Also issued as H. Doc 115. 92/1

BEALS CREEK, BIG SPRING, TEXAS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED DECEMBER 4, 1970, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON BEALS CREEK, BIG SPRING, TEXAS, IN PARTIAL RESPONSE TO A RESOLUTION OF THE COMMITTEE ON COMMERCE, UNITED STATES SENATE, ADOPTED AUGUST 4, 1936. IT IS ALSO IN RESPONSE TO THE FLOOD CONTROL ACTS OF JUNE 22, 1936, AUGUST 26, 1937 AND MARCH 2, 1945

MAY 25, 1971.—Referred to the Committee on Public Works and ordered to be printed with illustrations

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1971

62-221 O

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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 20310

Honorable Carl Albert
Speaker of the House of Representatives
Washington, D. C. 20515

May 21, 1971

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 4 December 1970, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on Beals Creek, Big Spring, Texas, in partial response to a resolution of the Committee on Commerce, United States Senate, adopted 4 August 1936. It is also in response to the Flood Control Acts of 22 June 1936, 26 August 1937 and 2 March 1945.

The views of the Governor of Texas and the Departments of the Interior, Agriculture, Transportation, and Health, Education, and Welfare are set forth in the inclosed communications. Copies of the environmental statement required by the National Environmental Policy Act of 1969 were sent to the Chairmen of the House and Senate Public Works Committees and the Council on Environmental Quality on 13 November 1970. The environmental statement included in the report of the Chief of Engineers was supplemented on 7 January 1971 with comments from the Departments of the Interior and Agriculture and the Governor of Texas.

Since this project meets all the requirements of Section 201 of the Flood Control Act of 1965 and involves little or no controversy, I recommend that the project be approved for appropriations.

The Office of Management and Budget advises that there is no objection to the submission of the report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of this project, if approved for appropriations, 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 Office of Management and Budget is inclosed.

Sincerely,

Stanley R. Resor

STANLEY A. RESOR
Secretary of the Army

1 Incl
Report

COMMENTS OF THE OFFICE OF MANAGEMENT AND BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

May 10, 1971

Honorable Stanley R. Resor
Secretary of the Army
Washington, D. C. 20310

Dear Mr. Secretary:

Mr. Robert E. Jordan's letter of February 17, 1971, submitted a copy of the favorable report of the Chief of Engineers on Beals Creek, Big Spring, Texas, requested by a resolution of the Committee on Commerce, United States Senate, adopted August 4, 1936. It is also in response to the Flood Control Acts of June 22, 1936; August 26, 1937; and March 2, 1945.

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

Sincerely,

Donald B. Rice

Donald B. Rice
Assistant Director

COMMENTS OF THE GOVERNOR OF TEXAS

PRESTON SMITH

GOVERNOR OF TEXAS

November 27, 1970

Lieutenant General F. J. Clarke
Chief of Engineers
Department of the Army
Building T-7, Gravelly Point
Washington, D. C. 20310

Dear General Clarke:

Inclosed herewith is a copy of the Order of the Texas Water Rights Commission, dated November 24, 1970, following its study and public hearing, pursuant to Article 7472e, VTCS, relating to your report on Beals Creek, Big Spring, Texas.

I concur in the findings and recommendation of the Commission that the project is feasible and in the public interest. I urge the early authorization and funding of the project by the Congress.

Your comments on the five points posed under the National Environmental Policy Act of 1969 credit the proposed project as enhancing the environment and providing beneficial impact on fish, wildlife and on the public welfare.

It is respectfully requested that the Federal effort in final planning and development of the proposed project be fully coordinated with the Texas Natural Resources agencies.

With my kind regards, I am

Sincerely,

Preston Smith

Preston Smith

TEXAS WATER RIGHTS COMMISSION

AN ORDER relating to recommmended Federal improvements as proposed by the Department of the Army, Corps of Engineers' report "Beals Creek at Big Spring, Texas".

