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LETTER
FROM
THE SECRETARY OF THE ARMY
TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED FEBRUARY 18, 1965, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A SURVEY OF EL PASO, EL PASO COUNTY, TEXAS, AUTHORIZED BY THE FLOOD CONTROL ACT APPROVED JULY 3, 1958



JUNE 16, 1965.—Referred to the Committee on Public Works and ordered to be printed with five illustrations

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1965

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ILLUSTRATION ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER
(Only Plate 1 printed)

- Plate 1. General Plan, El Paso Local Protection Project.
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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.



IN REPLY REFER TO:

June 11, 1965

Honorable John W. McCormack

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 18 February 1965, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on a survey of El Paso, El Paso County, Texas, authorized by the Flood Control Act approved 3 July 1958.

The views of the States of Texas and New Mexico, the Departments of the Interior and Agriculture, the Public Health Service and the International Boundary and Water Commission are set forth in the inclosed communications.

The Bureau of the Budget noted that the Commissioner of the American Section, International Boundary and Water Commission, in commenting on the report, indicated there is no assurance agreement will be reached concerning modification of the Rio Grande project. In that event, alternative measures would be required for protecting parts of the City of El Paso. The Bureau expects that if an alternative plan is developed a showing of economic feasibility will precede any request for funds to initiate construction. Subject to consideration of this comment the Bureau of the Budget has no objection to 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,


STEPHEN AILLES

Secretary of the Army

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT

BUREAU OF THE BUDGET

WASHINGTON, D.C. 20503

June 1, 1965

Honorable Stephen Ailes
Secretary of the Army
Washington, D. C. 20310

Dear Mr. Secretary:

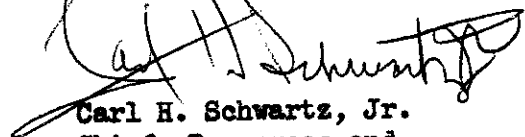
Mr. Alfred B. Fitt's letter of May 18, 1965, submitted the favorable report of the Chief of Engineers on a survey of streams at and in the vicinity of El Paso, El Paso County, Texas, authorized by Section 206 of the Flood Control Act of July 3, 1958.

With the various improvements recommended for authorization, there could result significantly higher peak discharges to the Rio Grande channel than would occur under existing conditions. Storm runoff could exceed the carrying capacity of the Rio Grande flood control project, maintained jointly with Mexico, downstream from the proposed El Paso project. Consequently, the Chief of Engineers recommends construction of certain improvements considered in this report be deferred until the International Boundary and Water Commission acts to increase the capacity of the Rio Grande floodway.

We note that in his letter of comment the Commissioner, American Section, International Boundary and Water Commission, states there is no assurance agreement will be reached concerning modification of the Rio Grande project. In that event, alternative measures would be required for protecting parts of the City of El Paso. The Bureau of the Budget expects that if an alternative plan is developed a showing of economic feasibility will precede any request for funds to initiate construction.

Subject to your consideration of the above, I am authorized by the Director of the Bureau of the Budget to advise you that there would be no objection to the submission of the proposed 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



JOHN CONNALLY
GOVERNOR OF TEXAS

February 6, 1965

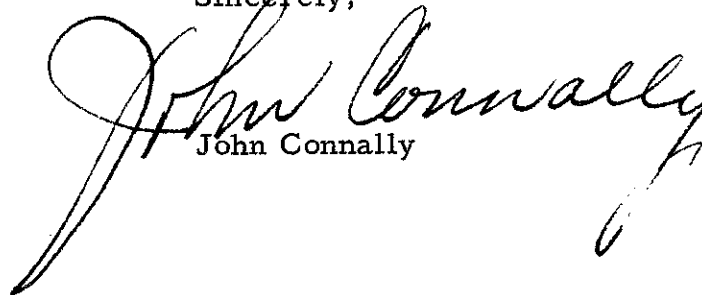
Lt. Colonel R. S. Kristoferson
Corps of Engineers
Assistant Director of Civil Works
for Plains Divisions
Department of the Army
Washington, D.C. 20315

Dear Colonel Kristoferson:

Attached is a copy of an Order entered by the Texas Water Commission on January 20, 1965 and received by this office on February 3. I hereby adopt the Commission's recommendations contained in Section 4 of said Order, particularly those contained in subsections (3) and (4) that "construction of improvements in the Northwest Area" are excluded, and "that ownership by the State of Texas of the waters involved be fully recognized."

With kindest regards,

Sincerely,


John Connally

TEXAS WATER COMMISSION



**AN ORDER approving the feasibility
of El Paso Flood Control and
Allied Purpose Project proposed in
a U. S. Corps of Engineers Survey
Report.**

BE IT ORDERED BY THE TEXAS WATER COMMISSION:

Section 1. Statement of Authority. Article 7472a, V.A.C.S.,
provides that upon receipt of any engineering reports submitted
by a federal agency seeking the Governor's approval of a federal
project, the Texas Water Commission shall study and make recom-
mendations to the Governor as to the feasibility of the federal
project. The Commission shall cause a public hearing to be held
to receive the views of persons or groups who might be affected
should the federal project be initiated and completed.

Section 2. Statement of Jurisdiction. (a) The Honorable
John B. Connally has requested that the Texas Water Commission
review the report of the Corps of Engineers, U. S. Army, entitled,
"Report on Survey for Flood Control and Allied Purposes," and to
enter its order finding the project recommended therein to be
feasible or not feasible. (b) In accordance with Article 7472a,
and after due notice by publication, the Commission caused a

hearing to be held on December 9, 1964, in El Paso, Texas, on said report, at which time all those interested or who might be affected should the project recommended in said report be initiated and completed were requested to come forward and give testimony.

Section 3. After fully considering all the evidence presented by persons and groups who may be affected should the project be initiated and completed, including the matters set forth in Section 4 of Article 7472e, the assurance of financial participation in the project by local interests, and the recommendations by the Chief Engineer of the Texas Water Commission, the Texas Water Commission hereby finds that the project is feasible and the public interest will be served thereby.

Section 4. The Commission recommends:

- (1) That the entire project be authorized by Congress at the earliest possible time;
- (2) That construction of the portion of the proposed project, as recommended in said report by the U. S. Corps of Engineers relating to flood prevention and allied purposes in and around El Paso, Texas, which provides for improvements in the Central Area and in the Southeast Area be started as soon as possible;
- (3) That inasmuch as construction of improvements in the Northwest Area is to be deferred until a later time, the Texas Water Commission withholds any recommendations relative

to that portion of the project until such time as the affected Federal agencies have reached agreement thereon and such improvements are recommended for construction by the Corps of Engineers;

(4) That ownership by the State of Texas of the waters involved be fully recognized by all interested parties and that lawful rights to the use of such waters, vested pursuant to state law, be respected, protected and preserved.

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 on the 20th day of January, 1965, the date of its passage, and it is so ordered.

SIGNED IN THE PRESENCE OF THE
TEXAS WATER COMMISSION

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

ATTEST:

/s/ Audrey Strandtman
Audrey Strandtman, Secretary

STATE OF TEXAS §
§
COUNTY OF TRAVIS §

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

Given under my hand and the seal of the Texas Water Commission, this the 2nd day of February, A.D., 1965.

Audrey Strandtman
Audrey Strandtman, Secretary

COMMENTS OF THE STATE OF NEW MEXICO



STATE OF NEW MEXICO

STATE ENGINEER OFFICE

SANTA FE

S. E. REYNOLDS
STATE ENGINEER

October 19, 1964

ADDRESS CORRESPONDENCE TO:
STATE CAPITOL
SANTA FE, N. M.

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

Your ref: ENGCW-PD

Dear Sir:

Your letter of September 11, 1964 transmitted for review in accordance with Public Law 534, 78th Congress your report, together with the reports of the Board of Engineers for Rivers and Harbors and reports of the District and Division Engineers, on a survey for flood control of streams in the vicinity of El Paso, Texas.

The State of New Mexico has no objection to the plan of improvement set forth in the report. As requested in your transmittal we have obtained the comments of the New Mexico Department of Game and Fish and that agency advises that they concur in your report. A copy of their letter is attached hereto.

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

Very truly yours,

A handwritten signature in cursive script, appearing to read "S. E. Reynolds".

S. E. Reynolds
State Engineer

PBM:b

Enclosure: Department of Game and Fish letter dated 9/29/64



State of New Mexico
DEPARTMENT OF GAME AND FISH

LADD S. GORDON
SECRETARY TO THE COMMISSION
AND DIRECTOR OF THE DEPARTMENT

STATE CAPITOL
SANTA FE
87501

STATE GAME COMMISSION
ROBERT J. BROWN, CHAIRMAN
LAS VEGAS
ALVA A. SIMPSON, JR.
SANTA FE
J. B. WARD
ARTESIA
DR. FRANK D. HIBBEN
ALBUQUERQUE
FLOYD TODD
CENTRAL

September 29, 1964

Mr. S. E. Reynolds, Secretary
Interstate Stream Commission
State Capitol
Santa Fe, New Mexico

Attention: Mr. David P. Hale

Dear Mr. Reynolds:

This will acknowledge receipt of your letter of September 25 with which you submitted a copy of the proposed report of the Chief Engineers along with the reports of the Board of Engineers for Rivers and Harbors, and of the District and Division Engineers on a survey of El Paso, El Paso County, Texas.

In compliance with your request for our review and comment, we wish to advise that we concur in this report, and return it herewith.

Thank you for the opportunity to comment on this development.

Yours very truly,

Ladd S. Gordon
LADD S. GORDON ^{T.M.}
Director

LSG/mw

COMMENTS OF THE DEPARTMENT OF THE INTERIOR



UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

November 5, 1964

Dear General Wilson:

This is in reply to your letter of September 11, 1964, requesting our views on a survey of El Paso, El Paso County, Texas.

Some lands and facilities of the Rio Grande Project of the Bureau of Reclamation would be affected by the proposed improvements, but full consideration has been given to these effects through the close coordination which has been maintained between the Corps of Engineers and the Bureau. The proposed works, with continued close coordination and full consideration of maintaining service obligations during advance planning and construction, would benefit the city, the Bureau of Reclamation, and the Rio Grande Project interests.

The Bureau of Sport Fisheries and Wildlife advises that the proposed local flood protection project for El Paso, Texas, would have no significant effect on fish and wildlife resources of the area, and does not afford opportunities for improvement of these resources.

Thank you for the opportunity of commenting on the recommended improvements.

Sincerely yours,

A handwritten signature in black ink, appearing to read "K. Holum", is written over a horizontal line.

Kenneth Holum

Assistant Secretary of the Interior

Lt. General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington, D. C. 20315

COMMENTS OF THE DEPARTMENT OF AGRICULTURE



DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D.C.

February 9, 1965

Honorable Stephen Ailes
Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Chief of Engineers' letter of September 11, 1964, transmitting for our review and comment his proposed survey report on El Paso, El Paso County, Texas.

The report finds that a single-purpose local flood control plan would meet present and long-range needs for protection of the area against flooding from the arroyos. The proposed plan of improvement consists of four independent elements, one of which is located in the Northwest Area, one in the Central Area, and two in the Copper System and Bluff Channel in the Southeast Area. The project comprises combinations of detention dams, diversions, and interceptor and outfall channels, together with appurtenant structures.

The estimated first cost of the project is \$15,624,000, of which \$12,493,000 would be the Federal construction cost and \$3,131,000 the non-Federal cost. Based on a 100-year period of analysis, the benefit-cost ratio for the entire plan is estimated at 1.7 to 1.0.

The report recommends that improvements in the Central Area and the Copper System in the Southeast Area be constructed as soon as practicable at an estimated cost of \$8,064,000 to the United States and that construction of improvements in the Northwest Area and the Bluff Channel in the Southeast Area be deferred until such time as construction is initiated by the International Boundary and Water Commission on the improvements which may be required to increase the capacity of the Rio Grande River and its floodway.

Most of the proposed works of improvement are for protection of urban developments. The relatively small amount of agricultural land to be benefited when construction is accomplished is expected to be gradually absorbed by urban development over the next 50 years. The affected flood plain covers about 9,000 acres, of which about 1,500 acres are presently devoted to agricultural production, most of it in cotton. The area is rapidly being urbanized and agriculture as a land use, based on an analysis of recent trends, is expected ultimately to be eliminated within the affected area.

There are no National Forests or National Grasslands within the project area, and effects of the project upon non-Federal woodland would not be of major significance.

There are no works of improvement planned or contemplated under programs administered by this Department which would affect or be adversely affected by the project recommended in this report.

We appreciate the opportunity to review the report.

Sincerely yours,

A handwritten signature in cursive script that reads "John A. Baker". The signature is written in dark ink and is positioned above the typed name.

John A. Baker
Assistant Secretary

COMMENTS OF THE PUBLIC HEALTH SERVICE



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
WASHINGTON, D.C. 20201

BUREAU OF STATE SERVICES

November 20, 1964

REFER TO:

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

Dear General Wilson:

This is in reply to General MacDonnell's letter of September 11, 1964, requesting comments on the Survey Report on El Paso, El Paso County, Texas.

Municipal and industrial water supply needs are discussed in the Public Health Service letter report, dated June 17, 1963, contained in Appendix E of the report. The practicability of modifying the flood control plans to include storage for municipal and industrial water supply was investigated by the Corps of Engineers but no feasible means could be found. On this basis, we conclude that storage for quality control by flow regulation is likewise not feasible in this project.

Prevention of flooding in the vicinity of El Paso will provide a more favorable environment for good public health practices.

Mosquito production may create problems unless preventive measures are included in the planning, construction, maintenance, and operation of the project. Detailed recommendations on this subject, prepared by the PHS Communicable Disease Center, Greeley, Colorado, in cooperation with the Texas State Department of Health, have been supplied to the District Engineer, U. S. Army Engineer District, Albuquerque, New Mexico.

The opportunity to review the report is appreciated. We stand ready to supply further consultation on request.

Sincerely yours,

A handwritten signature in cursive script that reads "Keith S. Krause".

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

COMMENTS OF THE INTERNATIONAL BOUNDARY AND WATER COMMISSION



INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

206 SAN FRANCISCO STREET
EL PASO, TEXAS 79950

MAILING ADDRESS:
P. O. BOX 1859

OFFICE OF THE COMMISSION
UNITED STATES SECTION

December 6, 1964

Dear General MacDonnell:

I appreciate the opportunity afforded by your letter of September 11, 1964, to review and comment upon the proposed report of the Chief of Engineers, together with reports of the Board of Engineers for Rivers and Harbors, and of the District and Division Engineers on a Survey for Flood Control and Allied Purposes, El Paso, El Paso County, Texas.

The reports of the Chief of Engineers and the Board of River and Harbors confirm the recognition in the District Engineer's Report, that proposed improvements in the Northwest Area and the Bluff Channel in the Southeast Area, would change flow conditions in the international section of the Rio Grande, and would require the prior approval of the Governments of the United States and Mexico through this Commission. With the understandings set forth in the reports, that construction of the above proposed improvements will be deferred until such time as construction is initiated on the improvements, which may be required to increase the capacity of the Rio Grande and its floodway by the International Boundary and Water Commission, I concur in the recommendations of the report.

At the same time, there should be the understanding that one or both Governments may find that improvements cannot be justified to increase the capacity of the international Rio Grande Rectification Project below El Paso-Juarez, nor in the Rio Grande Canalization Project upstream from the two cities. This understanding is reflected in the District Engineer's conclusions (paragraph 114c.). In this event, alternative local protection measures would be required for the Northwest Area and for the Bluff Channel in the Southeast Area, in order not to change flow conditions in the Rio Grande.

As a minor suggestion of an editorial nature: At the end of paragraph 21, ~~page 18~~, a sentence should be included to the effect that Caballo Dam also serves a flood control function and storage in the amount of 100,000 acre-feet is allocated to this purpose.

Again, my thanks to you, General, for your courtesy and consideration in providing opportunity for us to review the report.

Cordially,

J. F. Friedkin
Commissioner

Maj. Gen. R. G. MacDonnell,
Acting Chief of Engineers,
Headquarters, Department of the Army,
Office of the Chief of Engineers,
Washington, D. C. 20315.

EL PASO, EL PASO COUNTY, TEXAS

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY



IN REPLY REFER TO

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

ENG CW-PD

18 February 1965

SUBJECT: El Paso, El Paso County, Texas

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on a survey of streams at and in the vicinity of El Paso, El Paso County, Texas, authorized by Section 206 of the Flood Control Act of 3 July 1958. My report includes the reports of the District and Division Engineers and the Board of Engineers for Rivers and Harbors.

2. The reporting officers recommend the authorization of a single-purpose project for local flood protection designated as the El Paso Local Protection Project. The project is divided into four independent elements, one of which is located in the Northwest Area of El Paso, one in the Central Area, and two, the Copper System and the Bluff Channel, in the Southeast Area. The plan of improvement comprises combinations of detention dams, diversions, and interceptor and outfall channels, together with appurtenant structures. The District Engineer estimates the first cost of the project at \$15,624,000, of which \$12,493,000 would be the Federal construction cost and \$3,131,000 the non-Federal cost for lands, easements, rights-of-way, and relocations. Construction would be contingent upon the fulfillment of the requirements of local cooperation. The overall benefit-cost ratio is 1.7. The independent elements of the proposed project also are individually justified.

3. The proposed improvements in the Northwest Area and Bluff Channel in the Southeast Area would change flow conditions in an international section of the Rio Grande. Therefore, the reporting officers further recommend that the improvements comprising the El Paso Local Protection Project in the Central Area and the Copper System in the Southeast Area be constructed as soon as practicable, at an estimated cost of \$8,064,000 to the United States; and that

construction of improvements in the Northwest Area and the Bluff Channel in the Southeast Area be deferred until such time as construction is initiated on the improvements which may be required to increase the capacity of the Rio Grande and its floodway by the International Boundary and Water Commission.

4. The Board of Engineers for Rivers and Harbors concurs generally in the findings of the reporting officers and recommends the improvements, subject to local cooperation.

5. I concur in the recommendations of the Board. Use of the recently prescribed interest rate of 3-1/8 percent in computing annual charges and benefits would result in no appreciable change in the benefit-cost ratio.



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

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

ENGBR(31 Jan 64)

2nd Ind

SUBJECT: Report on Survey for Flood Control and Allied Purposes:
El Paso, El Paso County, Texas

Board of Engineers for Rivers and Harbors, Washington, D. C. 20315
13 July 1964

TO: Chief of Engineers, Department of the Army

1. The city of El Paso is in west Texas on the left bank of the Rio Grande in the reach which forms the international boundary between the United States and the Republic of Mexico. The flood problem at El Paso and vicinity is from two sources: The main stem of the Rio Grande and the numerous tributary arroyos which head on the eastern, southern, and western slopes of the adjacent Franklin Mountains. Inasmuch as this reach of the main stem of the Rio Grande is under the administration of the International Boundary and Water Commission, this report is limited to the problems created by the tributary arroyos.

2. The drainage area of the tributary arroyos that flood El Paso and vicinity comprises 128 square miles, a large part of which is within the city limits. All of the streams and arroyos under investigation are ephemeral and the waterways become poorly defined after leaving the mountain slopes. Damage is caused by ponding in the low areas, because of inadequate outlets to the Rio Grande, and by flowing waters en route to the ponding areas. Development in the flood plains is principally urban and suburban. The population of El Paso increased from 130,485 in 1950 to 276,687 in 1960 and a continued high rate of growth is predicted.

3. Floodflows from the steep arroyos attain high velocities which cause severe erosion and deposition of large quantities of sand, gravel, boulders, and other debris in the flood plains. Natural and man-made barriers obstruct flows and cause ponding of floodwater in urban, suburban, and agricultural areas. To facilitate study the overall arroyo flood problem area at El Paso and vicinity was divided into four topographically independent areas: Northwest, Central, Southeast, and Downtown. Existing improvements provide a reasonable degree of protection to the Downtown Area; however, serious flood problems exist in the other three areas. The city has constructed drainage and small flood-control works in some of these areas but the works are not adequate to cope with the problem. A master plan for flood control and drainage has been prepared by local interests to assure that any works constructed would form sound and effective units of a long-range plan designed to meet the future as

well as present needs. Local interests have requested the assistance of the Federal Government in providing the desired flood protection. The estimated value of property subject to flooding is \$258,321,000. Average annual flood damages, including an allowance for future development, are estimated at \$1,090,000. In addition, the city is confronted with the problem of meeting an increasing demand for municipal and industrial water created by a rapidly expanding population.

4. Local interests suggested a combination of all types of protective works including retention dams, drainage channels, levees, and storm sewers for solution of the flood problem. They also requested consideration of impoundment of water for municipal, industrial, and recreational purposes.

5. The District Engineer finds that a single-purpose local flood-control plan would meet present and long-range needs for protection of the area against flooding from the arroyos. He finds that it would be impractical to provide other water resource improvements in conjunction with local flood protection works, but believes that the proposed works would be compatible with comprehensive plans for development of water resources of the Rio Grande Basin. The proposed plan of improvement is divided into four independent elements, one of which is located in the Northwest Area, one in the Central Area, and two--the Copper System and Bluff Channel--in the Southeast Area. The project comprises combinations of detention dams, diversions, and interceptor and outfall channels; together with appurtenant structures.

6. The estimated first cost of the project is \$15,624,000, of which \$12,493,000 would be the Federal construction cost and \$3,131,000 the non-Federal cost for lands, easements, rights-of-way, and relocations of structures and utilities other than railroads or improvements constructed and maintained by the United States. Annual charges are estimated at \$595,000, including \$100,000 to local interests for operation and maintenance. The average annual benefits are estimated at \$1,033,000, consisting of \$994,000 for reduction of flood damages, including prevention of damages to future development, and \$39,000 for increased land utilization. Based on a 100-year period of analysis, the benefit-cost ratio for the entire plan is 1.7. The independent elements of the plan are individually justified, as shown in the following table:

Benefit-Cost Comparisons - (January 1964 Conditions and Prices)

Area	First costs	Annual charges	Total benefits	B/C ratio
<u>Northwest:</u>				
Federal	\$ 3,344,000	\$105,830		
Non-Federal	729,000	55,170		
Total, Northwest Area	\$ 4,073,000	\$161,000	\$ 537,200	3.3
<u>Central:</u>				
Federal	\$ 7,310,000	\$231,300		
Non-Federal	622,000	67,700		
Total, Central Area	\$ 7,932,000	\$299,000	\$ 336,000	1.1
<u>Southeast:</u>				
<u>Copper System:</u>				
Federal	\$ 754,000	\$ 23,860		
Non-Federal	635,700	26,140		
Subtotal, Copper System	\$ 1,389,700	\$ 50,000	\$ 53,500	1.1
<u>Bluff Channel:</u>				
Federal	\$ 1,085,000	\$ 34,340		
Non-Federal	1,144,300	50,660		
Subtotal, Bluff Channel	\$ 2,229,300	\$ 85,000	\$ 106,200	1.2
<u>Total Southeast:</u>				
Federal	\$ 1,839,000	\$ 58,200		
Non-Federal	1,780,000	76,800		
Total, Southeast Area	\$ 3,619,000	\$135,000	\$ 159,700	1.2
<u>El Paso Local Protection</u>				
<u>Project:</u>				
Federal	\$12,493,000	\$395,330		
Non-Federal	3,131,000	199,670		
Total Project	\$15,624,000	\$595,000	\$1,033,000	1.7
			:(rounded)	

7. Local interests concur generally in the proposed plan and have indicated their willingness and ability to cooperate in construction of the project. However, the United States Section, International Boundary and Water Commission, expressed concern regarding the possibility of flows from the improvements in the Northwest Area and the Bluff Channel of the Southeast Area combining

with flows on the Rio Grande and endangering the international Rio Grande floodway. These views were considered by the District Engineer in formulating his recommendations.

8. The District Engineer recommends authorization of the El Paso Local Protection Project as described in his report subject to the requirements of local cooperation. He further recommends that improvements in the Central Area and the Copper System in the Southeast Area be constructed as soon as practicable at an estimated cost of \$8,064,000 to the United States; and that construction of improvements in the Northwest Area and the Bluff Channel in the Southeast Area be deferred until such time as construction is initiated on the improvements which may be required to increase the capacity of the Rio Grande and its floodway by the International Boundary and Water Commission. The Division Engineer concurs.

9. 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. Careful consideration has been given to the communications received.

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

10. Views.--The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. The improvements proposed by the District Engineer are suitable and economically justified and the requirements of local cooperation are appropriate. The Board notes the interest of the International Boundary and Water Commission in the proposed improvements and that the Commissioner of the United States Section concurs in the recommendation that improvements in the Northwest Area and the Bluff Channel in the Southeast Area be deferred until the initiation of construction of certain improvements on the Rio Grande by the Commission.

11. Recommendations.--Accordingly, the Board recommends improvements at El Paso, Texas, for flood control by the construction of a system of detention reservoirs, diversion dikes, and channels, designed to collect, regulate, and discharge arroyo floodflows into the Rio Grande, generally in accordance with the plan of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable; at an estimated cost to the United States of \$12,493,000 for construction: Provided that, prior to construction, local interests furnish assurances satisfactory to the Secretary of the Army that they will:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project;

b. Hold and save the United States free from damages due to the construction works;

c. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Make any alterations to existing improvements, other than railroads or improvements constructed and maintained by the United States, which may be required because of the construction works;

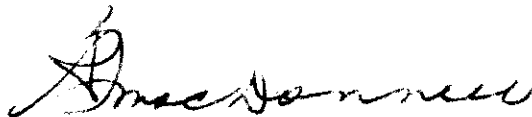
e. Prevent encroachment on all of the project works which would reduce their design capacities;

f. Take steps to prevent encroachment on existing defined waterways tributary to the project by zoning or other means such as enlargement, or other modifications, of the existing waterway facilities, to prevent the minor flood problems in these tributary waterways from developing into problems of serious proportions; and

g. Inform all concerned in a manner satisfactory to the Chief of Engineers that the project is designed to control floods originating above the structures and that some residual flooding may be expected from precipitation occurring below the structures.

12. The Board further recommends that improvements proposed for the Central Area and the Copper System of the Southeast Area be constructed as soon as practicable, at an estimated cost of \$8,064,000 to the United States, and that construction of improvements for the Northwest Area and the Bluff Channel of the Southeast Area be deferred until such time as construction is initiated on the improvements which may be required to increase the capacity of the Rio Grande and its floodway by the International Boundary and Water Commission.

FOR THE BOARD:



R. G. MacDONNELL
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

SYLLABUS

This report presents the results of an investigation of the flood and related problems on streams at and in the vicinity of El Paso, El Paso County, Tex. El Paso is situated in west Texas on the left bank of the Rio Grande in the reach which forms part of the international boundary between the United States and the Republic of Mexico. The flood problem at El Paso is from two sources; namely, the main stem of the Rio Grande and the tributary arroyos which head on the slopes of the adjacent Franklin Mountains. Inasmuch as the main stem of the Rio Grande is under the administration of the International Boundary and Water Commission, this report is not directly concerned with the main stem flood problem but is limited to the problems created by the tributary arroyos.

Sections of the city of El Paso and its outlying suburban developments are subject to flooding from the numerous normally dry arroyos which head on the eastern, southern, and western slopes of the Franklin Mountains and descend on the city. Floodwaters flow through the developed areas and pond in natural depressions which have no outlets to the Rio Grande. During the past 25 years the city has grown rapidly and expanded in several directions into areas subject to inundation. Records indicate that major flooding occurred in September 1941, and floods of damaging proportions occurred in 1950, 1955, 1957, 1959, 1962, and 1963. Average annual damages under existing conditions including an allowance for future development are estimated at \$1,090,100. In addition to the flood problems, the city is confronted with the problem of meeting an increasing demand for municipal and industrial water created by a rapidly expanding population. Water-associated recreational facilities also are needed to satisfy the increasing demand for outdoor recreation.

Numerous solutions to the arroyo flood problem were investigated including reservoirs, diversions, floodways, drains, and combinations thereof. Consideration also was given to the water supply and recreational needs but the water supply was determined to be insufficient to satisfy these needs. The improvement considered most feasible is a single-purpose flood control plan designated as the El Paso Local Protection Project which comprises a system of detention reservoirs, diversion dikes, and channels designed to collect, regulate, and discharge arroyo runoff into the Rio Grande. Moreover, the project is divided into four independent elements, one of which is located in the Northwest Area, one in the Central Area, and two (Copper System and Bluff Channel) in the Southeast Area.

The total first cost of the El Paso Local Protection Project is estimated at \$15,624,000, of which \$12,493,000 would be Federal and \$3,131,000, non-Federal. The Federal and non-Federal annual charges would be \$395,330 and \$199,670, respectively, a total of \$595,000. The annual benefits are estimated at \$1,032,900, yielding a benefit-cost

ratio of 1.7. The independent plans which comprise the El Paso Local Protection Project are also individually justified. Local interests concur in the plan and have indicated their willingness to cooperate in the construction and maintain and operate the project.

The District Engineer recommends that the El Paso Local Protection Project be authorized for construction by the United States subject to the conditions of local cooperation. He further recommends that all improvements recommended for the Central Area and the Copper System in the Southeast Area be constructed as soon as practicable, at an estimated cost of \$8,064,000 to the United States, and that construction on the remainder of the project be deferred until such time as construction is initiated on the improvements which may be required to increase the capacity of the Rio Grande and its floodway by the International Boundary and Water Commission.

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
FEDERAL BUILDING, 517 GOLD AVENUE SW
ALBUQUERQUE, NEW MEXICO 87103

January 31, 1964

SUBJECT: Report on Survey for Flood Control and Allied Purposes: El Paso, El Paso County, Texas

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

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

INTRODUCTION

1. AUTHORITY.- This survey report is submitted in response to an item included in Section 206 of the Flood Control Act approved July 3, 1958, (Title II, P. L. 85-500, 85th Congress), which reads as follows:

SECTION 206. The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvement and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers in drainage areas of the United States and its Territorial possessions, which include the following named localities:

* * * * *

Streams at and in the vicinity of El Paso, El Paso County, Texas

* * * * *

The survey investigation and report thereon were assigned to the Albuquerque District by the Division Engineer, U.S. Army Engineer Division, Southwestern, by 1st Indorsement dated August 4, 1958, on letter from the Chief of Engineers, subject: "El Paso, El Paso County, Texas," dated July 25, 1958.

2. PURPOSE AND EXTENT OF THE INVESTIGATION.- The objectives of this survey were to determine the extent and magnitude of the flood and water related problems at and in the vicinity of El Paso, Tex., develop a plan of improvement which would meet present and long-range needs of the area, and to determine the advisability and feasibility of improvements by the Federal Government.

3. The city of El Paso is situated in west Texas on the left bank of the Rio Grande which forms part of the international boundary between the United States and the Republic of Mexico. Although the authorization quoted above directed surveys for flood control and allied purposes on streams at and in the vicinity of El Paso, El Paso County, Texas, studies of potential flooding from the Rio Grande were not included in this survey because the main stem of the Rio Grande is under the jurisdiction of the International Boundary and Water Commission. However, there is a serious flood problem caused by floodflows in the numerous tributaries which head on the eastern, southern, and western slopes of the adjacent Franklin Mountains and descend upon El Paso. The drainage courses, after leaving the steep mountain slopes, become poorly defined through the developed areas and damage results from sheet flow and from ponding in the low areas because of inadequate outlets to the river. In the past, damage was not serious because local interests diverted the waters away from the developed areas; however, during recent years the city has grown rapidly and expanded into unprotected areas. The flood problem from the ephemeral tributaries of the Rio Grande has grown accordingly and is now of such proportions as to be beyond solution by local interests.

