated by the Bureau of Commercial Fisheries. It is suggested that " , except marine fisheries," be inserted between "fish" and "wildlife."

Page 3, paragraph 6. The marine fishery has not been evaluated and therefore line 15 should be modified by insertion of "fresh-water" between "the" and "fish." It would be appropriate to add a sentence immediately proceeding the penultimate sentence to read "Evaluation of the fishery resources was for the fresh-water fishery only. The marine fishery will be evaluated when the Bureau of Commercial Fisheries has had an opportunity to make adequate studies."

Page 18, paragraph 52. Please insert "exclusive of marine fisheries" between "fish" and "wildlife" in the last sentence because the reservoir probably will be detrimental to development of the marine fishery.

Page 21, paragraph 56. The second sentence indicates that Plan C meets in full the needs for fish and wildlife conservation. Please refer to the second and third sentences, first paragraph of our March 29, 1960, letter to you which states that the analysis is confined only to the fresh-water fishery and wildlife aspects. Our report does not reflect effects of the project upon the marine fisheries. The Bureau of Commercial Fisheries has advised

us that unquestionably there will be harmful effects. The Bureau of Commercial Fisheries plans to study this phase of the project when funds become available.

Page 25, paragraph 66. The 17,940 acres will now be 17,455 acres. It is suggested that the penultimate sentence be revised by changing "7,210" acres to "6,725" acres and by deletion of "3,410 acres of" and "3,800 acres of."

Page 25, paragraph 68. In line 2 it would be preferred that "General Plan" be capitalized because it is a specific document making lands available under the Fish and Wildlife Coordination Act. The last sentence is appropriate for discussion under "National Wildlife Refuge" but this sentence should also be included elsewhere in your report. An appropriate place would be in paragraph 108 as a new sentence between the first and second sentences. Additional studies will be required for features other than the national wildlife refuge. The marine fishery has not yet been investigated and this will be done by the Bureau of Commercial Fisheries when funds become available.

Page 26, paragraph 70. The first cost of the national wildlife refuge includes an item for $710,000 for the refuge area common to the Wallisville Reservoir. We do not understand inclusion of this cost here and in several other sections of your report in connection with first cost of a refuge although we recognize that perhaps it is necessary for your economic analysis. It appears to us that the first cost should be $1,747,500, as shown in Table 1 of our report, dated March 29, 1960.

Page 30, paragraphs 73 (d) and (e). It is noted that in paragraph (d) that commercial fisheries aspects and that part of the national wildlife refuge common to Wallisville Reservoir are included in paragraph (d) and that fishing and hunting are included in paragraph (e) with recreation. All aspects of fish and wildlife should be included in paragraph (d) as fish and wildlife. This does not appear to be consonant with Appendix III, paragraph 81, which states that hunting and fishing have been carefully excluded since those recreational activities are evaluated under fish and wildlife benefits. Paragraph (d) should be revised by addition of "fresh-water" immediately preceding "commercial fisheries."

Page 31, Table 5. It appears to us that the comments for page 30 also are applicable to this table. The fish and wildlife line should reflect fishing and hunting as

well as commercial fishing. Footnote (2) should read "Fresh-water commercial fishery." The marine sport fisheries and commercial fisheries have not been considered in our report, and until the Bureau of Commercial Fisheries provides this information, it will be necessary to distinguish between fresh-water and marine fisheries.

Page 33, Table 6. The comments pertaining to fish and wildlife and to recreation in Table 5 are also applicable to this table.

Page 34, paragraph 20. Please insert "fresh-water" between "supply" and "fish" because this report does not consider the marine fisheries aspects of the project.

Page 40, paragraph 93. It is suggested that the last sentence be revised to group together the two Bureaus of the U. S. Fish and Wildlife Service by wording such as "the Bureau of Sport Fisheries and Wildlife and the Bureau of Commercial Fisheries of the U. S. Fish and Wildlife Service."

Page 40, paragraph 94, line 6 should be revised by deletion of "fish" and substitution of "the fresh-water fishery."

Page 46, paragraph 108. Please insert "fresh-water" preceding "fishery" in line 3 because marine fisheries have not been considered in this report. Change "Service" to "Bureau" in line 5; line 7 change "17,950" to "17,455;" line 8 change "7,210" to "6,725;" and line 1, page 47 should be corrected to $1,135,500.

Page 47, paragraph 109. Change "Service" to "Bureau."

Page 48, paragraph 112b. Please change "fish" to "fresh-water fish" because marine fisheries have not been considered in this report.

Page 48, paragraph 113. In section (a) we would prefer "national wildlife refuge" to "migratory bird refuge" and "Fish and Wildlife Coordination Act" in lieu of "Public Law 85-624, 85th Congress." In section (b) "7,210" should be changed to "6,725" and $1,883,000" should be changed to "$1,135,500."

Page 50 and 51, paragraph 117. The same changes indicated for page 48, paragraph 113, are also applicable here.

Exhibit III, Plates 1 and 2. You probably will wish to revise the national wildlife refuge boundary to correspond with the boundary shown on Plate I of our report, dated March 29, 1960.

Volume 2 of 2

Appendix II, pages 31 through 34. Tables 4 and 5 will need revision to conform to the data for a national wildlife refuge shown in our report.

Page 28, paragraph 68. "Waterfowl" would be preferable to "wild fowl."

Page 31, paragraph 74. Construction of Wallisville Reservoir will result in no advantage and probably in a loss to the marine sport and commercial fisheries. It is suggested that the addition of "within the created reservoirs" at the end of sentence 3 and insertion of "fresh-water" as the second word in sentence 4 be made to aid clarification. Actually all fish and wildlife resources are natural resources. In the case of both fresh-water and marine fisheries they are either sport, considered recreational, or commercial. It is suggested that sentence 5 be revised to read "Similarly, the evaluated waterfowl benefits are wholly from increased hunting, and other benefits to this natural resource have been considered but are not capable of monetary evaluation."

Pages 32 and 35, Tables 10 and 12. The "Commercial Fishing" columns should be revised to read "Fresh-water commercial fishing" because the marine commercial fishery has not been evaluated in our report. On Table 12 "wildfowl" should be "waterfowl."

Page 33, paragraph 76. Please make the following changes: "17,940 acres" to "17,455 acres," and "7,210 acres" to "6,725 acres."

Page 33, paragraph 77. Please change "Service" to "Bureau."

Page 41, Table 15. Footnote (1) has a typographical error; the fourth word should be "refuge." It is suggested that footnote (2) be revised to read "Fresh-water commercial fishery benefits" because the marine fishery has not yet been evaluated. We believe that the fishing and hunting benefits should be included in the line for "Fish and wildlife" rather than under the "Recreation" line.

We appreciate the opportunity to review your report. We also recognize that our rather lengthy comments result from the urgency for preparation of your report in such a short time. The draft of your report, Volumes 1 and 2 of Serial Number 49, are being forwarded under separate cover. We would like to receive a copy of the final report.

Sincerely yours,

Carey H. Bennett

Carey H. Bennett
Acting Regional Director

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

P. O. Box 417
Temple, Texas
April 6, 1960

Colonel E. A. Hansen, District Engineer
U. S. Corps of Engineers
606 Santa Fe Building
Galveston, Texas

Dear Colonel Hansen:

Thank you for the opportunity to review the draft of your recently completed Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville Reservoir). We regret that the short period of time between the date we received our copy, March 28, and the time you needed the comments necessitated only a very hurried review of the material presented in the report.

General - We note that six alternate plans were considered in determining that plan "C", a dam location downstream from Wallisville, was the most economical. The report is well prepared and data presented were found to be adequate. Some of the details relative to the other five plans considered, however, cause some confusion to a reviewer of the report. The following comments have been made by technicians of this Service and are presented for your information and consideration:

Hydrology - It appears that no consideration was given to the possibility that floodwater retarding structures might be constructed above the Wallisville Reservoir. Our information indicates that four floodwater retarding structures may be constructed between the Wallisville and Livingston Reservoirs. Tentative data for these proposed sites show that the total effect of the four structures on the operation of the Wallisville Reservoir would be negligible.

Sedimentation - Sedimentation specialists of this Service state that the estimates of sediment delivered to the Livingston and Wallisville sites appear to be reasonable In following the calculations for determining the amount of sediment delivered, it was noted that the results were in close agreement with those obtained by our technicians.

Storage allocated to sediment is shown to be 12,800 acre-feet in the proposed plan for Wallisville Reservoir (Figure 22). Only 720 acre-feet of sediment per year would be delivered to the Wallisville Reservoir with the proposed Livingston Reservoir installed. It is assumed that the sediment storage in the Wallisville Reservoir was determined without considering the Livingston Rerservoir in place. In view of this, is it contemplated that the remaining sediment storage in the Wallisville Reservoir will be utilized for irrigation or other beneficial purposes following construction of the Livingston Reservoir?

Economics - The report does not indicate that the irrigation needs of agriculture have been provided for adequately. In the plan, water requirements have been assumed to be 37,500 acre-feet per month for a six-month period during each year. This is based on 50,000 acres irrigated annually. Census data indicate that substantially greater requirements for irrigation purposes may be expected in the future. Irrigated cropland harvested in Chambers, Jefferson and Liberty Counties was reported to be 168,000 acres in 1949, or about one-third of all land in irrigated farms in the three counties. The projected irrigated cropland requirements will be considerably greater by the year 2010. It is suggested that adjustment of storage allocations for conservation and irrigation purposes be considered to provide for future needs.

Plan C was selected as the alternative which maximized net benefits based on the evaluation of several alternate plans. It is doubtful that benefits can be maximized when conservation storage is included which produces benefits of about $2.25 per acre-foot and net benefits from irrigation storage are not included. It appears desirable that an evaluation of the net worth of irrigation storage, comparable to that of industrial and municipal storage should be included. In view of the declining levels of ground water described in the report, the benefits from irrigation storage could well exceed $2.25 per acre-foot.

In an effort to serve the overall interests of a watershed most effectively, consideration should be given to the needs of water users upstream as well as those downstream from the project. A project report containing the best analysis possible of such relative needs would aid the Board of Water Engineers in making a realistic allocation of water rights.

Drainage - It appears that there will be no adverse effects to the major drainage outlets in the Lower Trinity Soil Conservation District as a result of the project. All drains are in the Coast Prairie Land Resource Area well above the 4.0 foot mean sea level and enter the Trinity River at a rather steep gradient.

Irrigation - The present quality of irrigation water would be maintained and salt water intrusion would be prevented with installation of the salt water barrier. Also, the minimum pumping level during low flows would be raised to the level of the lake, thus reducing pumping costs.

Paragraph 38, page 12, line 6 of Volume 1 of text. It is suggested that you substitute "prevention" for "preservation".

Same paragraph, last sentence. Please consider deleting the last sentence and add in its place "Approximately 246 of these floodwater retarding structures have been constructed out of a total of about 1,330 planned for the watershed."

Very truly yours,

H. N. Smith
State Conservationist

U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
606 SANTA FE BUILDING
GALVESTON, TEXAS

ADDRESS REPLY TO:
DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
P. O. BOX 1229
GALVESTON, TEXAS

REFER TO: SWNGW-4

20 April 1960

Mr. H. N. Smith
State Conservationist
Temple, Texas

Dear Mr. Smith:

Thank you for your letter of 6 April 1960 furnishing your review findings and comments on our draft of Interim Review of Reports on Trinity River and Tributaries, Texas (Wallisville reservoir) dated 19 February 1960. Mr. John A. Short, River Basin Representative, Soil Conservation Service, Tulsa, Oklahoma, advises that the Forest Service has no comments regarding the subject interim report, and that your letter constitutes the comments of the Department of Agriculture on the subject report.

Your comments on the draft interim report have been carefully reviewed, and are summarized in the report. In response to your suggestion the report, paragraph 38, has been revised, as follows: The word "prevention" is changed to "preservation", and the last sentence now reads "Approximately 246 of 1,330 planned floodwater retarding structures have been constructed on the watershed." Further revision of the subject report in response to your comments and proposals is considered unnecessary at this time in view of information given in the following paragraphs.

Regarding your comments on hydrology, that no consideration was given to the possibility that flood water retarding structures might be constructed above the Wallisville reservoir, it is desired to point out that the report evaluates the effect of the Soil Conservation Service structures on the watershed above existing reservoirs in connection with the determination of sediment storage entering the Livingston and Wallisville reservoirs. Also, in connection with our preliminary investigation of flood control on the lower Trinity River consideration was given to the existing and proposed flood water retarding structures on the watershed as listed in your report on the Trinity River dated January 1959. The preliminary investigation for flood control revealed that storage for such purposes would not be economically justified in any of the Wallisville reservoirs that were studied. It was further found that the proposed and completed Soil Conservation Service structures would not provide any conservation

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storage on the watershed below the Livingston reservoir and would have no effect on the yield of water from the Wallisville reservoir. Accordingly, detailed information regarding these structures was excluded from the subject interim report.

With respect to your comment on storage allocated to sediment in the Wallisville reservoir it is desired to point out that the storage of 12,800 acre-feet existing below elevation 1.0 above m.s.l. is required primarily for salinity control during low flows on the river. The sediment inflow to the Wallisville reservoir is estimated at 819 acre-feet annually based on the assumption that the Livingston reservoir was constructed, and would contribute 431 acre-feet per annum. The sediment production from the area below Livingston reservoir is estimated at 388 acre-feet, annually. Operation of the Wallisville reservoir as described in the interim report proposes that the gated control structure in the river discharge channel be operated so as to maintain an open river during flood rises passing the control structure. It is estimated that about 95% of the silt load entering the Wallisville reservoir would pass out of the reservoir by the proposed operation of the control structure. On this basis, it is estimated that about 2,100 acre-feet of sediment would be deposited in the reservoir during the 50-year project life. Because of the requirement to maintain a head of one foot above mean sea level for salinity control purposes, it is considered inadvisable to allocate the available storage below elevation +1.0 to any other beneficial uses than for salinity control.

Your comments on economics are understood to concern mainly the adjustment of storage allocation for conservation and irrigation purposes, and that it is proposed to include in the interim report an evaluation of the net worth of irrigation storage as well as the net worth of municipal and industrial storage. The subject interim report does not designate any specified allocations of the conservation storage for the various beneficial uses, however, the cost of the conservation storage was based on the cost of providing an alternate reservoir project for municipal and industrial water supply. This evaluation of the water yield of the Wallisville reservoir was determined by the U. S. Public Health Service as set forth in its brief which accompanies the report as exhibit II. The local interests participating in the Wallisville reservoir project, consisting of the City of Houston, the Trinity River Authority of Texas and the Chambers-Liberty Counties Navigation District will determine the proper allocation of storage for the various uses. In this connection the City of Houston has agreed to furnish a definite amount of water from the Livingston reservoir for the local rice irrigation purposes. It is understood that the local rice irrigators are satisfied with the proposal made by the City of Houston. In view

of the foregoing it is considered that the report should not be revised to reflect the net worth of conservation and irrigation storage.

It is desired to point out further that irrigated crop land in Chambers, Jefferson and Liberty counties are irrigated by waters from both the Neches and Trinity Rivers. The interim report contains information to the effect that the total area under irrigation by waters from the Trinity River amounts to over 300,000 acres. Under the practice of allowing land to lie fallow for 2 years prior to cultivating of rice crops, the lands now being used for rice will be sufficient to maintain an average cropping program of about 90,000 acres annually. The deterrent factors to full use of these lands is considered to be the present day Government agricultural controls of the rice crop and lack of sufficient water supply necessary for irrigation of more than 90,000 acres annually. It is further considered that under the expected population growth of the Beaumont, Liberty, and Houston areas by the year 2010, a considerable portion of the irrigated farm lands would be converted to industrial and municipal purposes, particularly in the region adjoining the lower Trinity River. The study of the water needs in the area by the U. S. Public Health Service indicates that full utilization of all potential sources of water supply will be required within the next fifty years to meet the predicted growth of population and industry.

The Wallisville reservoir project is considered as an element in the overall plan of improvement for water conservation as contemplated by the Trinity River Authority. The Galveston and Fort Worth Districts, Corps of Engineers, in response to Congressional Authority, are undertaking a comprehensive study of the Trinity River and Tributaries in the interest of flood control, navigation, water conservation and allied purposes. The comprehensive study will give full consideration to the needs of water users on the watershed upstream of the Wallisville reservoir whereby the overall water requirements of the watershed will be served most effectively.

The favorable comments concerning the effect of the Wallisville reservoir on drainage and quality of irrigation water are noted.

Your early cooperation in furnishing comments and suggestions concerning the subject interim report on Wallisville reservoir is appreciated.