BE IT ORDERED BY THE TEXAS WATER RIGHTS COMMISSION

Section 1. Statement of Authority. Article 7472e, VTCS, provides that upon receipt of any engineering report submitted by a Federal agency seeking the Governor's action on a Federal project, the Texas Water Rights Commission shall study and make recommendations to the Governor as to the approval or disapproval of the feasibility of the Federal project and that the Commission shall cause a public hearing to be held to receive the views of persons or groups who might be affected by the Federal project.

Section 2. Statement of Jurisdiction. On October 15, 1970, the Honorable Preston Smith, Governor of Texas, requested that the Texas Water Rights Commission investigate and make recommendations concerning a report entitled, "Beals Creek at Big Spring, Texas", prepared by the Department of the Army, Corps of Engineers, in which are recommended improvements to the existing Beals Creek channel in the vicinity of Big Spring, Texas.

In accordance with the provisions of Article 7472e, supra, due notice having been given, the Commission conducted a public hearing on November 24, 1970, at 10:00 o'clock a.m., in the offices of the Commission, Sam Houston State Office Building, Austin, Texas, on said project, at which time, in accordance with public notice duly published in the Big Spring Daily Herald, all interested

parties were requested to appear and give testimony and submit evidence either for or against these projects.

Section 3. After fully considering the aforesaid project, included in the report of the Department of the Army, Corps of Engineers, entitled, "Beals Creek at Big Spring, Texas", and all evidence and exhibits introduced and presented at the hearing, the Commission finds that all of the criteria set forth in Section 4, Article 7472e, supra, relating to the feasibility of the project have been met and that said project is feasible and that the public interest would be served thereby.

NOW, THEREFORE, BE IT ORDERED BY THE TEXAS WATER RIGHTS COMMISSION, that the aforesaid Federal report concerning Beals Creek in the vicinity of Big Spring, Texas, be, and the same is hereby, approved and recommended to the Governor as feasible and in the public interest; and that early authorization and funding of this project by Congress are respectfully urged.

Executed and entered of record, this the 24th day of November, 1970.

TEXAS WATER RIGHTS COMMISSION

O. F. Dent, Chairman

/s/ Joe D. Carter
Joe D. Carter, Commissioner

/s/ Leslie R. Neal
Leslie R. Neal, Commissioner

ATTEST:

/s/ Audrey Strandtman
Audrey Strandtman, Secretary

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

20 November 1970

Dear General Clarke:

This responds to your letter of September 15, 1970, asking for our comments on your proposed report on Beals Creek, Big Spring, Texas, and Colonel Newman's letter of October 13, 1970, transmitting the draft environmental statement for the same project.

We have reviewed the proposed report and draft statement and in general concur with your recommendations. We offer the following comments for your information and use.

To protect water quality during the construction period in accordance with provisions of Section 21(a) of the Federal Water Pollution Control Act, as amended, and Executive Order 11507, we recommend that contract specifications require all contractors and subcontractors to:

1. Exercise care in the relocation of any petroleum product pipelines and take precautions in the handling and storage of hazardous materials, such as petroleum, herbicides, and pesticides, to prevent accidental spillage or usage that would result in water pollution.

2. Provide and operate sanitary facilities to adequately treat and dispose of domestic wastes in conformance with Federal and State water pollution control regulations.

3. Perform all construction operations so that they will keep erosion, turbidity, and siltation at the lowest level practicable.

With regard to the environmental statement, we find that it adequately describes the project's impact on the environment.

We appreciate the opportunity of presenting our views.

Sincerely,

J. G. WATT
Deputy Assistant Secretary of the Interior

Lt. General F. J. Clarke
Chief of Engineers
U.S. Department of the Army
Washington, D.C. 20314

x

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

October 21 1970

Honorable Stanley R. Resor
Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Chief of Engineers' letter of September 15, 1970, transmitting for our review and comment his proposed report and pertinent papers on Beals Creek, Big Spring, Texas.