4. As an initial step in this investigation, a public hearing was held by the District Engineer at El Paso on December 21, 1959, to give local interests an opportunity to present the local flood problem and express views concerning the character and extent of improvements desired to alleviate the condition on streams at and in the vicinity of El Paso. Testimony offered during the hearing is summarized under IMPROVEMENTS DESIRED. Representatives of other Federal agencies and the states concerned also were invited to attend the hearing and express their interests in the investigation. A field appraisal was made of the flood plain to determine the type and extent of existing improvements, property values, and flood damages. Engineering studies were made of the extent and characteristics of contributing watersheds, precipitation, storms, runoff, flood frequency, and sedimentation. Existing reservoirs and flood control works were studied to determine their adequacy as measured by current Corps of Engineers' criteria. City and county officials, the engineering advisors to the city, and

other individuals were consulted to determine trends of development and effects of flooding upon economic activities and property values. Data were collected, correlated, and analyzed to estimate future development of the area with and without improvement, and the benefits which could be expected to accrue to various types and combinations of improvements. Maps and aerial photographs prepared by other Federal agencies, State, and local interests, and used in this survey are listed in appendix A.

5. IMPROVEMENTS DESIRED.- During the public hearing the Mayor of El Paso described the flood control works that have been constructed. He stated that, because of the growing seriousness of the flood problem, he had appointed an advisory committee to study the needs of the city and upon their advice, had employed the services of three engineering firms to develop plans for the alleviation of flooding. In addition, he indicated that funds were available to undertake some of the most urgently needed work but that the aid of the Federal Government would be required to provide ultimate protection insofar as feasible for the entire city. Also, he suggested that a combination of all types of protective works such as retention dams, drainage channels, levees, storm sewers, etc., would be necessary for solution of the problem. A representative of the White Spur Association (Northwest Area of El Paso) requested that consideration be given to impoundment of floodwaters for municipal supply and for the development of a recreational area for both residents and tourists. Another resident of the Northwest Area stated that much damage had been suffered in the northern section of the city and requested alleviation of the problem. The superintendent of the Public Service Board stated that the city obtains its water supply from wells and that any flood control improvement which would decrease recharge of the aquifers would be a hardship on the city. He requested consideration of this condition in the design of future works. An engineer representing the City-County Health Service requested that future improvements be designed for proper control of mosquito breeding areas.

6. ARRANGEMENT OF REPORT.- The following sections of this report summarize the results of the studies conducted for selection of the plan of improvement presented herein, and the conclusions and recommendations of the Albuquerque District Engineer, based upon analysis of detailed technical data and related office studies further reported upon in the following:

Appendix A: Project Planning

Appendix B: Hydrology

Appendix C: Economic Base Study

Appendix D: Supplemental Economic Data

Appendix E: Coordination with Other Agencies

Information called for by Senate Resolution 148, 85th Congress.

DESCRIPTION OF WATERSHEDS

7. PHYSICAL CHARACTERISTICS.- El Paso is located in the westernmost tip of the State of Texas on the left bank of the Rio Grande. The Rio Grande, one of the principal streams in southwestern United States, is an interstate and international river of importance. From its source on the eastern slope of the Rocky Mountains in south-central Colorado, the Rio Grande flows eastward for about 150 miles to near Alamosa, and thence southward across the Colorado-New Mexico State line. Continuing southward the river nearly bisects New Mexico from north to south, and forms a portion of the New Mexico-Texas State boundary in the vicinity of El Paso. The river then bends eastward around the southern end of the Franklin Mountains and continues southeastward to the Gulf of Mexico, forming the international boundary between the United States and Mexico. The Rio Grande is almost 1,890 miles in length and drains an area of 335,500 square miles. El Paso is located at river mile 1,244.

8. The city of El Paso and suburban developments surround the southern tip of the Franklin Mountains, which form the terminus of the chain that extends southward from the Rocky Mountains in north-central New Mexico. The Franklin Mountains are about 20 miles in length, have a maximum width of about 8 miles, and rise to an elevation of 7,167 feet at the highest point. Structurally, the mountains are a great fault block which dips westward. The exposed rocks range in geologic age from Pre-Cambrian to Recent with nearly every geologic system represented. Most of the exposures, which are cut by Cretaceous dikes, sills, and faults, are older quartzites, porphyries, sandstones, shales, and granite with limestones discernibly predominating. The surface of the exposed formations has very little soil and supports no more than a meager growth of desert-type vegetation. The sloping outwash plains east and west of the mountains are made up of Quaternary surficial material derived from the highlands, with the size decreasing from boulders to fine sand as the travel distance increases. The depth of the surficial material varies from shallow at the foot of the mountains to infinite as the plains level off. There are stratified and unstratified zones and in places the material is cemented and semicemented by caliche.

9. The area investigated for this report comprises the watersheds of the arroyos and intermittent tributaries of the Rio Grande which rise on the slopes of the Franklin Mountains and the high mesas in the vicinity of El Paso and flow through the city toward the river. The more important named tributaries are McKelligon and Fusselman Canyons, but there are numerous unnamed arroyos, as shown on plate 1 following this report. The area studied in detail lies on the left bank of the Rio Grande and has a drainage area of about 128 square miles, of which a large percentage falls within the city limits of El Paso. Part of the Fort Bliss Military Reservation is located within the area and Biggs Air Force Base is adjacent on the east boundary. The terrain of

the area is such that it conforms naturally into four major subdivisions which have been designated as the Northwest, Central, Downtown, and Southeast Areas. These areas were analyzed separately to determine the extent of individual flood and other water resource problems and the interrelationship of possible solutions thereto.

10. STREAM CHARACTERISTICS.- All of the streams and arroyos under investigation are ephemeral. These waterways head on the western, southern, and eastern slopes of the Franklin Mountains and flow through the city and its suburbs toward the Rio Grande. However, in most cases the drainage courses, after leaving the mountains, become poorly defined through the developed areas and damage is caused by stream and sheet flow and by ponding in the low areas because of inadequate outlets to the Rio Grande. Streams in the sparsely vegetated steep mountain slopes and adjoining foothills flow at high velocities and carry large quantities of fine sediments and debris which, when deposited in the less steep improved areas, cause extensive damages.

11. In June 1958 the U.S. Geological Survey, at the request of the Corps of Engineers, established three stream gaging stations (water-stage recorders) on normally dry arroyos in the area under consideration. One gage, located on a major inlet to the existing Fort Bliss sump, was discontinued in 1961 because of a changed drainage pattern. Two gaging stations are in operation, one at the mouth of McKelligon Canyon and the other on Government Hill Ditch at the intersection of Montana and Houston Streets.

12. Because of the lack of adequate streamflow records for the arroyos in the area, it was not possible to determine discharges from actual flows. Peak flow determinations for some of the most recent floods have been made by indirect methods. Flows for the September 1941 and the September 1958 floods in the Northeast Area were determined by the use of synthetic unit hydrographs and rainfall excess determinations. The results of these studies are shown on plates 2 and 3, appendix B.

13. CLIMATOLOGY.- Two U.S. Weather Bureau stations are located in the El Paso area, one at the International Airport and the other at Ysleta, Tex. The Airport station has long-term records which were begun by the U.S. Army at Fort Bliss in 1850. In 1877 the Fort Bliss station was combined with the El Paso municipal station which has continuous records to date. The El Paso station records precipitation, temperature, and wind. The station at Ysleta was established by the U.S. Weather Bureau in 1939 and records precipitation, temperature, wind, and evaporation.

14. The climate in the vicinity of El Paso is semiarid continental, characterized by moderately hot summers, mild winters, and short temperate spring and fall seasons. The average frost-free period is 207 days, usually beginning early in April and lasting through October.

The average annual temperature at El Paso is 63.3° and the recorded temperature extremes are 109° and -6°. The average wind velocity is 10.7 miles per hour. The prevailing wind direction is from the south during the summer months and from the north during the winter. The fastest wind mile recorded was 70 miles per hour from the northwest in 1950. The average annual rate of class "A" pan evaporation is about 99 inches.

15. Precipitation during the summer months is usually in the form of thundershowers of short duration, resulting from convective or orographic lifting or a combination of both. The more intense of these storms follow a period of inflow of warm moist air from the Gulf of Mexico. Occasionally, precipitation occurs as a result of an invasion of tropical Pacific air. Frontal activity is prevalent in this area during the winter and early spring months and if moist air is present, rain or snow of light-to-moderate intensity results. The average annual precipitation at El Paso is about 7.83 inches. The maximum recorded at the Weather Bureau station during a 24-hour period was 2.89 inches in September 1941. About 59 percent of the annual precipitation occurs during the 4-month period of July through October, with the greatest amounts falling during July and August when small-area thundershowers are prevalent.

16. The average annual snowfall at El Paso is 4.6 inches. The snow melts very rapidly at the lower elevations and seldom remains on the ground for more than one or two days. The maximum snowfall recorded at the El Paso Weather Bureau station during a 24-hour period was 7.8 inches in November 1961.

17. El Paso is located in the transitional zone between the Gulf and Pacific rainfall provinces, with accompanying complex meteorological conditions further complicated by the presence of mountainous areas. No major flood-producing storms have occurred during the winter months, primarily because the semipermanent high-pressure area over the Great Basin in Utah inhibits the inflow of moist Pacific air. During the summer months intermittent flows of warm moist unstable air from the Gulf of Mexico, both at the surface and aloft, penetrate the area and, under certain concurrent upper air circulation patterns, produce severe thunderstorms. Recent storms for which relatively firm data are available are discussed under FLOOD HISTORY.

EXISTING WATER RESOURCES DEVELOPMENT

18. IMPROVEMENTS BY THE CORPS OF ENGINEERS.- There are no flood control improvements constructed by the Corps of Engineers on the Rio Grande or on the tributary arroyos at and in the vicinity of El Paso except for the drainage facilities constructed on the Fort Bliss Military Reservation.

19. RIO GRANDE CANALIZATION AND RECTIFICATION PROJECTS.- The Rio Grande Canalization Project, authorized in 1936, consists of improvement of the main stem of the Rio Grande from Caballo Dam, N. Mex., downstream for a distance of 105 river miles to the American Dam near El Paso, where the Rio Grande becomes the international boundary. Construction of the project was supervised by the U.S. Section of the International Boundary and Water Commission. A low-flow or pilot channel was excavated where cut-offs were made; elsewhere the old channel was used. Bank protection and control works consisting of piling and woven-wire fence revetments were provided. Jetties were installed to promote stability of the low-flow channel. Levees averaging about 6 feet in height above natural ground with 14-foot crowns were constructed to 1 on 3 slopes on the stream side and 1 on 2½ slopes on the landward side to provide a floodway. According to the International Boundary and Water Commission, the floodway capacity in the vicinity of El Paso is 12,000 c.f.s. above the American Dam and 11,000 c.f.s. below that point. Downstream from El Paso, the Rio Grande Rectification Project, constructed and maintained jointly by the United States and Mexico through their respective sections of the International Boundary and Water Commission, provides 85.6 miles of rectified channel and a floodway bounded by parallel levees extending to Quitman Canyon.

20. CITY OF EL PASO FLOOD CONTROL IMPROVEMENTS.-

a. Downtown.- Construction of a storm sewer system for downtown El Paso was initiated by the city in the 1920's. These works consist of pumping plants and storm sewers to collect and discharge storm runoff into the Rio Grande. During the years 1932-33 the Civilian Conservation Corps built a series of small check dams along the southeastern slope of the Franklin Mountains as far north as McKelligon Canyon to further improve flood control in the downtown area. In 1949-50 an extensive storm drainage system with outlets to the river was constructed in the downtown and older sections of the city at a cost of about \$3 million. In addition, a series of small detention dams was built around the point of the Franklin Mountains to supplement those of the Civilian Conservation Corps. Many of the latter were repaired and raised as a part of the program. These works provided a fair degree of flood protection to the principal sections of the city at that time. From 1950 to 1960, however, there was a rapid expansion of the city with extensive subdivision development for which only minor flood control and drainage improvements were provided. Following the floods of the late 1950's a bond issue was passed in the amount of \$2,481,000 for additional flood control and drainage works. A master plan for flood control was developed by the city to assure that any works constructed would form sound and effective units of an overall plan designated, insofar as possible, to meet future as well as present needs. The existing flood control works at El Paso and vicinity are shown on plate 2. The master plan is shown on plate 3.

b. Northwest Area.- The existing flood control facilities in the Northwest Area consist of ABC (Mulberry) and D (Thorn Drive) Dams, and the City Ditch. Montoya Drain, although not designed for floodwater conveyance, is used for floodwater storage and conveyance to the Rio Grande. ABC Dam has a contributing drainage area of 4.3 square miles and a capacity of 530 acre-feet. D Dam has a contributing area of 2.9 square miles and a capacity of 398 acre-feet. The City Ditch which parallels the AT&SF tracks was constructed to intercept arroyo flows and convey them to wasteland.

c. Central Area.- Existing flood control facilities in the Central Area include 8 dams, 3 drains, the Fort Bliss sump, and the Durazno Detention Reservoir. Fusselman Dam, which is under construction, will control 3.4 square miles of drainage area and has a capacity of 595 acre-feet. The outfall and pickup channel for this dam will control 2.6 square miles of drainage area and convey floodwaters to a natural sump northeast of the city. Keltner Dam, formed when Alabama Street was extended and raised, controls 0.5 square mile of drainage area and has a capacity of 47 acre-feet. In McKelligon Canyon, the WPA built 4 dams which have a total drainage area of 2.4 square miles and a total capacity of 95 acre-feet. Van Buren Dam has a contributing drainage area of 1.2 square miles and a capacity of 90 acre-feet. Pershing Dam, downstream from McKelligon Canyon, is formed by the earth-fill for Pershing Drive. The dam controls a drainage area of 1.9 square miles and has a capacity of 12 acre-feet. Tobin Ditch has a capacity varying from 176 to 540 c.f.s. Diana Drain has a capacity of approximately 600 c.f.s. Government Hill Ditch runs southward from Pershing Dam to the vicinity of Durazno Street and discharges into Durazno Detention Reservoir. The capacity of the ditch varies from approximately 280 to 660 c.f.s. Fort Bliss sump, located on the military reservation, has a storage capacity of 2,780 acre-feet. The Durazno Detention Reservoir has a contributing drainage area of 2.0 square miles and a capacity of 180 acre-feet.

d. Southeast Area.- The flood control facilities in the Southeast Area consist principally of Giles Dam, recently completed by the city, and the Pasotex Dam planned for future construction. Mesa Drain, an agricultural facility, carries off some of the floodflows. Giles Dam controls 0.7 square mile of watershed above Interstate Highway 10 and has a capacity of 93 acre-feet. Pasotex Dam will have a capacity in excess of 100 acre-feet.

21. IRRIGATION.- The Elephant Butte Dam located on the Rio Grande in New Mexico about 135 miles upstream of El Paso was completed by the Bureau of Reclamation in 1916. This dam impounds water for irrigation of about 155,000 acres of land in the Rio Grande Project and supplies

60,000 acre-feet of water annually to Mexico under the treaty of 1906. The Rio Grande Project comprises two irrigation districts; the Elephant Butte Irrigation District located in New Mexico and the El Paso County Water Improvement District No. 1 located in El Paso County. The project works consist of five diversion dams, about 600 miles of canals and laterals, and about 450 miles of deep drainage ditches. In 1938 the Bureau of Reclamation completed Caballo Dam about 27 miles downstream from Elephant Butte Dam. The purpose of this project is to re-regulate releases from Elephant Butte to meet the needs of irrigation and to permit the production of power without conflicting with the irrigation function.

22. MUNICIPAL AND INDUSTRIAL WATER SUPPLY.- In the early days of El Paso, water was obtained from shallow wells located downtown close to the Rio Grande. The supply was sufficient but complaints regarding the hardness and other undesirable qualities motivated the development of a new source of supply from deep wells drilled on the mesa north of Fort Bliss. In 1918 the use of water from the Rio Grande was discontinued and the ground water supply was augmented by drilling wells in what is now known as the Montana well field which yielded water of good quality. More recently the city has confined its well drilling program to the area north of the Mesa well field. Geologically, the well fields are located in the Hueco Bolson which extends from the mountains south of Juarez to a few miles north of the New Mexico-Texas State line. Since 1956 El Paso also has derived ground water supplies from the Mesilla Valley well fields located west of the Franklin Mountains in the Lower Mesilla Valley basin.

23. Since the fresh water supply in the ground water storage basins is limited in amount, the city has contracted with the U.S. Government and the El Paso County Improvement District No. 1 to obtain water from the Rio Grande by purchase and retirement of water right lands, which entitles the city to a maximum of 7,000 acre-feet of water per year. A second contract permits the diversion and use of storm water flows, return flows, and operating waste waters in the Rio Grande in excess of the requirements of the District and the Hudspeth County Conservation and Reclamation District No. 1. The city is entitled to 27,000 acre-feet annually from this source, if available; 11,000 acre-feet by direct diversion, and 16,000 acre-feet by pumping to storage for later use. The city has tentative plans for construction of a 3,000 acre-foot reservoir and a water treatment plant to be located near the southeast city limits at the Riverside Heading.

24. HYDROELECTRIC POWER.- A hydroelectric power station with a capacity of 24,300 kilowatts was installed on the Rio Grande at Elephant Butte Dam in New Mexico by the Bureau of Reclamation in 1940. Transmission lines were constructed to Las Cruces, N. Mex., to connect with privately owned lines extending south to El Paso and beyond, and west to Deming and Central, N. Mex. Power generation is controlled by the Rio Grande Compact which contemplates a normal release from project storage of

790,000 acre-feet annually. Restorage of releases in Caballo Reservoir, about 27 miles below Elephant Butte, enables more firm power to be produced than would be possible if power operation were confined only to those periods when water is released for irrigation. This hydro-electric power generating facility, located about 135 miles upstream, is the only such development in the vicinity.

25. RECREATION AND FISH AND WILDLIFE CONSERVATION.- The closest water-associated recreation areas of any consequence are located at Elephant Butte and Caballo Reservoirs which offer excellent boating, fishing, water skiing, and hunting opportunities.

ECONOMIC DEVELOPMENT

26. HISTORICAL BACKGROUND. Historical records of El Paso date back to about 1536 when the Spanish explorer Cabeza de Vaca wandered through the strategic mountain pass just west of the present location of the city. This pass became a gateway for the Spanish conquistadores and religious padres traveling between Mexico and the Rio Grande valley settlements in New Mexico. In 1662 the town of El Paso del Norte (now Ciudad Juarez, Chihuahua, Mexico) was settled across the Rio Grande from present-day El Paso. During the Pueblo Revolt of 1680 in New Mexico, the Indians drove the Spaniards southward and some of the refugees later founded the town of Ysleta, the first settlement in what is now the State of Texas. Today Ysleta is incorporated into the city of El Paso which was founded about 1830 and incorporated in 1875. The earliest reported census was taken in 1880 and showed a population of 736. The population has grown steadily each decade since 1880, except for the period 1930-40. During the decade 1950-60 the population of El Paso grew from 130,485 to 276,687, an increase of 112.0 percent, which placed it first in rate of gain among the larger cities of Texas.

27. ECONOMIC TRENDS.- For many years El Paso has experienced a sound growing economy stabilized by widely diversified industry. The city's economy is often expressed as being based on seven "C's": Cement, Cotton, Copper, Cattle, Clothes, Culture, and Climate. Among the more important industries are primary smelting and refining of ores, petroleum refining, manufacture of wearing apparel and building materials, and foodstuff production. The principal industrial establishments include a copper and lead smelter, a copper refinery, two oil refineries, a brewery, a cement plant, a lime plant, and a brick plant. Any sizable increase in manufacturing has an important influence on all other economic activities because of the greater job opportunities and personal income resulting therefrom. The number of persons employed in manufacturing increased from 5,282 in 1950 to 13,629 in 1960, an increase of 158.03 percent which placed El Paso first in rate of gain among Texas cities⁽¹⁾. The value added by manufacturing in 1961, as reported by

(1) Texas Business Review, June 1963.

the U.S. Department of Commerce in the 1961 Annual Survey of Manufacturing, was \$96.74 million. The economy is enhanced further by other basic activities such as tourism, government installation expenditures, wholesaling, and financing which draw income from outside the confines of the local area.

28. DEFENSE INSTALLATIONS.- The major contributors to the basic economy in and around El Paso are the military defense installations. Each year more than \$300 million from payrolls, construction and maintenance, and the purchase of thousands of items enters local commerce from the Fort Bliss Military Reservation, William Beaumont General Hospital, and Biggs Air Force Base, all located in and adjacent to El Paso, and from White Sands Missile Range and Holloman Air Development Center, located to the north in New Mexico.

29. BUSINESS ACTIVITIES.- El Paso is a wholesale distribution center for farm and ranch equipment, mining machinery and equipment, hardware, industrial supplies, and food. The city is a banking and financial center for a large area stretching north and south of the border. Retail sales, based on 1947-49 price levels, have increased steadily and now exceed \$260 million annually. On the same price basis, building permits for construction have averaged about \$50 million annually since 1958. The assessed tax valuation almost doubled in the 1950-60 decade and currently is about \$300 million.

30. AGRICULTURE.- Agriculture constitutes an important segment of the economy of the city of El Paso. Crops are raised on nearly 60,000 acres of irrigated Rio Grande valley land in El Paso County. Cotton and alfalfa are the principal crops. Other crops grown include barley, onions, lettuce, Irish potatoes, and other truck-type varieties. The uplands are occupied by large cattle and sheep ranches which move their cattle to the Rio Grande valley for winter pasturing and fattening. The value of cattle and other farm livestock sold in El Paso County in 1959 amounted to \$21.9 million and the value of all crops sold was \$11.2 million.

31. MUNICIPAL GOVERNMENT, UTILITIES, AND TRANSPORTATION.- El Paso is governed by a city council composed of a mayor and four aldermen. The municipally owned water system is capable of producing about 110 million gallons of water per day. The average daily consumption of water during 1960 was 60 million gallons. Since 1956 the city of El Paso has had primary and secondary treatment of sewage. Natural gas is supplied by two privately owned distribution companies, Southern Union Gas Company and Lea County Gas Company, which obtain their gas from the El Paso Natural Gas Company. The El Paso Electric Company, a privately owned utility, supplies electric power to the city from two power plants. Telephone Service is provided by The Mountain States Telephone and Telegraph Company. The municipally owned El Paso International Airport is located adjacent to the northeast city limits. A network of 5 railroad lines, 5 airlines, 11 bus lines, and 22 truck lines adequately serve the needs of the community.

32. TRENDS OF GROWTH AND DEVELOPMENT.- Economic indicators which might be used ordinarily in estimating future growth in the metropolitan area of El Paso include population, new construction, value added by manufacture, retail sales, wholesale sales, bank deposits, personal income, labor force, and employment. El Paso experienced a relatively slow growth for many years prior to 1945 but has expanded tremendously since that time. For this reason, projections of any of the factors listed above based on the past 15 years would be questionably high and if a much longer period of time, such as 50 years, were used, the projections would be unreasonably low. The best measure of probable future growth in the flood plains, particularly as applied to the increase in damageable property, can be obtained by comparison of the projections of national, state, and local population and personal income for the next 100 years.

33. The population of El Paso was projected at a rate of increase approximately midway between the rates for Texas and the United States. The 1960 population of 276,687 projected to the year 2020 is 1,030,000, and to 2060 is 1,330,000. This is a 100-year increase of 381 percent, or a rate of 1.6 percent per year compounded annually.

34. Per capita disposable income for El Paso in 1959 was about 80 percent of the national average. Historical statistics for the State of Texas show that, although Texas per capita income has never equalled the national figure, the percentage gap between the two has steadily narrowed from a differential of 32 percent in the 1930's to 16 percent in the 1940's, and to only 10 percent in the 1950's. It seems reasonable to assume that the Texas per capita income, and also that of El Paso, will eventually equal the national average. Thus, the El Paso per capita disposable personal income was projected from its 1960 standing of \$1,588 to an amount equal to the national average by the end of the next 100 years. The 100-year increase is 630 percent, equal to a rate of 2.0 percent per year compounded annually and an increase factor of 7.30.

FLOOD PROBLEMS

35. GENERAL.- As mentioned under PURPOSE AND EXTENT OF THE INVESTIGATION, the main stem of the Rio Grande is under the jurisdiction of the International Boundary and Water Commission; therefore, studies for this report have been limited to the problems caused by arroyo flooding at El Paso and vicinity. Runoff from the southern slope of the Franklin Mountains has always been a problem in the downtown business and older residential districts situated around the foot of the mountains. This problem led to city construction of storm sewer and drainage improvements which provide a reasonably good degree of protection. There is one major arroyo passing through the downtown area which, if subjected to the standard project storm described hereinafter, would produce a peak discharge of 2,350 c.f.s. The water

would flow through Arroyo Park, an area designed for this purpose, and discharge into storm sewers and streets that have sufficient capacity to convey it to the Rio Grande. Improvements to increase the degree of flood protection in the downtown business district would consist principally of new storm sewers which are a responsibility of local interests.

36. During the past decade, El Paso has expanded to the northwest, northeast, and southeast because the rugged Franklin Mountains, the Rio Grande, and Mexico prevent growth to the north, west, and southwest. To facilitate the economic and engineering studies required to formulate a plan for flood protection, El Paso and environs were subdivided into the Northwest, Central, and Southeast Areas, as shown on plate 1. These areas are separated by topographic features and therefore can be studied independently.

37. NORTHWEST AREA.- The Northwest Area is roughly rectangular in shape, bounded by the Rio Grande on the west and the crest of the Franklin Mountains on the east. The area comprises about 30 square miles extending from Borderland on the north almost to the American Dam on the south. About one-fourth of the area is valley land which is predominantly agricultural at the present time. Suburban type subdivisions occupy portions of the foothill lands. The rate of residential expansion into the Northwest Area has been rather slow; however, with the continued growth of El Paso, urbanization is expected to increase rapidly. The flood problem is caused by overflow from the arroyos which drain the western slopes of the Franklin Mountains. Floodwaters collect in the area between U.S. Highway 80 and the Rio Grande where there are no adequate outlets to the river. Damages are caused by flowing water and by ponded water in the low areas. ABC and D Dams, recently constructed by the city, would partially control the standard project flood. The existing Montoya Drain and City Ditch do not provide protection against floods of large magnitude.

38. CENTRAL AREA.- The Central Area comprises about 35 square miles located adjacent to the Northwest Area on the east and extending south to include Fort Bliss and part of the older business and residential section of the city. All of the Central Area except the steep southern and southeastern slopes of the Franklin Mountains is intensively developed for business, industrial, and residential purposes. Growth in this area has been rapid because of the expansion of Fort Bliss. There has been extensive subdivision development to the northeast on the broad alluvial fans at the foot of the Franklin Mountains and in the sumps of closed basins where ponding occurs. Runoff from the Franklin Mountains flows east and southeast through numerous arroyos and McKelligon Canyon to enter the developed portion of the city. In the Fort Bliss area, the storm runoff flows along streets, in drains such as Tobin Park and Diana, and in natural watercourses, to collect in and around Fort Bliss sump. The flowing water damages streets, residences, and other urban properties. When the volume of

ponded water exceeds the capacity of the Fort Bliss sump, the water spills to the south and damages military installations. The Fusselman Dam, in conjunction with the outfall channel and Northeast Ponding Area, would protect the northeast portion from the standard project flood originating above that facility. The dam would not contain the volume of the standard project flood but spillway discharges would be conveyed to the Northeast Ponding Area by the outfall channel. Keltner Dam would have little effect on the standard project flood due to its limited capacity and inability to reduce the flood peak. The four dams built by the WPA in McKelligon Canyon are limited in capacity and their spillways have operated many times since construction. The small storage capacity of Pershing Dam limits its effectiveness in the regulation of floodflows. Tobin Drain would not control hillside runoff of standard project flood magnitude. Diana Drain is adequate for storm sewer design but not for controlling large floods from hillside runoff. The Fort Bliss sump would not control the standard project flood. Government Hill Ditch now discharges into Durazno Dam. This dam would not control the standard project flood.

39. SOUTHEAST AREA.- The Southeast Area consists of an elongated tract of about 38 square miles located in the Rio Grande valley adjacent to the southeast boundary of the Central Area. The area extends southeast to the vicinity of Ysleta and north to the rim of the mesa. Most of the development is urban, with the newer subdivisions located on the mesa slopes and the older buildings and residential housing located on the valley floor. Storm runoff from the mesa flows through LaFayette, Jesuit, and Pendell Draws and other arroyos into developed urban areas including Hacienda Heights and Loma Terrace. Embankments of the Southern Pacific Railroad, local irrigation ditches, and the Franklin Canal cause ponding south of Hacienda Heights, in the vicinity of Loma Terrace, and along Zaragosa Road. The Giles Dam would not modify the standard project flood peak substantially and water flowing through the uncontrolled outlet would have no passage way to the Rio Grande. The capacity of Pasotex Dam, as planned, would not be sufficient to control the standard project flood.

40. STANDARD PROJECT FLOODS.- In order to establish criteria for analyzing the flood possibilities at El Paso and the degree of protection to be afforded, an estimate was made of the flood which might be expected to occur in each of the areas as the result of runoff from a "standard project storm." This storm, for a particular drainage area and season of year in which snowmelt is not a major consideration, represents the most severe flood-producing rainfall that is considered reasonably characteristic of the region in which the drainage basin is located.

41. An analysis of rainfall records for El Paso and nearby stations indicated that the most intense rainfall conditions occur during thunderstorm activity. A study of all small-area, high-intensity storms which could be transposed to the El Paso area indicated that the storm

which occurred at Las Cruces, N. Mex., on August 29-30, 1935, would be the most representative for determination of the standard project floods. The storm occurred 40 miles north of El Paso in an area with similar physical characteristics and at similar altitudes. The higher elevations at El Paso are characterized by steeper slopes than those at Las Cruces but computations indicate that the additional orographic effects would compensate for the difference in elevation; therefore, the storm was transposed without adjustment and centered critically over each of the three areas. The flood discharges which would result from these storms were then computed to determine the location and extent of the areas which would be inundated. The standard project flood plains are shown on plate 1.

42. EXTENT AND CHARACTER OF FLOODED AREAS.- The standard project flood plains comprise those areas subject to inundation by flowing water and by ponded floodwater. Economic field appraisals were made of the flood plains to determine the extent of development and the values of property subject to damage in the Northwest, Central, and Southeast Areas of El Paso, as discussed in the following paragraphs.

a. Northwest Area.- A large portion of the development in the Northwest Area is situated on the flat, fertile lands of the Lower Mesilla valley. The topographic features lend themselves readily to residential development. The standard project flood plain comprises about 1,950 acres of which 1,210 acres are subject to damage from ponded water and 740 acres are subject to damage from flowing water. The flood plain, presently suburban-agricultural in character, is about 5.3 miles in length, averages about one-half mile in width, and has a maximum width of 1.3 miles at the lower end. About 720 acres are being used to grow irrigated cotton and a few acres are devoted to the raising of corn, alfalfa, and maize. Development within the flood plain includes residential, commercial, and public improvements consisting of 630 residential units, 25 business establishments, 2 churches, an electric power plant, horse racetrack facilities, utilities, farm buildings, and irrigation improvements. Also included are 2.6 miles of railroad track, 2.1 miles of U.S. Highway 80-85, and city and county streets and roads. The value of land and improvements in the standard project flood plain is estimated at more than \$55 million, based on January 1964 price levels, as tabulated in table 1. Based on the projected increase in population for the city of El Paso, it is estimated that about 70 percent of the area will be in urban development by 1980 and that the area will be completely urban by the year 2060. The flood damage potential will increase accordingly.

b. Central Area.- The flood plain of the standard project flood in the Central Area is very irregular in shape. It is about 9 miles long from north to south and varies in width from a few hundred feet to a maximum of about 2 miles at the southern end. The flood plain covers about 5,100 acres, of which 3,180 acres are subject to damage primarily from ponded floodwaters and 1,920 acres from flowing

water, including a ponding area of 1,480 acres and 160 acres subject to damage from flowing water on the Fort Bliss Military Reservation. There are approximately 160 buildings in the military area, together with utilities, roads, and streets. The nonmilitary part of the Central Area is substantially urban in development except for the 352-acre Ascarate Park in the southeast, some undeveloped tracts in the north, and a few scattered city blocks. There are about 7,000 residences, 190 mobile homes, 500 business establishments, 12 schools, 15 churches, a major shopping center, public buildings, and utility lines and plants including the city water works Mesa Station which furnishes about 16 percent of the city water supply. Residential housing in the northern and southern portion of the flood plain is mostly of the moderate value subdivision type constructed during the last decade. Much of the residential property situated in the middle portion is comparatively old and closely spaced. Transportation facilities in the flood plain include U.S. Highways 54, 80, and 62-180, one-half mile of the future Interstate Highway 10, two lines of the Southern Pacific Railroad, and many miles of city streets. The total value of land and improvements in the flood plain of the standard project flood is estimated to be about \$163 million, based on January 1964 price levels, as tabulated in table 1.

c. Southeast Area.- The flood plain of the standard project flood in the southeast section of the city totals 1,840 acres of which 830 acres are subject to damage from ponding floodwaters and 1,010 acres from flowing water. The flood plain is long and narrow in shape, about 7.4 miles long, with a maximum width of about 0.8 mile. Improvements in the area include 2,140 residential units, 130 business establishments, 2 schools, 7 churches, a fire station, public buildings, farm buildings, irrigation facilities, and utilities. Transportation facilities include city and county streets and roads and a one-mile section of the Southern Pacific Railroad 28-track siding. Although the area is substantially urban, there are 600 acres of irrigated agricultural land devoted to the raising of cotton. Most of the residential housing is of low value and relatively old; however, in recent years there has been subdivision construction in the area including some high-value homes. Generally, all of the land is suitable for residential and business development and, based on the projected population growth for the El Paso metropolitan area, it is estimated that the southeast section will be completely urban by the year 2060. The total value of land and improvements in the standard project flood plain for this area is estimated at \$39 million, based on January 1964 price levels, as itemized in table 1.