Sincerely yours,

FRANKLIN B. MOON
Major, CE
Executive Officer

EXHIBIT II

REPORT, U. S. PUBLIC HEALTH SERVICE

MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

WALLISVILLE RESERVOIR

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII

In cooperation with the

DEPARTMENT OF THE ARMY
U. S. Army Engineer District-Galveston, Texas

FEBRUARY 1960

INTRODUCTION

In a letter dated June 8, 1959, the District Engineer, Fort Worth District, Corps of Engineers, requested the Region VII Office, Public Health Service, to recommend prospective needs for municipal and industrial water supply in the vicinity of the Trinity River Basin and to determine the economic value of meeting these needs from the proposed Wallisville Reservoir. This study was made in accordance with the provisions of the Memorandum of Agreement dated November 4, 1958, between the Department of the Army, and the Department of Health, Education, and Welfare, to provide assistance in implementing the Water Supply Act of 1958.

The assistance and cooperation of the following named persons and organizations were very important factors in compiling the data used in the study and are hereby acknowledged:

Professor I. W. Santry, Jr.
Civil Engineering Department
Southern Methodist University

Texas State Department of Health

Bureau of Business Research,
University of Texas

Texas Board of Water Engineers

U. S. Department of the Interior
Bureau of Reclamation

Mr. H. R. Norman, Brown and Root, Inc.

Public Works Department, Houston, Texas

Mr. R. Taylor, Layne-Texas Co.

Public Works Department, Dallas, Texas

SUMMARY AND CONCLUSIONS

1. The geographical area included in this study comprised the counties of Harris, Galveston, Chambers, and Jefferson, and part of Liberty County.

2. The study area has experienced a fantastic rate of economic and industrial development and corresponding population growth in the recent past. If adequate supplies of water are made available at reasonable cost, it is believed that its growth will continue at a rapid rate.

3. Projected water supply requirements for the area are 650 mgd in 1965 and 3,874 mgd by 2010.

4. The full utilization of all fresh water supplies in the area, including use of maximum feasible storage in Wallisville Reservoir, will be needed within the next fifty years.

5. In view of the indicated need for development of all possible sources within fifty years, and in consideration of special circumstances (more fully described herein), it was deemed advisable to depart from the "alternate cost" method, and to use a value for Wallisville water based on a contract price for water in Livingston Reservoir. On the latter basis, it is considered that a reasonable value for Wallisville water is 6.75 mills ($0.00675) per thousand gallons.

DESCRIPTION OF THE STUDY AREA

Geographic

The proposed Wallisville Dam site is located on the Trinity River in the vicinity of Wallisville, Texas, a few miles above its point of discharge into Trinity Bay. Figure 1 shows the location of the project and an outline of the area studied as a potential "market" for Wallisville water.

The study area, or demand area, consists of Harris, Galveston, Chambers, and Jefferson Counties and that part of Liberty County lying south of the upper end of Wallisville Reservoir. The boundaries of the study area were, of necessity, chosen arbitrarily and may be subject to change. Among the factors considered were the potential demand for water, feasibility of transmission from Wallisville, amount and character of present and future development, and the apparent advisability of encompassing more than the relatively small area of the Trinity River watershed below the reservoir site. Houston and Harris Counties were included especially because of the active interest of the City of Houston in obtaining Trinity River water. General adherence to county lines facilitated the correlation of available data on population and water use.

The study area lies within the Gulf Coastal area of Texas and is characterized by low, grass-covered plains. Two major rivers, the Trinity and the San Jacinto, traverse the area, and the Neches River forms its eastern border.

Economics

There is a wide diversity in the economies of the different parts of the region. Harris County, in which the City of Houston is located, is mainly an industrial county, with some agriculture. Tonnage wise, the Port of Houston is one of the largest seaports in the United States. Galveston County depends largely on deep-water shipping and Texas City industry for its economy. Jefferson County has a balanced economy maintained by agriculture, oil, and industry. Liberty and Chambers Counties are primarily agricultural.

The Counties of Harris, Galveston, and Jefferson are heavily populated, the population being principally urban in character. Liberty and Chambers Counties are less densely settled and are primarily rural in character. Population trends have been upward throughout the study area, with Harris, Galveston, and Jefferson Counties showing the most rapid growth. For example, the 1940 population of Harris County was 528,961, and its 1950 population was 806,701, an increase of 52.5 per cent in ten years. It appears reasonable to assume that a high rate of growth may be expected in the future.

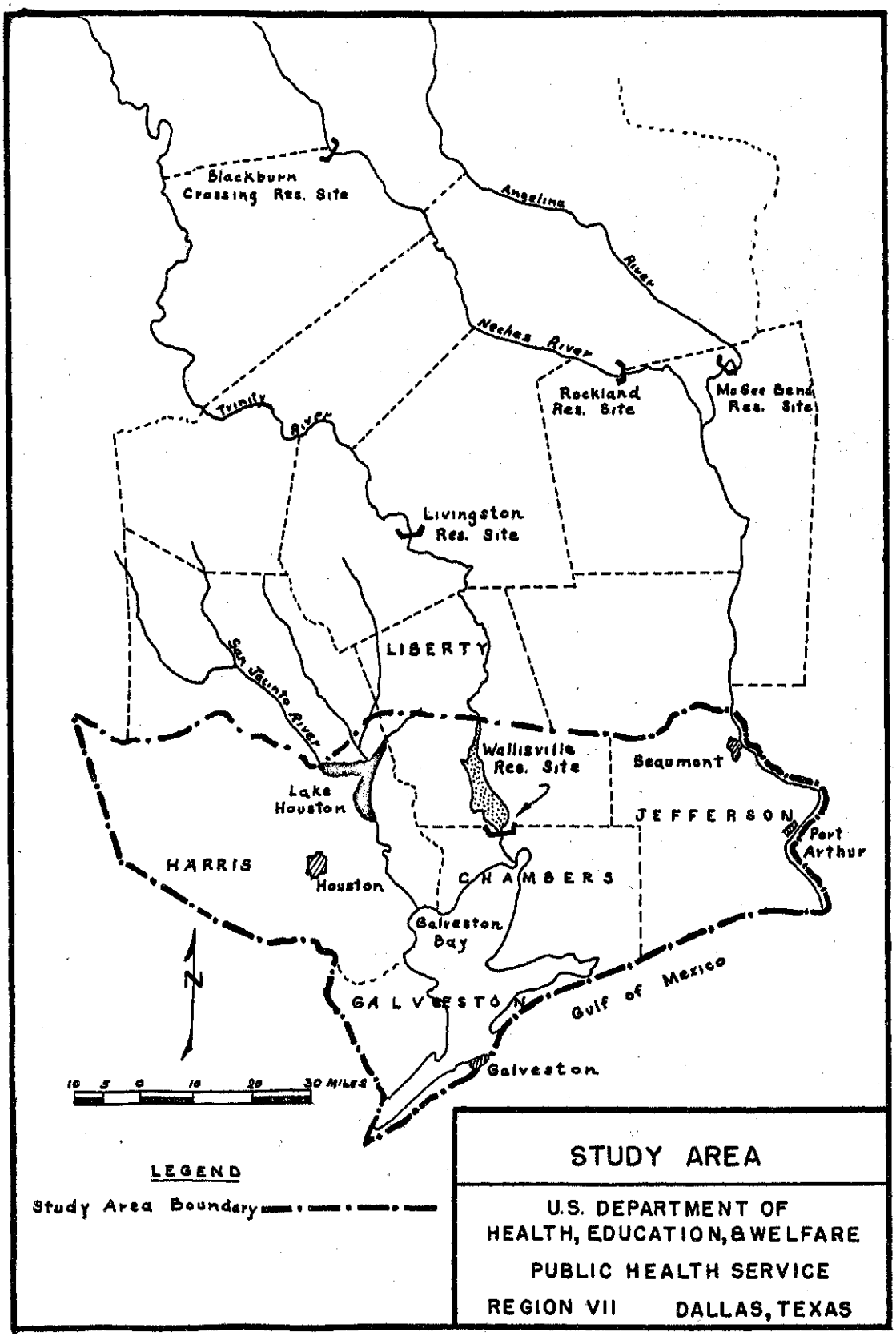
Blackburn Crossing Res. Site
Angelina River
Neches River
Trinity River
Rockland Res. Site
McGee Bend Res. Site
Livingston Res. Site
LIBERTY
San Jacinto River
Wallisville Res. Site
Beaumont
Lake Houston
JEFFERSON
Port Arthur
HARRIS
Houston
CHAMBERS
Galveston Bay
N
GALVESTON
Gulf of Mexico
Galveston
10 5 0 10 20 30 MILES
LEGEND
Study Area Boundary
STUDY AREA
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE I

Present Water Supplies

Present water requirements of the area are supplied, in most cases, from ground water aquifers. The principal sources of ground water are the Lissie and associated formations. The period from 1931 through 1954 saw a progressive decline in static water tables, ranging from 20 to 200 feet. The completion of Lake Houston Dam and resulting increased use of surface water in the Houston area led, in 1954, to the first decrease in ground-water pumping in that area since 1941. As a result, some recoveries of water levels have been noted since that time. A general subsidence of the land surface over a large part of the Houston area has been attributed to the declines in artesian pressures.[1/]

With the exception of Jefferson County, where chloride concentrations are high, the ground water in the area is generally of good quality for water supply purposes.

Port Arthur and Beaumont, in the Neches River Basin, derive their water supply from surface sources. A portion of Houston's supply is surface water from Lake Houston on the San Jacinto River.

From a study of data obtained from the Texas State Department of Health and other sources, it is estimated that the combined capacity of all existing water systems in the

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1/ Wood, Leonard A., Bulletin 5602, Texas Board of Water Engineers, February 1956.

study area is on the order of 396 mgd. This includes both ground and surface water supply systems. As will be discussed later in this report, it is further estimated that full utilization of this capacity will be required sometime before 1965, to meet increasing water requirements.

Present Water Use

An idea of the magnitude of present water use can be obtained by examination of Table 3 (Appendix). This table gives the average daily pumpage in mgd for the 21 principal cities of the area, as reported to the Texas State Department of Health for the year 1958. Total for the 21 cities was 136 mgd.

A large number of industries in the demand area obtain their water from an adjacent municipality. However, some industries, especially those with heavy demands, have developed their own supplies. For example, industries in the latter category are using an estimated 100 mgd in the Houston area.

FUTURE GROWTH AND WATER REQUIREMENTS

Population

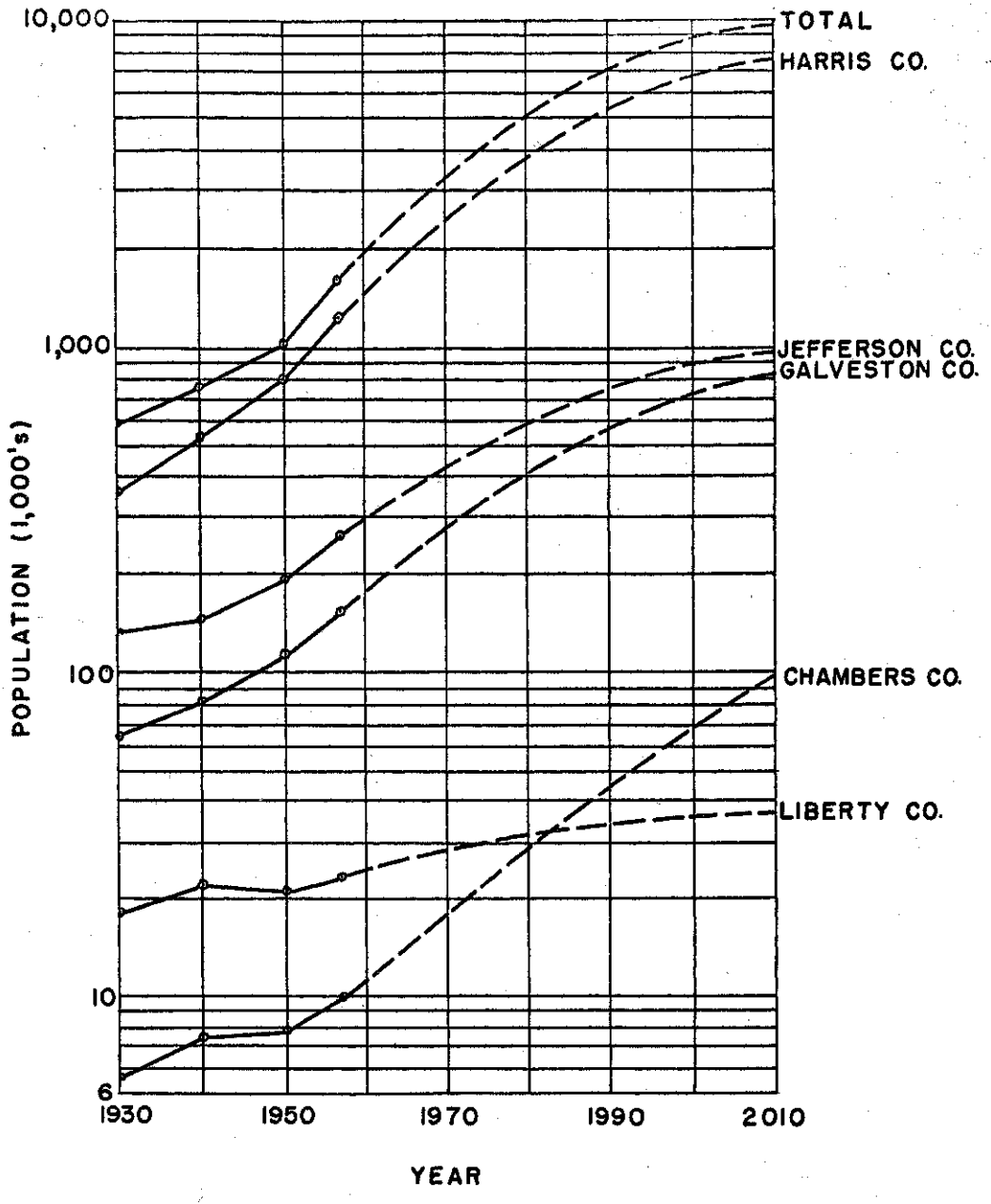
Figure 2 shows past and predicted future populations for each county (or portion thereof) and for the over-all area, for the period from 1930 to 2010. The historical population figures (and estimates for the year 1957) were obtained from the U. S. Bureau of the Census.

The population growth curves presented in Figure 2 are subject to the inaccuracies inherent in such long-range projections. In addition to historical records, they were based on consideration of type and density of population, the existence of raw materials for basic industry, notably petroleum and petrochemical, market potential, transportation facilities, including the intracoastal canal and deep-water channels, the labor market, and the present degree of saturation. It was assumed that water supply, adequate in quantity and quality, will be made available at reasonable cost, to meet the requirements of the predicted growth. Although a direct comparison cannot be made because of boundary differences, consideration was also given to the studies made by the Bureau of Business Research of the University of Texas, and published in various reports issued by the Bureau (see Bibliography).

Liberty County has experienced developments in oil and agriculture in recent years, which have reversed the previous declining population trend. Its growth may be further stimulated by the provision of inland navigation on the Trinity River. It is expected that it will continue to grow, although at a rate substantially lower than the other counties of the area.

Jefferson County is a highly industrialized area with an economy based on oil production and processing, manufacturing, agriculture, and shipping. Beaumont is an important seaport, Port Arthur is noted for its oil production, and Port Neches has extensive industry.

Chambers County is primarily agricultural at the present time. There is a fair amount of oil, rice, and cattle production in the county. In the future, there will be a need for expansion of the deep-water port facilities for the area. It is believed that a ship channel will probably be extended along the shore of Trinity Bay, with docking and transfer facilities near the mouth of the Trinity River. This is expected to stimulate development in Chambers County and accelerate its future growth rate.



POPULATION TRENDS

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

FIGURE 2

Harris County, the fastest growing county under study, has mainly an urban population, centered in the City of Houston, the largest Texas city. Houston is an extremely important seaport and the principal manufacturing center in the state. The leading industries to be found in the Houston area are petroleum, cotton, shipping, meat packing, and chemical. Also in Harris County are found cattle, oil, and some timber industries. Houston's past and present growth rates have been remarkably high, and it is believed that this high rate can be expected to continue, although progressively diminishing, through the study period of the next fifty years.

Galveston County, too, has a highly urbanized population. The port city of Galveston and the industrial area of Texas City are located in this county. It is anticipated that the petrochemical industries in Texas City will expand, and that the population of this county can be expected to grow as depicted on Figure 2.

The predicted populations for the entire study area are 2,446,000 for the year 1965 and 9,787,000 by 2010.

Water Requirements

For the purpose of this study, municipal (or domestic) and industrial water requirements have been divided into three categories:

(1) Fresh-water use by basic industry

(2) Brackish water used by basic industry

(3) Other fresh water requirements, called "Domestic Use" for brevity and including the needs for residential, municipal, nonbasic industries, and miscellaneous purposes not included in the first two categories.

As the term is used herein, Basic Industry refers to an industry which produces goods for sale outside the area and thus brings income into the area. Petroleum refineries and petrochemical plants are examples of this type of industry.