The proposed plan of improvement for flood control includes enlargement and realignment of 5.6 miles of channel in combination with nonstructural measures.

Forest resources of this area would not be affected adversely by the project nor would the project provide feasible opportunities for improvement of forest resources.

The proposed works of improvement would have no adverse or beneficial effects on existing or expected project activities of this Department.

We note that an environmental statement did not accompany this report.

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

Sincerely,

T. K. COWDEN
Assistant Secretary

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDANT (AWL)
U.S. COAST GUARD
WASHINGTON, D.C.
20591

12 October 1970

Lt. General F. J. Clarke
Chief of Engineers
Department of the Army
Washington, D. C. 20314

Dear General Clarke:

This is in response to your letter of 15 September 1970, addressed to Secretary Volpe, requesting comments concerning Beals Creek, Big Springs, Texas.

The concerned operating administrations of the Department of Transportation have reviewed your proposed report along with other pertinent papers.

This Department concurs in your recommendations for the improvement of Beals Creek, Texas for flood control through enlargement and realignment of 5.6 miles of channel in combination with nonstructural measures.

It is noted that the draft environmental impact statement, as required by Section 102(2)(c) of the National Environmental Policy Act of 1969 was not transmitted with the report. This Department will review the statement when it is forwarded.

It is noted from the Federal Highway Administration review of the proposed project that it will require the alteration of three bridges on Federal-aid routes and the construction of a bridge on a non-Federal-aid route. The cost of this work, $186,000, is a non-Federal cost. The sponsors, therefore, should be advised that Federal-aid highway funds may not be used to relieve them of the obligation assumed by them in connection with the construction of the project. It is assumed that the proposed bridge work will be coordinated with the Texas Highway Department and local highway authorities.

From the Federal Railroad Administration review of the project, it is noted that the Chief Engineer of the Texas and Pacific, Mr. E. T. Franzen, wrote to the Division and District Engineers of the Corps of Engineers on 17 July 1970 stating that certain factors concerning some of their industrial property would

condition their approval of the project. The Board of Engineers for Rivers and Harbors replied to Mr. Franzen on 23 July 1970 that most of the matters of concern to the Texas and Pacific Railroad could be resolved prior to construction. The matter was referred to Mr. Thomas, their District Engineer. The Federal Railroad Administration is satisfied that the situation will be resolved between the Corps of Engineers and Texas and Pacific Railroad.

The proposed project is in agreement with the policy of the Water and Land Resources Planning Policy Statement of 22 July 1970 in that this flood control project will considerably add to the protection from floods for the people of this area.

The opportunity offered this Department to review and comment on your proposed report is appreciated.

Sincerely,

R. Y. Edwards

R. Y. EDWARDS
Rear Admiral, U.S. Coast Guard
Chief, Office of Public and
International Affairs

COMMENTS OF THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

November 12, 1970

Lt. General F. J. Clarke, USA
Chief of Engineers
U.S. Corps of Engineers
Department of the Army
Washington, D.C. 20315

Dear General Clarke:

As requested in your letter of September 15, 1970, the interim report on Beals Creek at Big Spring, Texas, has been reviewed by the appropriate agencies of the Department that have an environmental interest.

The report describes a proposed flood control project for Beals Creek at the city of Big Spring, Texas. The proposal provides for enlargement and realignment of 5.6 miles of channel in combination with nonstructural measures.

Our review indicates public health benefits will accrue due to the protection from flooding which can cause safety hazards, damage to water supply and sewage disposal systems, and vector control problems, as well as other negative factors influencing the maintenance of public health.

To insure proper attention to health protection with regard to this proposal, we recommend that appropriate health guidelines outlined in the following publication be employed during the development and operation of the project:

> For control of disease vector problems: Prevention and Control of Vector Problems Associated with Water Resources (Public Health Service monograph, January 1965).

We have no objection to the authorization of this project insofar as the Department's interests and responsibilities are concerned.