TABLE 1. — Value of Land and Improvements in the El Paso Standard Project Flood Plains (January 1964 Conditions and Prices)

Item	Value of Land and Improvements in \$1,000			
	Northwest Area	Central Area	Southeast Area	Total
<u>Urban and suburban:</u>				
Residential	\$10,175	\$68,675	\$23,130	\$101,980
Business	2,471	21,044	3,615	27,130
Schools and churches	450	8,097	2,573	11,120
Utility lines and plants	38,048	15,157	4,200	57,405
Public property	13	5,660	400	6,073
Land	<u>2,088</u>	<u>16,459</u>	<u>2,220</u>	<u>20,767</u>
Subtotal	53,245	135,092	36,138	224,475
<u>Agricultural property:</u>				
Improvements	80	0	55	135
Land	<u>1,460</u>	<u>0</u>	<u>1,095</u>	<u>2,555</u>
Subtotal	1,540	0	1,150	2,690
<u>Streets and highways</u>	455	2,423	948	3,826
<u>Railroads</u>	260	566	1,135	1,961
<u>Military property</u>	<u>0</u>	<u>25,369</u>	<u>0</u>	<u>25,369</u>
Total Value	\$55,500	\$163,450	\$39,371	\$258,321

43. FLOOD HISTORY.— The city of El Paso and its outlying suburban developments are subject to flooding from the numerous normally dry arroyos which head on the eastern, southern, and western slopes of the Franklin Mountains. Floodwaters flow through the developed areas and pond in natural depressions which have no outlets to the Rio Grande. A large percentage of the area investigated was sparsely settled prior to World War II; however, since that time the city has grown rapidly and expanded in several directions into areas subject to flooding.

44. Severe rainstorms are reported to have occurred in July 1863 and 1881 with 8.0 inches and 6.5 inches of rain, respectively. Since little damage was done, only fragmentary records are available. Records indicate that major flooding occurred at El Paso during the storm of September 21, 1941, when rainfall of 2.99 inches was recorded. Subsequent floods of damaging proportions occurred in 1950, 1955, 1957, 1958, 1962, and 1963. Available information on experienced floods is given in the following paragraphs.

a. Flood of July 11, 1950.- Newspaper accounts of the storm stated that rain occurred over the Franklin Mountains in amounts of more than 3 inches on July 11. Although the Weather Bureau reported only a trace of rainfall at the International Airport, the Bureau also stated that:

All retainer dams in the McKelligon Canyon area overflowed and floodwaters rushed down most of the streets leading from the mountains. Tons of gravel and boulders were washed into Cobia, Elm, and Dyer Streets. At the underpass at Cobia Street, traffic was blocked by gravel and rocks piled 2 to 3 feet high. In the Beaumont Addition, homes were flooded and walls demolished.

This statement indicates that the damages occurred in the Central Area of El Paso and that the storm was centered over the eastern slope of the Franklin Mountains with little or no rain outside the city.

b. Flood of July 20-21, 1955.- Heavy rains over El Paso and vicinity during two periods on July 20 caused major flooding in the city. The first period lasted about two hours in the early morning, with rainfall averaging about 1.50 inches over the Franklin Mountains. The second period occurred in the evening, and an analysis of available data indicates that the average rainfall was about 4.0 inches over the mountains and 2.2 inches over the city. The Weather Bureau station at the International Airport recorded 1.71 inches of precipitation. The Fort Bliss sump stored about 730 acre-feet of floodwater. Runoff from the many arroyos heading in the mountains produced a peak discharge of 4,800 c.f.s. in the Rio Grande at the El Paso gaging station, according to records of the International Boundary and Water Commission. Minor damage was caused by ponding at Fort Bliss. Roads, streets, utility lines, and residential property in the Mountain View and Durazno areas suffered considerable flood damage.

c. Flood of September 10-11, 1958.- During the evening of September 10 and early morning of September 11, there were heavy thunderstorms over the Northwest Area of El Paso with precipitation varying from 1.7 inches downtown to 5.5 inches in the Coronado Hills on the western slope of the Franklin Mountains. The rainfall occurred during a 12-hour period with very high intensity in the early morning hours. Floodwaters ponded in the low areas and flooded houses to depths of 3 to 4 feet. It is estimated that there were about 1,330 acres in the flood plain. A peak flow of 4,700 c.f.s. occurred at the American Dam on the Rio Grande at 10 a.m. on September 11. Heavy thunderstorms in Rincon Valley about 80 miles upstream caused a peak flow of about 12,000 c.f.s. in the Rio Grande at the International Bridge on September 14. This is the maximum flow in Rio Grande at El Paso since 1925. The capacity of the levee system was taxed to the extent that sandbags were required in some locations to prevent overtopping; however,

overflow did occur in the vicinity of the El Paso Electric Company located adjacent to the river west of the Buena Vista subdivision.

d. Flood of September 2-5, 1962.- During the late evening of September 1 and early morning of September 2, heavy thundershowers produced rainfall over the Central Area of El Paso, which varied from 1.37 inches at the International Airport to 4.81 inches in the vicinity of the northeast city limits, with most of the rain falling in a 2-hour period and the total amount in 6 hours. A second storm occurred the evening of September 4 and continued until about 3 p.m. on September 5. This storm produced 1.76 inches of rainfall at International Airport, 3.0 inches at the northeast city limits, and about 2.0 inches over the south section of the area. The combination of the two storms resulted in ponding of approximately 1,400 acre-feet in the Fort Bliss sump. Water ponded about 3.5 feet deep in the Durazno district of the lower Central Area and flooded 73 residences and 14 business establishments. Altogether about 1,100 acres were inundated. The existing flood control improvements alleviated the condition but their capacities were insufficient to control the flood. Drains were overtopped and water flowed over the spillways of flood control detention structures.

e. Flood of August 18, 1963.- This flood was confined to a small portion of the Southeast Area and caused relatively minor property damage. However, one person drowned in Jesuit Draw. Floodwaters from Jesuit Draw overflowed the residential area of the valley and minor agricultural damage resulted from runoff originating in Pendell Draw. These arroyos head in the sandhills east of Interstate Highway 10. Residents of the flooded areas indicated that most of the flow passed in 30 minutes. Although there were no rainfall measurements, it is indicated by the volume of runoff that three or four inches of rain fell in 30 to 45 minutes. Jesuit Draw had an estimated peak discharge of 2,000 c.f.s. and Pendell Draw, 1,200 c.f.s. The flooded area consisted of about 35 acres including 65 homes, city streets, a park, and a cotton field. Water reached a maximum height of about 3 feet in some of the streets.

FLOOD DAMAGES

45. NATURE OF DAMAGES.- Flood damages at and in the vicinity of El Paso are caused by runoff of the surface waters and ponding in low areas. The topography is such that water flowing over the steep mountain slopes attains high velocities causing damage from erosion and transporting vast quantities of boulders, rocks, sand, and other debris. Natural and man-made barriers to the flowing water force the floodwater to pond over valuable urban property and agricultural croplands. This pattern of flood damage is characteristic of the three areas studied, with the exception of the Central Area which has no agricultural property. The areal extent and number of flood damage areas at El Paso have increased with each successive flood. The

average annual primary flood damages were estimated for each area by analyses of data obtained by field reconnaissance and flood damage surveys in October 1954, July 1955, September 1958, September 1962, and August 1963.

46. Flood damages include both tangible and intangible damages. Tangible damages are those subject to monetary evaluation and include physical damage to property and improvements, crop losses, emergency costs of flood fighting, and business and financial losses in and adjacent to the flood areas. Intangible damages are not susceptible to monetary evaluation and include danger to human life, added inconvenience and human discomfort, injury and exposure during floods, creation of conditions detrimental to health and security, and interruption of traffic, utility services, and normal community activities.

47. Physical damages include the cost of cleanup, damage to buildings, structures, and contents, damage to other improvements and property both movable and immovable. Streets, highways, railroads, roads, landscaped yards, utilities, and drainage structures are inundated and scoured at many points by high velocity flowing floodwaters en route to lower levels. In many areas the same type of listed improvements are buried under tons of sand, silt, rocks, and other debris. Street, curb, and sidewalk pavements, and lawns are particularly vulnerable; drainage structures are clogged; utility pipes are uncovered and broken; stone and blockwall fences are toppled; and basements are flooded. There are many adobe structures in the flood plain which are particularly vulnerable to water damage. Saturation of the lower portion of an adobe building often causes complete collapse of the structure.

48. Emergency costs include costs of evacuation and reoccupation, sandbagging and diking, relief for flood victims, additional policing, and other expenses. Business and financial losses are incurred as a result of a net loss of normal business profit and earnings of labor and management.

49. DAMAGES FROM PAST FLOODS.- The only information available regarding floods which occurred at El Paso prior to the October 1954 flood investigation is from newspaper accounts and statements of long-time residents. In October 1954 an investigation of the flood problems at El Paso was made at the request of the El Paso County Engineer. At that time damages were particularly acute in the Southeast Area in the newly developed Hacienda Heights with about 1,500 housing units and Rosedale with about 150 homes. In the Northwest Area, Smelertown and vicinity were damaged by the same storm. There was no damage in the Southeast Area from the July 1955 flood but damages in the Central and Northwest Area were estimated at \$640,000. The Mountain View section of the Central Area had approximately 250 new homes flooded up to one foot in depth by temporarily trapped water. The Durazno section suffered the most severe damage with floodwater accumulated up to 3 feet deep inside 56 homes for a period of several days. Water ponded on

Fort Bliss and Biggs Air Force Base. Also, there was damage in the Logan Heights and Beaumont Additions in the Central Area. In the Northwest Area, damages occurred in Mission Hills Addition, Smelter-town, and a large part of the upper valley. The estimated damages from the July 1955 flood are itemized in table 2.

50. About three years later, the September 1958 storm released up to 5.5 inches of rain on the slopes of the Franklin Mountains and the resultant damages to El Paso amounted to \$984,000. The city had increased in areal extent to about 105 square miles and the population had grown to about 280,000. Approximately 200 people were evacuated from flooded homes, ponded water covered over 700 acres of urban land, and most sections of the city were subjected to damage by flowing water. During the emergency, over 900 workers and 220 pieces of equipment were employed to evacuate, patrol, repair and rehabilitate, and effect whatever flood relief possible. Traffic was interrupted on U.S. Highways 54 and 80 and the railroads through the pass. Approximately 90 percent of the reported damage could have been prevented by suitable flood control improvements. The estimated damages from the September 1958 storm are itemized in table 2.

51. The rainfall from the storms of September 1-2 and 4-5, 1962, was comparable to that produced by the storms of 1955 and 1958 according to local officials. Flood control works constructed by the city were credited with preventing the damages from exceeding about \$855,000. The effects of this storm were felt in practically every section of the city. About 250 people were evacuated from homes flooded by water up to 3.5 feet deep. In addition to the success attributed to existing flood control structures, timely emergency flood fighting prevented many thousands of dollars of damage. The estimated damages caused by the September 1962 storm are itemized in table 2.

52. Only the Southeast Area of El Paso was hit by the flash flood of August 1963 which caused about \$39,000 tangible damages and the death of one El Paso citizen. About 35 acres adjacent to Lomaland Drive in the general vicinity of Pima Village, Loma Terrace, and Ranchland were damaged by floodwaters from Jesuit Draw and minor agricultural damage resulted from runoff from Pendell Draw. Also, damage was caused by deposition of silt in streets, yards, and homes. Water entered 13 homes causing floor, carpet, and furniture damage. Three residential yard walls were damaged by flowing water. The maximum depth of floodwater was about 3 feet in the city streets. During the flood, a man made an unsuccessful attempt to save his car from Jesuit Draw floodwaters. The car was washed against a barricade; the man was swept out of the car and drowned.

53. ESTIMATED DAMAGES FROM STANDARD PROJECT FLOODS.- Estimates were made of the damages which would be caused by the occurrence of the standard project flood in each of the areas. The total damages would amount to \$19,325 thousand, as itemized in table 3.

TABLE 2. — Estimated Damages from Major Floods - El Paso
El Paso County, Texas

Type	Damages		
	Jul 1955 Flood	Sep 1958 Flood	Sep 1962 Flood
Residential	\$174,000	\$447,500	\$340,000
Business and industrial	0	71,000	104,000
Schools and churches	0	0	6,000
Public buildings	0	1,000	5,000
Utilities	20,000	22,500	30,000
Streets, highways, and roads	300,000	147,000	145,000
Railroads	0	5,000	0
Agricultural	0	5,000	5,000
Indirect losses	66,000	75,000	165,000
Flood fight and miscellaneous	80,000	210,000	55,000
Total	\$640,000	\$984,000	\$855,000

TABLE 3. — Estimated Damages from Standard Project Floods at El Paso
(January 1964 Conditions and Prices)

Item	Estimated Damages in \$1,000			
	Northwest Area	Central Area	Southeast Area	Total
<u>Urban and suburban:</u>				
Residential	\$1,290	\$4,588	\$1,410	\$7,288
Business	95	564	279	938
Schools and churches	7	251	73	331
Utilities	82	165	50	297
Public property	0	67	20	87
Subtotal	1,474	5,635	1,832	8,941
<u>Agricultural property:</u>				
Improvements	109	0	5	114
Crops	58	0	65	123
Subtotal	167	0	70	237
<u>Streets and highways</u>	67	74	35	176
<u>Railroad</u>	15	102	15	132
<u>Military property</u>	0	8,935	0	8,935
<u>Business and financial losses</u>	605	47	6	658
<u>Emergency costs</u>	52	179	15	246
Total Damages	\$2,380	\$14,972	\$1,973	\$19,325

54. METHOD OF ESTIMATING AVERAGE ANNUAL DAMAGES.- The average annual damages to improvements in the three areas were estimated by first determining the depth-damage relationship in the flood plains. These curves were then converted to volume- and discharge-damage curves by the use of stage-volume curves for the ponded areas and stage-discharge curves for the areas damaged by flowing water. Damage-frequency relationships were then established by combining data from the volume- and discharge-damage curves with data from the volume- and discharge-frequency curves. A volume-cropland overflowed relationship was determined for the agricultural areas in the flood plain. Damages to crops were estimated from crop loss curves and weighted to reflect the time of year when floods are most likely to occur. Damage-frequency relationships for improvements and crops were then combined to determine the average annual damages. Volume-damage, discharge-damage, and damage-frequency relationship curves for each area under consideration are shown on plates 1 through 3, appendix D.

55. FUTURE DEVELOPMENT.- The average annual allowances for future growth in the flood plains at El Paso were determined from projections of population growth and disposable personal income over the next 100 years. A population growth curve was developed for each area and combined with the El Paso disposable personal income growth projection. The total disposable personal income factor was modified to allow for retardation in the area under consideration due to the flood threat. A curve was developed for each area showing the geometric mean of the projected growth factors for total disposable personal income and population. This mean represents the most logical measure of the probable future increase in damageable property and the resultant increase in damages in the flood plains. The present worth of each of the varying estimated annual geometric mean growth factors was computed for each area. The sum of the factors for each area was converted to an average annual allowance for future growth by the use of appropriate 3 percent interest tables. In some instances the overall allowance for future development in an area would not be applicable to certain subareas so they were considered individually. The average annual growth factors for urban improvements in the Northwest, Central, and Southeast Areas are 5.20 (520 percent), 0.43 (43 percent), and 1.21 (121 percent), respectively. At the present time the flood plains of the Northwest and Southeast Areas consist of urban lands, croplands, and vacant land. Since vacant lands are available, considerable urban development could take place without significant reduction in the amount of cropland. As the areas develop toward complete urbanization, a gradual reduction in cropland acreage will take place until none remains in the year 2060. Assuming that crop damages in the Northwest and Southeast Areas decline on a straight-line basis, or as an annuity decreasing at a constant rate of one percent per year for 100 years with interest at 3 percent, the average annual crop damages evaluated on the basis of present acreage would be 72 percent of the present value.

56. AVERAGE ANNUAL FLOOD DAMAGES.- The average annual flood damages in the Northwest Area under the existing state of development and without further improvement for flood control are estimated at \$95,300. Future growth in this area is expected to result in a 520 percent increase in average annual flood damages to urban and suburban improvements and a 28 percent decrease in average annual damages to crops because of urban expansion. Therefore, the average annual damages would increase to \$548,900, as itemized in table 4. The average annual flood damages under the existing state of development in the Central Area and without further improvement for flood control are estimated at \$265,400. Future growth in this area is expected to result in a 43 percent increase in annual flood damages to the urban and suburban properties in the flood plain. Therefore, the average annual damages would increase to \$362,100, as itemized in table 4. In the Southeast Area, the average annual damages under the existing state of development in the flood plain and without further improvement for flood control are estimated at \$88,300. Future growth in this area is expected to result in a 121 percent increase in annual flood damages to the urban and suburban improvements and a 28 percent decrease in the average annual damages to crops. Therefore, the average annual damages would increase to \$179,100, as itemized in table 4. The total average annual damages for the three areas amount to \$1,090,100.

TABLE 4. — Average Annual Damages at El Paso Without Additional Improvement for Flood Control (January 1964 Conditions and Prices)

Item	Northwest Area	Central Area	Southeast Area	Total
<u>Urban and suburban:</u>				
Average annual damages (existing state of development)	\$87,400	\$224,800	\$77,500	\$389,700
Allowance for future development (percentage of existing conditions)	520%	43%	121%	--
Average annual allowance for future development	454,500	96,700	93,800	645,000
	<hr/>	<hr/>	<hr/>	<hr/>
Subtotal, Average Annual Urban and Suburban Damages	541,900	321,500	171,300	1,034,700
<u>Crop damages:</u>				
Average annual damages (existing state of development)	3,200	0	10,800	14,000
Allowance for future development (percentage of existing conditions)	-28%	--	-28%	--
Average annual allowance for future development	-900	0	-3,000	-3,900
	<hr/>		<hr/>	<hr/>
Subtotal, Average Annual Crop Damages	2,300		7,800	10,100
<u>Fort Bliss:</u>				
Average annual damages (no allowance for future development)	--	40,600	--	40,600
<u>El Paso Electric Co. Power Plant:</u>				
Average annual damages (no allowance for future development)	4,700	--	--	4,700
	<hr/>	<hr/>	<hr/>	<hr/>
Total Average Annual Damages	\$548,900	\$362,100	\$179,100	\$1,090,100

OTHER WATER RELATED PROBLEMS

57. MUNICIPAL AND INDUSTRIAL WATER SUPPLY.- The municipal and industrial water supply for El Paso is obtained from wells and from Rio Grande surface waters as described under EXISTING WATER RESOURCES DEVELOPMENT. The Hueco Bolson, which is the major source of fresh well water for the area, is overlain and underlain by alluvial deposits containing moderate to highly mineralized water. Lowering the artesian head in the fresh water beds by pumping creates a differential in pressure between the salt water and fresh water aquifers causing the salt water to move toward or into the fresh water. The main source of fresh water recharge in the Hueco Bolson is believed to be runoff from the eastern slopes of the Franklin and Organ Mountains. Water production from the Hueco Bolson in 1961 was 70 m.g.d. (million gallons per day). Studies made by the U.S. Geological Survey indicate that the supply of fresh water from this aquifer has an expected life of 100 years based on the present rate of pumping. If the rate increases in the future as it has in the past, the life expectancy of this source of supply will be reduced to less than 50 years after 1970. The quality of the Rio Grande surface water deteriorates during the winter months because the major portion of the riverflow during this period consists of return flows from irrigated areas.

58. During the development and expansion of El Paso, several investigations and studies concerning the provision of adequate water supplies of suitable quality have been made by Federal, State, and local agencies. A report on the city water supply and distribution system problems was completed in 1961 by a firm of consulting engineers for the city of El Paso. The report states that the 1960 maximum water production capacity of the city of El Paso was 110 m.g.d. of which 20 m.g.d. was from surface supplies, principally the Rio Grande, and the balance, 90 m.g.d., from wells. The report also states that production capacity will be required to meet peak demands of 170 m.g.d. by 1970 and 225 m.g.d. by 1980.

59. Information furnished by the U.S. Public Health Service indicates that the city of El Paso, including the two military establishments, had a 1960 water use of about 60 m.g.d. Municipal water requirements have increased to a present 130 gallons per day per capita and are expected to maximize at 160 gallons per day per capita in 1970, and remain relatively constant thereafter. The projected water demand of El Paso County, which includes two military establishments and industrial use, is 90 m.g.d. by 1970, 192 m.g.d. by 1995, and 307 m.g.d. by 2020.

60. RECREATION.- The demands for outdoor recreation have greatly accelerated in recent years. Much of this recreational activity is related to the use and enjoyment of water resources. There is a definite need for water-associated recreation facilities in the immediate vicinity of El Paso since the closest water-associated

recreation areas of any consequence are the Elephant Butte and Caballo Reservoirs located about 115 miles to the north, near Truth or Consequences, N. Mex.

61. FISH AND WILDLIFE CONSERVATION.- Fish and wildlife are living natural resources basically associated with the land and water. Preservation and development of fish and wildlife resources are important to the economy and way of living. The recreational value of fish and wildlife is of significance to the well-being of people, possibly more so than the food value of this resource. Opportunities to engage in water-associated sports such as hunting and fishing in the El Paso area are limited and as the population increases, the demand for such opportunities also will increase.

PROJECT FORMULATION

62. OBJECTIVES.- The plan of improvement for El Paso and vicinity was formulated with the following objectives: (a) that any improvement proposed to solve the problems in the El Paso area would integrate with comprehensive plans for development of the water resources of the Rio Grande Basin; and (b) standard project flood protection would be provided, if economically feasible, because of the existing and anticipated suburban and industrial type of development in the area.

63. FLOOD CONTROL SOLUTIONS CONSIDERED.- Several basic types of flood control measures were considered in developing the plan of improvement for flood control in the El Paso area. These measures include: (1) major impoundments of runoff to control floodflows and reduce damages in downstream areas; (2) detention structures and small impoundments in headwater and tributary reaches to reduce peak floodflows downstream, thereby reducing scour and sediment deposition; (3) improvement of existing arroyo channels or construction of new channels to transport floodwaters, to points of discharge into the Rio Grande; (4) levees, dikes, bank protective works, and other training measures to direct the flow of water from arroyos into outfall channels; and (5) evacuation and flood plain zoning to minimize damages in the flood plains.

64. Numerous plans comprising various combinations of the above-mentioned features were studied. The four plans which proved to be the most feasible have been designated as Plans A, B, C, and D. Evacuation of the flood plain and broad scale flood plain zoning were found to be infeasible because of extensive developments within the rather large areas subject to flooding. Plans A and B are essentially reservoir plans; whereas, Plans C and D are combinations of reservoirs and diversion channels. Plan A comprises the master plan for each of the areas, as developed by consulting engineering firms engaged by the city of El Paso, except for certain modifications in the design of spillways to conform to Corps of Engineers criteria. The reservoirs of Plan A would not control the standard project floods developed in accordance with

Corps of Engineer criteria. The features of Plan A are shown on plate 3. The areas designated by Roman numerals I through IV on plate 3 are the study areas used by the consulting firms and are the same as the study areas used for this report except that Areas I and III were combined into the Central Area. Areas IV and II correspond to the Northwest and Southeast Areas, respectively. Plans B and C are shown on plates 4 and 5, respectively, and Plan D, the selected plan, is shown on plate 1. Each of the four plans consists of a group of three independent plans, one for each of the areas under consideration, as described in the following paragraphs.

65. NORTHWEST AREA.-

a. Plan A.- In the Northwest Area, Plan A consists essentially of a detention dam on each of the arroyos that discharge into the Rio Grande valley and collection channels to divert reservoir releases to existing valley drains which would be enlarged. There would be 25 detention reservoirs, varying in capacity from 25 to 403 acre-feet with a total volume of 4,298 acre-feet. In the event of the design flood for this plan, 3,630 c.f.s. would be discharged into the Rio Grande. The majority of the reservoirs would be located a short distance above the valley floor but others would be built on the slopes of the Franklin Mountains to afford protection to developments situated thereon. The estimated first cost of this plan is \$7,602,000. Since this plan would not provide protection against the standard project flood, which is desirable in urban areas, the benefits were not evaluated.

b. Plan B.- Plan B is similar to Plan A in that the flood control objective would be attained essentially by reservoir control. It differs primarily in that the reservoirs and all other elements of the plan would control the standard project flood. All of the reservoirs would be located to afford protection to property in or adjacent to the Rio Grande valley. It was determined that protection of some of the hillside subdivisions and developments in the extreme southern limits of the area could not be justified. However, the arroyo channels are well defined through the hillside developments and damages could be avoided by preventing encroachment thereon. In the development of Plan B, it was found that construction of seven large reservoirs to provide the capacity required to control the standard project flood would be more practical than numerous small structures as in Plan A. The existing ABC Dams shown on plate 2 would be enlarged to form Mulberry Dam, and the existing D Dam would be enlarged to form Thorn Drive Dam. Dams 5, 6, 8, 9, and the Buena Vista Dam would be new construction. Releases from all of the reservoirs would be conveyed to the Rio Grande by the Lower Diversion Channel. The Borderland Diversion would divert releases from Mulberry Dam and runoff from the intervening area between Mulberry and Thorn Drive Dams to the Lower Diversion Channel. The Upper Diversion would divert arroyo flows into Buena Vista Dam. The Buena Vista Outfall Channel and the Gibson Diversion would divert reservoir releases into the Lower Diversion Channel. All of the dams would have

ungated outlets and spillways. The total capacity of the reservoirs at spillway crest would be 5,738 acre-feet which is approximately twice the capacity of the Plan A reservoirs designed for the same area. The Lower Diversion Channel would be provided with tieback levees to protect against backwater flows from the Rio Grande. In the event of the standard project flood, the discharge into the Rio Grande would be about 3,660 c.f.s. The estimated first cost of Plan B is \$8,300,000 and the annual charges, \$327,000. The annual benefits are estimated at \$537,200 which yield a benefit-cost ratio of 1.6.

c. Plan C.- Plan C would control less flood runoff by reservoir impoundment and more by direct diversion than either Plan A or Plan B. The plan consists of only four dams, three of which would be the same as in Plan B: Thorn Drive, Mulberry, and Buena Vista Dams. Dams 5, 6, 8, and 9 of Plan B would be replaced by Mesa Dam, Mesa Diversion, and Cactus Diversion. Except for the Lower Diversion Channel, which would be enlarged, all other elements would be the same as Plan B. In the event of the standard project flood, the discharge into the Rio Grande would be about 7,100 c.f.s. The estimated first cost of Plan C is \$5,453,000 and the annual charges, \$216,645. The annual benefits of \$537,200 yield a benefit-cost ratio of 2.5.

d. Plan D.- Plan D, the selected plan, would control less flood runoff by reservoir impoundment and more by direct arroyo diversion than any of the plans considered for the Northwest Area. It would consist of Thorn Drive, Mulberry, and Buena Vista Dams which with their appurtenant structures, Borderland, Upper, and Gibson Diversions and the Buena Vista Dam Outfall Channel, would be the same as Plans B and C. The arroyo controlled by Mesa Dam and Mesa and Cactus Diversions of Plan C, and by Dams 5, 6, 8, and 9 of Plan B, would be allowed to discharge directly into the Lower Diversion Channel which would have a greater capacity than Plans B and C. In the event of a standard project flood, the discharge of the Lower Diversion Channel into the Rio Grande would be about 10,100 c.f.s. The estimated first cost of Plan D is \$4,073,000 and the annual charges, \$161,000. The annual benefits are estimated at \$537,200 which yield a benefit-cost ratio of 3.3.

66. CENTRAL AREA.-

a. Plan A.- As in the Northwest Area, Plan A would consist essentially of detention dams on each of the contributing arroyos and appurtenant channels and drainage facilities to convey discharges from the dams and runoff from uncontrolled areas to terminal points. Releases from most of the reservoirs would not reach Rio Grande, as in the Northwest Area, but would be diverted to two large sump areas where they would be dissipated by infiltration, transpiration, and evaporation. The plan would include 21 dams to operate in conjunction with the existing dams, the Northeast sump, and Northeast drains, and the McKinley-Mountain Avenue underground conduit. The Fort Bliss sump and the Lincoln Park and Playa drains would be enlarged. All other existing facilities would

be unchanged except that the unimproved portion of Tobin Park drain would be lined. The first cost of this plan would be about \$15,482,000. Since this plan would not provide protection against the standard project flood, which is desirable for highly developed urban areas, benefits were not evaluated.

b. Plan B.- As in the Northwest Area, Plan B would have fewer dams than Plan A but the reservoir capacity would be sufficient to control the standard project flood. There would be only five dams in Plan B; Northgate, Range, McKelligon, Fillmore, and Pershing. These dams together with the Northgate Interceptor Channel, the Northgate Diversion Channel, the Fort Bliss Diversion, and the Pershing Diversion Channel would control all but the smallest of the arroyos that would be controlled by Plan A. The Northgate Interceptor Channel and the Northgate Diversion Channel would convey arroyo runoff into Northgate Dam. Releases from Northgate Dam would flow through the Northgate Outlet Channel into Range Dam. Releases from Range Dam would be conveyed by an outlet channel to the existing Tobin Park Drain and discharge into the Fort Bliss sump which would be enlarged. The Fort Bliss Diversion would discharge directly into the Fort Bliss sump. The releases from McKelligon and Fillmore Dams and runoff from the intervening area would be collected in the Van Buren Reservoir and the releases from this dam would be conveyed underground to Pershing Dam by the Mountain Avenue Conduit. The Pershing Diversion Channel would intercept flows which would otherwise pond against Pershing Dam and divert them northward into the reservoir. Releases from Pershing Dam would flow through the Government Hill Ditch into a small catchment basin located at Yandell Drive and Boone Street. The Government Hill Ditch presently continues from the catchment basin to Durazno Reservoir; however, under Plan B a new underground conduit would be constructed to the Rio Grande and Durazno Reservoir would be utilized for local runoff only, for which the capacity is adequate. All elements of Plan B are designed to control the standard project flood to nondamaging proportions. In the event of the standard project flood, the discharge into Rio Grande would be 364 c.f.s. The total first cost is estimated at \$9,870,000 and the annual charges at \$381,600. The annual benefits would be \$343,300, yielding a benefit-cost ratio of 0.9.

c. Plan C.- Plan C is the same as Plan B except that the Fort Bliss Diversion would provide protection against the 100-year flood instead of standard project flood and the Fort Bliss sump would store runoff from the 200-year flood instead of the standard project flood. The Fort Bliss sump would not be enlarged but would be equipped with two 50,000 g.p.m. pumps which would discharge into the Fort Bliss Outfall Conduit, consisting of 2,500 feet of underground pipes and 6,500 feet of lined channel to Pershing Reservoir. In the event of the standard project flood, the discharge into the Rio Grande would be 364 c.f.s. The total cost of Plan C is estimated at \$8,250,000 and the annual charges at \$319,500. The annual benefits of the plan would be \$334,600, yielding a benefit-cost ratio of 1.0.

d. Plan D.- Plan D, the selected plan, differs from Plan C in that two more dams, Sunrise and Mountain Park, would be added. These two structures would reduce the peak inflow into the Fort Bliss Diversion and thereby control the standard project flood instead of the 100-year flood as in Plan C. Also, the Fort Bliss sump would be equipped with an underground gravity outlet conduit to Pershing Dam instead of pumps. In the event of the standard project flood, the peak flow into the Rio Grande from the Government Hill Outfall Conduit would be 364 c.f.s. The first cost of Plan D in the Central Area is estimated at \$7,932,000, and the annual charges, \$299,000. The annual benefits would be \$336,000, producing a benefit-cost ratio of 1.1.