There is a wide diversity in the water requirements of basic industries, depending upon the processes involved. For this reason, correlation of basic industrial water needs with population must start with an appraisal of the scope and nature of the various basic industries. The quality of water required will also depend upon the purpose for which it is used.

Predicated on an increasing awareness of the importance of conservation of fresh water (and continuing increase in its cost), it has been assumed that 80 per cent of the water requirements of basic industry will, in the future, be met by brackish water and 20 per cent by fresh water.

The increase in domestic water use in this country has been reflected in two ways, a greater gross demand as population increased, and a continuing increase in per capita consumption. It is generally agreed by those who have studied the problem that per capita rates will continue to rise in the future, reflecting a better standard of living, wider application of modern sanitation standards, and other factors.

Projections of the expected trend in per capita use were made for each county of the study area. Past trend and present base for each county were obtained from data collected by the Texas State Department of Health. These data were plotted and future trends projected graphically, guided by past record, judgment, and the predicted national trend.

Basic industrial water use was correlated with population by using data taken from Water Requirements Survey for Texas, Bulletin 5910, prepared by the Bureau of Business Research, University of Texas, and published in July 1959, by the Texas Board of Water Engineers. For that publication, an inventory

and classification of basic industries were made, together with a tabulation of quantity of water required per unit of product by each industry. Using a combined interrelationship of water quantities per unit produced, man-hours per unit, total employment per basic industry employee, and total population per worker, a per capita use figure was obtained for each area. The future per capita use figures for basic industry reflect the net result of two predicted offsetting trends, a decrease in man-hours per unit of product, and increased efficiency of water use; that is, a reduction in amount of water per unit of product.

Table 1 summarizes the results of the study of population and water use for the terminal year of projection, 2010, and also gives figures for the intermediate year 1965. The water requirement projection is also shown graphically on Figure 3 (Appendix).

Table 1 - Total Water Demand

County	Design Population	Domestic Use GPCD	Basic Industrial Use GPCD	Average Daily Fresh Water Requirement (mgd) Domestic	Industrial
		Year - 1965			
Chambers	15,300	140	4,730	2.1	14.5
Galveston	220,000	160	530	35.2	23.3
Harris	1,800,000	177	372	318.0	134.0
Jefferson	385,000	137	829	52.8	63.9
Liberty	26,000	123	576	3.2	3.0
Total	2,446,300			411.3	238.7
		TOTAL DEMAND BY 1965 - 650.0 mgd			
		Year - 2010			
Chambers	100,000	187	8,167	18.7	163.2
Galveston	860,000	230	972	198.0	155.0
Harris	7,800,000	249	611	1,940.0	953.0
Jefferson	990,000	190	1,248	188,0	247.0
Liberty	37,000	180	603	6,7	4.4
Total	9,787,000			2,351.4	1,522.6

TOTAL DEMAND BY 2010 - 3,874.0 mgd

Historical Record of Flows

The flow of the Lower Trinity River has been measured by the U. S. Geological Survey at Romayor, Texas, (mile 94) since 1924. Incomplete records are also available since October 1938 at Liberty, Texas, (mile 40).

The 33-year average flow at Romayor was 7,333 cfs. Maximum discharge of record was 111,000 cfs, on May 9, 1942, and minimum flow was 102 cfs, August 24 and 25, 1956. For the record flood of May 1942, the maximum discharge at Liberty, was 114,000 cfs, on May 12. Minimum flow at Liberty is affected by tidal action, and measurements are not available.

Quality of Water

The Trinity River below Livingston is generally of good quality for public water supply, except during periods of flood flow. At these times, sludge deposits are broken loose and organic matter that has collected on high ground is washed into the river.

At present, there are no industrial organic pollution loads entering the river in the lower reach. Reliable information is not available on the discharge of inorganic wastes to this portion of the river. However, chemical analyses of the water indicate that such wastes, if present, are not causing significant deterioration of quality.

Table 2 gives an inventory, based on 1958 estimates, of the municipal organic wastes entering the river at or below the City of Livingston.

Table 2 - Present and Future Sources of Organic Pollution

City	Type of Waste	Population Equivalents 1958	2010
Dayton	Municipal	800	600
Liberty	Municipal	2,550	1,650
Livingston	Municipal	200	2,220

The last column of the above table shows estimated waste loads to be expected by the year 2010. By that time, it is assumed that all towns will be achieving at least 85 per cent reduction of waste loads by treatment.

Data on chemical quality of the water are available for a sampling point near Romayor, Texas. Samples have been collected by the U. S. Geological Survey for a period of 16 years, since 1941, with some gaps in the record. Average concentrations for a ten-year period were as follows:

Sulphates	39 ppm
Chlorides	62 ppm
Dissolved Solids	279 ppm

Additional samples have been collected at Liberty, Texas, but only for a few months.

The concentrations of sulphates, chlorides, and total dissolved solids are not of serious magnitude at the present time. However, there is an upward trend in these concentrations, possibly caused by the increased discharge of municipal wastes upstream. It is roughly estimated that the concentrations will fall within the following ranges from now until the year 2010.

Sulphates	70	-	160 ppm
Chlorides	260	-	660 ppm
Total Dissolved Solids	390	-	1,240 ppm

From the foregoing, it may be concluded that Trinity River water now has a quality satisfactory for municipal and industrial use, and this will continue to be true, provided proper discipline is maintained over the disposal of wastes.

Assumed Plan of Operation

From information given by the Corps of Engineers, and according to the terms of an agreement made in 1959 between the City of Houston and the Trinity River Authority, the function of Wallisville Reservoir, insofar as water supply is concerned, will be as outlined below.

Livingston Reservoir (proposed for construction by the Trinity River Authority and the City of Houston) and Wallisville (now being studied by the Corps of Engineers) will be operated as an integral unit. Livingston, with an estimated yield of 1120 mgd for municipal and industrial purposes will be the major storage

reservoir. The downstream Wallisville Dam will serve as a diversion structure for Livingston water. Releases from Livingston will be picked up from Wallisville Reservoir, for transmission to market.

Although the primary regulatory function will be performed by Livingston, it is understood that it is possible to increase the combined yield by providing conservation storage in Wallisville Reservoir, and that the combined feasible yield could be 1200 mgd or more.

Need for Wallisville Water

If the growth patterns given in this and other studies are to take place as predicted, the full utilization of all potential sources of water supply will be required within the next 50 years. This means that there is no "alternate" source of water in the usual sense of the word, since "alternate" implies a freedom of choice. For this study area, it follows that the only freedom of choice will be in deciding the time sequence of utilization of the several sources, and even this freedom must be modified by the priority given to multiple-purpose projects for other purposes. It seems evident that the decision has already been made to utilize the Trinity River and the Livingston-Wallisville Project in the near future.

Value of Wallisville Water

On the basis that Wallisville will be operated as an integral part of a Livingston-Wallisville system, it is concluded that the

value of water in Wallisville is equal to the value of Livingston water, as established by the aforementioned agreement between the City of Houston and the Trinity River Authority. This value is 6.75 mills ($0.00675) per thousand gallons.

Table 3 - Present Water Users

City	Source	1958 Daily Use (mgd)
Alvin	Well	0.477
Anahuac	Well	0.118
Angleton	Well	0.528
Baytown	Well	2.630
Beaumont	Surface	12.615
Cleveland	Well	0.316
Danbury	Well	0.041
Dickinson	Well	0.495
Galveston	Well	11.416
Groves	Surface	0.984
Houston	Surface & Well	90.709
Lake Jackson	Well	0.440
League City	Well	0.192
Mount Belview	Well	0.141
Nederland	Well	0.662
Pasadena	Well	4.739
Pearland	Well	0.140
Port Arthur	Surface	6.288
Texas City	Well	2.365
Winnie	Well	0.113
Liberty	Well	0.579
	Total	135.988

APPENDIX

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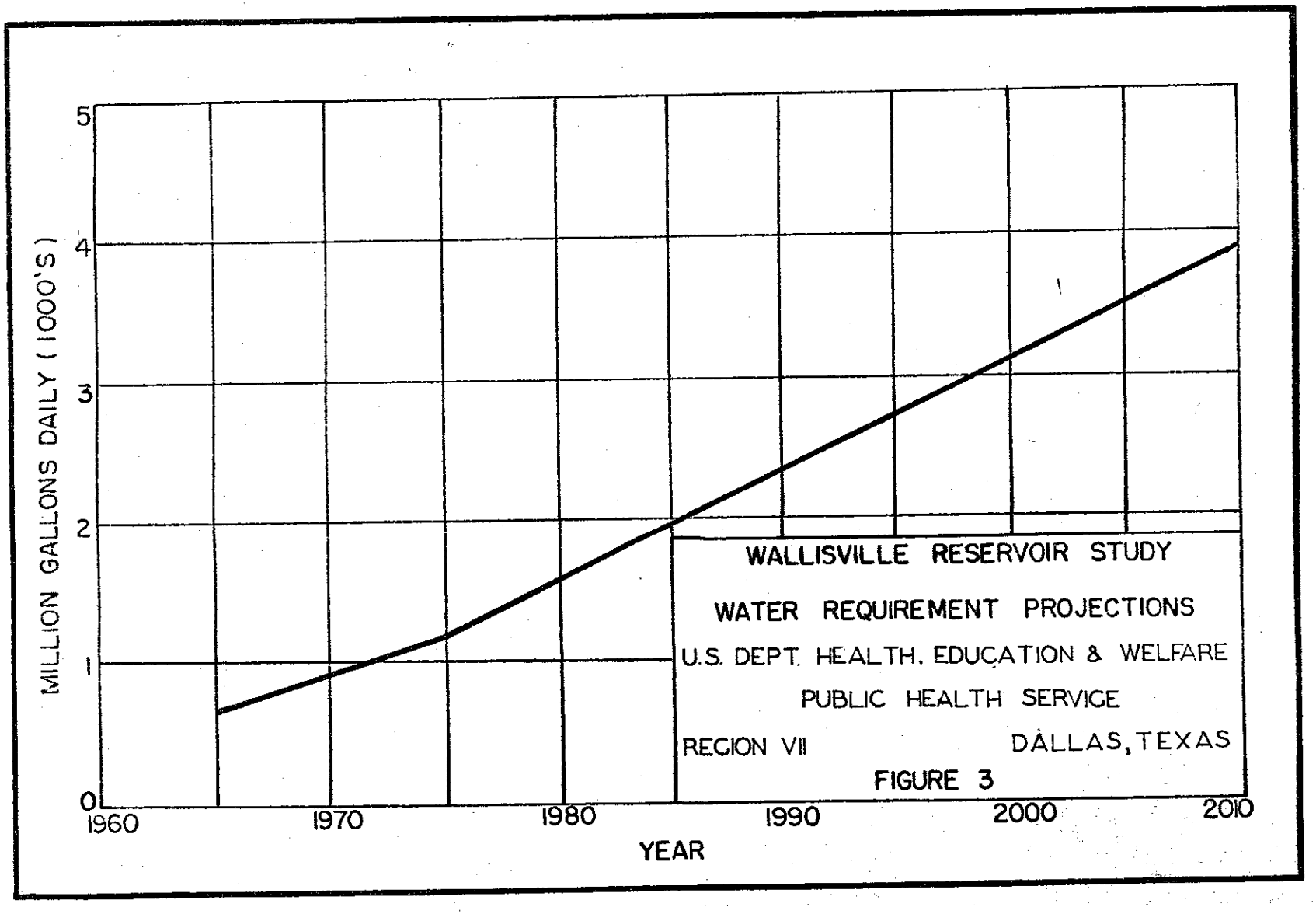
MILLION GALLONS DAILY (1000'S)
0
1
2
3
4
5
1960
1970
1980
1990
2000
2010
YEAR
WALLISVILLE RESERVOIR STUDY
WATER REQUIREMENT PROJECTIONS
U.S. DEPT. HEALTH. EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII
DALLAS, TEXAS
FIGURE 3

INTERIM REPORT

TRINITY RIVER AND TRIBUTARIES, TEXAS

(WALLISVILLE RESERVOIR)

EXHIBIT III

REPORT, BUREAU OF SPORT FISHERIES AND WILDLIFE

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

April 8, 1960

2-RBS

AIRMAIL

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1229
Galveston, Texas

Dear Sir:

Reference is made to the telephone call between Messrs. Arthur J. Kroll, Raymond B. St. John, and Karl G. Kobes on this date concerning a change in land acquisition cost for the national wildlife refuge on the Wallisville Reservoir.

This confirms agreement with Mr. Kroll that an estimate for severance damages in the amount of $50,000 will be added to the previous land acquisition cost estimate amounting to $1,085,500.

The above mentioned change will require revisions in our report. Kindly revise the following pages of Regional Director John C. Gatlin's letter dated March 29, 1960, to you:

Pages 11, 12, and 14 -- Change $1,085,500 to $1,135,500.

Pages 11 and 12 -- Change $1,697,500 to $1,747,500.

Sincerely yours,

Carey H. Bennett

Carey H. Bennett
Acting Regional Director

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)
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WYOMING

ADDRESS ONLY THE
REGIONAL DIRECTOR

March 29, 1960

2-RBS

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1229
Galveston, Texas

Dear Sir:

The Bureau of Sport Fisheries and Wildlife presents herein its report on fish and wildlife resources in relation to the Corps of Engineers survey study of the Wallisville Project, Chambers and Liberty Counties, Texas. This report reflects a 50-year period of analysis and is confined only to fresh-water fishery and wildlife aspects. It is evident that there will be some loss of nursery areas for marine fish and shellfish, but until the Bureau of Commercial Fisheries has been able to conduct the necessary investigations and adequate assessment, the project effects on the marine fisheries cannot be made. The report has been prepared in cooperation with the Texas Game and Fish Commission in accordance with the Fish and Wildlife Coordination Act, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq. This report has received the concurrence of the Texas Game and Fish Commission by letter dated January 27, 1960, signed by H. D. Dodgen, Executive Secretary.

Particular attention is given to the possibility of incorporating project facilities to benefit the national migratory bird management program. We believe the information submitted in this report will be helpful in your plans to develop the lower Trinity River in the vicinity of Wallisville, Texas, and your comments on our recommendations, including the feasibility of their implementation, will be appreciated. We also would appreciate being informed of the final plans when they are completed, so that we may re-evaluate the fish and wildlife aspects, if need be, to reflect actual project operation and features.

Information relative to the features of the project was obtained by conferences with Mr. A. B. Davis on July 13, 1959, and with Mr. Art Kroll on November 10, 1959, and by letters dated July 23 and December 15, 1959, from Mr. Kenneth Heagy, Chief, Engineering Division. Preliminary operation regimen and pertinent engineering data were transmitted with letters from Mr. Heagy, dated September 2, November 17, and December 15, 1959, and March 18, 1960.

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We have been requested to evaluate fish and wildlife resources of six proposed plans of reservoir development, designated by the Corps of Engineers as Plans A, B, C, D, E, and F, which would provide reservoir storages to elevation 3, 1/ 4, 10, 15, and 20, respectively. Plan A proposes no reservoir storage for conservation uses, and except for a description of its features is excluded from consideration hereinafter because effects upon the fish and wildlife resources would not be significant.

Wallisville Reservoir will be on the Trinity River, about 35 miles east of Houston, Texas, and about 42 miles west of Beaumont, Texas. It will serve as a unit in the comprehensive reservoir system proposed by the Trinity River Authority for ultimate development of the Trinity River Watershed. The purposes of the project will be water conservation for municipal, industrial, agricultural, and mining uses; navigation; salinity control; conservation of fish and wildlife; and recreation.

Reservoir operation for each proposed plan of development is based entirely on streamflows and runoff on the watershed downstream from the proposed Livingston Reservoir for a period from 1940 to 1958, inclusive, excluding spillage and releases of appropriated flows from Livingston Reservoir for use in the adjacent lower river area. Diversion of water for municipal and industrial purposes would be made from the reservoirs in addition to use of water for navigation purposes. All plans provide for a commercial lock 84 feet wide by 600 feet long. In addition, Plans D, E, and F also provide for a small craft lock 20 feet wide by 75 feet long. The total yields of reservoirs considered in Plans B, C, D, E, and F are estimated at 75, 105, 170, 235, and 280 second-feet, respectively, of which 12.4, 17.0, 4.5, 5.6, and 5.7 second-feet would be the average water use for navigation during critical drought periods. No constant minimum releases are proposed in any plan.

Plan A provides for the prevention of salt water intrusion in the lower Trinity River and for further advancement of the navigation channel to Liberty, Texas. The plan proposes construction of a 600-foot-long earth diversion dam with crest at elevation 8.0 across the Trinity River at river mile 3.9; a gate-controlled river diversion channel extending from about river mile 4.0 to the north shore of Trinity Bay, a distance of about 10,000 feet; and, appurtenant operating facilities including an access road to Wallisville, Texas. Plan A proposes no storage for conservation purposes, however, it proposes that the river be maintained at one foot above mean sea level by the river diversion control structure during low flow periods in the interest of preventing upstream salt water intrusion

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

through operation of the navigation lock, or through the river diversion channel.