Sincerely yours,

Roger O. Egeberg, M.D.
Assistant Secretary
for Health and Scientific Affairs

BEALS CREEK, BIG SPRING, TEXAS

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

IN REPLY REFER TO

ENGCW-PD

4 December 1970

SUBJECT: Beals Creek, Big Spring, Texas

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the report of the Board of Engineers for Rivers and Harbors, accompanied by the reports of the District and Division Engineers, in partial response to a resolution of the Committee on Commerce of the United States Senate adopted 4 August 1936, requesting a review of the reports on Colorado River, Texas, submitted in House Document Numbered 361, Seventy-first Congress, second session, and previous reports, with a view to determining if improvement in the interest of commerce and flood control is advisable at the present time, and also the Flood Control Acts of 22 June 1936, 26 August 1937, and 2 March 1945, relating to preliminary examinations and surveys of Colorado River and its tributaries, Texas.

2. The District and Division Engineers recommend improvement of Beals Creek, Texas, for flood control by enlargement and realignment of 5.6 miles of channel in combination with nonstructural measures. They estimate the first cost at $2,526,000, of which $1,578,000 would be the Federal cost for construction, and $948,000 would be the non-Federal cost for lands, easements, rights-of-way, and relocations. They further estimate the annual charges at $144,300, including $14,000 for non-Federal operation and maintenance, and average annual benefits at $237,400, based on an interest rate of 4-7/8 percent. The benefit-cost ratio is 1.6.

3. The Board of Engineers for Rivers and Harbors concurs in general in the findings of the reporting officers and recommends construction of the improvements subject to certain conditions of local cooperation.

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

F. J. CLARKE
Lieutenant General, USA
Chief of Engineers

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

IN REPLY REFER TO

ENGCW-PD

13 November 1970
* Supplemented on
7 January 1971

SUMMARY
COORDINATION OF ENVIRONMENTAL STATEMENT
ON
BEALS CREEK, BIG SPRING, TEXAS

1. Coordination of Environmental Statement.

	AGENCY	Date of Transmittal	Date of Comments
*	Department of the Interior	13 Oct 70	20 Nov 70
*	Department of Agriculture	13 Oct 70	13 Nov 70
	Department of Transportation	13 Oct 70	23 Oct 70
	Department of Health, Education and Welfare	13 Oct 70	12 Nov 70
*	State of Texas	13 Oct 70	27 Nov 70

2. Summary of Agency Comments and Views of the Chief of Engineers:

The correspondence from the interested State and Federal agencies is attached as an inclosure to the environmental statement. The agency comments concerning the environmental aspects of the project and the response of the Chief of Engineers are discussed below.

Department of Transportation.

Comment: The Department stated that no additional comments are made concerning the environmental impact of the project upon transportation.

Department of Health, Education, and Welfare.

Comment: The Department stated that the proposed project will have no significant adverse effect on environmental matters of concern to the Department. The Department further suggested an editorial revision.

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Response: The Corps of Engineers will revise the statement to incorporate the Department's suggestion during preconstruction planning.

* Department of the Interior

Comment: The Department finds that the environmental statement adequately describes the effect of the project upon the environment.

* Department of Agriculture

Comment: The Department offered no comment on the environmental statement.

* State of Texas

Comment: The Governor noted that the proposed project is credited with enhancing the environment and providing beneficial impact on fish and wildlife and on the public welfare.

9 October 1970

ENVIRONMENTAL STATEMENT
FOR

BEALS CREEK AT
BIG SPRING, TEXAS

PREPARED IN CONNECTION WITH
A SURVEY REPORT OF THE
FORT WORTH DISTRICT, CORPS OF ENGINEERS
FORT WORTH, TEXAS

D R A F T

BEALS CREEK AT BIG SPRING, TEXAS

ENVIRONMENTAL STATEMENT

1. Project Description. The proposed project consists of channel realignment and enlargement with a complementary overflow floodway on about 5.6 miles of Beals Creek running through the City of Big Spring, Texas. Big Spring is located in west central Texas about midway between Forth Worth and El Paso. The improved channel is designed to provide protection against floods which could be expected to occur on the average of once in 50 years. Regulation of future development and land use in the designated floodway area would reduce future flood losses up to the magnitude of the 100 year frequency flood. Excavated material from the channel would be used to fill low areas outside the floodway limits to provide new land for high quality use.