67. SOUTHEAST AREA.-

a. Plan A.- As in the other two areas, Plan A in the Southeast Area is essentially a reservoir plan. The plan includes 22 detention dams with capacities ranging from about 4 to 176 acre-feet. The Playa, Mesa, Middle, and Franklin Drains would be enlarged and 12 new drains would be constructed. Other construction would be a diversion dike and two pump stations with pumps to lift floodwaters over the levees into the Rio Grande. In the event of the design flood for this plan, 555 c.f.s. would be discharged into the Rio Grande. In addition to affording control from arroyos which contribute directly to the Southeast Area, Plan A also would provide for the disposal of releases from the Durazno Reservoir which is located in the Central Area. The estimated first cost of this plan is \$6,716,000. Since the plan would not provide protection against the standard project flood, which is desirable in urban areas, benefits were not evaluated.

b. Plan B.- Plan B is essentially an interceptor and diversion channel plan with small detention ponds located along the interceptor channels to reduce peak discharges. The plan consists of two independent components. Copper Channel, the principal feature of one component, would intercept arroyo flows above a portion of the damage area and divert the flows into Pasotex Dam. Copper Diversion would divert flows around a copper refinery into the Copper Channel. The Pasotex Dam would be enlarged to detain local runoff and provide the necessary hydraulic head to discharge floodwaters into the Copper Outfall Channel which would discharge into the Rio Grande. In the event of a standard project flood, the peak discharge into the Rio Grande from the Copper Outfall Channel would be 1,410 c.f.s. About 19,200 feet of the existing Mesa Drain, the principal feature of the other component, would be improved to convey overland and diverted flows from the eastern mesa watershed. Giles Road Diversion, Loma Terrace spur, and Pendale spur would intercept and divert major arroyo flows into the Mesa Drain system. A new outfall channel would be constructed from the Mesa Drain to a pumping pond adjacent to the Rio Grande levees. For topographical reasons, it would be necessary to provide a pumping station which would be equipped with four 60,000 g.p.m. pumps to lift the waters over the levees into the Rio Grande. Ponds C, D, E, and F would be included to reduce the

peak discharge in the Mesa Drain and the outfall channel. Numerous irrigation and drainage structures and 13 bridges would be required. The estimated first cost of the plan is \$4,748,500 and the annual charges, \$183,000. The estimated annual benefits are \$119,100, yielding a benefit-cost ratio of 0.7.

c. Plan C.- Plan C also consists of two independent components in the Southeast Area. The northwest component would be similar to Plan B except that Copper Dam would be added and the alignment of Copper Channel would be slightly different. Copper Dam would receive flows from Copper Diversion and reduce the standard project flood peak outflow into the Rio Grande to 300 c.f.s. The southeast component would control mesa runoff by reservoirs located above Interstate Highway 10. In this respect, it is similar to Plan A except that only two dams, Jesuit and Pendell, would be constructed. The Lafayette Draw Diversion into Jesuit Reservoir would replace several of the smaller dams. The two reservoirs would be large enough to control the standard project flood. Releases from the reservoirs would be discharged into existing arroyo channels which would be intercepted by Mesa Drain. Under this plan, no improvements would be made to Mesa Drain or the other drains. The estimated first cost is \$2,466,700, the annual charges, \$91,100. The annual benefits would be \$104,300, yielding a benefit-cost ratio of 1.1.

d. Plan D.- Plan D, the selected plan, also consists of two separate components similar to Plans B and C. The northwest component would be the same as for Plan C except that Copper Dam would be larger and the Copper Outfall Channel smaller. A larger dam would result in an overall savings because the standard project flood peak discharge into the outfall channel would be reduced to 100 c.f.s. The southeast component would consist exclusively of the Bluff Channel which would be new construction. This channel would extend along the toe of the mesa bluff above the areas of major damage. Arroyo flows would be intercepted and conveyed to the Rio Grande. The channel would have a right bank levee in the reach paralleling the bluff and the outfall section would have tieback levees on both banks to provide an uncontrolled outfall to the river. In the event of the standard project flood, the peak discharge into the Rio Grande would be about 4,010 c.f.s. The area between the two components is protected by the Giles Dam recently constructed by the city and the Mesa Drain. The load on Mesa Drain and its related facilities would be substantially reduced because most of the contributing runoff would be intercepted by Bluff Channel. The estimated first cost of Plan D in the Southeast Area is \$3,619,000 and the annual charges, \$135,000. The estimated annual benefits are \$159,700, yielding a benefit-cost ratio of 1.2.

68. SELECTION OF FLOOD CONTROL PLAN.- As stated previously, the objective in planning flood control improvements for El Paso and vicinity is to provide standard project flood protection. Plan A would not provide protection against the standard project flood; therefore, it was eliminated from further consideration. Plans B, C, and D would meet

this objective but Plans B in the Central and Southeast Areas would not be economically justified.

69. In the Northeast and Central Areas, the plans selected for detailed study would provide about the same flood control benefits so the most feasible plan thus becomes the plan which would provide these benefits at the least cost. A comparison of the costs and benefits of Plans B, C, and D in each of the areas under consideration is given in table 5. As indicated, Plan D would be the least costly in the Northwest and Central Areas and yield the greatest excess of benefits. In the Southeast Area, Plan C would be the least costly but it would produce the least benefits. Plan D however, would produce the most benefits at a lower cost than Plan B and yield a greater excess of benefits over costs than Plan C. Therefore, Plan D was selected as the most economical plan for flood control in each of the areas and designated as the El Paso Local Protection Project, as shown on plate 1.

TABLE 5. — Benefit-Cost Data - Local Protection Plans Considered
El Paso, El Paso County, Texas
(January 1964 Conditions and Prices)

Area	Plan	First Cost	Annual Charges	Annual Benefits	Excess of Benefits Over Costs	B/C Ratio
Northwest	B	\$8,300,000	\$327,000	\$537,200	\$210,200	1.6
	C	5,453,000	216,645	537,200	320,555	2.5
	D	4,073,000	161,000	537,200	376,200	3.3
Central	B	9,870,000	381,600	343,300	-38,300	0.9
	C	8,250,000	319,500	334,600	15,100	1.0
	D	7,932,000	299,000	336,000	37,000	1.1
Southeast	B	4,748,500	183,000	119,100	-63,900	0.7
	C	2,466,700	91,100	104,300	13,200	1.1
	D	3,619,000	135,000	159,700	24,700	1.2

70. OTHER WATER RESOURCE DEVELOPMENTS CONSIDERED.-

a. Municipal and industrial water supply.- As previously discussed under OTHER WATER RELATED PROBLEMS, the major source of municipal and industrial water is from underground aquifers but heavy demand exceeds the rate of recharge. Recognizing this condition, the city took action more than 20 years ago to obtain a surface supply by purchasing lands with rights to Rio Grande water. In 1960 the maximum production capacity of the city water system was reported to have been 110 m.g.d. of which 20 m.g.d. was from surface supplies, principally

the Rio Grande, and 90 m.g.d. from wells. During the preparation of this report several meetings were held with city officials and their consulting firms, and numerous studies were conducted in an effort to develop a multiple-purpose plan which would allow impoundment of the arroyo runoff for municipal and industrial use. The city officials advised that they are planning construction of a 3,000 acre-foot off-stream reservoir adjacent to the Rio Grande a short distance downstream from Belen. Rio Grande flows would be diverted into the reservoir by means of the existing Riverside Canal and heading which would require certain modification. Studies were made toward developing a plan whereby Bluff Channel flows could be discharged directly into this reservoir at a small additional project cost. It was determined, however, that to maintain dependable flood control, the reservoir would require a spillway and further that for topographic reasons a reservoir spillway would not be feasible. There is the possibility that when the reservoir is constructed, it might be practicable to install a control structure in the Bluff Channel Outfall to divert all or part of the flow into the reservoir via an enlarged Franklin Drain. Since the cost of such a structure would be the responsibility of local interests, it was not included as part of the flood control plan nor were the benefits evaluated. The practicability of modifying the flood control plans in the Northwest and Central Areas to include storage for municipal and industrial use also was investigated but no feasible means could be found.

b. Recreation.- Because of the lack of water-associated recreation areas in the vicinity of El Paso, it would be highly desirable to impound floodwaters for this purpose; however, due to the lack of a dependable water supply, it was not considered practicable to provide water-associated recreation facilities as a project purpose in any of the flood control detention reservoirs.

c. Fish and wildlife.- Construction and operation of the proposed project would not significantly affect fish and wildlife resources of the area. Because of the undependable water supply, the reservoirs would be dry most of the time and could not support a fishery. Therefore, it was considered impracticable to include fish and wildlife conservation or enhancement as a project purpose.

71. PLAN OF IMPROVEMENT.- The El Paso Local Protection Project would be a single-purpose flood control project consisting of independent plans for the Northwest Area, the Central Area, and the Southeast Area. The plan for the Southeast Area comprises two independent components designated as the Copper System and Bluff Channel. The project plan is shown on plate 1.

72. The Northwest Area plan consists essentially of three reservoirs and a diversion channel together with appurtenant facilities. Two of the dams, Mulberry and Thorn Drive, would be enlargements of existing structures and the third, Buena Vista Dam, would be new

construction. A diversion channel designated as the Lower Diversion Channel would convey the releases from the reservoirs and runoff from several uncontrolled arroyos to the Rio Grande via the Lower Diversion Outlet Channel. Other features of the plan include the Borderland Diversion which would convey releases from Mulberry Dam and the runoff from a small uncontrolled drainage area to the arroyo which serves as the outlet for Thorn Drive Dam; the Upper Diversion which would intercept and divert arroyo flow into the Buena Vista Reservoir; and the Buena Vista Dam Outfall Channel and Gibson Diversion which would divert flows into the Lower Diversion Channel. A structure would be provided in the Lower Diversion Channel to admit flows from the existing City Ditch, and the lower end of the Montoya Drain would be realigned to discharge into the Rio Grande immediately above the Lower Diversion Outfall Channel. All elements of the plan are designed to control the standard project flood.

73. The Central Area plan consists of seven dams plus diversions, outfall structures, and appurtenant facilities. Two of the dams, Northgate and Range, would detain flows from arroyos which flood a residential and business district in the northern portion of the area and reduce the flows to the capacity of the Tobin Park Drain which discharges into the Fort Bliss sump. The Northgate Interceptor Channel and the Northgate Diversion Channel would direct flows into Northgate Dam. Releases from Northgate Dam and runoff from the area below the Northgate Interceptor Channel would be carried to Range Dam via the Northgate Outlet Channel. The Fort Bliss Diversion Channel would intercept and divert arroyo flow directly to Fort Bliss sump. Sunrise and Mountain Park Dams would reduce peaks into the Fort Bliss Diversion Channel.

74. The Fort Bliss sump would not be modified but it would be drained by the Fort Bliss Sump Outlet Conduit which would discharge into Pershing Reservoir. McKelligon and Fillmore Dams would control fairly large drainage areas and releases from these structures would be carried by an arroyo leading to the Van Buren Dam, thence to Pershing Reservoir via the Mountain Avenue Outlet Conduit. Pershing Diversion Channel would divert flows into the reservoir that would otherwise be blocked by the dam embankment. Releases from Pershing Dam would flow into the Government Hill Ditch. This ditch, which would be modified only slightly, discharges into a small detention basin and, at present, flows from the basin are discharged into Durazno Reservoir. With the proposed plan in operation, flows from the basin would bypass Durazno Reservoir and discharge directly to the Rio Grande via the Government Hill Outfall Conduit. This would increase the effectiveness of Durazno Reservoir by reducing its contributing area.

75. The site of Range Dam was selected to provide maximum protection for the standard project flood plain below it. There is a small area north of Keltner Dam and east of Alabama Street that will not be protected by the plan of improvement. It was determined that

flood damages are minor in this area and that flood protection could not be justified at this time. Under existing conditions, the capacity of Fort Bliss sump is sufficient to control a flood with a recurrence interval of 100 years. With the proposed plan in operation, the protection would be extended to include floods up to the 200-year recurrence interval. The remaining features in the Central Area provide standard project flood protection. The capacity of the Government Hill Ditch which will carry discharges from Pershing Dam would not be increased to accommodate flow from local runoff, because local runoff resulting from the occurrence of the standard project storm above Pershing Dam would not coincide with the peak discharge from the dam.

76. The Southeast Area plan consists of two independent systems for flood control, the Copper System and the Bluff Channel together with necessary appurtenances. Bluff Channel would be provided as a separate component to intercept and convey runoff from the mesa arroyos to the Rio Grande. Copper Diversion and Copper Channel would divert and convey runoff into Copper Dam. The Copper Outlet Channel would convey releases from Copper Dam into Pasotex Dam which is now under construction by the city. Pasotex Dam would be modified to increase its capacity. The Copper Outfall Channel would then convey releases from Pasotex Dam to the Rio Grande.

77. The capacity of the Pasotex Dam as planned by the city would not be sufficient to control the standard project flood. This dam would be enlarged, as required, so that all of the facilities in the Copper System would provide standard project flood protection. Bluff Channel is designed to provide standard project flood protection. Giles Dam, recently constructed by the city, has sufficient capacity to provide protection from floods up to a recurrence interval of about 100 years. Damages from flowing water would not occur in the area immediately below the dam but major flooding from flowing and ponding water would occur when the water reaches the valley lands. There are several sources of runoff into the valley and therefore the damages that would be prevented by enlarging Giles Dam would not be sufficient to justify its modification.

78. With minor exceptions, the facilities in the El Paso Local Protection Project are designed to give protection against floods up to the magnitude of the standard project flood originating above the structures. However, provision for local drainage facilities to control runoff originating downstream will be the responsibility of local interests.

79. EFFECTS OF SELECTED PLAN.-

a. Municipal and industrial water supply.- The El Paso Local Protection Project would have little effect on the existing water supply for El Paso and vicinity. At the present time the city draws about 85 percent of its water from the Hueco Bolson and the remaining 15 percent from the Rio Grande. Inasmuch as the proposed plan of improvement

would provide for the draining of Fort Bliss sump, less water would be available for ground water recharge than under existing conditions. However, U.S.G.S. Water Supply Paper No. 919, Ground Water Resources of the El Paso Area, Texas, indicates that Fort Bliss sump waters which percolate into the ground do not reach the Hueco Bolson but recharge a perched water table of highly mineralized waters above the Hueco Bolson. The El Paso Local Protection Project would increase the average annual runoff to Rio Grande by about 260 acre-feet. Since the water supply storage reservoir planned by the city will be located downstream from all of the proposed outlets, there would be a greater amount of water available for diversion than under existing conditions.

b. Irrigation.- The selected plan of improvement would have no adverse effect on existing irrigation operations in the area. Equipment and maintenance crossings consisting mainly of low-water crossings would be provided. The tops of levees could be used for access when necessary. Severance of individual farms and the restoration or relocation of farm irrigation services could be resolved in the pre-construction planning stage.

c. Rio Grande Floodway capacity.- According to information furnished by the International Boundary and Water Commission, the capacity of the Rio Grande and its floodway is 12,000 c.f.s. above the American Dam and 11,000 c.f.s. below.

d. Project effects on Rio Grande Floodway.- Under standard project flood conditions the Lower Diversion Channel Outlet in the Northwest Area would discharge a peak flow of 10,100 c.f.s. The standard project flood hydrograph indicates that this peak would coincide with a flow in the Rio Grande of 1,100 c.f.s., or a total of 11,200 c.f.s., which is less than the capacity of Rio Grande above the American Dam. Before the peak reaches the leveed floodway downstream, it would be reduced by irrigation diversions and damping to less than floodway capacity. A larger combined peak could be produced from the uncontrolled area above the project from the same storm. Under existing conditions, runoff from the standard project storm would pond in the valley behind the Rio Grande levees; but, because of the limited storage in the ponding area, the levees might not contain the floodwaters and thus would be subject to overtopping. The standard project flood peak discharge from the Government Hill Outfall Conduit of the Central Area and the Copper Outfall Channel of the Southeast Area would be 364 c.f.s. and 100 c.f.s., respectively. The effect of these discharges on Rio Grande flows would be insignificant. The standard project flood peak discharge from Bluff Channel in the Southeast Area would be about 4,000 c.f.s. which would reach the Rio Grande several hours in advance of the

flows caused by this storm in the other areas. Furthermore, water supply and irrigation diversions above the outfall would deplete any flows in the Rio Grande. Therefore, the flow in the Rio Grande coincident with the flood peak would be considerably less than the floodway capacity.

ECONOMIC EVALUATION OF PROJECT

80. FIRST COSTS AND ANNUAL CHARGES.- The estimated first cost and annual charges for the El Paso Local Protection Project are given in table 6. First costs are based upon January 1964 price levels and include contingencies. The apportionment of costs between Federal and non-Federal interests is in accordance with laws and established policies governing local protection projects. Annual charges include interest and amortization of the Federal and non-Federal investment for a 100-year period at an interest rate of 3 percent, operation and maintenance charges, and the annual equivalent cost of major replacements.

TABLE 6 — Estimated First Costs and Annual Charges - El Paso Local Protection Project (Price Level - January 1964)

Item	Northwest Area	Central Area	Southeast Area		Total	Total Project Costs
			Copper System	Bluff Channel		
SUMMARY OF ESTIMATED COSTS:						
<u>Federal First Cost:</u>						
Relocations	\$164,000	\$208,800	\$15,000	\$186,000	\$201,000	\$573,800
Dams, general	36,000	84,000	12,000	--	12,000	132,000
Dams, outlet works & spillways	743,700	3,183,700	357,000	--	357,000	4,284,400
Channels	2,035,700	3,110,300	281,000	681,000	962,000	6,108,000
Drainage structures	--	--	--	98,000	98,000	98,000
Engineering and design	178,800	342,100	45,200	63,800	109,000	629,900
Supervision & administration	<u>185,800</u>	<u>381,100</u>	<u>43,800</u>	<u>56,200</u>	<u>100,000</u>	<u>666,900</u>
Total Federal First Cost*	3,344,000	7,310,000	754,000	1,085,000	1,839,000	12,493,000
<u>Non-Federal First Cost:</u>						
Lands and damages	468,600	201,100	635,000	647,000	1,282,000	1,951,700
Relocations	232,000	379,500	600	440,400	441,000	1,052,500
Engineering and design	13,900	19,550	60	29,440	29,500	62,950
Supervision & administration	<u>14,500</u>	<u>21,850</u>	<u>40</u>	<u>27,460</u>	<u>27,500</u>	<u>63,850</u>
Total Non-Federal First Cost	729,000	622,000	635,700	1,144,300	1,780,000	3,131,000
Total First Cost	\$4,073,000	\$7,932,000	\$1,389,700	\$2,229,300	\$3,619,000	\$15,624,000
INVESTMENT AND ANNUAL CHARGES:						
<u>Federal Investment:</u>						
Federal first cost	3,344,000	7,310,000	754,000	1,085,000	1,839,000	12,493,000
Interest during construction	<u>None</u>	<u>None</u>	<u>None</u>	<u>None</u>	<u>None</u>	<u>None</u>
Federal Investment	3,344,000	7,310,000	754,000	1,085,000	1,839,000	12,493,000
<u>Non-Federal Investment:</u>						
Non-Federal first cost	729,000	622,000	635,700	1,144,300	1,780,000	3,131,000
Interest during construction	<u>None</u>	<u>None</u>	<u>None</u>	<u>None</u>	<u>None</u>	<u>None</u>
Non-Federal Investment	729,000	622,000	635,700	1,144,300	1,780,000	3,131,000
Total Investment	\$4,073,000	\$7,932,000	\$1,389,700	\$2,229,300	\$3,619,000	\$15,624,000
<u>Federal Annual Charges:</u>						
Interest and amortization	<u>105,830</u>	<u>231,300</u>	<u>23,860</u>	<u>34,340</u>	<u>58,200</u>	<u>395,330</u>
Total Federal Annual Charges	105,830	231,300	23,860	34,340	58,200	395,330
<u>Non-Federal Annual Charges:</u>						
Interest and amortization	23,070	19,700	20,000	36,335	56,335	99,105
Operation and maintenance	<u>32,100</u>	<u>48,000</u>	<u>6,140</u>	<u>14,325</u>	<u>20,465</u>	<u>100,565</u>
Total Non-Federal Annual Charges	55,170	67,700	26,140	50,660	76,800	199,670
Total Annual Charges	\$161,000	\$299,000	\$50,000	\$85,000	\$135,000	\$595,000

*Does not include preauthorization study cost of \$156,500.

81. **BENEFITS.-** Flood control benefits would accrue to the El Paso Local Protection Project by prevention of flood damages from flowing and ponded water. Intangible and secondary benefits would be attributable to the project, but have not been evaluated. Although these benefits were not utilized in computation of the benefit-cost ratio, it is apparent that they enhance the desirability of the project.

a. Flood damages prevented.- The annual benefit creditable to the proposed plan of improvement for the prevention of flood damage is the difference between the average annual damages with and without the project. The total average annual flood damages without the project in operation amount to \$1,090,100, including an allowance of \$641,100 for damages to future development in the flood plain. The total average annual flood damages with the project in operation would be \$96,200, including an allowance of \$40,600 for damages to future development. The total benefits attributable to the project for the prevention of flood damages are therefore \$993,900. The average annual flood damages preventable by the plans of improvement in each of the three areas of El Paso are itemized in table 7.

TABLE 7. — Average Annual Flood Damage Prevention Benefits - El Paso Local Protection Project (January 1964 Conditions and Prices)

Item	Northwest Area	Central Area	Southeast Area	Total
Average annual damages without local protection project	\$548,900	\$362,100	\$179,100	\$1,090,100
Average annual damages with local protection project in operation	23,700	45,100	27,400	96,200
Average annual flood damage prevention benefits	\$525,200	\$317,000	\$151,700	\$993,900

b. Benefits from increased land utilization.- The history of flooding and the threat of future flooding have prevented about 1,900 acres of land in the flood plains from being utilized to the optimum degree for urban and suburban purposes. The annual enhancement benefit creditable to the project for removal of the flood hazard, which will result in increased utilization of these lands, is equal to the expected net increase in annual return. This benefit is over and above and is not duplicative of the estimated benefits from the prevention

of flood damages to crops and improvements, as shown in table 7. The market value of urban lands approximates the capitalized net return; therefore, the expected increase in net return is measured by the expected increase in market value. It is anticipated that removal of the flood threat will increase the value of these lands about \$780,000, as shown in table 8. This value, reduced to an annual basis at an interest rate of 5 percent, would yield an annual benefit of \$39,000 for increased land utilization.

TABLE 8. — Benefits from Increased Land Utilization
El Paso Local Protection Project (January 1964
Conditions and Prices)

Study Area	Acres	Increase in Land Value (per acre)	Total Increase	Benefits*
Northwest	600	\$400	\$240,000	\$12,000
Central	100	1,000	100,000	5,000
	200	500	100,000	5,000
	<u>600</u>	300	<u>180,000</u>	<u>9,000</u>
Subtotal	900		380,000	19,000
Southeast	<u>400</u>	400	<u>160,000</u>	<u>8,000</u>
Total	1,900		\$780,000	\$39,000

*Increase in value reduced to an annual return at an interest rate of 5 percent.

c. Collateral benefits.— As discussed under OTHER WATER RESOURCE DEVELOPMENTS CONSIDERED, the city of El Paso has developed a plan to increase its municipal and industrial water supply by diverting floodwaters from the Rio Grande and storing 3,000 acre-feet of this water in an off-stream reservoir. It is planned to locate the diversion at the Riverside Canal diversion dam downstream from Belen. With construction of the selected plan of improvement, floodwater which now ponds in the flood plains shown on plate 1 would be conveyed to the Rio Grande. This floodwater could then be diverted by the city of El Paso in accordance with their proposed plan. Under the above-described conditions, floodflows which are not now available to El Paso could be used to supplement the municipal and industrial water supply and the project would thereby benefit the city. However, due to the uncertainties involved in the utilization of these floodflows, the benefits from this source have not been evaluated. Therefore, the

El Paso Local Protection Project has not been credited with collateral benefits for municipal and industrial water supply.

d. Secondary benefits.- Most of the industry in El Paso is located outside the flood plain and the city is served by a network of highways and several railroads. Therefore, the chance of coincidental major flooding in enough places to cause a transportation problem is extremely remote and no measurable secondary benefits to the general economy would result from construction of the project.

e. Intangible benefits.- The intangible benefits of flood control at El Paso would include prevention of loss of human life, reduction of hazards to health, enhancement of public security, and prevention of the interruption of normal community activities, business operations, and vehicular traffic. Disruption of the military activities at Fort Bliss also would be reduced.

f. Negative benefits.- Negative benefits are not expected to result from construction of the proposed project. There will be a loss of taxes from properties required for project construction; however, this loss would be offset by increases in tax revenue from properties protected by the project.

82. The total annual benefits accorded the El Paso Local Protection Project amount to \$1,032,900 as itemized in table 9.

TABLE 9. — Average Annual Benefits - El Paso Local Protection Project (January 1964 Conditions and Prices)

Type of Benefit	Northwest Area	Central Area	Southeast Area	Total
Flood damage prevention	\$525,200	\$317,000	\$151,700	\$993,900
Increased land utilization	12,000	19,000	8,000	39,000
Total	\$537,200	\$336,000	\$159,700	\$1,032,900

83. BENEFIT-COST COMPARISONS.- The total annual benefits that would accrue to the El Paso Local Protection Project, when compared with the annual charges, yield a benefit-cost ratio of 1.7. Table 10 lists the benefit-cost comparisons for each of the three areas and the two independent systems, Bluff Channel and Copper System in the Southeast Area.

TABLE 10. — Benefit-Cost Comparisons - El Paso Local Protection Project (January 1964 Conditions and Prices)

Area	First Costs	Annual Charges	Total Benefits	B/C Ratio
<u>NORTHWEST:</u>				
Federal	\$3,344,000	\$105,830		
Non-Federal	<u>729,000</u>	<u>55,170</u>		
Total, Northwest Area	4,073,000	161,000	\$537,200	3.3
<u>CENTRAL:</u>				
Federal	7,310,000	231,300		
Non-Federal	<u>622,000</u>	<u>67,700</u>		
Total, Central Area	7,932,000	299,000	336,000	1.1
<u>SOUTHEAST:</u>				
<u>Copper System:</u>				
Federal	754,000	23,860		
Non-Federal	<u>635,700</u>	<u>26,140</u>		
Subtotal, Copper System	1,389,700	50,000	53,500	1.1
<u>Bluff Channel:</u>				
Federal	1,085,000	34,340		
Non-Federal	<u>1,144,300</u>	<u>50,660</u>		
Subtotal, Bluff Channel	2,229,300	85,000	106,200	1.2
<u>Total Southeast:</u>				
Federal	1,839,000	58,200		
Non-Federal	<u>1,780,000</u>	<u>76,800</u>		
Total, Southeast Area	3,619,000	135,000	159,700	1.2
<u>EL PASO LOCAL PROTECTION PROJECT:</u>				
Federal	12,493,000	395,330		
Non-Federal	<u>3,131,000</u>	<u>199,670</u>		
Total Project	\$15,624,000	\$595,000	\$1,032,900	1.7

LOCAL COOPERATION

84. PROPOSED LOCAL COOPERATION.- In the event that the El Paso Local Protection Project as described in this report is constructed by the United States, local interests should be required to:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction and operation of the project;

b. Hold and save the United States free from damages due to construction and operation of the project;

c. Maintain and operate the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Make any alterations to existing improvements, other than railroads or improvements constructed and maintained by the United States, which may be required because of the construction works;

e. Prevent encroachment on the diversion and outlet channels which would reduce their design capacities;

f. Take steps to prevent encroachment upon existing defined waterways tributary to the project by zoning or other means, such as enlargement or other modification of the existing waterway facilities to prevent the minor flood problems on these tributary waterways from developing into problems of serious proportions; and

g. Inform all individuals concerned in a manner satisfactory to the Secretary of the Army that the El Paso Local Protection Project is designed to control floods originating above the structures and that some residual flooding may be expected from precipitation occurring below the structures.

85. A public hearing and numerous public meetings and conferences have been held at El Paso concerning the solution of the flood and water related problems at and in the vicinity of El Paso. Upon completion of investigations made for this report, a conference was scheduled by the District Engineer with local interests at El Paso to obtain their views regarding the plan of improvement considered most feasible and, subject to their approval of the plan, to obtain assurances of their willingness to cooperate in the construction of the project if it is authorized. The conference was held November 26, 1963, at which time each element of the plan was described in detail and the requirements of local cooperation were explained. City officials expressed approval of the plan and gave verbal assurance of their willingness and ability to participate in construction of the project. Subsequent to the conference, city officials forwarded their written approval of the plan of improvement and stated that the city would furnish the required local cooperation. A copy of their letter is included in appendix E.

COORDINATION WITH OTHER AGENCIES

86. GENERAL.- During the preparation of this report, close coordination of studies relating to the water resources problems and needs of El Paso, Tex., and vicinity, and solutions thereto has been maintained with interested Federal agencies, the State of Texas, and the U.S. Section of the International Boundary and Water Commission. Valuable assistance was rendered by the U.S. Public Health Service, the U.S. Fish and Wildlife Service, the U.S. Bureau of Reclamation, the U.S. Section of the International Boundary and Water Commission, the U.S. Army Air Defense Center, Fort Bliss, Tex., and the Texas State Highway Department in the formulation and evaluation of the proposed plan of improvement. A letter report prepared by the U.S. Public Health Service concerning current and future water supply problems at El Paso is included in appendix E. A letter report prepared by the Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, regarding fish and wildlife resources at and in the vicinity of El Paso also is included in appendix E. To further the coordination of projects and programs, a draft of this report was submitted to the regional offices of all interested Federal agencies for review at field level and to the States of Texas and New Mexico. Their views and comments are summarized in the following paragraphs. Copies of written comments are included in appendix E.

87. U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE.- The State Conservationist commented that there are no works of improvement planned or contemplated under programs administered by the Soil Conservation Service which would affect or be adversely affected by the proposed El Paso Local Protection Project.

88. U.S. DEPARTMENT OF COMMERCE:

a. Bureau of Public Roads.- The Assistant Regional Engineer, Region Six, pointed out that Federal-aid highway funds cannot be used to help finance any highway work in connection with the proposed flood control project.

b. Coast and Geodetic Survey.- The Deputy Director stated that the comments of the Coast and Geodetic Survey would be incorporated with those of the Department of Commerce when the final report is reviewed.

c. Weather Bureau.- The Area Hydrologic Engineer, South Central Area, advised that he had reviewed the draft of report and had no comments.

89. U.S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE.- The Regional Program Director, Water Supply and Pollution Control, Public Health Service, Fort Worth Regional Office, commented that prevention of flooding at El Paso would provide a more favorable environment for good public health practices. He concurred in the report statement

that storage in the project to meet needs other than flood control at El Paso would not be practical, and referred to the Public Health Service report on industrial water supply needs included in appendix E. In addition, he advised that comments on the vector control aspects of the El Paso Local Protection Project would be provided by the Communicable Disease Center at a later date.