Plan B provides for a conservation storage reservoir to elevation 3 and will create a 21,570-acre reservoir. The average annual maximum pool will be at elevation 3, and the average annual minimum pool will be at elevation 2.5. The reservoir water level will be at conservation pool elevation about 70 percent of the time. It will affect about 38 miles of streams and 2,560 acres of lakes.

Plan C provides for a conservation storage reservoir to elevation 4 and will create a 23,200-acre reservoir. The average annual maximum pool will be at elevation 4.0, and the average annual minimum pool will be at elevation 3.3. The reservoir water level will be at conservation pool elevation about 67 percent of the time. It will affect about 40 miles of streams and 2,560 acres of lakes.

Plan D provides for a conservation storage reservoir to elevation 10 and will create a reservoir of about 27,350 acres. The average annual maximum pool will be at elevation 9.8, and the average annual minimum pool will be at elevation 8.4. The reservoir water level will be at conservation pool elevation 55 percent of the time. It will affect about 89 miles of streams and 3,588 acres of lakes.

Plan E provides for a conservation storage reservoir to elevation 15 and will create a reservoir of about 38,700 acres. The average annual maximum pool will be at elevation 14.3 , and the average annual minimum pool will be at elevation 12.3. The reservoir water level will be at conservation pool elevation about 49 percent of the time. It will affect about 99 miles of streams and 3,588 acres of lakes.

Plan F provides for a conservation storage reservoir to elevation 20 and will create a 51,900-acre reservoir. The average annual maximum pool will be at elevation 19.0, and the average annual minimum pool will be at elevation 16.8. The reservoir water level will be at conservation pool elevation about 45 percent of the time. The reservoir will affect about 105 miles of streams and 3,596 acres of lakes.

The dam for Plans A, B, and C will cross the Trinity River at river mile 3.9 and for Plans D, E, and F at river mile 8.6 in Chambers County. The dam in Plans B and C will consist of a non-overflow earth embankment paved with 6-inch-thick concrete. For Plans D, E, or F the dam will be an earthen structure, riprapped on the upstream side to top of dam and on the bay side to protect the dam from possible 15-foot hurricane tides. The dam in Plans D and E will have a combination gated and overflow spillway of earth embankment paved with 6-inch-thick concrete. Plan F will have a gated spillway.

The reservoir will extend upstream into Liberty County in all plans. There will be four irrigation diversions from the reservoir in addition to diversion of water for municipal and industrial uses for the city of Houston. A navigation lock will be constructed in the dam on the right bank, off channel of the river to permit barge navigation upstream. The lock will be 84 feet by 600 feet in Plans B, C, D, E, or F. A small-craft lock 20 feet wide by 76 feet long will be provided adjacent to the navigation lock as proposed in Plans D, E, and F. A 9- by 150-foot navigation channel is proposed in Plans D, E, and F and will extend about 0.65 mile downstream to the Trinity River and about 2.5 miles upstream to the Trinity River channel within the reservoir. In Plans B and C a levee-gated river diversion channel is proposed and will extend from the dam downstream across the marshes and drain into Trinity Bay in the vicinity of Mud Bayou.

The Trinity River is formed by the confluence of the West Fork and Elm Fork of the Trinity near Dallas, Texas, and flows about 500 miles in a southeasterly direction and drains into Trinity Bay. The basin has an overall length of about 340 miles and a maximum width of about 100 miles. Its total drainage area is about 17,845 square miles.

Downstream from Liberty, the Trinity River meanders through a swampy flood plain. The flood plain is 2 to 6 miles wide and is largely timbered to about river mile 12. Two distinct types of woodland are evident. The typical moist bottom-land type is composed of water oak, live oak, overcup oak, pecan, willow, hackberry, honey locust, ash, elm, and beech. In numerous small depressions and old silted-in oxbows with shallow standing water, tupelo gum and cypress occur, composing a true swamp-type forest. Thick stands of sweet gum and willow occupy the transitional zone between bottom-lands and swamp forests. Willows dominate the stream bank vegetation. From about river mile 12 to the stream's mouth, the flood plain is marshy, and the principal vegetation is reed grass and marsh millet.

In its ever-changing process of flooding, silting, and scouring new courses, the meandering Trinity River has cut off numerous oxbow lakes and has deposited a delta in Trinity Bay to form Turtle Bay. Lake Charlotte and several other smaller lakes were formed by similar processes. A levee and control structure at the mouth of Turtle Bay, now called Lake Anahuac, prevents salt water intrusion and maintains the bay as a fresh-water lake to supply irrigation water.

The Trinity River ranges in width from 175 to 375 feet with an average depth of 6 to 7 feet. Inland tugs and barges are able to go upstream as far as Moss Bluff, river mile 20. Streamflow is variable and the water is usually muddy. At the Romayor Gaging Station (32-year period of record) the daily flow has ranged from a minimum of 104 second-feet (August 24-25, 1956) to a maximum of 111,000 second-feet (May 9, 1942). Average flow was 7,143 second-feet. Flows are influenced by several large reservoirs in the Dallas-Fort Worth area and by sewage discharges from those cities.

The silt load of the Trinity River at the Romayor Gage has averaged 3,622 acre-feet per year. It is assumed that the amount of silt entering Wallisville Reservoir from the Trinity River will be reduced by the proposed Livingston Reservoir and that the combined effects of the two reservoirs will result in a sharp decrease in the amount of silt entering Trinity Bay. Data on the amount of reduction in silt deposition, however, are not available.

The project area lies in a subhumid region, where the annual precipitation of 51.15 inches is fairly evenly distributed throughout the year. Average frost-free period is 261 days, and temperatures average 54° F. in January and 83° F. in July. Mean annual temperature is 63° F.

The division between the Coastal Plains and East Texas Timber physiographic provinces occurs just north of the upstream portion of the project area, and a small finger of East Texas Timber County extends to the eastern edge of the project area. Soils of the East Texas Timber portion are light, well-drained sands. Most of the project area is characterized by poorly drained sandy loams, coastal clays, and alluvial soils.

The availability of air, bus, rail, highway, pipeline, barge, and ship transportation, in combination with vast supplies of natural resources, has facilitated the growth of industries in Houston, Beaumont, Texas City, and Orange. Although petroleum and petrochemicals are now predominant in the industrial complex, a wide diversity of other industries also is contributing toward making the region one of the most rapidly growing industrial centers in the United States. Agriculture, devoted primarily to rice production and cattle-raising, remains an important segment of the economy, and by producing large quantities of food supplies close to population centers, further stimulates industrial and population growth.

The Wallisville Project is centrally located in the heavily populated Houston-Beaumont area. Port Arthur, Orange, Baytown, Texas City, and Galveston are other nearby cities. Based on 1957 estimates, over 1,600,000 people reside within 50 to 60 miles of the project area, and by the year 2010, the population is expected to be about 9.8 million.

Fresh-water fisheries in about 70 miles of the Trinity River, 7 miles of Lost River, 11.5 miles of Old River, 9 miles of Cut-Off Slough, and 7.5 miles of Pickett's Bayou; and in Gum Slough Lake, 8 acres; Snag Lake, 8 acres; Day Lake, 120 acres; Lake Charlotte, 1,000 acres; Lost Lake, 960 acres; Old River Lake, 920 acres; and Cotton Lake, 580 acres, from the mouth of Trinity River to the upstream limit of the proposed reservoir site are within the potential

influence of Wallisville Reservoir at river mile 8.6. The reservoir at river mile 3.9 also will affect the fresh-water fisheries in Lost River, Old River, Cut-Off Slough, Lost Lake, Old River Lake, Cotton Lake, and Lake Charlotte, and in 5 miles of Pickett's Bayou and about 10 to 12 miles of Trinity River.

The streams are muddy and sluggish-flowing and, except for the Trinity River, are relatively shallow with heavily silted bottoms. Duckweeds are common in the backwater areas. The water surface of Pickett's Bayou, Cut-Off Slough, and those portions of Old River and Lost River lying upstream of Old River Lake are partially shaded by a dense canopy of bottom-land timber. The lakes also are shallow and their bottoms are covered with several feet of mud.

Fishes common to lakes and streams are gars, buffalofishes, carp, freshwater drum, bullheads, bowfin, gizzard shad, bluegill, and redear sunfish. Flathead catfish, blue catfish, channel catfish, and white crappie also occur in lakes and streams but are more abundant in Trinity River, Old River, and to a lesser extent in Old River Lake, Day Lake, Snag Lake, and Gum Slough. Marine fishes and crustaceans ascend the tidal reaches of the Trinity River and Old River. White crappie and catfishes are the principal fishes sought by sport fishermen. Pole and line and trotline are the principal methods of fishing.

Demands for fresh-water fishing from 1,600,000 people, who reside within 60 miles of the project area, are great and will increase still further by the year 2010 when the population is expected to be 9.8 million people. Existing stream and lake facilities, for the most part, are accessible to public use, and despite the low catch they receive considerable fishing pressure. Local people usually prefer stream fishing. City people do most of their fishing in bottom-land lakes.

Annual fishing expenditures associated with fishing in streams and lakes in the project area without the project will be about $31,000 with Plan B or C, $45,000 with Plan D, $47,000 with Plan E, and $49,000 with Plan F.

About 30 individuals derive their livelihood from commercial fishing in the Trinity River and Old River Lake for catfishes, carp, buffalofishes, freshwater drum, and bait minnows, principally redhorse shiner and spottail shiner. Principal gear used in fishing are hoop nets, gill nets, trammel nets, trotlines, and glass-jar traps. Most of the catfishes are sold locally, while most of the carp, buffalofishes, and freshwater drum are shipped to the Houston and Beaumont areas. Minnows are usually sold to local bait-stand operators. Fresh-water commercial catches are expected to increase in the future as human population and demand increases. Catfish and bait-minnow catch is not expected to increase; the demand for these fishes now exceeds the supply. Without the project, the annual commercial catch is expected to be 27,000 pounds of fish valued at $8,000 with Plan B, 30,000 pounds of fish valued at $9,000 with Plan C, 127,000 pounds of fish and 660,000 minnows valued

at $45,000 with Plan D, 146,000 pounds of fish and 780,000 minnows valued at $52,000 with Plan E, and 159,000 pounds of fish and 860,000 minnows valued at $57,000 with Plan F.

With the project, similar reservoir fishery habitats will be created by each proposed plan for the Wallisville Reservoir. The reservoir is expected to be muddy and eventually dominated by rough-fish populations. The dams considered in Plans B and C will form a shallow reservoir which will be dominated initially by rough-fish populations. Although game fish stocking may not be practicable, the proximity of large human population centers and the scarcity of reservoir fishing facilities in an area of great demand will make intensive fishing inevitable. There will be considerable difference in fisherman use under the various proposed Wallisville Reservoir plans. Annual fisherman expenditures associated with sport fishing in Wallisville Reservoir considered in Plans B and C will be about $200,000 and in Plans D, E, and F $750,000.

Judging by current fresh-water commercial fishing regulations and local attitudes toward commercial fishing, it is anticipated that no minnows will be taken from the reservoir and that commercial fishermen will be permitted to take catfish by hook and line only. The demand for catfishes will be greater than the supply. The market for carp, buffalofishes, river carpsuckers, and freshwater drum is expected to remain relatively stable, well below the capacity of the reservoir to produce these species. The annual commercial fish catch will be about 127,000 pounds valued at $38,000 annually for Plans C, B, or D, about 146,000 pounds valued at $44,000 for Plan E, and about 159,000 pounds valued at $48,000 for Plan F.

The amount of nutrients and fresh water that will enter the bay areas will be reduced considerably and will have an adverse and cumulative effect on marine fisheries. Until such time as studies have been made, the effects of the project on marine fisheries will remain unknown.

Two major types of wildlife habitat are represented in the reservoir sites and downstream flood plain. The downstream flood plain is comprised of fresh-water and salt-water marshlands interspersed with numerous small lakes and bayous. The marshlands and fresh-water lakes and bayous continue into the reservoir site, but upstream from river mile 12, the area is largely dominated by bottom-land hardwoods and swamp-type timber. The vegetation in the area is comprised predominantly of plants associated with wetlands. About 45 percent is marsh.

The wildlife reflects the wetland nature of the habitat. Although gray squirrels, fox squirrels, white-tailed deer, raccoons, cottontails, swamp rabbits, opossums, nutrias, minks, otters, and alligators are present, they rank well below waterfowl as important wildlife resources. Hunting and chase of upland game is made difficult by swamps, dense vegetation, and reluctance of landowners to permit hunting. Only

on the land affected by Plan F is there sufficient habitat for upland-game hunting. It is estimated that sportsmen's expenditures associated with hunting upland game will be about $1,000 annually.

Fur animals are trapped sparingly because low pelt prices and sparse populations of the more desirable species of fur animals have made trapping unprofitable.

The saline and brackish marshes in the downstream flood plain near Trinity Bay offer attractive feeding and resting habitat for waterfowl. Upstream, the fresh-water marshes do not provide as much feeding habitat as the saline-brackish marshes but together with streams and lakes provide resting habitat. Adjacent to the reservoir area and downstream flood plain are thousands of acres in rice and rice-grassland rotation. Waterfowl habitat affected by the Wallisville Project comprises approximately 13,300 acres with Plans B and C, and about 17,500 acres with Plans D, E, and F. The project area is centrally located in one of the most important wintering grounds in the Central Flyway, and the Trinity River Basin is considered one of the major waterfowl migration routes in the State. Within 50 miles of the project site, peak populations of 1 million ducks, geese, and coots have been observed for short periods during the winter months.

Waterfowl that winter in the area are mallards, mottled ducks, gadwalls, baldpates, pintails, shovelers, redheads, canvasbacks, scaups, buffleheads, Canada geese, white-fronted geese, snow geese, blue geese, and coots. Large numbers of green-winged and blue-winged teal migrate through the area. Mottled ducks, wood ducks, and fulvous tree ducks nest here. Various species of rails, gallinules, and shore birds use the area as nesting or wintering habitat.

The marshes, small lakes, and bayous near the mouth of the Trinity River provide considerable waterfowl hunting. The demands for waterfowl hunting by a large population of people within 60 miles of the project area are now greater than can be met by existing waterfowl resources on the upper Texas Gulf Coast and are expected to increase still further by the year 2010, when the anticipated human population in the region is expected to be about 9.8 million. Furthermore, waterfowl hunting is destined to remain the most important type of hunting available along this portion of the Texas Coast. The traditions and interests of the people of the region have long been oriented toward waterfowl hunting. Demands for hunting leases on waterfowl habitat are so great that many landowners and hunting camp operators receive considerable income by leasing lands and furnishing services to sportsmen's clubs, corporations, and individual hunters. Waterfowl hunting on the Wallisville Project area and the downstream flood plain is of primary economic importance to local people. Economic returns from waterfowl hunting are assured indefinitely by the multitudes of hunters willing to pay well for hunting privileges.

Waterfowl-day use in the Wallisville Project area and downstream flood plain is approximately 11 million bird-days annually with each of the five plans under consideration. It is not possible to evaluate monetarily the value of waterfowl on habitat affected by the project. However, sportsmen's expenditures associated with waterfowl hunting are a partial, though not total, measure of the value of the area to waterfowl. These expenditures will be about $69,000 annually without the project.

The project will create a fresh-water reservoir which will be attractive to waterfowl and will provide a resting place in an important wintering area, sufficiently large to fulfill the needs of many waterfowl. Even though turbidity is expected to inhibit the growth of many desirable aquatic plants, waterfowl use of the reservoir will be increased by proximity of attractive feeding areas in nearby ricefields and coastal marshes. Reduction of fresh-water flows to the downstream marshes will not detract from their value as feeding areas because of the change from fresh-water to brackish marsh. This habitat will continue to influence waterfowl populations to remain in the general area of the reservoir.

Local experience with waterfowl hunting indicates that increased hunting opportunities will be provided only if there is adequate access and if hunting is carefully regulated. If there is adequate public access under the Corps of Engineers' plan of reservoir management, there will be greater use of project lands for hunting by the public with the project than without the project.

The Wallisville Project will eliminate or impair the usefulness of some upland-game and fur-animal habitat; however, the magnitude of these resources will be insignificant. Reservoir Plans B, C, D, or E will inundate largely marshlands, small lakes, and streams and will affect little bottom-land forest. Plan F will inundate some bottom-land hardwoods, but the forest land is not highly productive of upland game. The reservoir will flood a large area of land and will increase waterfowl habitat. Plan B or C will receive 16,800,000 waterfowl-days use and $89,000 sportsmen's expenditures, annually. Plan D will result in about 14,500,000 waterfowl-days use and $69,000 in associated sportsmen's expenditures, annually. Plan E or F will result in approximately 15 million waterfowl-days use and $77,000 sportsmen's expenditures, annually.