The study was prepared in partial response to a resultion of the Senate Committee on Commerce adopted 4 August 1936, the Flood Control Act of 22 June 1936, and River and Harbor Acts approved 26 August 1937 and 2 March 1945, respectively. These congressional authorizations requested an investigation and report covering the Colorado River and Tributaries, Texas, in the interest of navigation and flood control. Preparation of an interim report on Beals Creek at Big Spring, Texas, was authorized by the Chief of Engineers 16 January 1968. The proposed project has a 1.6 benefit to cost ratio.

2. Environmental Setting Without the Project. The City of Big Spring is subject to frequent damaging floods from Beals Creek because of inadequate channel capacities. There have been about 30 damaging floods at Big Spring since 1890. These floods are caused by runoff from general storms in the upper drainage areas or from locally intense thunderstorms. Beals Creek is an intermittent stream which rises in the High Plains region and passes through a series of natural salt lakes before entering the city. These lakes located near the western edge of the city often dry up in the summer and high salinity concentrations have resulted from evaporation. Beals Creek runs west to east through the city and continues generally eastward some 67 miles to its confluence with the Colorado River. The High Plains region above Big Spring contains numerous playas or wet-weather lakes which control most of the runoff in this area. There is about 494 square miles of contributing drainage area above the city. Terrain consists generally of rolling plains with occasional peaks and grassy prairie with mesquite and salt cedars. Predominate soils are sandy and sandy loams. Ranching and farming are the principal occupations in the rural upper basin area.

Big Spring, founded near a natural spring from whence came its name, is the county seat of Howard County and is the principal trade and service center for a large surrounding area. Economic activity encompasses not only agriculture and the railroad but also a diversity of wealth-producing elements including oil and petro chemicals, an Air Force Jet Training Base, a college, and two large Government-owned Hospitals. The population of the city has increased at an average annual rate of 4.49 percent since 1920 and currently has a population of about 35,100. Within the city, Beals Creek is little more than a small ditch interspersed with growths of weeds and salt cedar. Accumulations of silt at the mouths of small interior drainage streams further obstruct the channel. Commercial and industrial development is concentrated largely near the Texas and Pacific Railroad tracks along Beals Creek and beside U. S. Highway 80. Outward from the industrial area, the land is used primarily for residential purposes.

There are about 350 residences and 250 business and industrial establishments in the 1,100 acre flood hazard area including the extensive Texas and Pacific Railroad yards. The total value of these, together with various utilities and other properties in the flood plain is estimated at $19,000,000. Historical trends indicate that future development in the flood problem area along Beals Creek in the main will be limited to redevelopment and upgrading of existing improvements and undeveloped lands subject to flooding within the city.

These lands which are ideally located relative to access roads, railroads, and major highway arteries are expected to be developed with or without the project. There is no fish or shellfish life in Beals Creek within the proposed project area nor in the entire 60 miles reach downstream to its confluence with the Colorado River. Stream gaging data recorded 40 miles downstream from Big Spring indicates that there is no flow in the stream for several months at a time during the year. During its intermittent periods of flow, the water quality of Beals Creek is poor because of the high content of salt and inorganic solids. There is no fish life in Beals Creek within the proposed project area. Lands in the flood plain area have little value from a wildlife habitat viewpoint because of the urban development that has taken place. Outdoor recreation opportunities are provided for at a large municipal park and the 343-acre Big Spring State Park located at the southwest edge of the city. There are no significant historic or scientific features endangered by the posposed project. No rare or endangered species of botanical or zoological origin are known to exist in the project area.