90. U.S. DEPARTMENT OF THE INTERIOR:

a. Office of the Secretary, Southwest Region.- The Acting Regional Coordinator stated that the regional directors of the bureaus with primary interest in the El Paso area would submit their comments individually on the draft of report.

b. Bureau of Mines.- The Acting Area Director, Area IV, Mineral Resource Office, stated that review of data available in his office indicated that the El Paso Local Protection Project would have no adverse effect on the mineral industries in the area and that reduction of flooding would be beneficial to mineral resources. He also stated that no field examination was made of the area but that his office has no objection to the proposed construction.

c. Bureau of Reclamation.- The Regional Director, Region 5, and the Project Manager of the Rio Grande Project, El Paso, commented on the El Paso Local Protection Project as it would affect the irrigation facilities of the Rio Grande Project, with particular reference to the capacity of the Montoya Drain and provision of bridge crossings over canals, drains, and laterals. Applicable revisions of the report have been made in conformance with these comments. The necessity for adequate crossings for passage of maintenance equipment and for farm operations was emphasized. The Director also stated that any right-of-way privilege or easement negotiated by the Bureau of Reclamation for the use of the irrigation and drainage facilities in either the Elephant Butte Irrigation District or the El Paso County Water Improvement District No. 1 must be with the consent of the Board of Directors of the affected District.

d. Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service.- Prior to completion of the draft of report, design details of the proposed plan of improvement were coordinated with the Regional Director of the Bureau of Sport Fisheries and Wildlife, Region 2, Albuquerque, N. Mex., and the Field Supervisor, Branch of River Basin Studies, Fort Worth, Tex. In connection with the studies and by authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) a letter report on the proposed El Paso Local Protection Project was prepared by the Regional Director to accompany this report. The report concluded that the overall effects of the project on fish and wildlife resources would be insignificant. A copy of a letter expressing the concurrence of the Executive Director, Texas Parks and Wildlife Department, was attached to the report.

Subsequent to review of the draft of this report, the Chief, Division of Technical Services, Region 2, advised that the Bureau had no further comments.

e. Geological Survey.- The Contact Official, Southwest Field Committee, Region Six, recommended appropriate hydrologic instrumentation for monitoring and evaluating projects built for flood protection. This recommendation is concurred in and necessary stream gages will be provided as a part of the project and provision made for their maintenance and operation.

f. Bureau of Land Management.- The Acting State Director, Santa Fe, N. Mex., stated that the proposed plan of improvement would not affect public lands administered by the Bureau of Land Management.

g. National Park Service.- The Acting Regional Director, Southwest Region, stated that an archeological survey should be made of the various project sites in advance of construction. He added that when the El Paso Local Protection Project is authorized, a survey and any necessary excavations would be accomplished by the National Park Service.

h. Bureau of Outdoor Recreation.- The Acting Regional Director, Mid-Continent Region 3, declined to comment on the draft of report without benefit of an interagency cooperative agreement.

91. FEDERAL POWER COMMISSION.- The Acting Regional Director, Fort Worth Regional Office, stated that the recommended plan of improvement would not be adaptable to the development of hydroelectric power; and that the increase in Rio Grande streamflow would result in insignificant, if any, benefit to potential and existing power developments located downstream from El Paso.

92. HOUSING AND HOME FINANCE AGENCY.- The Regional Director, Region V, Urban Renewal Division, stated that the Agency has no current projects in the area under investigation but that he would appreciate being advised of future development resulting from the study.

93. INTERNATIONAL BOUNDARY AND WATER COMMISSION.- The Commissioner of the United States Section advised that the U.S. Section concurs in the recommendations of the report. He stated that the principal interest and concern of the Commission are the changes in Rio Grande flow conditions anticipated as the result of the proposed El Paso Local Protection Project, and the effect of such changes on Rio Grande projects under its jurisdiction. He stated further that the U.S. Section will initiate joint studies and investigations with the Mexico Section to determine the additional flood protection, if any, which may be warranted and the manner in which it could be most effectively achieved.

94. STATE OF TEXAS.- The Chief Engineer, Texas Water Commission, stated that a review of the draft of report indicated that the proposed project would afford protection to valuable properties at and in the vicinity of El Paso and permit a better balanced economic development of the protected areas. He further stated that formal comments will be made by the Commission in accordance with Texas statutes when the report is received from the Chief of Engineers.

95. STATE OF NEW MEXICO.- The State Engineer commented that the State of New Mexico would offer no objection to the proposed plan of improvement as described in the draft of report. He also called attention to some minor discrepancies in the report which have been corrected as suggested.

96. RIO GRANDE COMPACT COMMISSION.- The Chairman and Federal Representative of the Commission had no comment on the draft of report.

DISCUSSION

97. This report presents the results of an investigation made to determine the flood control and other water related needs at and in the vicinity of El Paso, Tex., and the solutions considered to meet these needs. El Paso is situated in west Texas on the left bank of the reach of the Rio Grande which forms part of the international boundary between the United States and Mexico.

98. The flood problem at El Paso and vicinity is from two sources: (1) the main stem of the Rio Grande and (2) the numerous tributary arroyos which head on the eastern, southern, and western slopes of the adjacent Franklin Mountains and descend upon the city. During the 1930's, the International Boundary and Water Commission constructed a leveed floodway on the Rio Grande with a capacity of about 12,000 c.f.s. above the American Dam and 11,000 c.f.s. below the dam. The American Diversion Dam is located on the Rio Grande at the point where the river becomes a part of the international boundary. Inasmuch as the main stem of the Rio Grande is under the administration of the International Boundary and Water Commission, this report is not directly concerned with the main stem flood problem but is limited to the problems created by the tributary arroyos.

99. For topographical reasons, the overall arroyo flood problem area at El Paso and vicinity was divided into the following independent study areas: Northwest, Central, Southeast, and Downtown Areas. The solutions considered for each area also are independent. The Downtown Area includes the principal business district and the older residential sections of the city. Because existing improvements provide a reasonable degree of protection to this area, no further improvement for flood control and related purposes was found to be warranted. In the other three areas, however, serious flood problems exist and improvements for flood control are justified.

100. In addition to the flood problems at El Paso and vicinity, the city is faced with the problem of meeting an increasing demand for municipal and industrial water, created by a rapidly expanding population. Water-associated recreational facilities also are needed to satisfy the increasing demand for outdoor recreation. These problems were given consideration but because of the low annual rainfall and runoff, it would be impracticable to provide water resources improvements for purposes other than flood control.

101. Although there is evidence that heavy flooding occurred in the Northwest, Central, and Southeast Areas prior to 1940, the flooded areas were sparsely developed and only minor damage occurred. However, in the past 20 years development has spread rapidly into these areas and created a major flood problem. The value of property subject to flooding is estimated at \$258,321,000, comprising \$55,500,000, \$163,450,000, and \$39,371,000 in the Northwest, Central, and Southeast Areas, respectively. The average annual damages in the respective areas including an allowance for future development are \$548,900, \$362,100, and \$179,100, a total of \$1,090,100.

102. Numerous solutions to the arroyo flood problem were investigated including reservoirs, diversions, floodways, drains, and combinations thereof. The improvement considered most feasible from an engineering and economic standpoint consists of a single-purpose plan for flood control, designated as the El Paso Local Protection Project. The project comprises four independent elements, one of which is located in the Northwest Area, one in the Central Area, and two in the Southeast Area. The two plans in the Southeast Area are designated as the Copper System and Bluff Channel.

103. The plan for the Northwest Area consists essentially of three reservoirs and a diversion channel together with appurtenant facilities. Two of the reservoirs would be enlargements of existing structures and the other would be new construction. The diversion channel would convey the releases from the reservoirs and runoff from several uncontrolled arroyos and areas below the dams to the Rio Grande. In the event of the standard project storm, the peak discharge from the diversion channel into Rio Grande would be about 10,100 c.f.s. The Rio Grande flow from the same storm which would coincide with this peak is estimated at 1,100 c.f.s. making a total of 11,200 c.f.s. Allowing for withdrawals for irrigation and reductions through bank storage, the Rio Grande floodway would contain this flow. A larger combined peak could be produced from the uncontrolled area above the project from the same storm. Under existing conditions, runoff from the standard project storm would pond in the valley behind the Rio Grande levees; but because of the limited storage in the ponding area, the levees might not contain the floodwaters and thus would be subject to overtopping.

104. The Central Area plan consists basically of seven reservoirs plus diversions and outlet channels operating in conjunction with the existing facilities. The releases from four of the reservoirs and the diverted runoff from several uncontrolled arroyos would discharge into the existing Fort Bliss sump. Releases from the sump and from two other reservoirs would be conveyed to the terminal reservoir. Releases from the terminal reservoir would be conveyed to the Rio Grande by means of an existing ditch and an outfall conduit. In the event of the standard project flood, the peak discharge to Rio Grande would be 364 c.f.s. The coincident flow on the Rio Grande from the same storm would be nominal and the combined flows would be only a fraction of the channel capacity.

105. The Copper System plan for the Southeast Area consists essentially of a system of two reservoirs together with diversions and an outfall channel. The upper reservoir would be new construction and the lower reservoir would be an enlargement of an existing structure. The diversions would intercept arroyo flows and discharge them into the upper reservoir and the releases from this structure would be conveyed to the lower reservoir. Releases from the lower reservoir would be conveyed to the Rio Grande through the outfall channel. Through regulation provided by this system, the standard project flood peak discharge into the Rio Grande would be only 100 c.f.s.

106. The Bluff Channel would intercept arroyo flows above the area of principal damage and convey these flows to the Rio Grande. The peak discharge from the channel into the Rio Grande would be about 4,000 c.f.s. under design or standard project flood conditions. The coincident flow on Rio Grande from the same storm combined with the project discharge would be well within the capacity of the Rio Grande floodway.

107. The total first cost of the El Paso Local Protection Project is estimated at \$15,624,000, of which \$12,493,000 would be Federal and \$3,131,000, non-Federal. The Federal and non-Federal annual charges would be \$395,330 and \$199,670, respectively, a total of \$595,000. The non-Federal annual charges consist of \$99,105 for interest and amortization and \$100,565 for project operation and maintenance. The annual benefits are estimated at \$1,032,900, yielding a benefit-cost ratio of 1.7. The project is therefore economically justified. Furthermore, the four independent plans which comprise the El Paso Local Protection Project are individually justified. Local interests approve the plan and have stated in writing that they will provide the required items of local cooperation.

108. Concern has been expressed by the United States Section, International Boundary and Water Commission, regarding the possibility of flows from the improvements in the Northwest Area and the Bluff Channel of the Southeast Area combining with flows on the Rio Grande and endangering the international Rio Grande floodway. Both of these

plans would change flow conditions on the Rio Grande by collecting and diverting, into the river, interior runoff which now ponds on the valley floor. The United States Section of the Commission has advised that such changes would have to be approved by the two governments through the Commission. The United States Section also advised that an investigation is being made of the degree of protection now afforded on the Rio Grande and that which may be warranted.

109. Because the Rio Grande main stem is under the jurisdiction of the International Boundary and Water Commission, no studies were made by the Corps of Engineers in connection with this report regarding the Rio Grande floodway or of the feasibility of increasing its capacity. Some of the areas which would be protected by the proposed project are protected by the Rio Grande levees.

110. The El Paso Local Protection Project was selected because, with minor exceptions, it would provide standard project flood protection and produce the greatest excess of benefits over costs of all plans considered which would afford the same degree of protection. In the Northwest Area the plan would control flooding partially by reservoirs and partially by direct diversion into Rio Grande. An alternative plan was investigated that would provide equal protection, principally by reservoirs. The peak discharge into the Rio Grande from the standard project flood with the alternative plan in operation would be about 3,660 c.f.s. as compared to 10,100 c.f.s. for the selected plan. The peak discharge on Rio Grande from the uncontrolled area above the project would be 13,400 c.f.s., the same as the selected plan. Furthermore, due to the delay caused by reservoir retention, the peak discharges from the alternative project could synchronize with higher flows on the Rio Grande. In addition, the first cost of this alternative plan would be over \$4 million greater than that of the selected plan but no additional flood control benefits would accrue. Therefore, the additional expenditure would have to be justified by benefits to land and improvements along the main stem of the Rio Grande. Since a study of the main stem was not made for this report, such benefits were not determined.

111. Bluff Channel was selected for the Southeast Area because it also would provide the maximum excess of benefits over costs. Other plans were studied which would discharge smaller flows into the Rio Grande. The only alternative plan showing justification would involve reservoirs located above Interstate Highway 10. With this plan in operation, the discharge into Rio Grande from the standard project flood would be negligible, but the remaining uncontrolled drainage area between the reservoir and the area of principal damage would be so large that there would be a residual flood problem of undesirable proportions. For these reasons, it was concluded that there is no feasible alternative to Bluff Channel.

112. Since the proposed improvements in the Northwest Area and Bluff Channel would change flow conditions in an international section of the Rio Grande, construction should be deferred until such time as changes of flow conditions are approved by the two governments. The estimated first cost of the El Paso Local Protection Project excluding improvements in the Northwest Area and the Bluff Channel is \$9,321,700, of which \$8,064,000 would be Federal and \$1,257,700, non-Federal. The annual charges are \$349,000 and the annual benefits, \$389,500, yielding a benefit-cost ratio of 1.1. The individual benefit-cost ratios of the Central Area plan and the Copper System also are 1.1.

113. Additional information on the El Paso Local Protection Project and alternative projects called for by Senate Resolution 148, 85th Congress, adopted January 28, 1958, is presented in a supplement to this report.

CONCLUSIONS

114. CONCLUSIONS.- The District Engineer concludes that:

a. Participation by the United States in a project to control floods originating on tributaries of the Rio Grande at and in the vicinity of El Paso, Tex., is warranted.

b. The most feasible plan of improvement from an engineering and economic standpoint is the plan designated as the El Paso Local Protection Project. This plan is economically justified on the basis of evaluated benefits and annual charges.

c. The proposed plan of improvement in the Northwest Area and Bluff Channel in the Southeast Area would change flow conditions in the Rio Grande, through the reach which forms part of the international boundary between the United States and Mexico, by collecting and diverting, to the river, interior runoff which now naturally ponds on the valley floor. Such changes would require approval by the two governments through the International Boundary and Water Commission. This will require investigation of the degree of protection which should be provided by the Rio Grande Canalization Project above El Paso, Tex., and Juarez, Chihuahua, and the international Rectification Project downstream from the two cities. If construction of improvements is warranted as determined and agreed upon by the two governments to increase the capacity of the Rio Grande floodway, this work should be initiated before construction is started on improvements in the Northwest Area and on Bluff Channel.

d. Local interests concur in the plan and have indicated their willingness to cooperate in the construction, and maintain and operate the project.

RECOMMENDATIONS

115. The District Engineer recommends that construction of the El Paso Local Protection Project be authorized at an estimated first cost to the United States of \$12,493,000, provided that no construction shall begin until local interests commit themselves to:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction and operation of the project;

b. Hold and save the United States free from damages due to the construction and operation of the project;

c. Maintain and operate the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Make any alterations to existing improvements, other than railroads or improvements constructed and maintained by the United States, which may be required because of the construction works;


e. Prevent encroachment on the diversion and outlet channels which would reduce their design capacities;

f. Take steps to prevent encroachment upon existing defined waterways tributary to the project, by zoning or other means such as enlargement or other modification of the existing waterway facilities, to prevent the minor flood problems on these tributary waterways from developing into problems of serious proportions; and

g. Inform all individuals concerned in a manner satisfactory to the Secretary of the Army that the El Paso Local Protection Project is designed to control floods originating above the structures and that some residual flooding may be expected from precipitation occurring below the structures.

116. The District Engineer further recommends that all improvements comprising the El Paso Local Protection Project in the Central Area and the Copper System in the Southeast Area be constructed as soon as practicable, at an estimated cost of \$8,064,000 to the United States, and that construction of improvements in the Northwest Area and the Bluff Channel be deferred until such time as construction is initiated on the improvements which may be required to increase the capacity of the Rio Grande and its floodway by the International Boundary and Water Commission.

11 Incl
Listed on page 54


GERALD W. HOMANN
Colonel, CE
District Engineer

II Incl

1. Plate 1 - General Plan,
El Paso Local Protection Project
2. Plate 2 - Existing Flood
Control Works
3. Plate 3 - Plan A, Alternative
Plans Considered
4. Plate 4 - Plan B, Alternative
Plans Considered
5. Plate 5 - Plan C, Alternative
Plans Considered
6. Appendix A - Project Planning
7. Appendix B - Hydrology
8. Appendix C - Economic Base Study
9. Appendix D - Supplemental Economic
Data
10. Appendix E - Coordination with
Other Agencies
11. Information called for by S.R. 148

[First endorsement]

SWDGW-4

SUBJECT: Report on Survey for Flood Control and Allied Purposes:
El Paso, El Paso County, Texas

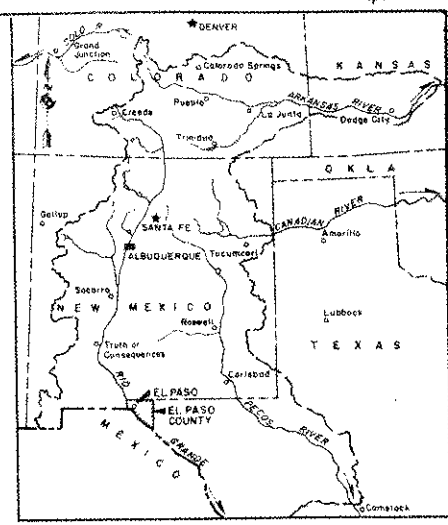
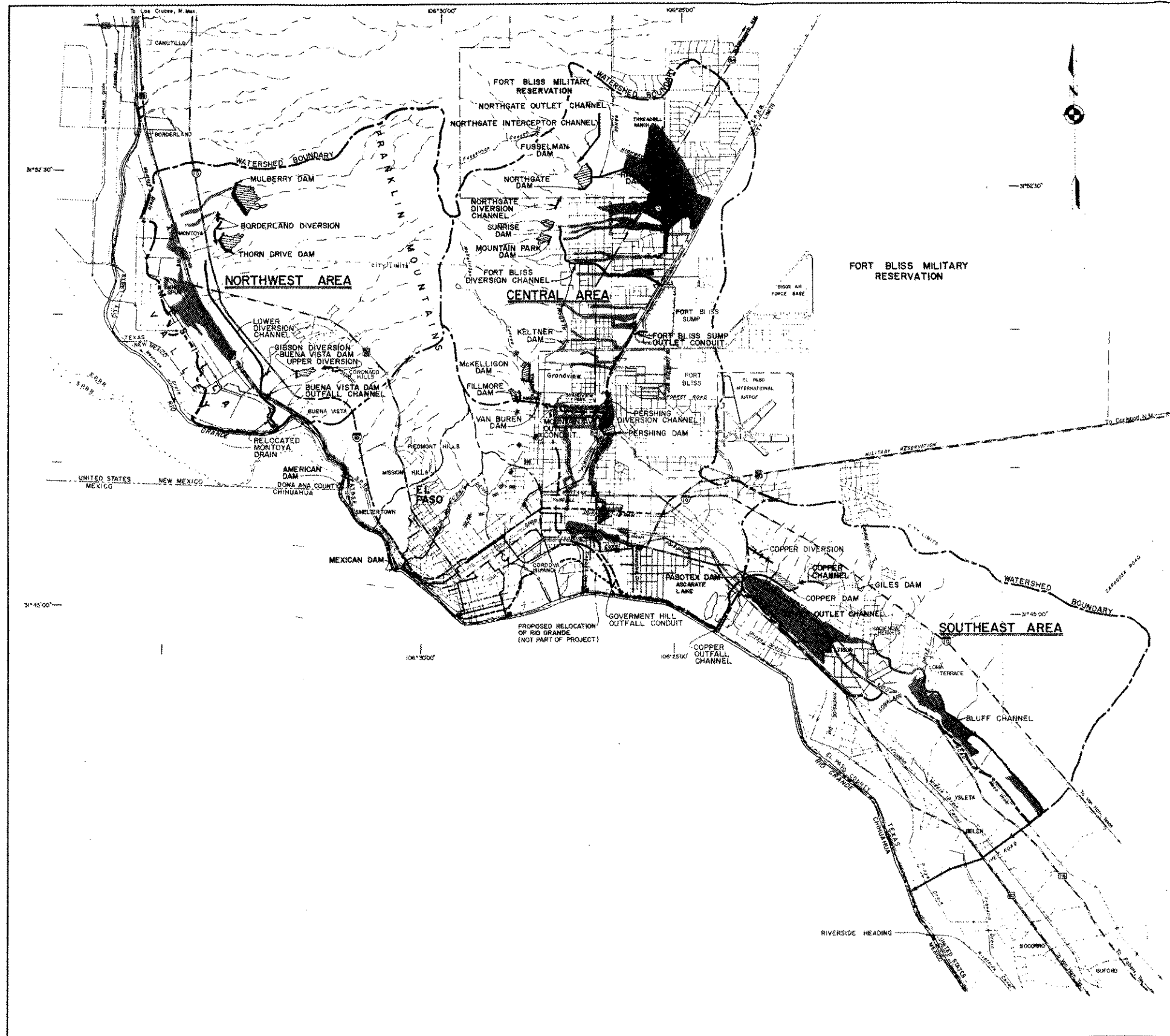
United States Army Engineer Division, Southwestern, Dallas, Texas
March 30, 1964

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

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



C. H. DUNN
Brigadier General, USA
Division Engineer



VICINITY MAP
SCALE IN MILES
0 100 150 200 250

LEGEND

- INTERSTATE HIGHWAY
- PROPOSED INTERSTATE HIGHWAY
- U.S. HIGHWAY
- STATE HIGHWAY
- STREETS AND SECONDARY ROADS
- RAILROAD
- PERENNIAL STREAM
- EPHEMERAL STREAM
- DETENTION DAM (EXISTING)
- IRRIGATION CANAL
- DRAIN DITCH
- CITY LIMITS (APPROX)
- MILITARY RESERVATION
- STATE AND INTERNATIONAL BOUNDARY
- PUMPING PLANT
- WATERSHED BOUNDARIES OF AREAS UNDER CONSIDERATION
- WATERSHED BOUNDARIES OF SUB-AREAS UNDER CONSIDERATION
- POUNDED WATER SPF FLOOD PLANS WITHOUT RECOMMENDED PLAN
- FLOWING WATER SPF FLOOD PLANS WITHOUT RECOMMENDED PLAN
- PROPOSED DAM
- PROPOSED CHANNEL
- PROPOSED DIVERSION
- PROPOSED CONDUIT

BIO GRANDE BASIN EL PASO, EL PASO COUNTY, TEXAS
REPORT ON SURVEY FOR FLOOD CONTROL & ALLIED PURPOSES
EL PASO, EL PASO COUNTY, TEXAS
EL PASO LOCAL PROTECTION PROJECT

GENERAL PLAN
SCALE IN FEET
1" = 10,000'

ALBUQUERQUE DISTRICT, ALBUQUERQUE, N. M.
SUBMITTED BY: *[Signature]* APPROVED BY: *[Signature]*
CHIEF, PLANNING & DESIGN BRANCH: *[Signature]* DISTRICT ENGINEER: *[Signature]*
TO ACCOMPANY REPORT COVERING EL PASO, EL PASO COUNTY, TEXAS FILE NO. _____

49-267 O-65 (Page p. 64)

REPORT ON SURVEY FOR FLOOD CONTROL AND ALLIED PURPOSES
EL PASO, EL PASO COUNTY, TEXAS

APPENDIX D - SUPPLEMENTAL ECONOMIC DATA

INTRODUCTION

1. PURPOSE AND SCOPE.- The purpose of this appendix is to present supplementary economic data and detailed damage and benefit information pertinent to the flood problem at and in the vicinity of El Paso, Tex., caused by floodwaters originating on the slopes of the adjacent Franklin Mountains and surrounding mesa lands.

2. SOURCE OF DATA AND PRICE LEVELS.- Data relative to property values and flood damages were determined by economic field appraisals, interviews with local governmental officials and realtors, and from a search of published and unpublished data and reports. Data presented in this appendix are on the basis of prices and conditions which prevailed during January 1964, unless indicated otherwise.

3. AREAS UNDER CONSIDERATION.- Studies were made of the flood problems of four areas within and in the immediate vicinity of the city of El Paso. Preliminary information gathered for one of these areas, the downtown business section of El Paso, indicated that existing improvements provide a reasonable degree of protection from flooding by mountain or mesa runoff so no further consideration was given to this area. The other three areas subject to flooding were studied in detail and the flood plains are described in the following paragraphs. The three areas under consideration and the flood plains are delimited on plate I following the main report.

FLOOD PLAIN DATA

4. NORTHWEST AREA.- The flood plain in the Northwest Area begins at a point about 4.2 miles northwest of downtown El Paso and extends northwestward for 5.3 miles, about 1.0 mile beyond the city limits. It has a maximum width of 0.8 mile. The area subject to flooding by the standard project flood totals 1,950 acres of suburban-agricultural lands. Irrigated cotton is grown on about 720 acres and corn, alfalfa, and maize are grown on another 10 acres. Building improvements include 630 residential units, 25 businesses, 2 churches, the 250,000-KW Rio Grande electric power plant, a horse racetrack, farm buildings, and irrigation ditches. Within the area subject to flooding are 2.6 miles of the AT&SF Railway System, 2.1 miles of U.S. Highway 80-85, and city and county streets and roads. A flood of standard project magnitude would create a series of ponds which would cover about 1,210 acres of the flood plain and the ponds would be interconnected by flowing waters which would inundate the remaining 740 acres.

5. CENTRAL AREA.- The flood plain in the Central Area begins about 10 miles northeast of downtown El Paso and extends southwestward for about 6 miles and thence southeast for another 6 miles to the Rio Grande levees. The area is irregular in shape and varies in width from a few hundred feet to about 1.9 miles at the southern end. The flood plain comprises approximately 5,100 acres, including 1,640 acres of the Fort Bliss Military Reservation. There are 160 military buildings within the flood plain on Ft. Bliss. In the non-military area there are about 7,000 residences, 190 mobile homes, 500 business units, 12 schools, a major shopping center, 15 churches, public buildings, and utility lines and plants, including the City Water Works Mesa Station, which furnishes about 16 percent of the city water supply. Transportation facilities in the flood plain include U.S. Highways 54, 80, and 62-180, 0.5 mile of the future Interstate Highway 10, two lines of the Southern Pacific Railroad, as well as many miles of city streets. Most of the residential property in the central part of this area is old, closely spaced, and of low value. Residential housing in the northern and southern parts is mostly of the moderate value subdivision type constructed during the last decade. The non-military part of the Central Area is occupied by urban development except for the 352-acre Ascarate Park in the southeast, some undeveloped tracts in the north, and a few scattered vacant blocks. A flood of standard project magnitude in the Central Area would create ponding on 1,280 acres at the southern end of the flood plain, ponding on three tracts comprising 210 acres in the central portion plus inundation of 470 acres by flowing water, ponding on 1,480 acres on the Ft. Bliss Military Reservation plus inundation of 160 acres by flowing water, and ponding on 210 acres northwest of Ft. Bliss plus inundation of 1,290 acres by flowing water.

6. SOUTHEAST AREA.- The flood plain in the Southeast Area begins about 5 miles east of downtown El Paso and extends in a southeastward direction for 7.4 miles. The area is 1,840 acres and the maximum width is about 0.8 mile. The flood plain is principally urban. Although much of the residential housing is quite old and of low value, there has been some recent subdivision construction and there are several high-priced residences in the area. The improvements consist of 2,140 residences, 130 business units, 2 schools, 7 churches, a public library, a fire station, farm buildings, irrigation ditches, public buildings, and utility lines. Transportation facilities included are city and county streets and roads and a one-mile section of Southern Pacific Railroad 28-track siding. Cotton is raised on about 600 acres of land by means of irrigation. A flood of standard project magnitude in the Southeast Area would create two ponds, covering 830 acres, which would be connected by flowing waters inundating the remaining 1,010 acres.

7. VALUE OF PROPERTY.- The total value of land and improvements in the three flood plains under consideration amounts to \$258,321,000, as itemized in table 1.

TABLE 1. — Value of Land and Improvements in the El Paso Standard Project Flood Plains (January 1964 Conditions and Prices)

Item	Value of Land and Improvements in \$1,000			
	Northwest Area	Central Area	Southeast Area	Total
<u>Urban and suburban:</u>				
Residential	\$10,175	\$68,675	\$23,130	\$101,980
Business	2,471	21,044	3,615	27,130
Schools and churches	450	8,097	2,573	11,120
Utility lines and plants	38,048	15,157	4,200	57,405
Public property	13	5,660	400	6,073
Land	<u>2,088</u>	<u>16,459</u>	<u>2,220</u>	<u>20,767</u>
Subtotal	53,245	135,092	36,138	224,475
<u>Agricultural property:</u>				
Improvements	80	0	55	135
Land	<u>1,460</u>	0	<u>1,095</u>	<u>2,555</u>
Subtotal	1,540		1,150	2,690
<u>Streets and highways</u>	455	2,423	948	3,826
<u>Railroads</u>	260	566	1,135	1,961
<u>Military property</u>	<u>0</u>	<u>25,369</u>	<u>0</u>	<u>25,369</u>
Total Value	\$55,500	\$163,450	\$39,371	\$258,321

FLOOD DAMAGES

8. GENERAL.— Flood damages at and in the vicinity of El Paso are caused by flowing water from tributary arroyos en route to the Rio Grande Valley floor, and by ponding of floodwater. Flood damages include both tangible and intangible damages. Tangible damages are those subject to monetary evaluation and include physical damage to property, reduction of net crop income, emergency costs, and business and financial losses both in and adjacent to the flood area. Intangible damages are those not susceptible to monetary evaluation and include danger to human life, human discomfort, injury and exposure during floods, creation of conditions detrimental to health and security, and interruption of normal community activities.

9. Physical damages include the cost of cleanup, damage to buildings and damage to other improvements and property. The railroads, highways, streets, roads, and utilities are inundated and scoured by high-velocity arroyo flows en route to low areas and are buried under rocks, sand, and other debris. Landscaping and crops also are damaged by scour and deposition, but the major damage to all property is by inundation. Some of the structures affected by major floods are of adobe construction and are especially vulnerable to flood damage because saturation of the lower few inches of an adobe wall will often cause complete collapse of the structure.

10. Emergency costs include cost of evacuation and reoccupation, sandbagging and diking, relief for flood victims, and additional policing. Business and financial losses are incurred as a result of a net loss of normal business profit and earnings of labor and management. These losses are exclusive of those that are recovered by postponed and alternative sales and those activities remote from the area where adjustments in supply of materials can be made.

11. DAMAGES FROM KNOWN FLOODS.- There was very little development in the flood plains under consideration in this report until after World War II. The earliest recorded flooding occurred in September 1941. Undoubtedly, runoff from severe rainstorms, such as those known to have occurred in 1863 and 1881 and probably on many other occasions before 1941, spread over the then uninhabited mountain slopes and mesa lands; but, since there was hardly any damage, there are no records of the floods. Subsequent to development of the areas, there have been few years without some flood damage. Floods of major proportions occurred in 1949, 1950, 1955, 1957, 1958, and 1962. Minor floods occurred in 1954 and 1963. Detailed estimates of damages are available for the floods of 1955, 1958, and 1962. The flood of July 1955, primarily the result of heavy rains which fell on the Franklin Mountains, caused damages of about \$640,000 within the city of El Paso. Water ponded on a total of about 450 acres and overflowed an additional 390 acres. A greater flood occurred in September 1958 and caused damages estimated at \$984,000. Rainfall amounts varied from 1.70 inches in the downtown area to 5.50 inches in the Coronado Hills area on the western slope of the Franklin Mountains. Most of the rainfall occurred within a 12-hour period. The area flooded included 700 acres by ponded water and 630 acres by flowing water. In September 1962, rains occurred which were comparable to those which caused the 1955 and 1958 floods, and the flood damages were estimated at \$855,000. About 510 acres were flooded by flowing water and 590 acres by ponded water. The latest flood occurred in August 1963 in southeast El Paso as the result of a small but very intense rainstorm. Although the area flooded was small and damages were only about \$39,000, a drowning occurred at Jesuit Draw. The damages caused by the 1955, 1958, and 1962 floods are itemized in table 2.