The Wallisville Project site is favorably located with respect to major waterfowl wintering grounds. The importance of waterfowl habitat at the project site will become progressively greater as waterfowl habitat elsewhere on the Texas Coast is being rapidly engulfed by increasing industrial and urban expansions, agricultural drainage, and multiple-purpose water development projects induced by the dynamic local economy. It is of utmost importance that areas capable of development for conservation of waterfowl in the Central Flyway be encouraged to the greatest extent possible.

The project has a potential for various types of development to improve management for waterfowl. Deleterious effects of obnoxious vegetation can be minimized and often controlled through management to increase the amount of habitat on the reservoir area.

A prime need for waterfowl management on wintering grounds is increased food production which can be attained by several methods such as "green tree" reservoir management on selected areas, purchase and development of a limited acreage of lands adjoining the reservoir for food production, and planned reservoir water level manipulations to permit planting and growing of food crops for ducks in portions of the reservoir area. For Plan B or C gradually drawing down the reservoir water level 6 inches during a 60-day period beginning in April or May, and slowly raising the water level for 60 days to conservation pool elevation beginning in August or September would be desirable to flood the feeding areas. Lowering the reservoir water level early in the growing season would prevent killing some of the hardwoods that would be subjected to inundation on the upstream portion of the reservoir. For Plans D, E, or F, similar results could be achieved with 3-foot water level fluctuations for the same periods.

A refuge area would assist in the conservation of waterfowl in the Central Flyway. It would tend to stabilize the movements of waterfowl wintering on the upper Texas Coast and would provide a resting area where waterfowl might go for protection to escape the heavy hunting pressure on the coastal wintering grounds. Considering that many man-made changes of the coastal habitat will probably react unfavorably to waterfowl populations in the future, maintaining present population levels will be a precarious task at best. Further complications may arise from unfavorable weather extremes, such as droughts and unforeseen natural disasters. A national wildlife refuge could prove to be of inestimable value to waterfowl during these periods of adversity.

It would be feasible to develop selected portions of project land and water for waterfowl management and there would be a considerable increase in use of the area by waterfowl. Additional benefits resulting from large expenditures associated with hunting would also result. Plans B, C, and F are suitable for waterfowl development. Studies by the Corps of Engineers indicate that Plan C, which provides for storage to elevation 4 feet, is the most feasible plan of improvement for multiple-purpose use. The plan for the proposed national wildlife refuge is, therefore, based upon Plan C.

To realize the full potential for waterfowl development on the project area, the refuge should be located as shown on Plate I. The total area of the refuge is estimated to be about 17,455 acres of which about 10,730 acres would comprise a portion of the Wallisville Reservoir and about 6,725 acres would be refuge land area adjoining the reservoir.

The additional 6,725 acres of refuge lands would be required for a buffer zone to protect the waterfowl wintering on the refuge and to provide food for the ducks and geese. Cleared lands would be cultivated and timbered lands suitable for food production would be cleared. If sorghum or green forage crops are grown no irrigation water would be required; however, if rice is grown, an estimated 4,000 acre-feet of water would be needed annually. Based upon this preliminary estimate, about 4,000 acre-feet of annual storage would be required and should be included in the project plan and should be a nonreimbursable cost to the project. Pumping costs would be an annual operation and maintenance charge to be assumed by the Bureau of Sport Fisheries and Wildlife. These lands should be purchased as an integral part of the project on a nonreimbursable basis. All lands and water within the refuge boundary, approximately 17,455 acres, should be made available to the Secretary of the Interior under 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.

Refuge development would consist of a headquarters group that will comprise several residences, service building with office, equipment storage building, shop, and associated utility facilities and structures, fencing, posting, road and trail construction, minimum recreational facilities and development of food production areas, "green tree" reservoirs, and marshes.

Cost of land acquisition is estimated to be $1,135,500 and development of the refuge facilities will amount to a total of $1,747,500. Operation and maintenance costs are estimated to be $104,200 annually. Development and operation and maintenance costs will be assumed by the Bureau of Sport Fisheries and Wildlife. These estimates, based upon 1959 costs, are shown in Table 1.

Table 1 - Estimated Land Acquisition, Development, and Operating Costs for Proposed Trinity National Wildlife Refuge

Land Acquisition, 6,725 acres	$1,135,500
Development costs:	
Fencing, 35 mi. @ $1,000 per mile	$ 35,000
Posting, 35 mi. @ $50 per mile	1,750
Roads and trails	15,000
Food production areas as needed 1,500 acres @ $125 per acre (includes clearing, leveling, and ditching)	187,500
Pump house and pumping equipment	95,000
"Green Tree Reservoir" development 1,500 acres @ $35 per acre	52,500
Marsh development, including control structures 2,000 acres @ $50 per acre	100,000
Recreation development	25,000
Refuge Headquarters Buildings	100,250
Subtotal	$ 612,000
Total	$1,747,500
Estimated annual operating costs:	
Salaries, regular personnel	$ 30,000
Farming, 1,500 acres @ $18 per acre	27,000
Maintenance and operation of pumping plant	2,000
"Green Tree Reservoir" maintenance	2,500
Marsh maintenance (pest plant control, etc.)	20,000
Road maintenance	1,200
Fence maintenance	4,000
Recreational area maintenance	7,500
General maintenance	10,000
Total	$ 104,200

Benefits that will accrue from a waterfowl refuge are impossible to evaluate monetarily, for in addition to improved waterfowl hunting locally, the refuge will provide a much-needed wintering area for waterfowl in the Central Flyway. Many people will come to see the birds and the number of visitors who will observe the birds will be far greater than the number who will hunt them. Waterfowl use will be about 19,000,000 waterfowl-days annually. It is estimated that with intensive management of the refuge expenditures associated with waterfowl hunting will be about $150,000 annually. It is considered that the benefits of a national wildlife refuge would be at least equal to the cost of land acquisition and development.

In summation the Wallisville Project will result in substantial benefits to the fresh-water sport fishery through creation of a reservoir fishery. Plans B and C will result in considerable gains to the commercial fishery and Plans D, E, and F, will result in a loss to this fishery. Effects on the estuarine sport and commercial fisheries are not known.

Construction of this project will result in almost complete elimination of upland-game habitat. With Plans B and C there will be a considerable increase in benefits to waterfowl and with Plan D there will be no gain or loss to waterfowl. Plans E and F will result in some benefit to waterfowl. Establishment of a national wildlife refuge, including sufficient lands, would provide food and protection that would result in greatly increased use by waterfowl and by hunters. Modifications of reservoir operating levels would provide for greater use of the project by waterfowl.

In view of the foregoing discussions, it is recommended:

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

(2) That adequate access to the reservoir be provided to assure free public fishing and hunting.

(3) That the reservoir be operated for waterfowl management as follows: (a) During a 60-day period beginning April or May, lower the water level 6 inches with Plans B and C, and 3 feet with Plans D, E, or F; and (b) beginning in August or September, slowly raise the water level for 60 days to conservation pool elevation.

(4) That the project be authorized to include a national wildlife refuge.

(5) That approximately 6,725 acres of land adjoining the Wallisville Reservoir, as delineated on Plate I, be purchased at an estimated cost of $1,135,500 as an integral part of the project and be made available to the Secretary of the Interior in accordance with 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.

(6) That 4,000 acre-feet of annual storage of water for waterfowl food production be included in the project plans as a nonreimbursable cost to the project.

(7) That federally owned land and project waters be open to free use for hunting and fishing except for sections reserved for waterfowl management, safety, efficient operation, or protection of public property.

(8) That additional detailed studies of fish and wildlife resources, including studies of effects upon the estuarine fishery, be conducted as necessary by the United States Fish and Wildlife Service and the Texas Game and Fish Commission after the project is authorized, in accordance with the Fish and Wildlife Coordination Act, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq., and such reasonable modifications in and additions to the authorized project facilities be made as may be agreed upon by the Secretary of the Interior, the Executive Secretary, Texas Game and Fish Commission, and the Chief of Engineers, for the conservation and development of fish and wildlife resources.

The investigations preparatory to this report were made in cooperation with the Texas Game and Fish Commission. The report is based upon data available from the Corps of Engineers prior to March 18, 1960, and any modifications should be brought to the attention of the Bureau of Sport Fisheries and Wildlife and the Texas Game and Fish Commission. The cooperation of the Galveston District, Corps of Engineers, in furnishing engineering data and planning information is appreciated.

Sincerely yours,

John C. Gatlin

John C. Gatlin
Regional Director

Distribution:

(7) Executive Secretary, Texas Game and Fish Commission, Austin, Texas
(1) Director, Marine Laboratory, Texas Game and Fish Commission, Rockport, Texas
(1) Regional Director, Region 2, Bureau of Commercial Fisheries, St. Petersburg Beach, Florida
(1) Director, Biological Laboratory, Bureau of Commercial Fisheries, Galveston, Texas
(2) Regional Director, Region 3, National Park Service, Santa Fe, New Mexico
(2) Regional Engineer, Region VII, Public Health Service, Department of Health, Education, and Welfare, Dallas, Texas

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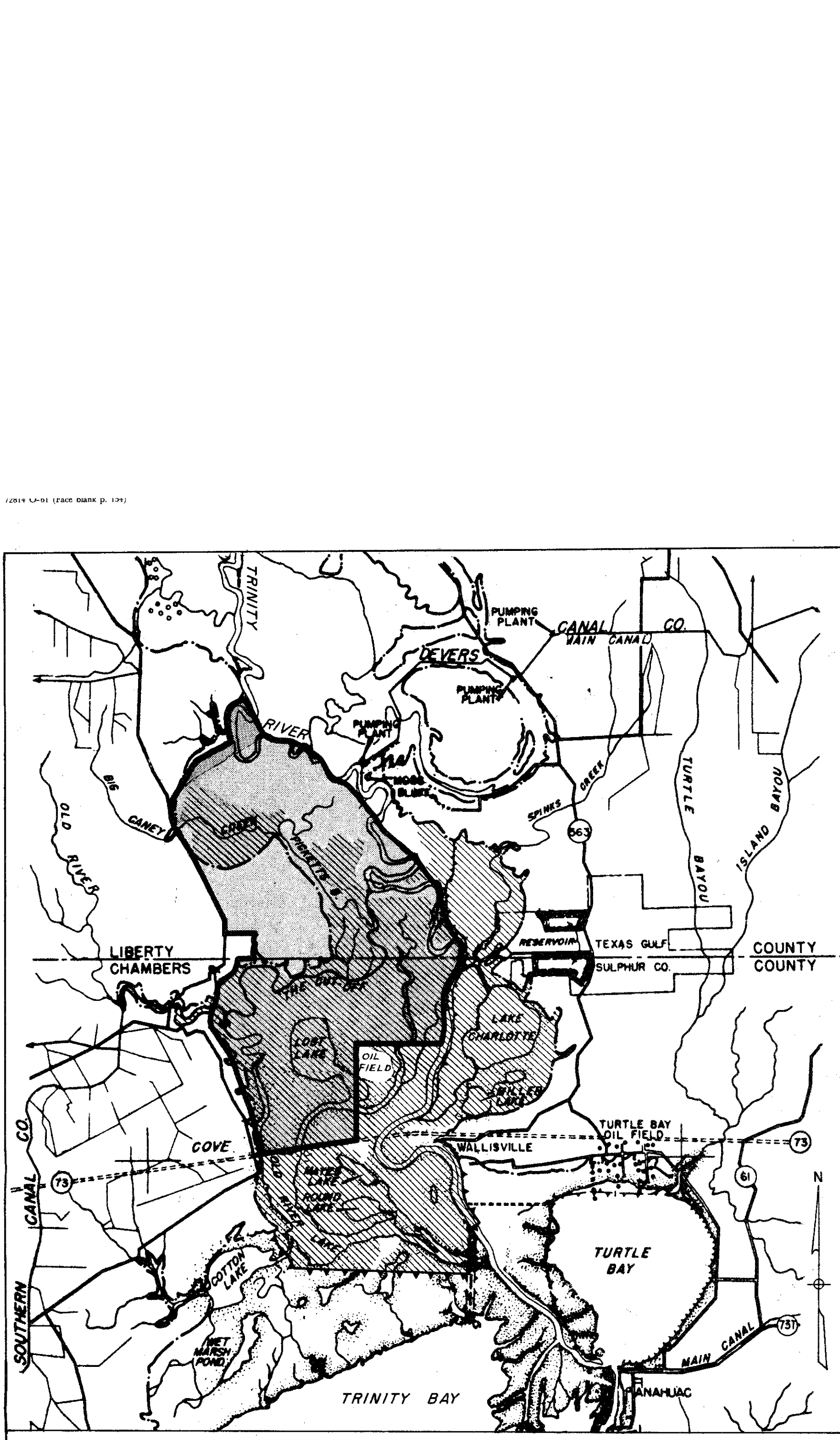

LEGEND

- PROPOSED REFUGE BOUNDARY
- PROPOSED REFUGE
- PROPOSED RESERVOIR
- PROPOSED DAM

Scale 0 2 3 MILES

COMPILED FROM U.S. CORPS OF ENGINEERS
DRAWING NO. TRIN. 201-41

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

PROPOSED TRINITY NATIONAL WILDLIFE REFUGE WALLISVILLE PROJECT

TRINITY RIVER, LIBERTY & CHAMBERS CO'S, TEX.

ALBUQUERQUE, NEW MEXICO REGION 2

DATE: MARCH 1960 PLATE I

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

February 27, 1961

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1229
Galveston, Texas

Dear Sir:

The Bureau of Sport Fisheries and Wildlife presents herein its revised report on fish and wildlife resources in relation to the Corps of Engineers survey study of the Wallisville Project, Chambers and Liberty Counties, Texas.

This report reflects a 50-year period of analysis and is confined only to fresh-water fishery and wildlife aspects. It is evident that there will be some loss of nursery areas for marine fish and shellfish, but until the Bureau of Commercial Fisheries has been able to conduct the necessary investigations and adequate assessment, the project effects on the marine fisheries cannot be made. The report has been prepared in cooperation with the Texas Game and Fish Commission in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). This report has received the concurrence of the Texas Game and Fish Commission.

Particular attention is given to the possibility of incorporating project facilities to benefit the national migratory bird management program. We believe the information submitted in this report will be helpful in your plans to develop the lower Trinity River in the vicinity of Wallisville, Texas, and your comments on our recommendations, including the feasibility of their implementation, will be appreciated. We also would appreciate being informed of the final plans when they are completed, so that we may re-evaluate the fish and wildlife aspects, if need be, to reflect actual project operation and features.

Information relative to the features of the project was obtained by conferences with Mr. A. B. Davis on July 13, 1959, and with Mr. Art Kroll on November 10, 1959, and by letters dated July 23 and December 15, 1959, from Mr. Kenneth Heagy, Chief, Engineering Division. Preliminary operation regimen and pertinent engineering data were transmitted with letters from Mr. Heagy dated September 2, November 17, and December 15, 1959, and March 18, 1960.

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We have been requested to evaluate fish and wildlife resources of six proposed plans of reservoir development designated by the Corps of Engineers as Plans A, B, C, D, E, and F, which would provide reservoir storages to elevation 3, 1/ 4, 10, 15, and 20, respectively. Plan A proposes no reservoir storage for conservation uses, and except for a description of its features is excluded from consideration hereinafter because effects upon the fish and wildlife resources would not be significant.

Wallisville Reservoir will be on the Trinity River about 35 miles east of Houston, Texas, and about 42 miles west of Beaumont, Texas. It will serve as a unit in the comprehensive reservoir system proposed by the Trinity River Authority for ultimate development of the Trinity River Watershed. The purposes of the project will be water conservation for municipal, industrial, agricultural, and mining uses; navigation; salinity control; conservation of fish and wildlife; and recreation.

Reservoir operation for each proposed plan of development is based entirely on streamflows and runoff on the watershed downstream from the proposed Livingston Reservoir for a period from 1940 to 1958, inclusive, excluding spillage and releases of appropriated flows from Livingston Reservoir for use in the adjacent lower river area. Diversion of water for municipal and industrial purposes would be made from the reservoirs in addition to use of water for navigation purposes. All plans provide for a commercial lock 84 feet wide by 600 feet long. In addition, Plans D, E, and F also provide for a small craft lock 20 feet wide by 75 feet long. The total yields of reservoirs considered in Plans B, C, D, E, and F are estimated at 75, 105, 170, 235, and 280 second-feet, respectively, of which 12.4, 17.0, 4.5, 5.6, and 5.7 second-feet would be the average water use for navigation during critical drought periods. No constant minimum releases are proposed in any plan.

Plan A provides for the prevention of salt water intrusion in the lower Trinity River and for further advancement of the navigation channel to Liberty, Texas. The plan proposes construction of a 600-foot long earth diversion dam with crest at elevation 8.0 across the Trinity River at river mile 3.9; a gate-controlled river diversion channel extending from about river mile 4.0 to the north shore of Trinity Bay, a distance of about 10,000 feet; and appurtenant operating facilities including an access road to Wallisville, Texas. Plan A proposes no storage for conservation purposes; however, it proposes that the river be maintained at one foot above mean sea level by the river diversion

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

control structure during low flow periods in the interest of preventing upstream salt water intrusion through operation of the navigation lock or through the river diversion channel.