3. Impact Statement. The following information is furnished in response to Section 102 (2) (c) of the National Environmental Policy Act of 1969.

a. Identify "the environmental impacts of the proposed action". The following physical changes to the existing environment will take place if the proposal is undertaken. This proposal will require a permanent commitment of 136 acres of flood plain lands for channel construction. About 300 acres of idle flood plain lands will be converted to potential industrial and residential use by the placement of excavated material obtained from

channel construction. The sparse vegetation and wildlife now existing on these lands will be displaced.

The construction of the proposed channel improvements would provide a marked increase in the public health and improved living conditions for the residents of Big Spring. At present a large segment of the established business and industrial area of the city is subject to frequent floods. Reduction of flood damages would encourage a greater sense of Civic pride and permit the use of available economic resources for development rather than for replacement of losses. The improved channel will minimize the occurrence of mosquito breeding ponding areas and provide an adequate outlet for the city's proposed interior storm drainage system. The project will improve the visual appearance of unpleasant surroundings which result from neglect and misuse of urban areas subject to frequent flooding. Selective plantings and various land treatment measures will blend the channel and complementary floodway into the existing landscape to provide a pleasing and functional project in which the public may take pride of ownership. Regulation and control of future development within the designated floodway area by the zoning ordinance of the city will effectively reduce future flood damages.

b. Identify "any adverse environmental effects which cannot be avoided should the proposal be implemented". The proposed project would result in the conversion of about 136 acres of presently idle urban lands to project lands for channel right-of-way. Material excavated from the channel will be placed on about 300 acres of undeveloped lands along the channel which are presently subject to flooding. These lands, as well as those needed for the channel, are located within the city and have little or no wildlife habitat value because of the urbanization that has taken place. Minor adverse environmental effects including a temporary increase in dust and noise may be experienced during the construction of the project. However, upon completion of the improvement, including landscaping and erosion control measures, it is considered that these effects would be minimal and of short duration. The improved channel will not increase the silt loading of the stream.

c. Identify "alternatives to the proposed action". The recommended plan meets the short and long term flood control needs of the basin and it is consistent with present national policy dealing with flood protection.

An alternative to the proposed project would be to forego any flood protective measures. The alternative would preserve the existing environment but would not be compatible with the desires of local residents who must endure the economic losses and physcial hardships associated with frequent damaging floods. This alternative offers no relief from the serious flooding problem and would only hasten the deterioration of the existing environment in the interest of preserving low valued wildlife habitat.

Non-structural alternatives alone consisting of permanent evacuation, flood proofing, and flood warning with temporary evacuation were considered during

the planning process. However, because of the urbanization that has taken place in the flood plain including the extensive railroad facilities, the high costs of flood proofing about 350 residences and 250 businesses, the flashy nature of floods in the area, and the totally inadequate channel capacity of Beals Creek within the city, these alternatives acting alone were found impractical or infeasible unless used in conjunction with structural measures.

Structural measures alone consisting of levees, diversions, channel improvements, reservoirs, and combinations of reservoir and channel improvements were also considered during the planning process. As individual solutions, none of the alternatives would have any distinct developmental or environmental advantage over the recommended plan and would require major relocations more land, larger structures, and cause greater adverse environmental impacts than the recommended combination channel with complementary overflow floodway.

Zoning regulations have been adopted by the City which includes the designation of a floodway in which no future construction or land filling would be permitted if such work would restrict the passage of floodwaters.

d. Discuss "the relationship between local short term uses of man's environment and the maintenance and enhancement of long term productivity". The construction of the recommended plan will require a commitment of 136 acres of land which will be lost to future generations. There will be a permanent loss of the existing flora and fauna on these lands. Channel side slopes will be turfed and over seeded and suitable sodding and plantings will be located to enhance the overall project area.

The project is also expected to change the use on about 300 acres of idle, unproductive land adjacent to the channel and floodway to a higher value by filling to an elevation above the 100 year flood line. The fill material will be graded to provide a harmonious blend between existing terrain and channel floodway.