TABLE 2. — Estimated Damages from Major Floods, El Paso, El Paso County, Texas

Type	Flood Damages		
	July 1955	September 1958	September 1962
Residential	\$174,000	\$447,500	\$340,000
Business and industrial	0	71,000	104,000
Schools and churches	0	0	6,000
Public buildings	0	1,000	5,000
Utilities	20,000	22,500	30,000
Streets, highways, and roads	300,000	147,000	145,000
Railroads	0	5,000	0
Agricultural	0	5,000	5,000
Indirect losses	66,000	75,000	165,000
Flood fight and miscellaneous	<u>80,000</u>	<u>210,000</u>	<u>55,000</u>
Total	\$640,000	\$984,000	\$855,000

12. METHOD OF ESTIMATING DAMAGES.— The potential damages from floods of various magnitudes in each of the three areas were estimated and reduced to an average annual basis for the purpose of determining the annual flood damage preventable by the different plans of improvement considered.

13. The following procedure was used in estimating average annual damages. The flood plains of each of the standard project floods were delineated on topographic maps, differentiating between lands subject to flooding by flowing water or ponded water. The damages that would be caused by the standard project floods and by floods with stages ranging downward in one-foot increments to the point of zero damage were estimated by field examination of the improvements. The depth-damage relationships were established and then converted to volume and discharge-damage curves by the use of appropriate stage-volume or stage-discharge curves. Damage-frequency relationships were then prepared for each area by use of discharge or volume frequencies to determine the average annual damages to improvements with and without the plans considered. A volume-cropland overflowed relationship was established for the agricultural areas. Damages to crops were estimated from crop-loss curves and weighted to reflect the time of year when floods are most likely to occur. Damage-frequency relationships for improvements and crops were then combined to determine the average annual damages. Volume-damage, discharge-damage, and damage-frequency relations for each of the areas under consideration are shown on plates 1, 2, and 3.

14. DAMAGES FROM THE STANDARD PROJECT FLOODS.- The estimated damages which would be caused by an occurrence of the standard project flood in each of the areas under consideration are itemized in table 3.

TABLE 3. — Estimated Damages from Standard Project Floods at El Paso (January 1964 Conditions and Prices)

Item	Flood Damages in \$1,000			
	Northwest Area	Central Area	Southeast Area	Total
<u>Urban and suburban:</u>				
Residential	\$1,290.0	\$4,588	\$1,410	\$7,288.0
Business	95.0	564	279	938.0
Schools and churches	7.2	251	73	331.2
Utilities	81.8	165	50	296.8
Public property	0.0	67	20	87.0
Subtotal	1,474.0	5,635	1,832	8,941.0
<u>Agricultural property:</u>				
Improvements	109.0	0	5	114.0
Crops	58.0	0	65	123.0
Subtotal	167.0		70	237.0
<u>Streets and highways</u>	67.0	74	35	176.0
<u>Railroad</u>	15.0	102	15	132.0
<u>Military property</u>	0.0	8,935	0	8,935.0
<u>Business and financial losses</u>	605.0	47	6	658.0
<u>Emergency costs</u>	52.0	179	15	246.0
Total Damages	\$2,380.0	\$14,972	\$1,973	\$19,325.0

15. AVERAGE ANNUAL DAMAGES WITHOUT ADDITIONAL IMPROVEMENT FOR FLOOD PROTECTION.- The estimated average annual damages with the existing flood control improvements in operation, based on the present state of development in the flood plain with the addition of an allowance for future development in each area, are listed in table 4.

TABLE 4. — Average Annual Damages without Additional Improvement for Flood Protection (January 1964 Conditions and Prices)

Item	Northwest Area	Central Area	Southeast Area	Total
<u>Urban and suburban:</u>				
Average annual damages (existing state of development)	\$87,400	\$224,800	\$77,500	\$389,700
Allowance for future development (percentage of existing conditions)	520%	43%	121%	
Average annual allowance for future development	454,500	96,700	93,800	645,000
Subtotal, Average Annual Urban and Suburban Damages	541,900	321,500	171,300	1,034,700
<u>Crop damages:</u>				
Average annual damages (existing state of development)	3,200	0	10,800	14,000
Allowance for future development (percentage of existing conditions)	-28%		-28%	
Average annual allowance for future development	-900		-3,000	-3,900
Subtotal, Average Annual Crop Damages	2,300	0	7,800	10,100
<u>Fort Bliss:</u>				
Average annual damages (no allowance for future development)	--	40,600	--	40,600
<u>El Paso Electric Co. Power Plant:</u>				
Average annual damages (no allowance for future development)	4,700	--	--	4,700
Total Average Annual Damages	\$548,900	\$362,100	\$179,100	\$1,090,100

TABLE 5. — Average Annual Damages with Selected Plan in Operation
(January 1964 Conditions and Prices)

Item	Northwest Area	Central Area	Southeast Area	Total
<u>Urban and suburban:</u>				
Average annual damages (existing state of development)	\$3,800	\$14,700	\$12,200	\$30,700
Allowance for future development (percentage of existing conditions)	520%	43%	121%	
Average annual allowance for future development	19,800	6,300	14,800	40,900
Subtotal, Average Annual Urban and Suburban Damages	23,600	21,000	27,000	71,600
<u>Crop damages:</u>				
Average annual damages (existing state of development)	200	0	600	800
Allowance for future development (percentage of existing conditions)	-28%		-28%	
Average annual allowance for future development	-100		-200	-300
Subtotal, Average Annual Crop Damages	100	0	400	500
<u>Fort Bliss:</u>				
Average annual damages (no allowance for future development)	--	24,100	--	24,100
<u>El Paso Electric Co. Power Plant:</u>				
Average annual damages (no allowance for future development)	0	--	--	0
Total Average Annual Damages	\$23,700	\$45,100	\$27,400	\$96,200

16. AVERAGE ANNUAL DAMAGES WITH SELECTED PLAN IN OPERATION.- The estimated average annual damages with the local protection project operating, based on the existing state of development in the flood plain and with the addition of an allowance for future development in each area, are listed in table 5.

BENEFITS

17. FLOOD DAMAGE REDUCTION BENEFITS.- The annual benefit creditable to the El Paso Local Protection Project for the prevention of flood damages is the difference between the estimated average annual damages with and without the project operating. These benefits, including an allowance for future development, are given in table 6.

TABLE 6. — Annual Flood Damage Reduction Benefits - El Paso Local Protection Project (January 1964 Prices)

Item	Northwest Area	Central Area	Southeast Area	Total
Average annual damages without the local protection project	\$548,900	\$362,100	\$179,100	\$1,090,100
Average annual damages with the local protection project	23,700	45,100	27,400	96,200
Total Annual Flood Reduction Benefits	\$525,200	\$317,000	\$151,700	\$993,900

18. BENEFITS FROM INCREASED LAND UTILIZATION.- Although most of the experienced floods at El Paso have caused only small losses to the individual property owner, the hazard has prevented the land from being utilized to the optimum degree for agricultural, industrial, and urban development. Any change in land use to a higher order as the result of removal of the flood risk would be a benefit to the project over and above and not duplicative of benefits accruing from the prevention of flood damages to crops and improvements in the flood plains. The annual enhancement benefit from increased land utilization is the expected increase in annual net return from the lands. The net return is measured by the annual equivalent of the increase in market values. The increased land utilization benefits for each of the areas under consideration are discussed in the following paragraphs.

a. Northwest Area.- The land in this area is quite flat and the flood threat from flowing water has not noticeably affected land utilization. Flooding by ponding, however, has prevented about 600 acres from being fully utilized for urban and suburban purposes. If protected from floods, the market value of the land would increase about \$400 per acre, or a total of \$240,000. This value reduced to an annual return at an interest rate of 5 percent amounts to \$12,000 annually.

b. Central Area.- Deep and frequent ponding in this area has markedly affected the utilization of about 100 acres of land for urban purposes. Flood protection would cause the market value to increase about \$1,000 per acre, or a total of \$100,000. Another 200 acres subject to deep, rapidly flowing water would increase in value by \$500 per acre, or a total of \$100,000. Six hundred acres subject to less severe flooding from flowing water would increase an estimated \$300 per acre, or a total of \$180,000. No change in land use is anticipated within the Fort Bliss Military Reservation or other parts of the Central Area. The total increase in land values amounts to \$380,000 which, reduced to an annual net return at 5 percent, would produce an annual benefit of \$19,000.

c. Southeast Area.- In this area there are about 400 acres of land subject to shallow ponding that would be more highly utilized for urban and suburban purposes if protected from flooding. The market value would increase \$400 per acre, or a total of \$160,000. This amount reduced to an annual net return at an interest rate of 5 percent would yield an annual benefit of \$8,000.

19. NEGATIVE BENEFITS.- Negative benefits are economic losses such as loss of income and taxes from property required for project construction. Many of the lands required for project construction are natural watercourses of undeveloped range land. Some features of the project will require the acquisition of productive lands but losses therefrom have been included in the project costs for lands and damages. Any loss of taxes resulting from construction of the project would be offset by additional taxes due to the increase in value of the protected properties. Construction of the El Paso Local Protection Project will not create any measurable adverse effects in other areas. Therefore, no negative benefits have been assigned to the project.

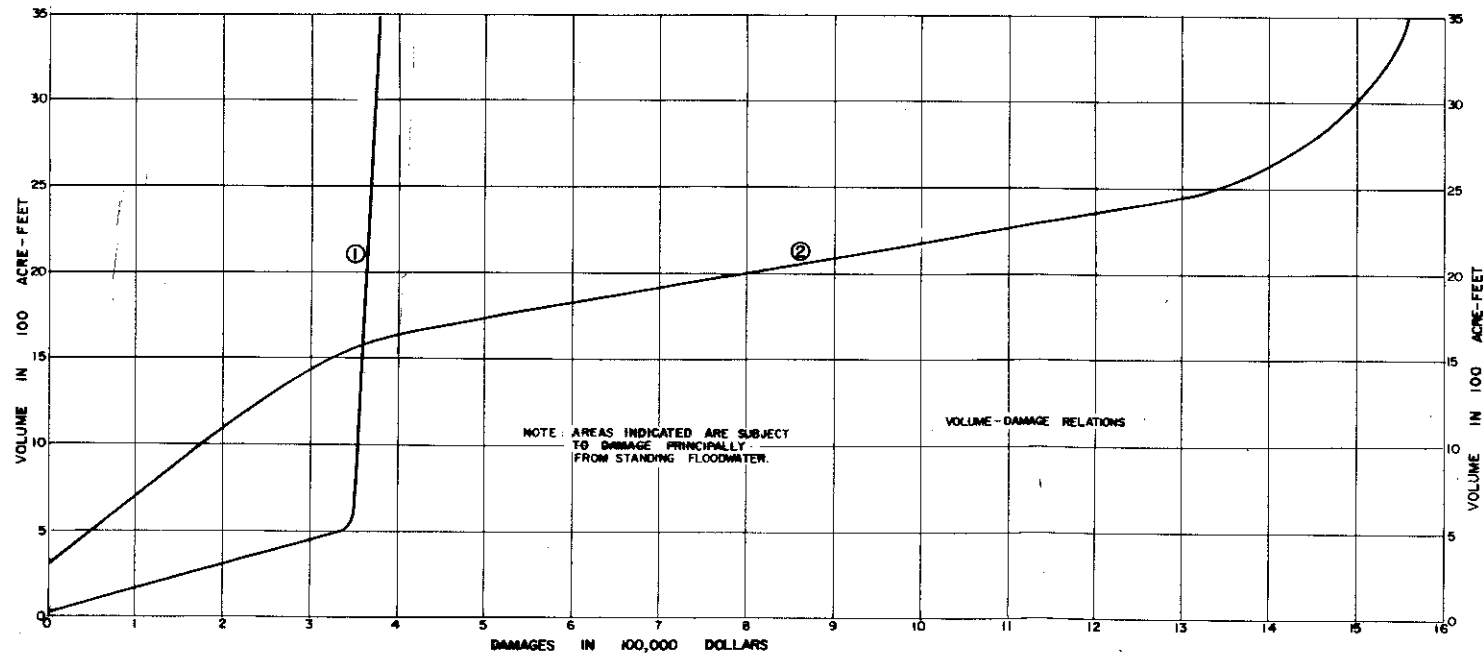
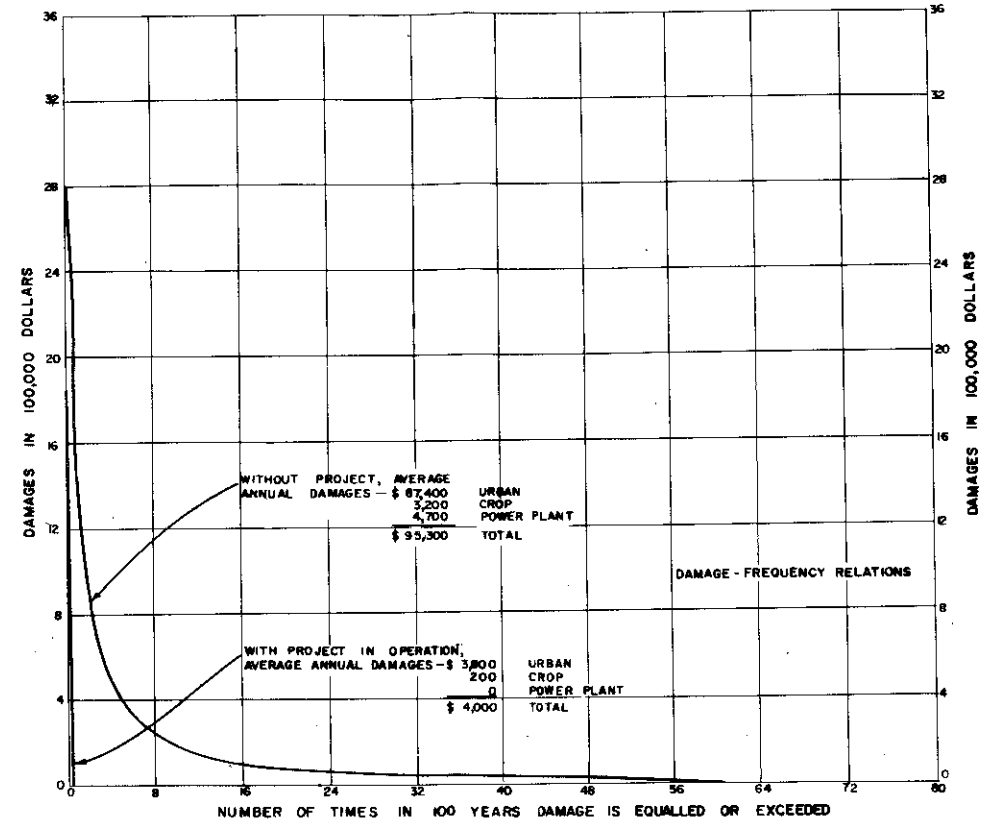
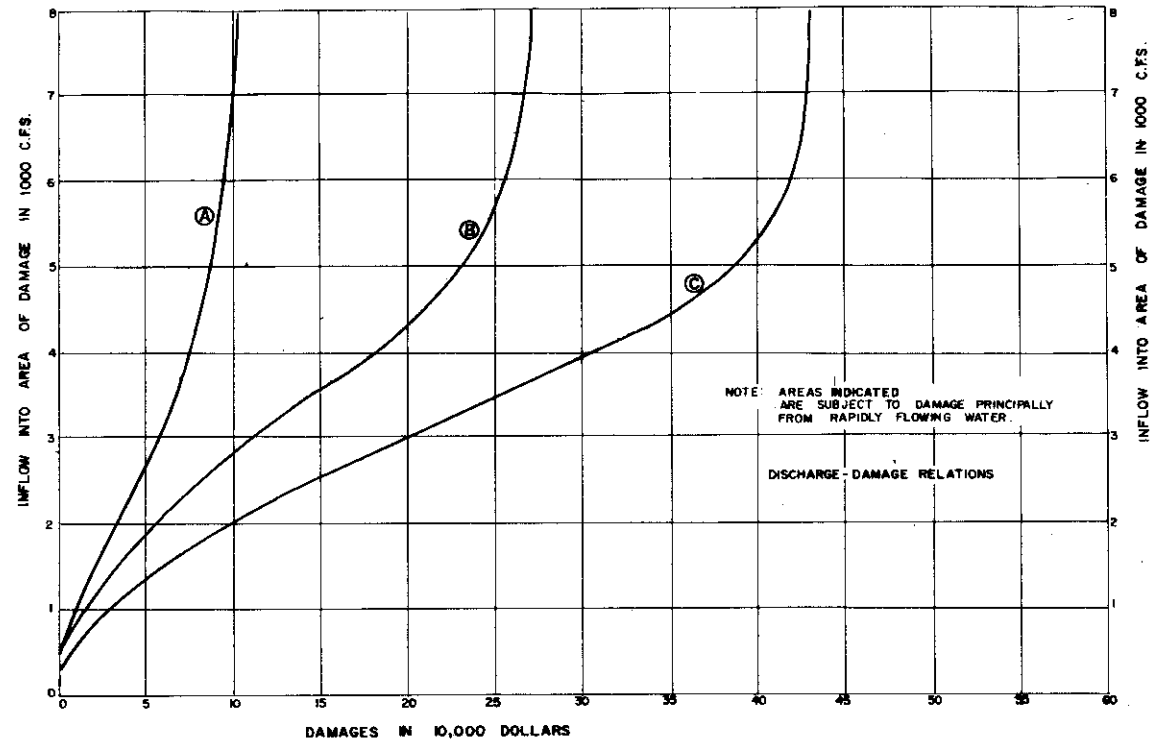
20. SECONDARY AND COLLATERAL BENEFITS.- Although El Paso is a trade and industrial center for a large region, floods will not significantly affect industrial production or transportation of goods. Since most of El Paso's industry is located outside the flood plains and the city is served by a widespread fine network of highways and several railroads, the chance of coincidental major flooding in enough places to cause a transportation problem is extremely remote. Therefore, there would be no measurable secondary benefits to the general economy

as a result of the project. Neither would there be any significant collateral benefits, incidental or otherwise, creditable to the project.

21. TOTAL BENEFITS.- The total annual benefits computed for the El Paso Local Protection Project are summarized in table 7.

TABLE 7. — Average Annual Benefits - El Paso Local Protection Project
((January 1964 Prices)

Type of Benefit	Northwest Area	Central Area	Southeast Area	Total
Flood damage reduction	\$525,200	\$317,000	\$151,700	\$993,900
Increased land utilization	<u>12,000</u>	<u>19,000</u>	<u>8,000</u>	<u>39,000</u>
Total Benefits	\$537,200	\$336,000	\$159,700	\$1,032,900



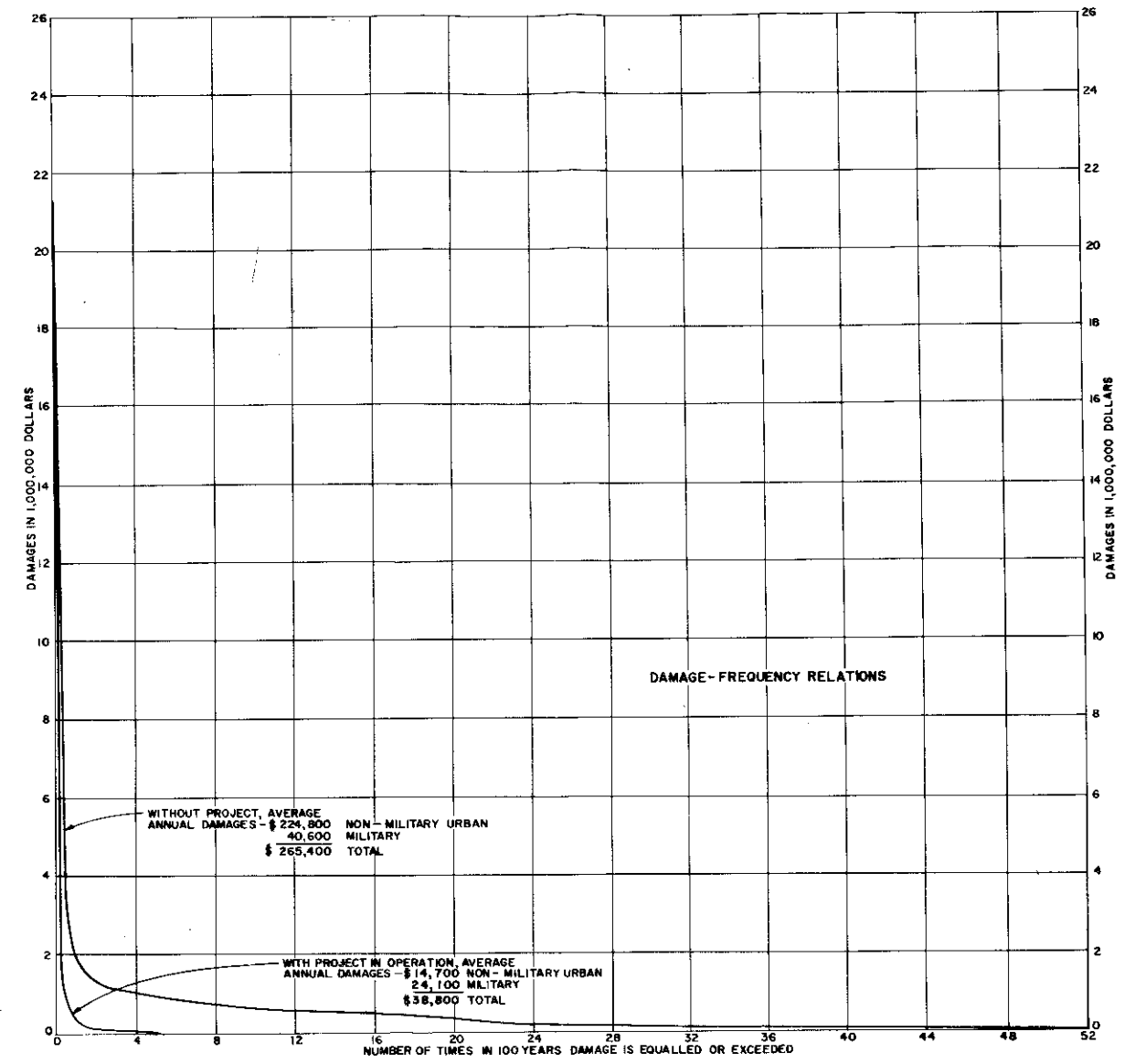
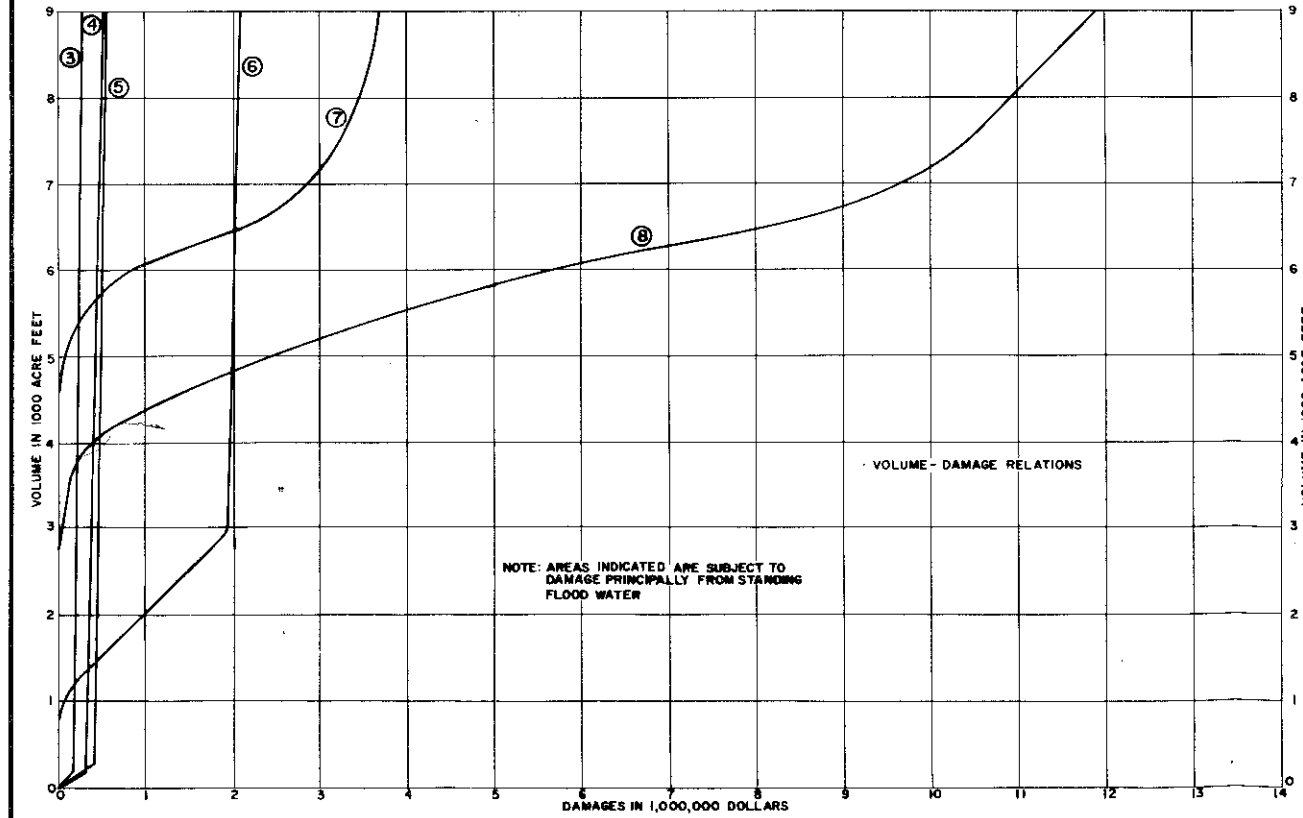
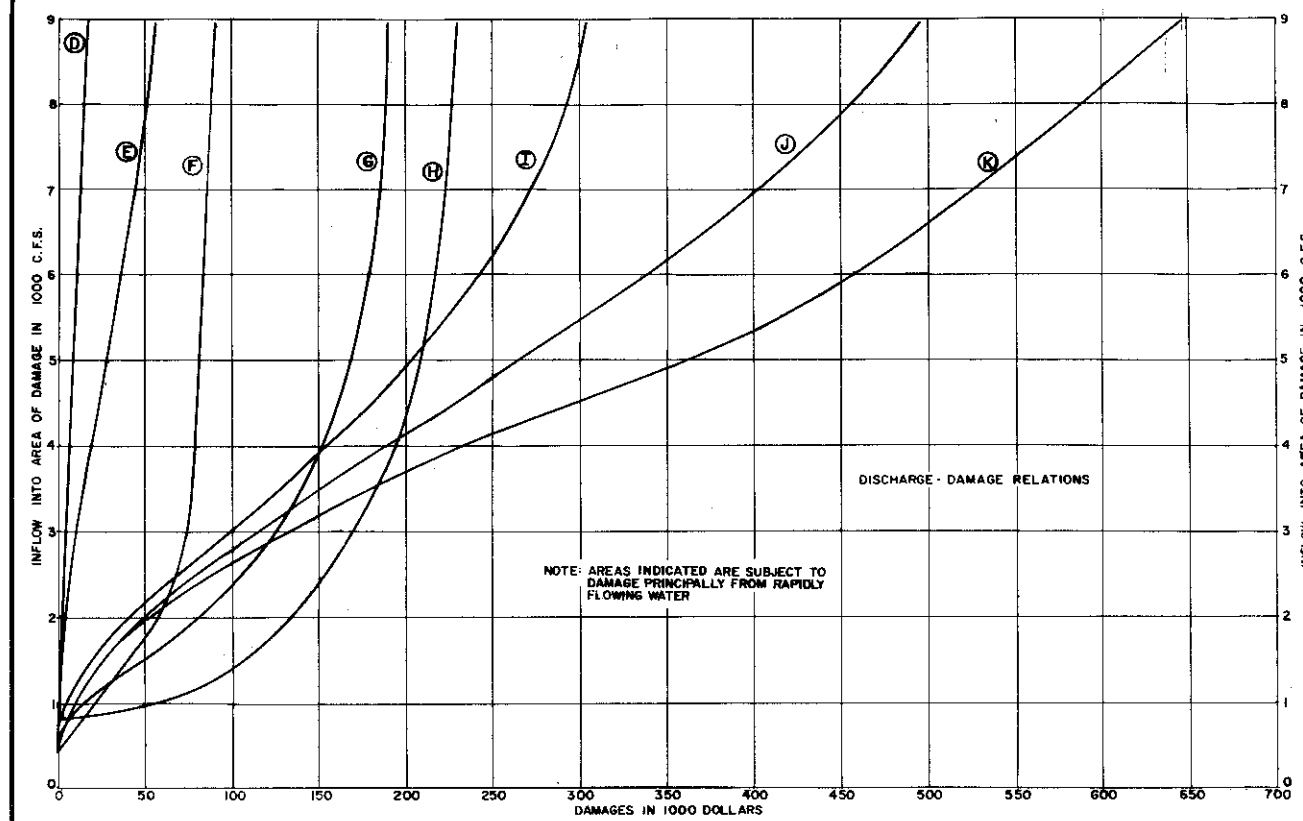
NOTE: NUMBERS AND LETTERS ON DISCHARGE-DAMAGE AND VOLUME-DAMAGE CURVES REFER TO AREAS SHOWN ON PLATE 4 OF THIS APPENDIX

RIO GRANDE BASIN EL PASO, EL PASO COUNTY, TEXAS
 REPORT ON SURVEY FOR FLOOD CONTROL & ALLIED PURPOSES EL PASO, EL PASO COUNTY, TEXAS

**NORTHWEST AREA
 DAMAGE - FREQUENCY RELATIONS
 EXISTING STATE OF DEVELOPMENT IN
 THE FLOOD PLAIN**

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE, N.M.
 TO ACCOMPANY REPORT COVERING EL PASO, EL PASO COUNTY, TEXAS FILE NO. RG-ELP-D-1



NOTE: NUMBERS AND LETTERS ON DISCHARGE-DAMAGE AND VOLUME-DAMAGE CURVES REFER TO AREAS SHOWN ON PLATE 4 OF THIS APPENDIX

RIO GRANDE BASIN EL PASO, EL PASO COUNTY, TEXAS
REPORT ON SURVEY FOR FLOOD CONTROL & ALLIED PURPOSES
EL PASO, EL PASO COUNTY, TEXAS