Plan B provides for a conservation storage reservoir to elevation 3 and will create a 21,570-acre reservoir. The average annual maximum pool will be at elevation 3, and the average annual minimum pool will be at elevation 2.5. The reservoir water level will be at conservation pool elevation about 70 percent of the time. It will affect about 38 miles of streams and 2,560 acres of lakes.

Plan C provides for a conservation storage reservoir to elevation 4 and will create a 23,200-acre reservoir. The average annual maximum pool will be at elevation 4.0, and the average annual minimum pool will be at elevation 3.3. The reservoir water level will be at conservation pool elevation about 67 percent of the time. It will affect about 40 miles of streams and 2,560 acres of lakes.

Plan D provides for a conservation storage reservoir to elevation 10 and will create a reservoir of about 27,350 acres. The average annual maximum pool will be at elevation 9.8, and the average annual minimum pool will be at elevation 8.4. The reservoir water level will be at conservation pool elevation 55 percent of the time. It will affect about 89 miles of streams and 3,588 acres of lakes.

Plan E provides for a conservation storage reservoir to elevation 15 and will create a reservoir of about 38,700 acres. The average annual maximum pool will be at elevation 14.3, and the average annual minimum pool will be at elevation 12.3. The reservoir water level will be at conservation pool elevation about 49 percent of the time. It will affect about 99 miles of streams and 3,588 acres of lakes.

Plan F provides for a conservation storage reservoir to elevation 20 and will create a 51,900-acre reservoir. The average annual maximum pool will be at elevation 19,0, and the average annual minimum pool will be at elevation 16.8. The reservoir water level will be at conservation pool elevation about 45 percent of the time. The reservoir will affect about 105 miles of streams and 3,596 acres of lakes.

The dam for Plans A, B, and C will cross the Trinity River at river mile 3.9 and for Plans D, E, and F at river mile 8.6 in Chambers County. The dam in Plans B and C will consist of a non-overflow earth embankment paved with 6-inch-thick concrete. For Plans D, E, or F the dam will be an earthen structure, riprapped on the upstream side to top of dam and on the bay side to protect the dam from possible 15-foot hurricane tides. The dam in Plans D and E will have a combination gated and overflow spillway of earth embankment paved with 6-inch-thick concrete. Plan F will have a gated spillway.

The reservoir will extend upstream into Liberty County in all plans. There will be four irrigation diversions from the reservoir in addition to diversion of water for municipal and industrial uses for the City of Houston. A navigation lock will be constructed in the dam on the right bank, off channel of the river to permit barge navigation upstream. The lock will be 84 feet by 600 feet in Plans B, C, D, E, or F. A small-craft lock 20 feet wide by 75 feet long will be provided adjacent to the navigation lock as proposed in Plans D, E, and F. A 9- by 150-foot navigation channel is proposed in Plans D, E, and F and will extend about 0.65 mile downstream to the Trinity River and about 2.5 miles upstream to the Trinity River channel within the reservoir. In Plans B and C a levee-gated river diversion channel is proposed and will extend from the dam downstream across the marshes and drain into Trinity Bay in the vicinity of Mud Bayou.

The Trinity River is formed by the confluence of the West Fork and Elm Fork of the Trinity near Dallas, Texas, and flows about 500 miles in a southeasterly direction and drains into Trinity Bay. The basin has an overall length of about 340 miles and a maximum width of about 100 miles. Its total drainage area is about 17,845 square miles.

Downstream from Liberty, the Trinity River meanders through a swampy flood plain. The flood plain is 2 to 6 miles wide and is largely timbered to about river mile 12. Two distinct types of woodland are evident. The typical moist bottom-land type is composed of water oak, live oak, overcup oak, pecan, willow, hackberry, honey locust, ash, elm, and beech. In numerous small depressions and old silted-in oxbows with shallow standing water, tupelo gum and cypress occur, composing a true swamp-type forest. Thick stands of sweet gum and willow occupy the transitional zone between bottom-lands and swamp forests. Willows dominate the stream bank vegetation. From about river mile 12 to the stream's mouth, the flood plain is marshy, and the principal vegetation is reed grass and marsh millet.

In its ever-changing process of flooding, silting, and scouring new courses, the meandering Trinity River has cut off numerous oxbow lakes and has deposited a delta in Trinity Bay to form Turtle Bay. Lake Charlotte and several other smaller lakes were formed by similar processes. A levee and control structure at the mouth of Turtle Bay, now called Lake Anahuac, prevents salt water intrusion and maintains the bay as a fresh-water lake to supply irrigation water.

The Trinity River ranges in width from 175 to 375 feet with an average depth of 6 to 7 feet. Inland tugs and barges are able to go upstream as far as Moss Bluff, river mile 20. Streamflow is variable and the water is usually muddy. At the Romayor Gaging Station (32-year period of record) the daily flow has ranged from a minimum of 104 second-feet (August 24-25, 1956) to a maximum of 111,000 second-feet (May 9, 1942). Average flow was 7,143 second-feet. Flows are

influenced by several large reservoirs in the Dallas-Fort Worth area and by sewage discharges from those cities.

The silt load of the Trinity River at the Romayor Gage has averaged 3,622 acre-feet per year. It is assumed that the amount of silt entering Wallisville Reservoir from the Trinity River will be reduced by the proposed Livingston Reservoir and that the combined effects of the two reservoirs will result in a sharp decrease in the amount of silt entering Trinity Bay. Data on the amount of reduction in silt deposition, however, are not available.

The project area lies in a subhumid region, where the annual precipitation of 51.15 inches is fairly evenly distributed throughout the year. Average frost-free period is 261 days, and temperatures average 54° F. in January and 83° F. in July. Mean annual temperature is 63° F.

The division between the Coastal Plains and East Texas Timber physiographic provinces occurs just north of the upstream portion of the project area, and a small finger of East Texas Timber Country extends to the eastern edge of the project area. Soils of the East Texas Timber portion are light, well-drained sands. Most of the project area is characterized by poorly drained sandy loams, coastal clays, and alluvial soils.

The availability of air, bus, rail, highway, pipeline, barge, and ship transportation, in combination with vast supplies of natural resources, has facilitated the growth of industries in Houston, Beaumont, Texas City, and Orange. Although petroleum and petrochemicals are now predominant in the industrial complex, a wide diversity of other industries also is contributing toward making the region one of the most rapidly growing industrial centers in the United States. Agriculture, devoted primarily to rice production and cattle-raising, remains an important segment of the economy, and by producing large quantities of food supplies close to population centers, further stimulates industrial and population growth.

The Wallisville Project is centrally located in the heavily populated Houston-Beaumont area. Port Arthur, Orange, Baytown, Texas City, and Galveston are other nearby cities. Based on 1957 estimates, over 1,600,000 people reside within 50 to 60 miles of the project area; and by the year 2010, the population is expected to be about 9.8 million.

Fresh-water fisheries in about 70 miles of the Trinity River, 7 miles of Lost River, 11.5 miles of Old River, 9 miles of Cut-Off Slough, and 7.5 miles of Pickett's Bayou; and in Gum Slough Lake, 8 acres; Snag Lake, 8 acres; Day Lake, 120 acres; Lake Charlotte, 1,000 acres; Lost Lake, 960 acres; Old River Lake, 920 acres; and Cotton Lake, 580 acres, from the mouth of Trinity River to the upstream limit of the proposed reservoir site are within the potential

influence of Wallisville Reservoir at river mile 8.6. The reservoir at river mile 3.9 also will affect the fresh-water fisheries in Lost River, Old River, Cut-Off Slough, Lost Lake, Old River Lake, Cotton Lake, and Lake Charlotte, and in 5 miles of Pickett's Bayou and about 10 to 12 miles of Trinity River.

The streams are muddy and sluggish-flowing and, except for the Trinity River, are relatively shallow with heavily silted bottoms. Duckweeds are common in the backwater areas. The water surface of Pickett's Bayou, Cut-Off Slough, and those portions of Old River and Lost River lying upstream of Old River Lake are partially shaded by a dense canopy of bottom-land timber. The lakes also are shallow and their bottoms are covered with several feet of mud.

Fishes common to lakes and streams are gars, buffalofishes, carp, freshwater drum, bullheads, bowfin, gizzard shad, bluegill, and redear sunfish. Flathead catfish, blue catfish, channel catfish, and white crappie also occur in lakes and streams but are more abundant in Trinity River, Old River, and to a lesser extent in Old River Lake, Day Lake, Snag Lake, and Gum Slough. Marine fishes and crustaceans ascend the tidal reaches of the Trinity River and Old River. White crappie and catfishes are the principal fishes sought by sport fishermen. Pole and line and trotline are the principal methods of fishing.

Demands for fresh-water fishing from 1,600,000 people, who reside within 60 miles of the project area, are great and will increase still further by the year 2010 when the population is expected to be 9.8 million people. Existing stream and lake facilities, for the most part, are accessible to public use, and despite the low catch they receive considerable fishing pressure. Local people usually prefer stream fishing. City people do most of their fishing in bottom-land lakes.

Annual fishing expenditures associated with fishing in streams and lakes in the project area without the project will be about $31,000 with Plan B or C, $45,000 with Plan D, $47,000 with Plan E, and $49,000 with Plan F.

About 30 individuals derive their livelihood from commercial fishing in the Trinity River and Old River Lake for catfishes, carp, buffalofishes, freshwater drum, and bait minnows, principally redhorse shiner and spottail shiner. Principal gear used in fishing are hoop nets, gill nets, trammel nets, trotlines, and glass-jar traps. Most of the catfishes are sold locally, while most of the carp, buffalofishes, and freshwater drum are shipped to the Houston and Beaumont areas. Minnows are usually sold to local bait-stand operators. Fresh-water commercial catches are expected to increase in the future as human population and demand increases. Catfish and bait-minnow catch is not expected to increase; the demand for these fishes now exceeds the supply. Without the project, the

annual commercial catch is expected to be 27,000 pounds of fish valued at $8,000 with Plan B, 30,000 pounds of fish valued at $9,000 with Plan C, 127,000 pounds of fish and 660,000 minnows valued at $45,000 with Plan D, 146,000 pounds of fish and 780,000 minnows valued at $52,000 with Plan E, and 159,000 pounds of fish and 860,000 minnows valued at $57,000 with Plan F.

With the project, similar reservoir fishery habitats will be created by each proposed plan for the Wallisville Reservoir. The reservoir is expected to be muddy and eventually dominated by rough-fish populations. The dams considered in Plans B and C will form a shallow reservoir which will be dominated initially by rough-fish populations. Although game fish stocking may not be practicable, the proximity of large human population centers and the scarcity of reservoir fishing facilities in an area of great demand will make intensive fishing inevitable. There will be considerable difference in fisherman use under the various proposed Wallisville Reservoir plans. Annual fisherman expenditures associated with sport fishing in Wallisville Reservoir considered in Plans B and C will be about $200,000 and in Plans D, E, and F $750,000.

Judging by current fresh-water commercial fishing regulations and local attitudes toward commercial fishing, it is anticipated that no minnows will be taken from the reservoir and that commercial fishermen will be permitted to take catfish by hook and line only. The demand for catfishes will be greater than the supply. The market for carp, buffalofishes, river carpsuckers, and freshwater drum is expected to remain relatively stable, well below the capacity of the reservoir to produce these species. The annual commercial fish catch will be about 127,000 pounds valued at $38,000 annually for Plans B, C, or D, about 146,000 pounds valued at $44,000 for Plan E, and about 159,000 pounds valued at $48,000 for Plan F.

The amount of nutrients and fresh water that will enter the bay areas will be reduced considerably and will have an adverse and cumulative effect on marine fisheries. Until such time as studies have been made, the effects of the project on marine fisheries will remain unknown.

Two major types of wildlife habitat are represented in the reservoir sites and downstream flood plain. The downstream flood plain is comprised of fresh-water and salt-water marshlands interspersed with numerous small lakes and bayous. The marshlands and fresh-water lakes and bayous continue into the reservoir site, but upstream from river mile 12, the area is largely dominated by bottom-land hardwoods and swamp-type timber. The vegetation in the area is comprised predominantly of plants associated with wetlands. About 45 percent is marsh.

The wildlife reflects the wetland nature of the habitat. Although gray squirrels, fox squirrels, white-tailed deer, raccoons, cottontails, swamp rabbits, opossums, nutrias, minks, otters, and alligators are present, they rank well below waterfowl as important wildlife resources. Hunting and chase of upland game is made difficult by swamps, dense vegetation, and reluctance of landowners to permit hunting. Only on the land affected by Plan F is there sufficient habitat for upland-game hunting. It is estimated that sportsmen's expenditures associated with hunting upland game will be about $1,000 annually.

Fur animals are trapped sparingly because low pelt prices and sparse populations of the more desirable species of fur animals have made trapping unprofitable.

The saline and brackish marshes in the downstream flood plain near Trinity Bay offer attractive feeding and resting habitat for waterfowl. Upstream, the fresh-water marshes do not provide as much feeding habitat as the saline-brackish marshes but together with streams and lakes provide resting habitat. Adjacent to the reservoir area and downstream flood plain are thousands of acres in rice and rice-grassland rotation. Waterfowl habitat affected by the Wallisville Project comprises approximately 13,300 acres with Plans B and C, and about 17,500 acres with Plans D, E, and F. The project area is centrally located in one of the most important wintering grounds in the Central Flyway, and the Trinity River Basin is considered one of the major waterfowl migration routes in the State. Within 50 miles of the project site, peak populations of 1 million ducks, geese, and coots have been observed for short periods during the winter months.

Waterfowl that winter in the area are mallards, mottled ducks, gadwalls, baldpates, pintails, shovelers, redheads, canvasbacks, scaups, buffleheads, Canada geese, white-fronted geese, snow geese, blue geese, and coots. Large numbers of green-winged teal and blue-winged teal migrate through the area. Mottled ducks, wood ducks, and fulvous tree ducks nest here. Various species of rails, gallinules, and shore birds use the area as nesting or wintering habitat.

The marshes, small lakes, and bayous near the mouth of the Trinity River provide considerable waterfowl hunting. The demands for waterfowl hunting by a large population of people within 60 miles of the project area are now greater than can be met by existing waterfowl resources on the upper Texas Gulf Coast and are expected to increase still further by the year 2010, when the anticipated human population in the region is expected to be about 9.8 million. Furthermore, waterfowl hunting is destined to remain the most important type of hunting available along this portion of the Texas Coast. The traditions and interests of the people of the region have long been oriented toward waterfowl hunting. Demands for hunting leases on waterfowl habitat are so great that many landowners and hunting camp operators receive considerable income by leasing lands and furnishing services to

sportsmen's clubs, corporations, and individual hunters. Waterfowl hunting on the Wallisville Project area and the downstream flood plain is of primary economic importance to local people. Economic returns from waterfowl hunting are assured indefinitely by the multitudes of hunters willing to pay well for hunting privileges.

Waterfowl-day use in the Wallisville Project area and downstream flood plain is approximately 11 million bird-days annually with each of the five plans under consideration. It is not possible to evaluate monetarily the value of waterfowl on habitat affected by the project. However, sportsmen's expenditures associated with waterfowl hunting are a partial, though not total, measure of the value of the area to waterfowl. These expenditures will be about $69,000 annually without the project.

The project will create a fresh-water reservoir which will be attractive to waterfowl and will provide a resting place in an important wintering area sufficiently large to fulfill the needs of many waterfowl. Even though turbidity is expected to inhibit the growth of many desirable aquatic plants, waterfowl use of the reservoir will be increased by proximity of attractive feeding areas in nearby ricefields and coastal marshes. Reduction of fresh-water flows to the downstream marshes will not detract from their value as feeding areas because of the change from fresh-water to brackish marsh. This habitat will continue to influence waterfowl populations to remain in the general area of the reservoir.

Local experience with waterfowl hunting indicates that increased hunting will be provided only if there is adequate access and if hunting is carefully regulated. If there is adequate public access under the Corps of Engineers' plan of reservoir management, there will be greater use of project lands for hunting by the public with the project than without the project.

The Wallisville Project will eliminate or impair the usefulness of some upland-game and fur-animal habitat; however, the magnitude of these resources will be insignificant. Reservoir Plans B, C, D, or E will inundate largely marshlands, small lakes, and streams and will affect little bottom-land forest. Plan F will inundate some bottom-land hardwoods, but the forest land is not highly productive of upland game. The reservoir will flood a large area of land and will increase waterfowl habitat. Plan B or C will receive 16,800,000 waterfowl-days use and $89,000 sportsmen's expenditures, annually. Plan D will result in about 14,500,000 waterfowl-days use and $69,000 in associated sportsmen's expenditures, annually. Plan E or F will result in approximately 15 million waterfowl-days use and $77,000 sportsmen's expenditures, annually.

The Wallisville Project site is favorably located with respect to major waterfowl wintering grounds. The importance of waterfowl

habitat at the project site will become progressively greater as waterfowl habitat elsewhere on the Texas Coast is being rapidly engulfed by increasing industrial and urban expansions, agricultural drainage, and multiple-purpose water development projects induced by the dynamic local economy. It is of utmost importance that areas capable of development for conservation of waterfowl in the Central Flyway be encouraged to the greatest extent possible.

The project has a potential for various types of development to improve management for waterfowl. Deleterious effects of obnoxious vegetation can be minimized and often controlled through management to increase the amount of habitat on the reservoir area.

A prime need for waterfowl management on wintering grounds is increased food production which can be attained by several methods such as "green tree" reservoir management on selected areas, purchase and development of a limited acreage of lands adjoining the reservoir for food production, and planned reservoir water level manipulations to permit planting and growing of food crops for ducks in portions of the reservoir area. For Plan B or C gradually drawing down the reservoir water level 6 inches during a 60-day period beginning in April or May, and slowly raising the water level for 60 days to conservation pool elevation beginning in August or September would be desirable to flood the feeding areas. Lowering the reservoir water level early in the growing season would prevent killing some of the hardwoods that would be subjected to inundation on the upstream portion of the reservoir. For Plans D, E, or F, similar results could be achieved with 3-foot water level fluctuations for the same periods.

A refuge area would assist in the conservation of waterfowl in the Central Flyway. It would tend to stabilize the movements of waterfowl wintering on the upper Texas Coast and would provide a resting area where waterfowl might go for protection to escape the heavy hunting pressure on the coastal wintering grounds. Considering that many man-made changes of the coastal habitat will probably react unfavorably to waterfowl populations in the future, maintaining present population levels will be a precarious task at best. Further complications may arise from unfavorable weather extremes, such as droughts and unforeseen natural disasters. A national wildlife refuge could prove to be of inestimable value to waterfowl during these periods of adversity.

It would be feasible to develop selected portions of project land and water for waterfowl management and there would be a considerable increase in use of the area by waterfowl. Additional benefits resulting from large expenditures associated with hunting would also result. Plans B, C, and F are suitable for waterfowl development. Studies by the Corps of Engineers indicate that Plan C, which provides for storage to elevation

4 feet, is the most feasible plan of improvement for multiple-purpose use. The plan for the proposed national wildlife refuge is, therefore, based upon Plan C.

To realize the potential for waterfowl development on the project area, the refuge should be located as shown on Plate 1. The total area of the refuge is estimated to be about 12,730 acres of which about 10,730 acres would comprise a portion of the Wallisville Reservoir and about 2,000 acres would be refuge land area adjoining the reservoir. The 2,000 acres of land that would be purchased for the refuge would include about 800 acres of upland and about 1,200 acres of bottom land located in the vicinity of Pickett's Bayou.

The additional 2,000 acres of refuge lands would be required for a buffer zone to protect the waterfowl wintering on the refuge and to provide food for the ducks and geese. Cleared lands would be cultivated and timbered lands suitable for food production would be cleared. If sorghum or green forage crops are grown no irrigation water would be required; however, if rice is grown, an estimated 4,000 acre-feet of water would be needed annually. Based upon this preliminary estimate, about 4,000 acre-feet of annual storage would be required and should be included in the project plan and should be a nonreimbursable cost to the project. Pumping costs would be an annual operation and maintenance charge to be assumed by the Bureau of Sport Fisheries and Wildlife. These lands should be purchased as an integral part of the project on a nonreimbursable basis. All lands and water within the refuge boundary, approximately 12,730 acres, should be made available to the Secretary of the Interior under 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.).

Refuge development would consist of a headquarters group that will comprise several residences, service building with office, equipment storage building, shop, and associated utility facilities and structures, fencing, posting, road and trail construction, minimum recreational facilities and development of food production areas, "green tree" reservoirs, and marshes.

Cost of land acquisition is estimated to be $400,000 and development of the refuge facilities will amount to a total of $944,000. Operation and maintenance costs are estimated to be $91,600 annually. Development and operation and maintenance costs will be assumed by the Bureau of Sport Fisheries and Wildlife. These estimates, based upon 1959 costs, are shown in Table 1.

Table 1 - Estimated Land Acquisition, Development, and Operating Costs for Proposed Trinity National Wildlife Refuge

Item	Cost
Land Acquisition, 2,000 acres	$400,000
Development costs:	
Fencing, 40 mi. @ $1,000 per mile	$ 40,000
Posting, 40 mi. @ $50 per mile	2,000
Roads and trails	15,000
Food production areas as needed 800 acres @ $125 per acre (includes clearing, leveling, and ditching)	100,000
Pump house and pumping equipment	95,000
"Green Tree Reservoir" development 1,200 acres @ $35 per acre	42,000
Marsh development, including control structures 2,000 acres @ $50 per acre	100,000
Recreation development	50,000
Refuge Headquarters Buildings	100,000
Subtotal	$544,000
Total	$944,000
Estimated annual operating costs:	
Salaries, regular personnel	$ 30,000
Farming, 800 acres @ $18 per acre	14,400
Maintenance and operation of pumping plant	2,000
"Green Tree Reservoir" maintenance	2,500
Marsh maintenance (pest plant control, etc.)	20,000
Road maintenance	1,200
Fence maintenance	4,000
Recreational area maintenance	7,500
General maintenance	10,000
Total	$ 91,600

Benefits that will accrue from a waterfowl refuge are impossible to evaluate monetarily, for in addition to improved waterfowl hunting locally, the refuge will provide a much-needed wintering area for waterfowl in the Central Flyway. Many people will come to see the birds and the number of visitors who will observe the birds will be far greater than the number who will hunt them. Waterfowl use will be about 18,000,000 waterfowl-days annually. It is estimated that with intensive management of the refuge expenditures associated with waterfowl hunting will be about $120,000 annually. It is considered that the benefits of a national wildlife refuge would be at least equal to the cost of land acquisition and development.

In summation, the Wallisville Project will result in substantial benefits to the fresh-water sport fishery through creation of a reservoir fishery. Plans B and C will result in considerable gains to the commercial fishery and Plans D, E, and F will result in a loss to this fishery. Effects on the estuarine sport and commercial fisheries are not known.

Construction of this project will result in almost complete elimination of upland-game habitat. With Plans B and C there will be a considerable increase in benefits to waterfowl and with Plan D there will be no gain or loss to waterfowl. Plans E and F will result in some benefit to waterfowl. Establishment of a national wildlife refuge would provide food and protection that would result in greatly increased use by waterfowl and by hunters. Modifications of reservoir operating levels would provide for greater use of the project by waterfowl.

In view of the foregoing discussions, it is recommended:

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

(2) That adequate access to the reservoir be provided to assure free public fishing and hunting.

(3) That the reservoir be operated for waterfowl management as follows: (a) During a 60-day period beginning April or May, lower the water level 6 inches with Plans B and C, and 3 feet with Plans D, E, or F; and (b) beginning in August or September, slowly raise the water level for 60 days to conservation pool elevation.

(4) That the project be authorized to include a national wildlife refuge.

(5) That approximately 2,000 acres of land adjoining the Wallisville Reservoir, as delineated on Plate 1, be purchased at an estimated cost of $400,000 as an integral part of the project and be made available to the Secretary of the Interior in accordance with 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.).

(6) That 4,000 acre-feet of annual storage of water for waterfowl food production be included in the project plans as a nonreimbursable cost to the project.

(7) That federally owned land and project waters be open to free use for hunting and fishing except for sections reserved for waterfowl management, safety, efficient operation, or protection of public property.

(8) That additional detailed studies of fish and wildlife resources, including studies of effects upon the estuarine fishery, be conducted as necessary by the United States Fish and Wildlife Service and the Texas Game and Fish Commission after the project is authorized, in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and such reasonable modifications in and additions to the authorized project facilities be made as may be agreed upon by the Secretary of the Interior, the Executive Secretary, Texas Game and Fish Commission, and the Chief of Engineers, for the conservation and development of fish and wildlife resources.

The investigations preparatory to this report were made in cooperation with the Texas Game and Fish Commission. The report is based upon data available from the Corps of Engineers prior to March 18, 1960, and any modifications should be brought to the attention of the Bureau of Sport Fisheries and Wildlife and the Texas Game and Fish Commission. The cooperation of the Galveston District, Corps of Engineers, in furnishing engineering data and planning information is appreciated.

Sincerely yours,

John C. Gatlin

John C. Gatlin
Regional Director

Distribution:

(7) Executive Secretary, Texas Game and Fish Commission, Austin, Texas
(1) Director, Marine Laboratory, Texas Game and Fish Commission, Rockport, Texas
(1) Regional Director, Region 2, Bureau of Commercial Fisheries, St. Petersburg Beach, Florida
(1) Director, Biological Laboratory, Bureau of Commercial Fisheries, Galveston, Texas
(2) Regional Director, Region 3, National Park Service, Santa Fe, New Mexico
(2) Regional Engineer, Region VII, Public Health Service, Department of Health, Education, and Welfare, Dallas, Texas
(2) Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Fort Worth, Texas

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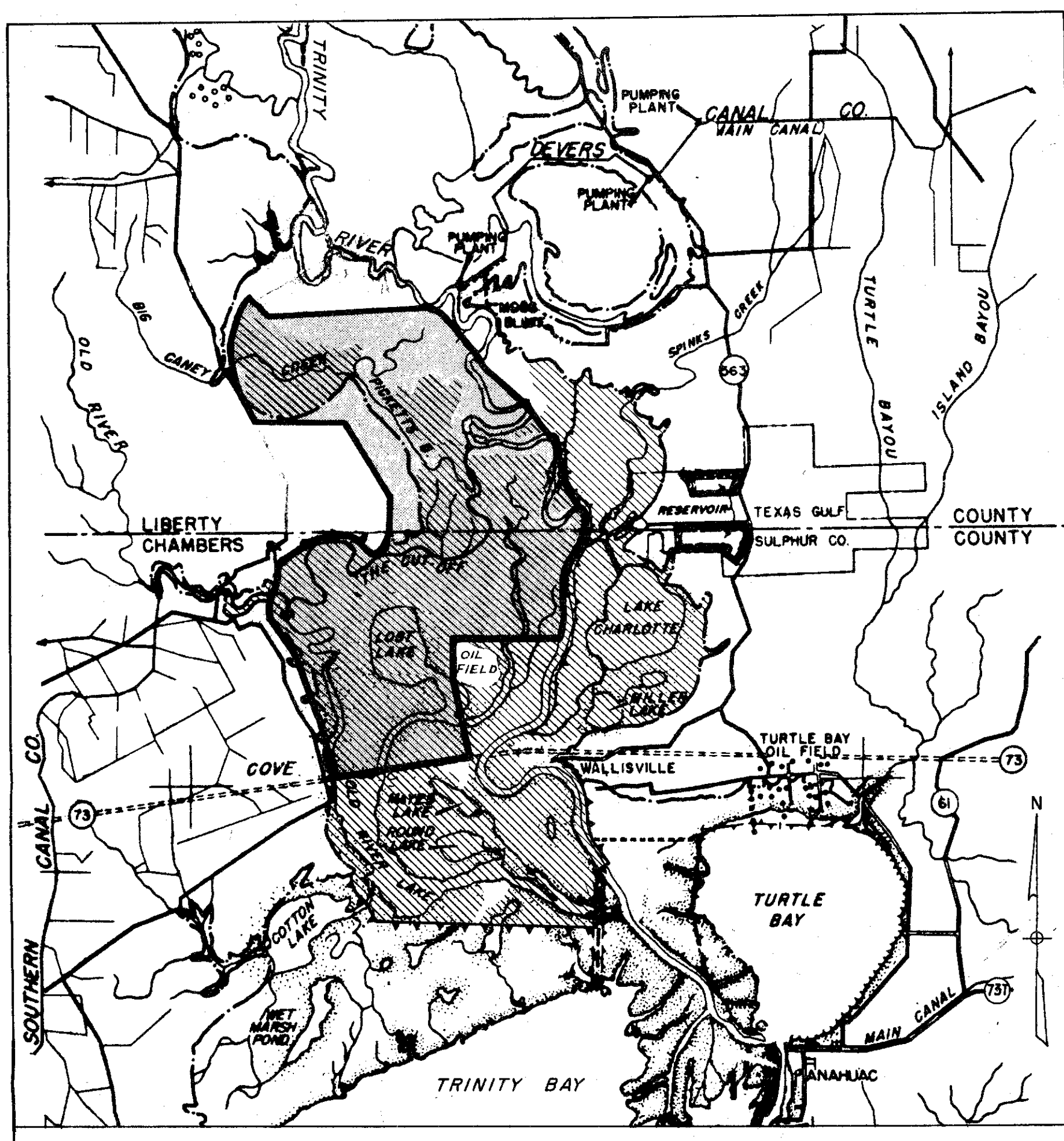

LEGEND

- PROPOSED REFUGE BOUNDARY
- PROPOSED REFUGE
- PROPOSED RESERVOIR
- PROPOSED DAM

Scale 0 1 2 3 MILES

COMPILED FROM U.S. CORPS OF ENGINEERS
DRAWING NO. TRIN. 201-41

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

PROPOSED TRINITY NATIONAL WILDLIFE REFUGE WALLISVILLE PROJECT

TRINITY RIVER, LIBERTY & CHAMBERS CO'S, TEX.

ALBUQUERQUE, NEW MEXICO REGION 2

DATE: FEB. 1961 PLATE I

INTERIM REVIEW OF REPORTS ON

TRINITY RIVER AND TRIBUTARIES, TEXAS

(WALLISVILLE RESERVOIR)

APPENDIX IV

STATEMENT OF LOCAL INTERESTS

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INTERIM REVIEW OF REPORTS ON
TRINITY RIVER AND TRIBUTARIES, TEXAS
(WALLISVILLE RESERVOIR)

APPENDIX IV

STATEMENT OF LOCAL INTERESTS

1. This appendix presents statements of local interests concerning the salt water problem resulting from navigation improvements in Galveston Bay and Trinity River.

The letter submitted by Mr. Guy C. Jackson, Jr., Chairman of the Chambers-Liberty Counties Navigation District contains information regarding salt water intrusion in the lower Trinity River and the causes of such salinity intrusion.

2. The Lone Star Canal Company in letter dated 30 August 1909 (copy on page 5) addressed to Captain Jno. C. Oakes, Galveston, Texas, requested permission to make certain works of improvement at the mouth of the Trinity River in the interest of securing a reliable supply of fresh water for the purpose of rice irrigation. The letter states that the Trinity River had furnished an abundant supply of water for the six years (1903-1909) but failed to supply a sufficient amount in 1909 and the company was required to pump bay water containing .05% (500 ppm) to .5% (5000 ppm) of salt. It is further stated that 13,800 acres of rice were planted in 1909 and that the shortage of fresh water and use of salty bay waters resulted in a loss of fully half the crop evaluated at $250,000.

3. The alleged effects of constructing the navigation projects in the upper Galveston Bay area on the salinity of the fresh water in the lower Trinity River, its delta area, and the northeast portion of Trinity Bay are set forth in the affidavits (copy inclosed) furnished by individuals as follows:

Name	Residence	Date of affidavit	Pages
Otis Parker	Anahuac, Texas	19 Jan 1954	7
Normie Sherman	Anahuac, Texas	20 Jan 1954	9
D. D. Wilcox	Anahuac, Texas	20 Jan 1954	11
J. M. Johnson	Houston, Texas	22 Jan 1954	13
E. L. Nolte	Anahuac, Texas	26 Jan 1954	15

January 4, 1954

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1229
Galveston, Texas

Dear Col. Lang:

In connection with the interim report on Trinity River and Tributaries, Texas, Channel to Liberty, dated January 30th, 1953, there are a few facts we wish to call to your attention.

The development of the irrigation canals taking water from the lower Trinity River started in 1901 to 1905. The Lone Star Canal Company (now Chambers-Liberty Counties Navigation District), with its pumping plant at Anahuac, Texas, commenced its operations in 1901.

This canal system had no difficulty from salt water intrusion until the development of the Houston Ship Channel was started. From that time on the constant increase of salt water was noted.

This intrusion of salt water was traced by the then operators of the Lone Star Canal Company and it was found that the salt water came up the Houston Ship Channel spreading on up the west side of Trinity Bay and on into the western passes of Trinity River Delta. Some of this salt water would find its way into the Trinity River and on the outgoing tide such "block" of salt water would pass the intake of the Lone Star Canal Company. It would be necessary to stop pumping irrigation water until such block of salt water had passed the intake.

This intrusion also reached the pumping plant of the Old River Canal Co. (now Southern Canal Company), causing them to cease pumping.

The investigations made by the operators of the Lone Star Canal Company also disclosed a "pool" of fresh water on the East side of Trinity Bay which pool worked back and forth with the tides. This pool of fresh water has been very important to the operators of the Lone Star Canal Company.