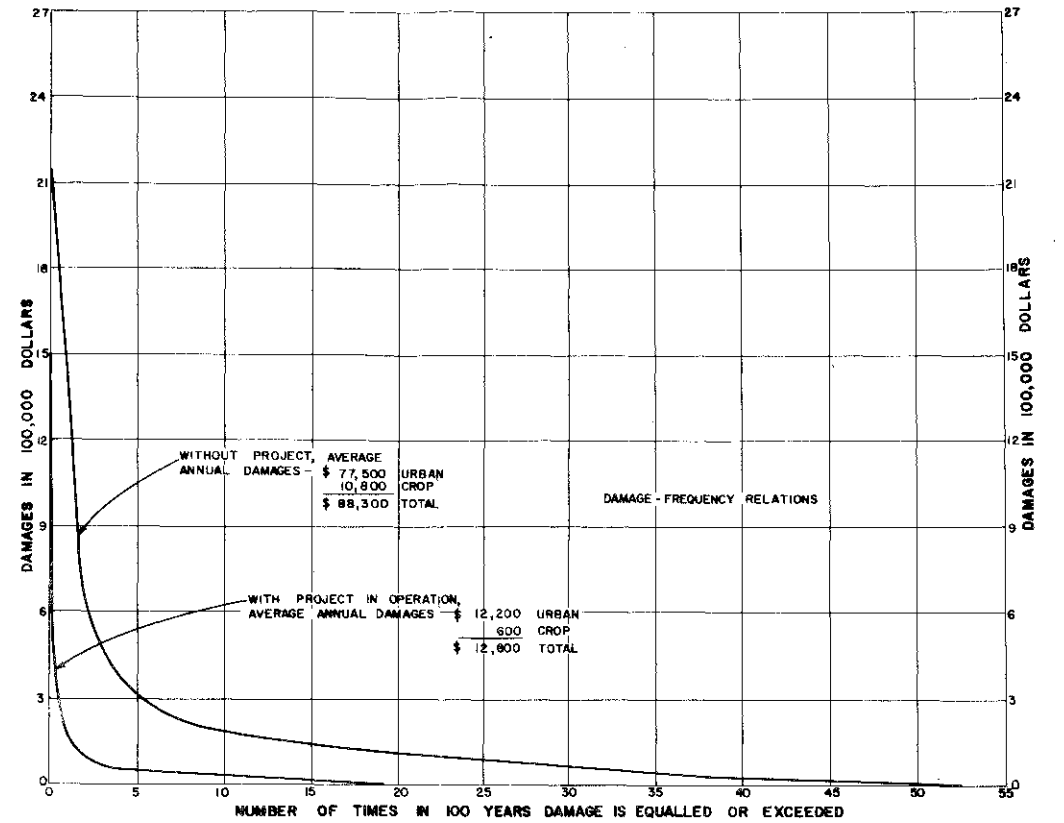
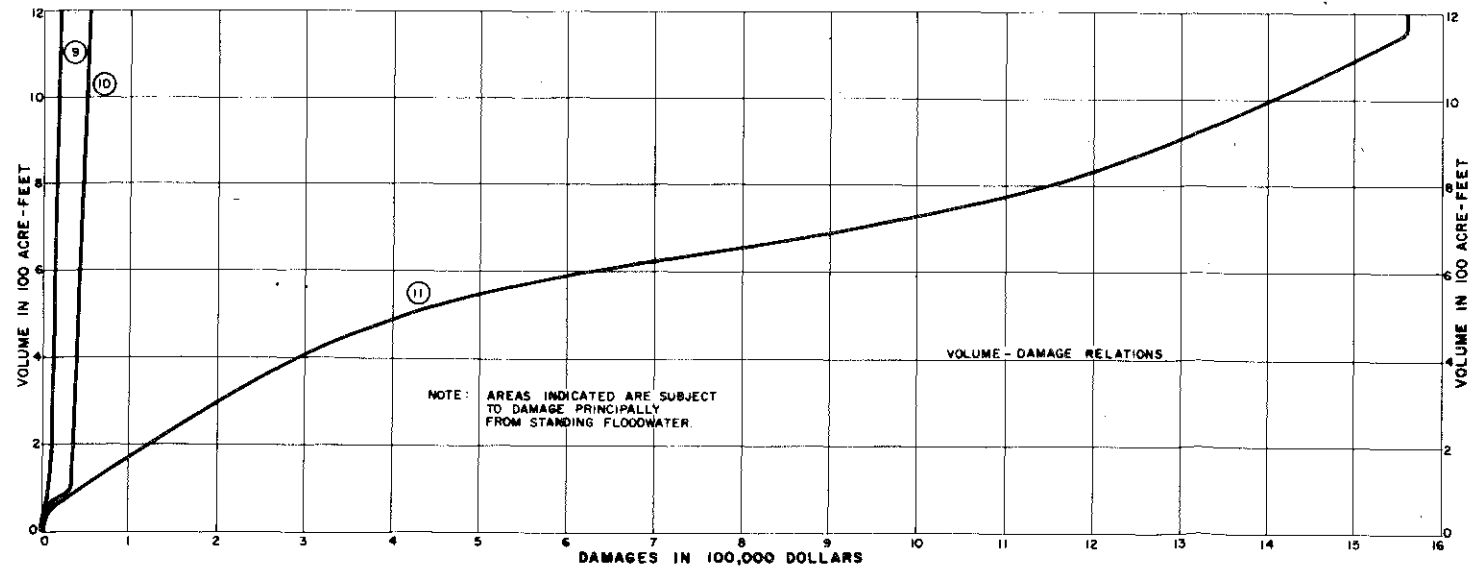
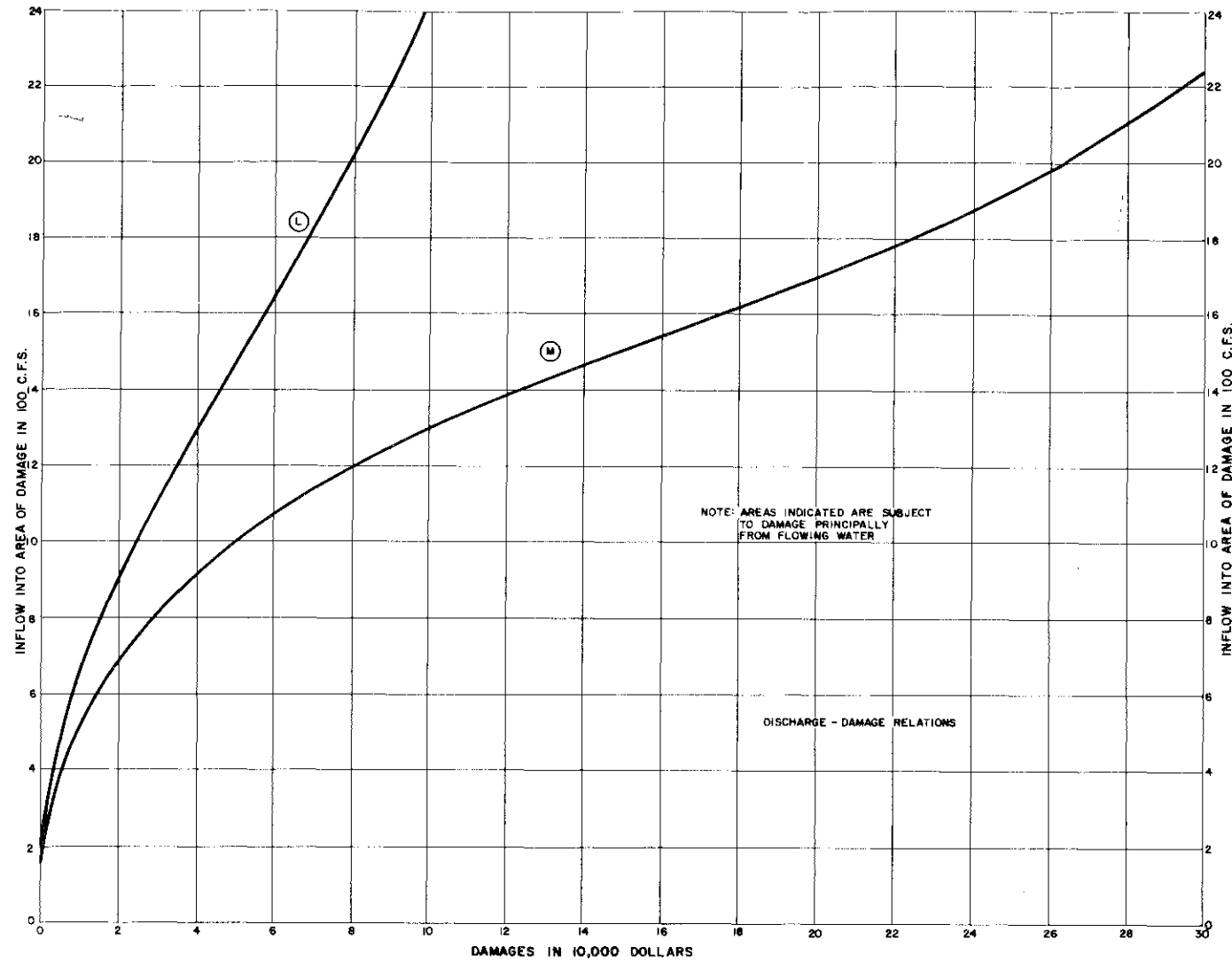
**CENTRAL AREA
DAMAGE - FREQUENCY RELATIONS**
EXISTING STATE OF DEVELOPMENT IN
THE FLOOD PLAIN

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE, N.M.
TO ACCOMPANY REPORT COVERING EL PASO, EL PASO COUNTY, TEXAS

FILE NO.
RG-ELP-D-2

49-267 O-65 (Face blank p. 76) No. 2



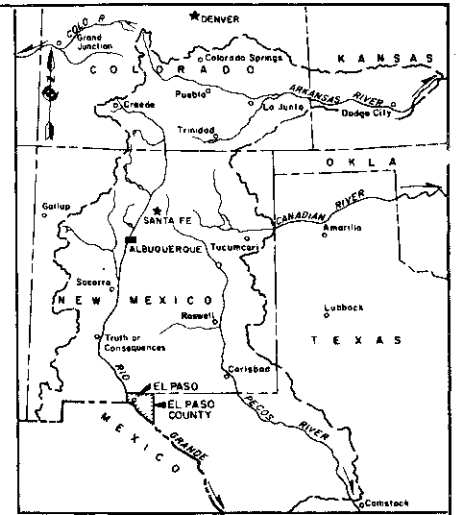
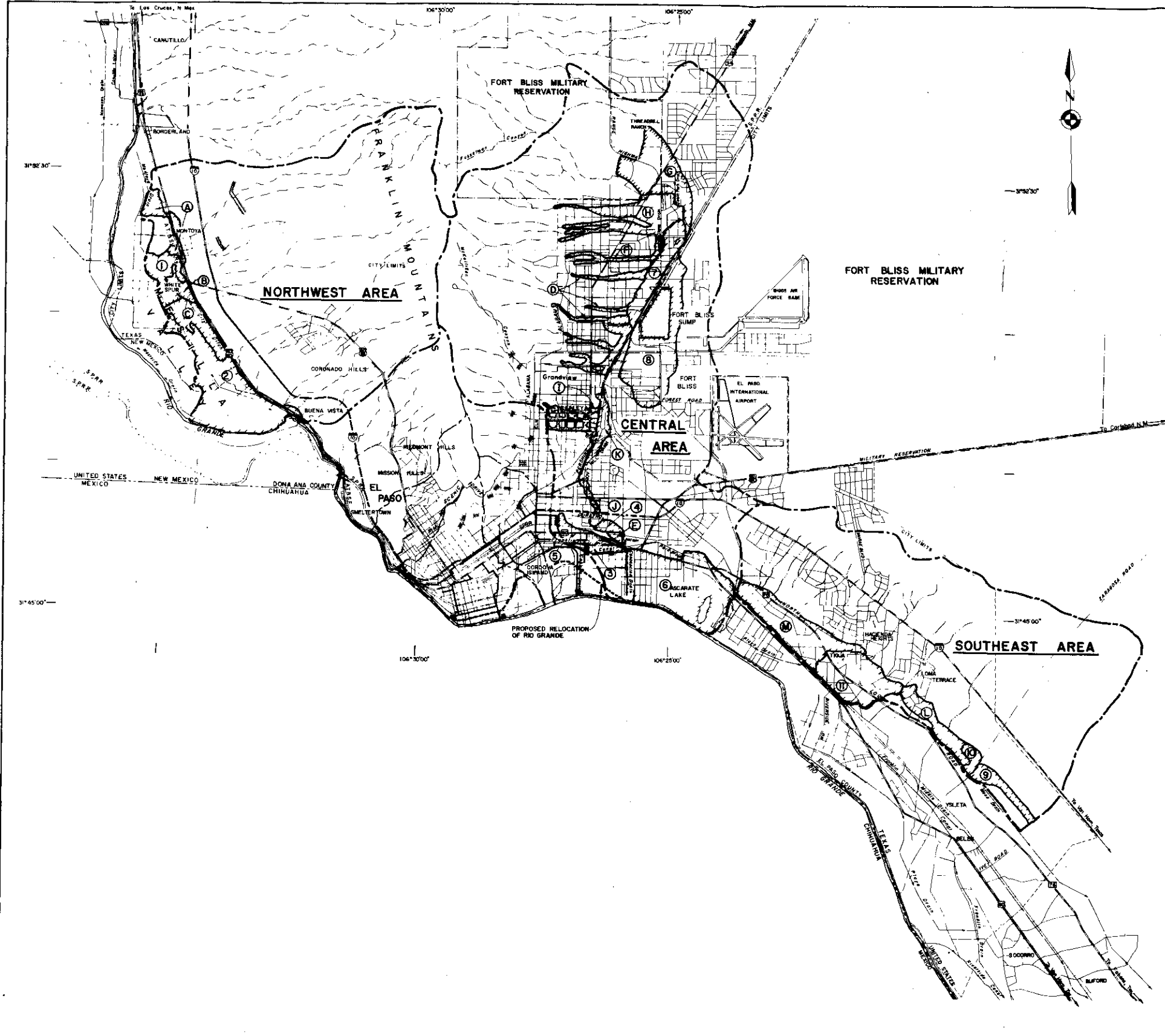
NOTE: NUMBERS AND LETTERS ON DISCHARGE - DAMAGE AND VOLUME - DAMAGE CURVES REFER TO AREAS SHOWN ON PLATE 4 OF THIS APPENDIX

RIO GRANDE BASIN EL PASO, EL PASO COUNTY, TEXAS
 REPORT ON SURVEY FOR FLOOD CONTROL & ALLIED PURPOSES
 EL PASO, EL PASO COUNTY, TEXAS

**SOUTHEAST AREA
 DAMAGE - FREQUENCY RELATIONS
 EXISTING STATE OF DEVELOPMENT IN
 THE FLOOD PLAIN**

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE, N.M.
 TO ACCOMPANY REPORT COVERING EL PASO, EL PASO COUNTY, TEXAS FILE NO. RG-ELP-D-3



VICINITY MAP
SCALE IN MILES
0 60 120 180 240

LEGEND

- INTERSTATE HIGHWAY
- PROPOSED INTERSTATE HIGHWAY
- U.S. HIGHWAY
- STATE HIGHWAY
- STREETS AND SECONDARY ROADS
- RAILROAD
- PERENNIAL STREAM
- EPHEMERAL STREAM
- DETENTION DAM
- IRRIGATION CANAL
- DRAIN DITCH
- CITY LIMITS (APPROX)
- MILITARY RESERVATION
- STORM DRAINS
- PUMPING PLANT
- WATERSHED BOUNDARIES OF AREAS UNDER CONSIDERATION
- WATERSHED BOUNDARIES OF SUB-AREAS UNDER CONSIDERATION
- AREAS SUBJECT TO FLOOD DAMAGE CAUSED PRINCIPALLY BY PONDING WATER
- AREAS SUBJECT TO FLOOD DAMAGE CAUSED PRINCIPALLY BY FLOWING WATER
- LIMITS OF FLOOD DAMAGE AREAS

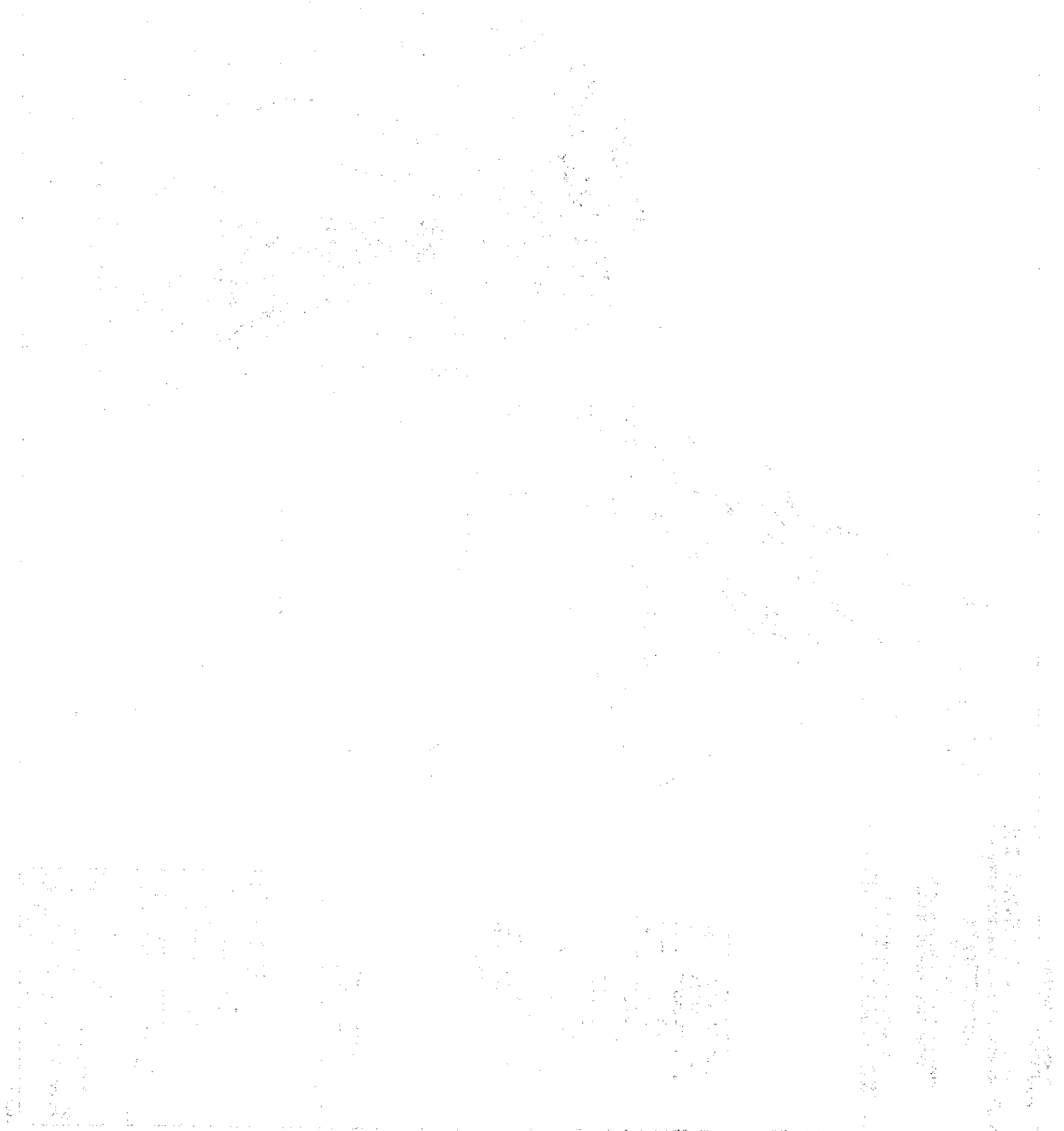
RIO GRANDE BASIN EL PASO, EL PASO COUNTY, TEXAS
REPORT ON SURVEY FOR FLOOD CONTROL & ALLIED PURPOSES
EL PASO, EL PASO COUNTY, TEXAS

FLOOD DAMAGE AREA INDEX
EXISTING STATE OF DEVELOPMENT IN THE FLOOD PLAIN

SCALE IN FEET
0 4000 8000 12000

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE, N.M.
TO ACCOMPANY REPORT COVERING
EL PASO, EL PASO COUNTY, TEXAS

FILE NO.
RG-ELP-D-4



APPENDIX E - COORDINATION WITH OTHER AGENCIES



UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 648
Temple, Texas 76502

February 27, 1964

Colonel Gerald W. Homann
District Engineer
U. S. Corps of Engineers
Federal Building
517 Gold Avenue, S. W.
Albuquerque, New Mexico 87103

Dear Colonel Homann:

Thank you for the opportunity to review a draft of the "Report on Survey for Flood Control and Allied Purposes, El Paso, El Paso, County, Texas." Copies of the draft sent to Mr. Howard Matson, Head of the Fort Worth Engineering and Watershed Planning Unit and to this office are being returned in accord with the request in your letter of transmittal.

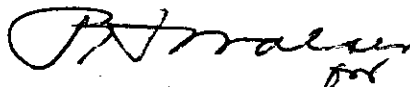
The report presents results of an investigation made to determine the flood control and other water related needs at and in the vicinity of El Paso, Texas, and the solutions considered to meet these needs.

Following investigation of numerous plans for solutions to the arroyo flood problems, the improvement designated as the El Paso Local Protection Project was determined to be the most feasible from an engineering and economic standpoint. This project, recommended by the District Engineer, and contingent on commitments by local interests, consists of four independent elements and includes a system of reservoirs, channels, levees, and diversions to control floods originating on tributaries of the Rio Grande and in the vicinity of El Paso. Most of the proposed measures are for protection of urban developments.

There are no works of improvement planned or contemplated under programs administered by the Soil Conservation Service which would affect or be adversely affected by the project recommended in this report.

The cooperation of your personnel in coordination of planning activities for resources development is appreciated. If we can assist you further, please let me know.

Sincerely yours,



H. N. Smith
State Conservationist

Attachments (2)

REGION SIX

ARKANSAS
LOUISIANA
OKLAHOMA
TEXAS

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

March 4, 1964

IN REPLY REFER TO:

06-00.1

Colonel Gerald W. Homann
District Engineer
Corps of Engineers
517 Gold Avenue, S. W.
Albuquerque, New Mexico 87103

Dear Colonel Homann:

We have reviewed your preliminary report on flood control for El Paso, Texas, furnished with your 14 February 1964 letter. We apologize for overlooking your request for a reply prior to 28 February.

We do not find any mention of highway work resulting from the flood control project, but we assume that if any such work is required, it is included in the alteration of existing improvements to be provided by local interests mentioned on pages 53 and 59, and in the \$1,052,500 Non-Federal relocations in Table 6. We wish to point out that Federal-aid highway funds cannot be used to help finance such work.

We appreciate the opportunity to review this report. We are returning it in accordance with your request. We are not certain as to whether you furnished a copy to our Texas Division office at Austin. If you do not plan to furnish a copy of the approved report direct to our Austin Office, we would appreciate your furnishing us two copies.

Sincerely yours,



Bill L. Andrews
Assistant Regional Engineer

Encl:
Preliminary report

U.S. DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
WASHINGTON 25, D.C.

OFFICE OF THE DIRECTOR

March 4, 1964

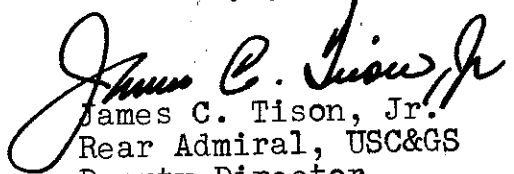
IN REPLY REFER TO: C-10

Mr. Gerald W. Homann
District Engineer
U.S. Army Engineer District, Albuquerque
Federal Building, 517 Gold Avenue S.W.
Albuquerque, New Mexico

Dear Mr. Homann:

The draft of your proposed report on survey for flood control and allied purposes, El Paso, El Paso County, Texas was forwarded to this office by our Fort Worth District Officer and is being returned under separate cover. Our comments will be incorporated with those of the Department of Commerce when the final report on the project is reviewed in this Department.

Sincerely yours,


James C. Tison, Jr.
Rear Admiral, USC&GS
Deputy Director

UNITED STATES DEPARTMENT OF COMMERCE

WEATHER BUREAU

AREA HYDROLOGIC ENGINEER

507 U. S. Court House
Fort Worth, Texas 76102

February 20, 1964

District Engineer
U. S. Army Engineer District, Albuquerque
Corps of Engineers
P. O. Box 1538
Albuquerque, New Mexico 87119

Dear Sir:

With reference to your letter SWAGH-1 dated February 14, 1964 transmitting your preliminary report on survey for flood control and allied purposes, El Paso, El Paso County, Texas, we wish to advise that we have reviewed this report and the Weather Bureau has no comments. We are returning the report as requested in your reference letter.

Very truly yours,



Richard J. MacConnell
Area Hydrologic Engineer

Enclosure

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE
Tenth Floor - 1114 Commerce Street
Dallas 2, Texas

PUBLIC HEALTH SERVICE

February 20, 1964

Your reference:
SWAGW-1

Colonel Gerald W. Homann
District Engineer
U.S. Army Engineer District, Albuquerque
Corps of Engineers
Federal Building, 517 Gold Avenue, S.W.
Albuquerque, New Mexico 87103

Dear Colonel Homann:

We have reviewed your report on survey for flood control and allied purposes, El Paso County, Texas.

Municipal and industrial water supply needs are discussed in the Public Health Service report which is contained in Appendix E.

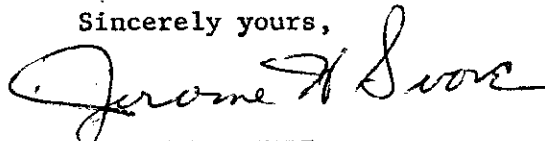
We concur with your statement on page 46, paragraph 91, that storage to meet other than flood control needs would not be practical in this proposed project.

Prevention of flooding in the vicinity of El Paso will provide a more favorable environment for good public health practices.

Comments on vector control aspects of this proposed project will be provided by our Communicable Disease Center at a later date. This interagency review would be facilitated if a copy of the tentative draft could be provided in advance.

We appreciate this opportunity to review your field level draft.

Sincerely yours,



JEROME H. SVORE
Regional Program Director
Water Supply & Pollution Control

Enclosure
Report draft

cc: New Mexico Dept. of Public Health

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

PUBLIC HEALTH SERVICE

1114 Commerce Street
Dallas 2, Texas

June 17, 1963

District Engineer
U.S. Army Engineer District, Albuquerque
P. O. Box 1538
Albuquerque, New Mexico

Dear Sir:

In response to your letters of January 30 and March 12, 1963, this office has made water use projections for El Paso County, Texas, based upon economic and demographic studies of the area. Benefits attributable to municipal and industrial water supply from your two proposed projects have been determined.

The El Paso Standard Metropolitan Statistical Area (El Paso County) has experienced a phenomenal growth rate with population increases of 48.7 percent between 1940 and 1950 and 61.1 percent between 1950 and 1960. Two military establishments, a dry climate, numerous tourist attractions, and favorable conditions for industrial expansion will contribute to a continued high rate of population expansion.

Irrigated cotton, cattle feeding, and dairy products have been the predominate agricultural segments of the economy and are expected to be of importance in the future. Cattle feeding, which experienced a sharp increase in recent years, is expected to become more important to agricultural income in the El Paso area while resulting in expanded meat processing facilities.

As shown in Table 1, manufacturing employment in the area has increased more than threefold since 1940. Food and apparel manufacturing, oil refining, and copper and lead smelting constitute the principal manufacturing segments of the economy. Manufacturing concerns in the area used about 9 million gallons daily in 1960 which amounted to about 14 percent of El Paso's water requirement.

The importance of military and tourist activities are reflected in Table 1 under "All Others Employed" and "Armed Forces."

Table 1

Employment and Labor Force
El Paso County
(1940-1960)

	-----1940-----		-----1950-----		-----1960-----	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
Agriculture	3,651	7.3	3,604	5.9	1,808	1.9
Mining	232	0.5	289	0.5	146	0.2
Manufacturing	4,668	9.4	7,116	11.6	14,127	15.2
All Others Employed*	37,543	75.3	48,207	78.3	70,865	76.2
Unemployed	3,735	7.5	2,291	3.7	6,054	6.5
Civilian Labor Force	N/A	N/A	61,507	100.0	93,000	100.0
Armed Forces	N/A	N/A	15,935		24,964	
Total Labor Force	49,829	100.0	77,442		117,964	

*In 1940 includes those employed on public works (WPA, NYA, CCC, etc.)

El Paso County is expected to maintain a high rate of growth, reaching 3,000,000 persons in the year 2070. (See Table 2.) Population projections assume that an adequate supply of water will be provided to serve future needs within the county.

Table 2

Present and Projected Populations
El Paso County
(1960-2070)

<u>Year</u>	<u>Total Population</u>
1960	314,000
1970	465,000
1995	1,000,000
2020	1,620,000
2045	2,300,000
2070	3,000,000

The city of El Paso, industry, and two military establishments had a 1960 water use of about 60 million gallons daily. These requirements were met from both ground and surface water sources.

Municipal water requirements have been increasing to a present 130 gallons per capita day and are expected to maximize at 160 gallons per capita day in 1970 and remain relatively constant thereafter. Water needs of the two military establishments are included with projected municipal demands in Table 3. Projected industrial water requirements are based on a continued growth of low water-using industry in the El Paso area.

Table 3

Projected Water Demands of El Paso County
(Million Gallons Daily)
(1970-2070)

<u>Year</u>	<u>Total</u>	<u>Municipal</u>	<u>Industrial</u>
1970	90	74	16
1995	192	160	32
2020	307	259	48
2045	432	368	64
2070	560	480	80

Benefits are calculated on the basis of utilizing an aquifer having a high dissolved solids concentration as the most reasonable alternative source of water. The value of these benefits is 29 cents per thousand gallons and is at least equivalent to the difference in cost of treating water from this aquifer and treating waters from the city's present sources. El Paso plans to use this aquifer for a water supply by the year 1965.

The flood control plan proposed for the city of El Paso as described in your letter of January 30, 1963, would make available, on an average annual basis, 634 acre-feet (0.57 million gallons daily) of water for municipal and industrial use. This amount of water could be made available by using controlled flood discharges as a supplement to present ground and surface sources. Benefits attributable to the provision of municipal and industrial water from the proposed project would have an average annual value of \$60,000.

The flood and sediment control plan proposed in your letter of March 12, 1963, would result in water salvage at the downstream Elephant Butte Reservoir. This plan is estimated to salvage and increase yields of the Elephant Butte Reservoir by 4,000 acre-feet annually (3.58 million gallons daily). If these increased yields can be made available to the city of El Paso, the resulting benefits would amount to \$378,000 annually.

Water quality control by flow regulation will be studied in the forthcoming Rio Grande Basin Comprehensive Study.

We appreciate this opportunity to express our views concerning your proposed projects.

Sincerely yours,

A handwritten signature in cursive script that reads "Jerome H. Svore". The signature is written in black ink and is positioned above the typed name.

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



UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
SOUTHWEST REGION

FEDERAL BUILDING, P. O. BOX 1467

MUSKOGEE, OKLAHOMA

February 19, 1964

Col. Gerald W. Homann
District Engineer
U.S. Army Engineer District
Corps of Engineers
Federal Building
517 Gold Avenue, S.W.
Albuquerque, New Mexico

Dear Col. Homann:

Your courtesy in providing a copy of the draft of your proposed Report on Survey for Flood Control and Allied Purposes, El Paso, El Paso County, Texas, for my review is appreciated.

I note that you have consulted with the Bureau of Sport Fisheries and Wildlife during your survey and surely you would have also consulted with the Bureau of Reclamation. Those are the bureaus with primary Interior interest in the City of El Paso area. It would be presumptuous of me to attempt to express their interests in the flood problem and I will return the draft copy without further comment.

I enjoyed reviewing it because of having lived at El Paso several years ago while employed in the Bureau of Reclamation.

Sincerely yours,

Kenneth D. McCall
Acting Regional Coordinator

Enclosure



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Office of
AREA DIRECTOR

AREA IV
MINERAL RESOURCE OFFICE

ROOM 208 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA

February 20, 1964

Col. Gerald W. Homann, District Engineer
Corps of Engineers
U. S. Army Engineers District, Albuquerque
517 Gold Avenue, S. W.
Albuquerque, New Mexico 87103

Your File SWAGW-1

Dear Col. Homann:

Thank you for sending us a copy of the draft of the proposed report on survey for flood control and allied purposes, El Paso, El Paso County, Texas, for field level review.

The plan of improvement for flood control consists of four separate plans, essentially as follows:

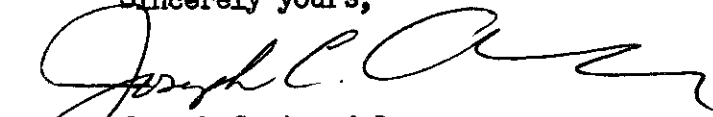
1. The Northwest Area plan consists of three reservoirs and a diversion channel
2. The Central Area plan consists of seven reservoirs plus diversions and outlet channels operating in conjunction with existing facilities
3. The Copper System of the Southeast Area consists of two reservoirs together with diversions and an outfall channel
4. The Bluff Channel to intercept arroyo flows above the area of principal damage and convey these flows to the Rio Grande

The ratio of average annual benefits (\$1,032,900) to annual average cost (\$595,000) is 1.7 to 1.0.

In 1962, cement, stone, and sand and gravel valued at \$5,286,138 were produced in El Paso County.

A review of all available office data indicates that the proposed plan of improvement would have no adverse effect on the mineral industries in the area. The reduction of flooding resulting from the construction of reservoirs, all relatively small, and channels would be beneficial to mineral resources. The Area IV Mineral Resource Office has no objection to the proposed construction. No field examination was made.

Sincerely yours,



Joseph C. Arundale,
Acting Area Director
Area 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

March 3, 1964

Col. Gerald W. Homann
District Engineer
Corps of Engineers
517 Gold Avenue, S.W.
Albuquerque, New Mexico 87103

Your reference:
SWAGW-1

Dear Colonel Homann:

In accordance with the request in your letter of February 14, 1964, the preliminary draft of your Report on Survey for Flood Control and Allied Purposes, El Paso, El Paso County, Texas, has been reviewed by this office and by the Project Manager of our Rio Grande Project, El Paso, Texas. Our comments on the preliminary draft of your report are as follows:

Northwest Area

The Plan and Profile for the Northwest Area, Plate 3 in Appendix A, shows the outlet of the Montoya Drain to be relocated in such manner that the flood control channel enters the river west of the El Paso Electric Company property, and that a 48-inch CMP siphon w/gate is to be provided at the point where the flood control channel crosses the present channel of the Montoya Drain. This appears to be in recognition of the comment made by the Project Manager of our Rio Grande Project in his December 9, 1963, letter to you to the effect that the El Paso Electric Company had a property right to the use of the flow of the Montoya Drain. The CMP in place at this time is a 60-inch pipe; therefore, it is believed the same diameter pipe should be used that currently exists downstream at the entrance to the El Paso Electric Company property.

The typical section for the Montoya Drain, shown on Plate 11 in Appendix A, shows the designed capacity of the drain to be 80 c.f.s. We wish to call attention to the fact that our project office has a record of 182 to 188 c.f.s. of drain and waste water (no flood water) on several occasions in normal years being discharged to the river from this drain. In this connection, drain flows during the past 12

or 13 years cannot be considered to be average or normal because of the influence of the drought years. As stated in the preceding paragraph, the El Paso Electric Company has a contractual right to the use of this drain water; and unless the El Paso Electric Company requests a change in the contract, the availability of the flow of the drain to pass into their property must be continued.

Southeast Area


Plate 8 in Appendix A shows that the outlet channel from the Pasotex Dam ponding area passes under the railroad tracks and the Franklin Canal in a 48-inch RCP. It appears that the 48-inch RCP lies under the Ascarate Wasteway Channel, but this is hard to determine because of the reduced size of the drawing. If this is the case, it appears that it may be under the bottom of the Ascarate Wasteway to just beyond the Playa Drain Crossing, and from that point on it diverges to the west of the Ascarate Wasteway Channel. Construction schedules would have to be arranged so as not to interfere with the passage of water during the irrigation season. In this connection, we wish to point out that water flows in the Franklin Canal in all months except January.

Plate 10 in Appendix A shows the crossing of the valley floor by the Bluff Channel. In general, the proposed structures appear to be adequate. As pointed out in the Project Manager's letter of December 9, 1963, the crossing of the canals, drains, and laterals should provide for sufficient bridge crossings for the passage of equipment from one side to the other. This is very important as equipment must move on the banks of such facilities. In addition, where the Bluff Channel cuts through farms, adequate access crossings for farm operations should be provided. It is noted in paragraph b. Irrigation, page 46 of the main report, that the selected plan of improvement would have no adverse effect on existing irrigation operations in the area, and that equipment and maintenance crossings would be provided; and, also, that severance of individual farms and the restoration of farm irrigation services could be resolved in the preconstruction planning stage. This, also, is highly important from the standpoint of necessity and maintenance of good will.

We wish to emphasize the statement made in the Project Manager's letter of December 9 to the effect that any right-of-way privilege or easement that the Bureau of Reclamation negotiates for the use of the irrigation and drainage facilities in either the Elephant Butte Irrigation District or the El Paso County Water Improvement District No. 1 must be with the consent of the Board of Directors of the affected District.

We appreciate the opportunity afforded us to review your proposed report. In accordance with your request, the review copy of the report is being returned under separate cover. Please furnish one copy of your final report to this office and one copy to our project office in El Paso.

Sincerely yours,


Regional Director

Separate cover: (36036)
1 copy report

cc:
Project Manager, El Paso, Texas
(w/o enclosure)



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

RIO GRANDE PROJECT
211 U. S. COURT HOUSE
EL PASO, TEXAS

IN REPLY
REFER TO:

February 25, 1964

Col. Gerald W. Homann
District Engineer
Corps of Engineers
Federal Building
517 Gold Avenue, S. W.
Albuquerque, New Mexico

Your reference: SWAGW-1

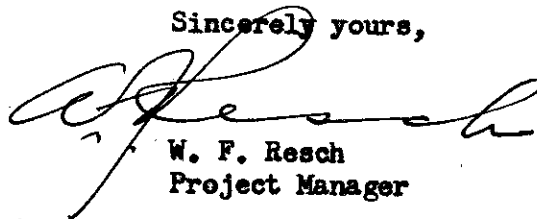
Dear Colonel Homann:

Returned herewith is the preliminary, subject-to-revision copy of "Report on Survey for Flood Control and Allied Purposes, El Paso, El Paso County, Texas" which you kindly transmitted to me for comments by your letter of February 14, 1964.

My comments are being forwarded to the office of the Regional Director for incorporation with any comments his office makes; while the report is being returned directly to you.

I will greatly appreciate receiving a copy of the final report.

Sincerely yours,



W. F. Resch
Project Manager

Enclosure



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

P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

February 19, 1964

District Engineer
Corps of Engineers, U. S. Army
P.O. Box 1538
Albuquerque, New Mexico

Dear Sir:

In your letter of February 14, 1964, referenced SWAGW-1, you requested our review and comment on the draft of the proposed report on survey for flood control and allied purposes, El Paso, El Paso County, Texas.

We are pleased to note that your treatment of fish and wildlife is in accord with our report of December 18, 1963, a copy of which appears in Appendix E of your draft.

We appreciate the opportunity to comment on your report.

Sincerely yours,


Carey H. Bennett, Chief
Division of Technical Services

cc:

Executive Director, Texas Parks and Wildlife Department, Austin, Texas
Field Supervisor, Branch of River Basin Studies, Bureau of Sport
Fisheries and Wildlife, Fort Worth, Texas



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

Branch of River Basin Studies
1104 T. & P. Building
Fort Worth, Texas 76102

February 25, 1964

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1538
Albuquerque, New Mexico 87103

Dear Sir:

By this letter, we are returning the copy of your draft of the proposed report on survey for flood control and allied purposes, El Paso, El Paso County, Texas, which you sent us on February 14, 1964.

Our Bureau's comments to the report have been sent to you by our Regional Office in Albuquerque.

Thank you for the opportunity to review this draft report.

Sincerely yours,

Herbert H. Brusman

Herbert H. Brusman
Acting Field Supervisor

Enclosure



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

P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

December 18, 1963

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1538
Albuquerque, New Mexico

Dear Sir:

This letter constitutes our Bureau's report in relation to the El Paso Local Protection Project in the vicinity of El Paso, Texas. It is intended to meet your needs in relation to a survey for flood control and allied purposes which is being made under the authority of Section 206 of the Flood Control Act, approved July 3, 1958 (72 Stat. 305).

This report has been prepared pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and has received the concurrence of the Texas Parks and Wildlife Department as signified by the letter of December 12, 1963, signed by J. Weldon Watson, Executive Director, copy of which is enclosed.

The purpose of the project is to prevent serious flood damage to El Paso and vicinity which is caused by floodwaters originating on the slopes of the Franklin Mountains and surrounding mesa lands. Project features will include detention dams, channels, and conduits, and diversion dikes to intercept and convey the floodwaters to outfalls into the Rio Grande or into existing drains. Most of these features are located within or close to urbanized lands.

Fishery resources in the project area are considered to be insignificant. We understand that no water is available to establish fishery pools in the detention basins. Therefore, the project will have little or no effect on fishery resources.

Rabbits and quails are the most common wildlife in the project area. Project effects on wildlife resources will be insignificant.

Establishment of detention reservoirs in the vicinity of El Paso presents an excellent opportunity to establish fish habitat in the area. Benefits of considerable magnitude could be realized if a fishery were established in any of the reservoirs. It is our understanding, however, that no water is available for this purpose. Furthermore, it is our understanding that increasing the size of the detention structures to assure adequate permanent pools on high value land within and near the City of El Paso as well as development of supplemental water supplies to assure maintenance of such pools would be of prohibitive cost.

If there are significant changes in the project plans which were transmitted to us by letter of November 21, 1963, or if there is a potential for developing a water supply for fishery purposes, we would appreciate a chance to make further comments on this project.

We appreciate the opportunity to comment on the project at this time.

Sincerely yours,


Lewis R. Garlick
Acting Regional Director

Enclosure

Copies 10

Distribution:

- (4) Executive Director, Texas Parks and Wildlife Department, Austin, Texas
- (1) Regional Coordinator, Southwest Field Committee, U. S. Department of the Interior, Muskogee, Oklahoma
- (1) Area Director, Bureau of Mines, Area 4, Bartlesville, Oklahoma
- (1) Regional Engineer, Public Health Service, Region 7, Dallas, Texas
- (2) Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Fort Worth, Texas

PARKS AND WILDLIFE DEPARTMENT

COMMISSIONERS
V. L. E. ODOM
CHAIRMAN, AUSTIN
A. W. MOURSUND
MEMBER, JOHNSON CITY
JAMES M. DELLINGER
MEMBER, CORPUS CHRISTI



J. WELDON WATSON
EXECUTIVE DIRECTOR

JOHN H. REAGAN BUILDING
AUSTIN, TEXAS 78701

December 12, 1963

Mr. Carey H. Bennett, Chief
Division of Technical Services
Bureau of Sport Fisheries and Wildlife
P. O. Box 1306
Albuquerque, New Mexico

Dear Mr. Bennett:

Reference is made to your letter of December 10, 1963, with which was enclosed a copy of Colonel Gerald W. Homann's letter of November 21, 1963, and accompanying information for the El Paso Local Protection Project, El Paso, Texas. Also enclosed was a review draft of the Bureau's report on this project.

We have reviewed the draft and concur in the report as submitted.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "J. Weldon Watson".

J. Weldon Watson
Executive Director

JWW:EAW:em



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SOUTHWEST FIELD COMMITTEE, REGION SIX
807 Brazos Street
Austin, Texas 78701

IN REPLY REFER TO:

SWAGW-1

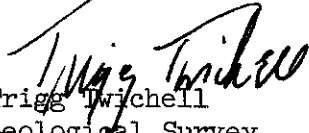
February 28, 1964

Colonel Gerald W. Homann
District Engineer
U. S. Army Engineer District, Albuquerque
Corps of Engineers
Federal Building
517 Gold Avenue, SW
Albuquerque, New Mexico 87103

Dear Colonel Homann:

We are enclosing the Corps of Engineers' "Report on Survey for Flood Control and Allied Purposes - El Paso, El Paso County, Texas", transmitted with your letter of February 14, 1964. This report was received on February 19, and requested that it be returned to reach your office by February 28, 1964. This did not permit proper time for making a review of the report. It is returned without comment, other than that we recommend that appropriate hydrologic instrumentation be made for monitoring and evaluating projects which are built for flood protection.

Very truly yours,


Trigg Twitchell
Geological Survey
Contact Official

Enclosure
cc: Douglas R. Woodward,
Washington, D. C.



UNITED STATES
DEPARTMENT OF THE INTERIOR

IN REPLY REFER TO:

BUREAU OF LAND MANAGEMENT

300

STATE OFFICE
P. O. Box 1449
Santa Fe, New Mexico
87501

February 28, 1964

Mr. Gerald W. Homann
Colonel, CE
District Engineer, Corps of Engineers
Federal Bldg., 517 Gold Avenue, SW
Albuquerque, New Mexico

Dear Mr. Homann:

We are returning the draft of "Report On Survey For Flood Control and Allied Purposes" as you requested in your February 14, 1964 letter.

The draft was referred to our Las Cruces District Manager, and his report indicates that the project will not affect public lands administered by the Bureau of Land Management.

We appreciate having been afforded the opportunity to review this report.

Sincerely yours,

W. J. Anderson
Acting State Director

Enclosure



UNITED STATES
DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE
Southwest Region
Santa Fe, New Mexico

IN REPLY REFER TO:

February 26, 1964


L7423

Mr. Gerald W. Homann, Colonel, CE
U.S. Army Engineer District
Federal Building, 517 Gold Avenue, S.W.
Albuquerque, New Mexico

Dear Colonel Homann:

Reference is made to your report flood control measures for El Paso, Texas (your file SWAGW-1). We have no comments on the project other than that an archeological survey should be made of the various units of the project in advance of construction. When this project has been authorized we will have a survey, and any necessary excavations, made.

Sincerely yours,


J. M. Carpenter
Acting Regional Director



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION

Mid-Continent Region 3
7860 West 16th Avenue
Denver, Colorado 80215

February 26, 1964

~~A~~
Colonel Gerald W. Homann, District Engineer
U. S. Army Engineer District, Albuquerque
Corps of Engineers
517 Gold Avenue, S. W.
Albuquerque, New Mexico 87103

Your Reference:
SWAGW-1

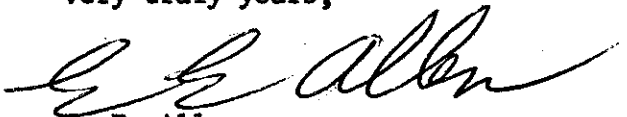
Dear Colonel Homann:

By memorandum dated February 14 you transmitted to this office the Preliminary Report on Survey for Flood Control and Allied Purposes, El Paso, El Paso County, Texas, for our comments.

We are presently operating on a limited budget and with limited personnel, and without benefit of an interagency cooperative agreement between our respective agencies; therefore, we decline to comment on the report.

The report is returned as requested.

Very truly yours,


E. E. Allen
Acting Regional Director

Enclosure

FEDERAL POWER COMMISSION
REGIONAL OFFICE

100 North University Drive
Fort Worth, Texas 76107
February 27, 1964

The District Engineer
U.S. Army Engineer District, Albuquerque
Federal Building, 517 Gold Avenue, S. W.
Albuquerque, New Mexico 87103

Dear Sir:

Reference is made to your letter of February 14, 1964 enclosing a copy of the draft of the proposed report on survey for flood control and allied purposes, El Paso, El Paso County, Texas, for our review and comments.

We have reviewed the report and the improvements recommended therein with particular attention to the effect of such improvements on development of hydroelectric power, either existing or potential. The selected plan of improvement involves retention dams, drainage channels, and related works to control flooding from ephemeral streams tributary to the Rio Grande. The recommended improvements are not adaptable to the development of hydroelectric power, however, the proposed plan would change flow conditions in the Rio Grande by collecting and diverting to the river interior runoff which now naturally ponds on the valley floor. The increase in Rio Grande stream flow would result in an insignificant, if any, benefit to potential and existing hydroelectric power developments located downstream from El Paso, the Amistad and Falcon projects, respectively, about 700 and 1,000 river miles below El Paso.

We appreciate the opportunity to review the report and submit comments, which are prepared at field level and should not be construed as those of the Federal Power Commission.

As requested in your letter, the copy of your report is being returned herewith.

Sincerely yours,

Lenard B. Young
Regional Engineer

By


Acting

Enclosure No. 4117:
As stated above



HOUSING AND HOME FINANCE AGENCY

OFFICE OF THE REGIONAL ADMINISTRATOR

300 West Vickery Boulevard

Fort Worth 4, Texas 76104

February 25, 1964

REGION V

~~AA~~
Col. Gerald W. Homann
District Engineer
U. S. Army Engineers
517 Gold Avenue, S. W.
Albuquerque, New Mexico

Dear Col. Homann:

Subject: SWAGW - 1

This will acknowledge receipt of the preliminary report on a Survey for Flood Control and Allied Purposes in the vicinity of El Paso, Texas.

We have no current projects in the area included in the study. However, we will appreciate being advised of future developments growing out of the study.

If you have not already done so, we would suggest you advise the Planning Officer of the State Health Department, Austin, Texas.

Returned herewith is a copy of subject preliminary report.

Sincerely,

For

Leonard E. Church
Regional Director
Urban Renewal Division

Enclosure



INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO
206 SAN FRANCISCO STREET
EL PASO, TEXAS

MAILING ADDRESS:
P. O. BOX 1859

OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

March 4, 1964

Dear Colonel Homann:

I appreciate the opportunity to review the draft of your Report on Survey and Flood Control and Allied Purposes, El Paso, El Paso County, Texas, received with your letter of February 14, 1964.

I am pleased to advise that this Section concurs in your recommendations that construction of the El Paso Local Protection Project be authorized subject to your requirements for local cooperation, and that construction in the Central Area and the Copper System in the Southeast Area be constructed as soon as practicable, and that construction of improvements in the Northwest Area and the Bluff channel in the Southeast Area be deferred until such time as construction is initiated on the improvements which may be required to increase the capacity of the Rio Grande and its floodway by the International Boundary and Water Commission.

The principal interest and concern of this Commission is, of course, that the proposed Local Flood Control Project for the City of El Paso not increase the flood hazard from the Rio Grande, neither upstream from El Paso along the Canalization Project constructed and maintained by this Section, nor in the international section of the river which divides and passes in front of the business districts of the two cities, nor downstream therefrom along the international Rio Grande Rectification Project, constructed and maintained by the Governments of the United States and Mexico through this Commission. This important interest and concern is recognized in your report wherein it states that flood discharges from works of the selected plans in the Northwest and Southeast Areas would change flow conditions by collecting and diverting river interior runoff which now ponds on the valley floor. Such changes will occur in not only the Canalization

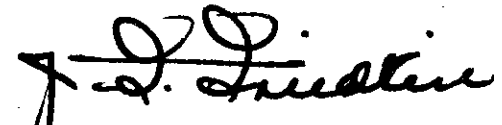
Colonel Gerald W. Homann,
District Engineer,
U.S. Army Engineer District, Albuquerque,
Federal Building, 517 Gold Ave., S.W.,
Albuquerque, New Mexico.

Project above El Paso, but the international river section and project at and below El Paso, and therefore must be subject to the approval of the two Governments.

This Section of the Commission will as soon as practicable undertake jointly with Mexico studies and investigations to determine the additional protection, if any, which may be warranted in the Rio Grande Projects under its jurisdiction and if so, the manner in which it can be most effectively achieved. We will keep you informed.

We are especially appreciative of the consideration and cooperation of you and your staff on international phases of your report, and look forward to working with you in development of the proposed project.

Cordially,


J. F. Friedkin
Commissioner

TEXAS WATER COMMISSION

COMMISSIONERS

JOE D. CARTER, CHAIRMAN
O. F. DENT
H. A. BECKWITH

SAM HOUSTON
STATE OFFICE BUILDING

AREA CODE 512
GREENWOOD 5.4514



P. O. BOX 12311
CAPITOL STATION
AUSTIN, TEXAS, 78711

March 9, 1964

JOHN J. VANDERTULIP
CHIEF ENGINEER

C. R. BASKIN
ASS'T. CHIEF ENGINEER

BURREL ROWE
CHIEF EXAMINER

AUDREY STRANDTMAN
SECRETARY

Colonel G. W. Homann
Corps of Engineers, U.S. Army
Federal Building
517 Gold Avenue, S.W.
Albuquerque, New Mexico 87103

Dear Colonel Homann:

Reference is made to your letter of February 14, 1964, concerning your report on Survey for Flood Control and Allied Purposes, El Paso, El Paso County, Texas.

A study of the improvements proposed in the report, which will consist of flood control for various sections of the City of El Paso, indicates that the project will afford protection for valuable properties and will permit a better balanced economic development of the protected areas, with the annual benefits exceeding the annual costs.

Formal comments of our agency upon the report will be made in accordance with Texas statutes, when the report is received from the Chief of Engineers.

Sincerely yours,

A handwritten signature in cursive script that reads "John J. Vandertulip".

John J. Vandertulip
Chief Engineer



STATE OF NEW MEXICO

STATE ENGINEER OFFICE

SANTA FE

S. E. REYNOLDS
STATE ENGINEER

ADDRESS CORRESPONDENCE TO:
STATE CAPITOL
SANTA FE, N. M.

March 4, 1964

Gerald W. Homann, Colonel
District Engineer
Corps of Engineers
Albuquerque District
Federal Bldg.
Albuquerque, New Mexico

Dear Colonel Homann:

Your letter of 14 February 1964 forwarded for field-level comment your draft of a report on Survey for Flood Control and Allied Purposes, El Paso, El Paso County, Texas.

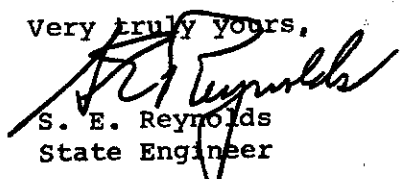
The last sentence of paragraph 22, page 18 of your report indicates that El Paso has derived ground-water supplies from wells located in New Mexico. This matter was discussed with Mr. Redmond of your staff and he has advised that the referenced statement is not correct and that the report will be revised accordingly.

In paragraph 24, pages 18 and 19, the following appears, ". . . the Rio Grande Compact which limits use of water below this point to 790,000 acre-feet annually." Actually the Rio Grande Compact does not limit the use of water below Elephant Butte Dam to 790,000 acre-feet annually, the compact contemplates a normal release from "Project Storage" of 790,000 acre-feet per year.

The State of New Mexico offers no objection to the plan of development as outlined in the subject report. The State welcomes the opportunity to comment on water resources development that may affect her interests.

As requested in your letter copies of the draft report are being returned under separate cover.

Very truly yours,


S. E. Reynolds
State Engineer

PBM:b

JUDSON F. WILLIAMS
MAYOR

ROBERT H. GABEL
CITY CLERK



November 27, 1963

ALDERMEN
OLIVER G. NORDMARKEN
MAYOR PRO TEM
HECTOR BENCOMO
ASHLEY G. CLASSEN
FREDERICK H. MCKINSTRY

Colonel Gerald W. Homann
District Engineer
U. S. Army Engineer District, Albuquerque
P. O. Box 1538
Albuquerque, New Mexico

Dear Colonel Homann:

Reference is made to the meeting of the City Council of the City of El Paso, and other interested persons on November 26, 1963, during which your representatives explained the proposed El Paso Local Protection Project and requested the views of local interests.

This letter is to advise you that the City of El Paso will cooperate with the Corps of Engineers in the construction of the proposed project and furnish the required local cooperation as follows:

- (a) Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction and operation of the project.
- (b) Hold and save the United States free from damages due to the construction and operation of the project.
- (c) Maintain and operate the works after completion in accordance with regulations prescribed by the Secretary of the Army.
- (d) Make any alterations to existing improvements, other than railroads or improvements constructed and maintained by the United States, which may be required because of the construction works.
- (e) Prevent encroachment on the diversion and outlet channels which would reduce their design capacities.
- (f) Take steps to prevent encroachment upon existing defined waterways tributary to the project by zoning or other means such as enlargement or other modification

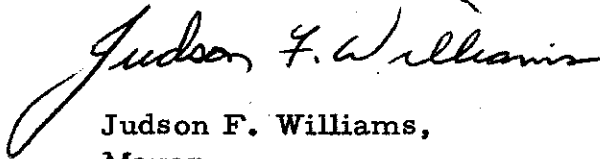


EL PASO The International City

of the existing waterway facilities to prevent the minor flood problems on these tributary waterways from developing into problems of serious proportions.

We greatly appreciate your interest, as well as your cooperation and assistance, in this matter of vital importance to El Paso.

Sincerely,

A handwritten signature in cursive script that reads "Judson F. Williams". The signature is written in dark ink and is positioned above the typed name.

Judson F. Williams,
Mayor

/rv

EL PASO, EL PASO COUNTY, TEXAS
REPORT ON SURVEY FOR FLOOD CONTROL AND ALLIED PURPOSES

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 El Paso Local Protection Project would be a single-purpose flood control project consisting of independent plans for the Northwest, Central, and Southeast Areas as described below. An economic life of 100 years was used for project analysis.

a. **Northwest Area.**- The Northwest Area plan consists essentially of three reservoirs and a diversion channel together with appurtenant facilities. Two of the dams, Mulberry and Thorn Drive, would be enlargements of existing structures and the third, Buena Vista Dam, would be new construction. A diversion channel designated as the Lower Diversion Channel would convey the releases from the reservoirs and runoff from several uncontrolled arroyos to the Rio Grande via the Lower Diversion Outlet Channel. Other features of the plan include the Borderland Diversion which would convey releases from Mulberry Dam and the runoff from a small uncontrolled drainage area to the arroyo which serves as the outlet for Thorn Drive Dam; the Upper Diversion which would intercept and divert arroyo flow into the Buena Vista Reservoir; and the Buena Vista Dam Outfall Channel and Gibson Diversion which would divert flows into the Lower Diversion Channel. A structure would be provided in the Lower Diversion Channel to admit flows from the existing City Ditch, and the lower end of the Montoya Drain would be realigned to discharge into the Rio Grande immediately above the Lower Diversion Outfall Channel. All elements of the plan are designed to control the standard project flood.

b. **Central Area.**- The Central Area plan consists of seven dams plus diversions, outfall structures, and appurtenant facilities. Two of the dams, Northgate and Range, would detain flows from arroyos which flood a residential and business district in the northern portion of the area and reduce the flows to the capacity of the existing Tobin Park Drain which discharges into the existing Fort Bliss sump. The Northgate Interceptor Channel and the Northgate Diversion Channel would direct flows into Northgate Dam. Releases from Northgate Dam and runoff from the area below the Northgate Interceptor Channel would be carried to Range Dam via the Northgate Outlet Channel. The Fort Bliss Diversion Channel would intercept and divert arroyo flow directly to Fort Bliss sump. Sunrise and Mountain Park Dams would reduce peak flows into the Fort Bliss Diversion Channel. The existing Fort Bliss

sump would not be modified but would be drained by the Fort Bliss Sump Outlet Conduit which would discharge into Pershing Reservoir. McKelligon and Fillmore Dams would control fairly large drainage areas and releases from these structures would be carried by an arroyo leading to the existing Van Buren Dam, thence to Pershing Reservoir via the Mountain Avenue Outlet Conduit. Pershing Diversion Channel would divert flows into the reservoir that would otherwise be blocked by the dam embankment. Releases from Pershing Dam would flow into the existing Government Hill Ditch. This ditch, which would be modified only slightly, discharges into a small detention basin and, at present, flows from the basin are discharged into Durazno Reservoir. With the proposed plan in operation, flows from the basin would bypass Durazno Reservoir and discharge directly to the Rio Grande via the Government Hill Outfall Conduit. This would increase the effectiveness of Durazno Reservoir by reducing its contributing drainage area.

c. Southeast Area.- The Southeast Area plan consists of two independent systems for flood control, the Copper System and the Bluff Channel together with necessary appurtenances. Bluff Channel would be provided as a separate component to intercept and convey runoff from the mesa arroyos to the Rio Grande. Copper Diversion and Copper Channel would divert and convey runoff into Copper Dam. The Copper Outlet Channel would convey releases from Copper Dam into Pasotex Dam which is now under construction by the city. Pasotex Dam would be modified to increase its capacity. The Copper Outfall Channel would then convey releases from Pasotex Dam to the Rio Grande.

3. With minor exceptions, the El Paso Local Protection Project facilities are designed to give protection against floods up to the magnitude of the standard project flood originating above the structures. However, provision for local drainage facilities to control runoff originating downstream from the structures would be the responsibility of local interests.

4. PROJECT COSTS AND BENEFIT-COST RATIO.- The estimated first cost of the project and the annual charges, benefits, and benefit-cost ratios for 50-year and 100-year periods of analysis are listed in the accompanying tabulations.

5. EXTENT OF INTEREST IN THE PROJECT.- The extent of interest in the project is illustrated by the testimony presented at the public hearing and meetings with local interests. This testimony is summarized in the section of the report entitled IMPROVEMENTS DESIRED. Local interests have indicated, in writing, their willingness and ability to cooperate in construction of the project. A copy of the letter is included in appendix E.

6. ALTERNATIVE PROJECTS CONSIDERED.- Several plans were considered in addition to the plan selected for the solution of the flood and related problems at El Paso and vicinity. Alternative plans

included varying amounts of reservoir storage in conjunction with levees and channels. The plans are described in the section of the report entitled PROJECT FORMULATION.

El Paso Local Protection Project - Benefit-Cost Comparisons, 50-Year Period of Analysis (January 1964 Conditions and Prices)

Area	First Costs	Annual Charges	Total Benefits	B/C Ratio
<u>NORTHWEST:</u>				
Federal	\$3,344,000	\$129,981		
Non-Federal	<u>729,000</u>	<u>61,019</u>		
Total, Northwest Area	4,073,000	191,000	\$429,000	2.2
<u>CENTRAL:</u>				
Federal	7,310,000	284,140		
Non-Federal	<u>622,000</u>	<u>71,860</u>		
Total, Central Area	7,932,000	356,000	302,300	0.8
<u>SOUTHEAST:</u>				
Copper System:				
Federal	754,000	29,308		
Non-Federal	<u>635,700</u>	<u>30,692</u>		
Subtotal, Copper System	1,389,700	60,000	46,100	0.8
Bluff Channel:				
Federal	1,085,000	42,174		
Non-Federal	<u>1,144,300</u>	<u>58,826</u>		
Subtotal, Bluff Channel	2,229,300	101,000	91,500	0.9
Total Southeast:				
Federal	1,839,000	71,482		
Non-Federal	<u>1,780,000</u>	<u>89,518</u>		
Total, Southeast Area	3,619,000	161,000	137,600	0.9
<u>EL PASO LOCAL PROTECTION PROJECT:</u>				
Federal	12,493,000	485,602		
Non-Federal	<u>3,131,000</u>	<u>222,398</u>		
Total Project	\$15,624,000	\$708,000	\$868,900	1.2

El Paso Local Protection Project - Benefit-Cost Comparisons, 100-Year
 Period of Analysis (January 1964 Conditions and Prices)

Area	First Costs	Annual Charges	Total Benefits	B/C Ratio
<u>NORTHWEST:</u>				
Federal	\$3,344,000	\$105,830		
Non-Federal	<u>729,000</u>	<u>55,170</u>		
Total, Northwest Area	4,073,000	161,000	\$537,200	3.3
<u>CENTRAL:</u>				
Federal	7,310,000	231,300		
Non-Federal	<u>622,000</u>	<u>67,700</u>		
Total, Central Area	7,932,000	299,000	336,000	1.1
<u>SOUTHEAST:</u>				
Copper System:				
Federal	754,000	23,860		
Non-Federal	<u>635,700</u>	<u>26,140</u>		
Subtotal, Copper System	1,389,700	50,000	53,500	1.1
Bluff Channel:				
Federal	1,085,000	34,340		
Non-Federal	<u>1,144,300</u>	<u>50,660</u>		
Subtotal, Bluff Channel	2,229,300	85,000	106,200	1.2
Total Southeast:				
Federal	1,839,000	58,200		
Non-Federal	<u>1,780,000</u>	<u>76,800</u>		
Total, Southeast Area	3,619,000	135,000	159,700	1.2
<u>EL PASO LOCAL PROTECTION PROJECT:</u>				
Federal	12,493,000	395,330		
Non-Federal	<u>3,131,000</u>	<u>199,670</u>		
Total Project	\$15,624,000	\$595,000	\$1,032,900	1.7