The continued deepening and widening of the Houston Ship Channel has constantly increased this salt water intrusion. It is evident that this condition would have prevailed even if no improvement of any kind had been made on the Anahuac Channel.

The salt water intrusion has been further increased by the development of new Anahuac Channel along the East side of Trinity Bay, the increased depth of the old Anahuac Channel and the cutting of the bars in the River near Wallisville, Texas.

This situation reached a dramatic climax in 1952 when it was necessary for the canal operators to construct a temporary dam in the Trinity River to stop salt water from reaching the pumping plants of Devers Canal Company and Richmond Irrigation Company.

The two canal operators nearest the mouth of the river have through the years protected themselves, to the best of their ability, by the construction of temporary dams and levees all of which is not a proper, adequate, or equitable solution of the problem.

This condition and the causes therefor has been brought to the attention of your department on numerous occasions and many solutions have been considered. The present proposal is the only one that appears to be sound and workable.

It is the sincere desire of all local interests that this proposal receive the approval of all departments of the Federal Government interested as the fresh water supply in the lower Trinity River is of primary importance.

We desire to continue to cooperate in the continued development and extension of navigable channels, but not to the extent of destroying the local economy developed upon the use of fresh water from the lower Trinity River.

Sincerely yours,

CHAMBERS-LIBERTY COUNTIES NAVIGATION DISTRICT

/s/ Guy C. Jackson, Jr.

GUY C. JACKSON, JR., Chairman

GCJ:vm

cc - Devers Canal Company
- Richmond Irrigation Company
- Southern Canal Company

August 30, 1909

Capt. Jno. C. Oakes,
Galveston, Texas

Dear Sir:-

We hereby ask permission to do the following work affecting navigable waters in this vicinity.

A. The closing of all passes between Turtle Bay and the Trinity River, also Jacks Pass, at points to be selected later, as shown by double red lines on map hereto attached.

B. The construction of a suitable dam with Lock across the mouth of Turtle Bay.

C. The excavation of a shallow channel between the Trinity River and the head of Smiths Bayou as shown by double dotted lines in red on above map.

Our reasons for this request are as follows:

Our pumping plant, located at Anahuac is the sole water supply for 13,800 acres of rice planted this year with a possible increase to 40,000 acres in the near future.

The rice crop requires an abundant supply of fresh water which we have had from the Trinity River for the past six years. This year the Trinity has failed to supply us and we have been obliged to pump for our crop water from the Bay containing from .05% to .5% of salt and for a large portion of the time the water contained so much salt that it could destroy any crop. So that we have had a short supply of dangerous quality.

The results show so far a loss of fully half the crop worth about $250,000.00.

The fear of repetition of these conditions in future years has already greatly depreciated the value of all property in this vicinity.

The only visible means for restoring these values and for protecting future developments is to convert Turtle Bay into a body of fresh water by means of the plan outlined above.

Turtle Bay is supplied with fresh water from Turtle Bayou and Whites Bayou which drain an area of about one hundred square miles.

The connection of Turtle Bay with the Trinity through Smiths Bayou as proposed through a shallow canal would equalize the surface of the River and Turtle Bay and in the absence of a supply of fresh water from Turtle Bayou and Whites Bayou would enable us to draw the surface water from the Trinity at that point which is reliably fresh water.

The closing of Jacks Pass would prevent the inflow of salt water to that portion of the Trinity.

Turtle Bay is a shallow body of water and is not used to any extent for navigation except by a few small boats in the charcola trade whose requirements would be met by the proposed lock which for a large portion of the year can be entirely left open for traffic.

The dam across the mouth of Turtle Bay North of Browns Pass leaves that Pass open and unobstructed for navigation and the channel of that Pass should be improved by the building of this dam as the current would be more concentrated than now.

We do not hesitate to say that the rice industry in this vicinity must be abandoned in the near future unless a reliable supply of fresh water can be secured without delay as no industry can prosper under a constant menance such as we have experienced this year.

We have under contract thirteen miles of extensions to our main canal and laterals, also contemplate an enlarged capacity in our pumping plant so that our failure to secure a future supply of fresh water will prove disastrous to the largest agricultural interest in this part of the state.

If this plan is approved as outlined, we will submit detailed drawings and specifications later for your final approval.

Yours very truly,

Lone Star Canal Company

By_____

THE STATE OF TEXAS §
§
COUNTY OF CHAMBERS §

BEFORE ME, the undersigned authority, on this day personally appeared Otis Parker, known to me to be a credible person, and who, after being by me first duly sworn, upon his oath deposes and says as follows:

My name is Otis Parker; I am 72 years of age and now live in Anahuac, Texas.

I moved to Anahuac in 1900 and went to work for the Lone Star Canal Company helping build and extend the canal system. There was a little amount of rice farmed in 1900 right next to the Town of Anahuac but the Canal really got started going good in 1901. I helped build most of the canals and laterals as I worked a mule team and a slip in putting up the canals and laterals. As a matter of fact I have worked for every owner of the canal up to and including the present time so I am familiar with what has been going on ever since the canal was built.

When the canal at Anahuac first started operating and for a number of years afterwards we had no trouble whatsoever with salt water. In fact we never did have trouble with salt water until the government cut through Red Fish Reef at Red Fish Light and dug a channel on up to the mouth of Buffalo Bayou. From that time on we began to have trouble with salt water during our pumping season.

When we started having trouble with salt water, then we started taking tests of the water to find out where it was coming from and we found that the salt water came up through the government cut in Red Fish Reef and on up the channel to Buffalo Bayou and then up the west side of the Bay into the western passes of the river and would come on into the river and there reach our pumping plant. We also found from these tests that there was a block or pool of fresh water that stayed along the east shore of Trinity Bay and we could pump out of this pool on the in coming tides and until the salt water from the west side of the bay worked through the passes to reach our pumping plant.

The government kept working on the channel going to Houston and we kept having more trouble with salt water. Finally, the local people voted a bond issue and built a levee to hold this salt water away from the pumps and let us pump from Turtle Bay, but this washed out with a storm in 1915 and then later they raised some more money and built it back again, but another storm washed that out. Later in the early 1930's it was build back again by the folks that owned the canal at that time and with this levee, it would cut the salt water off from getting into Turtle Bay and let us pump out of that Bay when the salt water came around the west side of the Bay and into the River and until the outgoing tides would clean out this salt water and carry it on back out. With this kind of arrangement we could pump

from the river and from pool of fresh water along the East side of the Bay until the salt water came around from the West and then close our river gates and pump out of Turtle Bay until the salt water had gone out again.

Even with the levee that was built and re-built between the river and Turtle Bay, we still lost lots of crops to salt water.

The farmers got awfully disgusted because they kept deepening the channel toward Houston and our salt water problems got worse all the time.

/s/ Otis Parker
Otis Parker

SWORN TO AND SUBSCRIBED BEFORE ME BY Otis Parker this 19th day of January, 1954.

/s/ Mrs. Annette R. Dugas
Notary Public, Chambers County, Texas

THE STATE OF TEXAS)
COUNTY OF CHAMBERS)

BEFORE ME, the undersigned authority, on this day personally appeared Otis Parker, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this 19th Day of January, 1954.

/s/ Mrs. Annette R. Dugas
Notary Public, Chambers County, Texas

THE STATE OF TEXAS §
§
COUNTY OF CHAMBERS §

BEFORE ME, the undersigned authority, on this day personally appeared Normie Sherman, known to me to be a credible person, and who, after being by me first duly sworn, upon his oath deposes and says as follows:

My name is Normie Sherman; I am 72 years of age and have lived at Anahuac, Texas, all of my life.

I started making my own living at 14 years of age by working on sail boats between the upper part of Trinity Bay and Galveston, receiving as wages at that time $2.50 per week, plus board. Later when they started the pumping plant at Anahuac, Texas, I worked running this plant for seven years in a row, starting to work in 1901 and at that time Dick Garland and A. L. Williams were operating this system. I know we did not have trouble with salt water during these first seven years as we never did shut down the plan because the water was too salty for the rice. After I had worked for the canal company for seven years, I went back to running boats on the Bay and they did begin to have trouble with salt water getting to the pumping plant but this occured after the government started cutting through Red Fish Reef and deepening a channel up toward the mouth of Buffalo Bayou. We called this cut that the government made "Morgan's Cut" and the tidal water would rush through this cut on an incoming tide so strong that we would have to anchor and wait for the tide to start out before we could get through the government cut.

I know that this salt water problem got worse and worse as the government continued to improve the channel going up to Houston and later, I believe it was about 1914, the farmers and land owners raised some money and built a levee to hold the salt water out of Turtle Bay. This levee was washed out by storm and was later rebuilt and washed out again by another storm and then was again rebuilt in the early 1930's when the canal properties were purchased by E. L. Nolte and others.

/s/ Normie Sherman
Normie Sherman

SWORN AND SUBSCRIBED BEFORE ME by Normie Sherman this the 20th day of January, 1954.

/s/Vivian Maddox
Notary Public, Chambers County, Texas

THE STATE OF TEXAS §
§
COUNTY OF CHAMBERS §

BEFORE ME, the undersigned authority, on this day personally appeared Normie Sherman, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this the 20th day of January, 1954.

/s/Vivian Maddox
Notary Public, Chambers County, Texas

THE STATE OF TEXAS)
)
COUNTY OF CHAMBERS)

BEFORE ME, the undersigned authority, on this day personally appeared D. D. Wilcox, known to me to be a credible person, and who, after being by me first duly sworn, upon his oath deposes and says as follows:

My name is D. D. Wilcox; I am 72 years of age and now live at Anahuac, Texas.

I moved to Anahuac from Beaumont, Texas, in the year of 1902 and have lived here continuously ever since. I am familiar with the starting and operation of the canal with the pumping plant at Anahuac, Texas, as it had only been in operation about a year when I moved to Anahuac. After I had lived here several years, I worked for the Lone Star Canal Company for two years as canal rider on the No. 1 Lateral. I do not remember the exact years, but it was during the time when Mr. Ellis was Canal Manager and the Emerson family owned the canal system.

During the time that I worked for the canal company and even after that time, I had a boat and would make trips across the Bay, as that was one of the main means of transportation at that time. I know that we were having trouble with salt water and on my own initiative took a number of water samples at different times across the Bay in order to find out about the salt water. From these samples, I discovered that the salt water was coming up the channel that was cut to go to Buffalo Bayou in Houston and spreading up the West side of the Bay and on into the western mouths of the Trinity River. I also found that there was a body of fresh water that lay alongside the East shore of Trinity Bay.

We had to watch this salt water intrusion during low flows of the Trinity River as it would come on up through the passes and then reach our pumping plant. Also it would go up the passes through Old River Lake to the Old River Plant and usually they got their salt water before we did at Anahuac.

From the time I came here until the government cut through Red Fish Reef at Red Fish Light and then cut a channel on northward toward Buffalo Bayou, we did not have any trouble with this salt water. The salt water intrusion got worse as they continued to develop the Houston ship channel and the farmers had a lot of difficulty and on several years lost their crops due to the salt water.

/s/ D.D. Wilcox
D. D. Wilcox

SWORN TO AND SUBSCRIBED BEFORE ME BY D. D. Wilcox this the 20th day of January, 1954.

/s/ Vivian Maddox
Notary Public, Chambers County, Texas

THE STATE OF TEXAS §
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COUNTY OF CHAMBERS §

BEFORE ME, the undersigned authority, on this day personnally appeared D. D. Wilcox, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same for the purposes and consideration therein expressed.

given under my hand and seal of office this the 20th day of January, 1954.

/s/Vivian Maddox
Notary Public, Chambers County, Texas

THE STATE OF TEXAS)
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COUNTY OF HARRIS)

BEFORE ME, the undersigned authority, on this day personally appeared J. M. Johnson, known to be a credible person, and who, after being by me first duly sworn, upon his oath deposes and says as follows:

My name is J. M. Johnson, I am 73 years of age and now live in Houston, Texas.

My father and I first started farming rice near Bay City, Texas. We later moved to Anahuac, Texas, in 1907 to farm rice on the Lone Star Canal, which was started in 1901.

We moved to Anahuac as there was good land and plenty of fresh water but after we had been there a few years we began to have trouble with salt water intrusion.

I am familiar with the condition about the water as I worked for the Lone Star Canal Company for many years after I moved to Anahuac.

Our salt water troubles increased with the development of the Houston ship channel. In order to prove this we took daily water samples for two years during the entire pumping season. I know about this as I was employed by the farmers to take the samples. We took twenty samples each day during the pumping season and at different times of the day and at different locations. By taking these samples we found that the salt water came up the Houston channel and then up the West side of Trinity Bay and on up the western passes of the Trinity River and Old River where it would be drawn into the pumping plants of the Lone Star Canal and the Old River Canal. I would follow this salt water daily until it reached the pumping plant, then we would shut down the pumps until the outgoing tide took the polluted water out again.

From the taking of these samples we also found that a pool of fresh water remained along the East shore of Trinity Bay and we could pump from this block of water on the incoming tide and until the salt water from the Houston Channel and penetrated into the river through the western passes of the delta.

We complained about this condition but never could get any help, so in 1925 I moved my rice farming to the Devers Canal Company and farmed on that canal until 1945 when I moved my farming operations to Katy, Texas, where I could get an underground supply of good water.

/s/J. M. Johnson
J. M. Johnson

SWORN TO AND SUBSCRIBED BEFORE ME BY J. M. Johnson this the 22nd day of January, 1954.

/s/ Virginia L. Hewitt
Notary Public, Harris County, Texas

THE STATE OF TEXAS)
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COUNTY OF HARRIS)

BEFORE ME, the undersigned authority, on this day personally appeared J. M. Johnson, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this the 22nd day of January, 1954.

/s/ Virginia L. Hewitt
Notary Public, Harris County, Texas
Virginia L. Hewitt

THE STATE OF TEXAS §
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COUNTY OF CHAMBERS §

BEFORE ME, the undersigned authority, on this day personally appeared E. L. Nolte, known to me to be a credible person, and who, after being by me first duly sworn, upon his oath deposes and says as follows:

My name is E. L. Nolte, I am 50 years of age and have lived at Anahuac, Texas, since 1932.

I have farmed rice and operated irrigation canals all of my life. In 1932 I and three other men came to Anahuac and purchased the pumping plant and canals of the old Lone Star Canal Company, which properties were owned at that time by W. C. Tyrrell of Beaumont, Texas. We started operation in 1932 and continued to operate said canal each and every year until 1947 when we sold the pumping plant, water rights and canal system to the Chambers-Liberty Counties Navigation District.

When we bought the canal system in 1932, the protection levee which had been constructed by previous operators of the canal, between the Trinity River and Turtle Bay was broken in several places. We repaired this levee in 1935 and continued to keep it in repair as long as we operated the canal system. This protection levee permitted us to hold a small amount of fresh water in Turtle Bay which we could mix with the salty water from the river and from Trinity Bay thereby permitting us to operate on a limited scale.

We had trouble with salt water each and every year while we operated this canal system and in order to trace out the source of this trouble, we took samples of water in Trinity Bay at various locations in the Bay during each of these pumping seasons. From this sampling of water we found that the salt water difficulty was primarily caused from salt water coming up the Houston Ship Channel and thence up the west side of Trinity Bay and on in to the western passes of the river to points in the river north of our pumping plant. On the out going tides a portion of this salt water would pass by our pumping plant and then we would have to mix this water with the water from Turtle Bay in order to obtain water for the watering of the rice. Often times we would have to shut down entirely and wait for a rain or a rise in the river.

Also from the samples of water taken from the Bay we also found there was a pool of fresh water that lay along the east shore line of Trinity Bay and on incoming tides this pool of water would come in to the lower reaches of the Trinity River and to our pumping plant so we could pump from this pool of fresh water until the tide started out again. We depended a great deal on this pool of water.

The chambers-Liberty Counties Navigation District was created in 1944 and immediately started promoting navigation on the Trinity River. They were successful in having the channel moved from the middle of Trinity Bay to the east shore line thereof and obtained funds for its construction. My associates and I realized that this would destroy the pool of fresh water along the east side of Trinity Bay and upon which we had depended for a portion of our supply of water; therefore, we considered it advisable to sell out, the navigation district was interested in purchasing, so we sold the system to the District. We did not feel that we could continue to operate this canal system in the face of the continued deepening of channels by the Federal Government and the promotion of this by the local district as our water supply would be completely destroyed and still the laws of the state would require us to furnish water to those who desired to farm rice on the old canal system as originally established and extended.

/s/ E. L. Nolte
E. L. Nolte

SWORN AND SUBSCRIBED TO BEFORE ME by E. L. Nolte this 26th day of January, 1954.

/s/ Hazel Gunn
Notary Public, Chambers County, Texas

THE STATE OF TEXAS)
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COUNTY OF CHAMBERS)

BEFORE ME, the undersigned authority, on this day personally appeared E. L. Nolte, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE this the 26th day of January, 1954.

/s/Hazel Gunn
Notary Public, Chambers County, Texas