The combination of structural and non-structural measures provide protection from a 50-year frequency flood and minimize damages from floods up to and including the 100-year frequency flood. The level of protection provided by this project will enhance man's environment on both a short and long term basis and provide the inducement to use available economic resources for development rather than for replacement of losses. The improved channel will allow the city to proceed with long proposed storm drainage plans essential to preserving the well being of present and future residents of Big Spring.

e. Identify "any irreversible and irretrievable commitment of resources which would be involved in the proposed action should it be implemented". An irreversible commitment of resources which would be involved if the proposed action should be implemented is the 136 acres of vacant urban land needed for the realigned and enlarged channel. Also,

about 300 acres of presently idle land would be converted to commercial uses as a result of the project. The existing flora and fauna on these lands would be lost but selective landscaping treatment will mitigate this loss. The labor resource associated with construction will also be irreversibly and irretrievably committed.

4. Coordination of Plan. All agencies of the Federal government who have an interest in water resource planning were invited to participate in this flood control study. A public hearing was held so that State and local interests groups could identify the pressing water resource needs of Beals Creek at Big Spring. Upon completion of planning, the recommended project was presented to the officials of the City of Big Spring who heartily endorsed the project.

Coppies of the completed survey report were submitted to regional offices of interested Federal agencies and to the State of Texas for their views and comments. The following paragraphs summarize these comments and cite actions taken in response to them.

a. Bureau of Reclamation stated that the plan of development will have no known effect on any existing or proposed Bureau of Reclamation projects.

b. Bureau of Mines, Bartlesville Office of Mineral Resources, has no objection to the proposed works of improvement.

c. Bureau of Outdoor Recreation indicated that it has no comments, stating that they lack adequate resources to review effectively all reports currently being received.

d. Federal Water Quality Administration stated that it is not anticipated that a project of this type will have any adverse effect upon the quality of the waters.

e. Bureau of Sport Fisheries and Wildlife letter report stated that the project works would have no effect on fish and wildlife, and would not offer feasible opportunities for the improvement of these resources. Their report was concurred with by the Texas Parks and Wildlife Department.

f. U. S. Geological Survey recommended the rebuilding of the gaging station Beals Creek at Big Spring, and the establishment of a peak-stage station at the location Beals Creek above Big Spring.

After authorization of the project, these gages will be included in our cooperative stream gaging program with the U. S. Geological Survey.

g. Southwestern Power Administration noted that the project area is outside of their area of operations and will not affect their interests.

h. Soil Conservation Service advised that the works of improvement will not be significantly affected by, or have any effect upon, an existing or proposed Soil Conservation Service watershed project or program in the area.

i. Department of Health, Education, and Welfare indicated that significant public health benefits would accrue due to the protection from flooding damages, and further benefits may be anticipated from channel improvement, as it will minimize the occurance of ponding areas which would be conducive to mosquito breeding.

j. Department of Housing and Urban Development concurred in the proposed plan of improvement and suggested that consideration be given to the following:

(1) Requirements of the development of flood insurance maps if there is an interests in the Flood Insurance Program.

(2) A Watershed Treatment Program above the city and HU 's Open Space and Urban Beautification Program.

Implementation of the proposal will not preclude the participation in these programs at such time as local interests express a desire to do so.

k. Bureau of Public Roads. No comment received.

l. Federal Power Commission states that the proposed improvements are not adaptable for the development of hydroelectric power and will not affect existing or potential hydroelectric resources.

m. State of Texas, Division of Planning Coordination, indorses the proposed plan of improvement. The following comments were made.

(1) Texas Water Rights Commission stated the Commission may consider the project under Article 7472e when the final report is made to the Governor of Texas.

(2) Texas Water Quality Board stated that adequate measures should be provided so that the sewerage facilities of the city will not be adversely affected.

Implementation of the proposed plan will not affect operation of sewerage facilities during normal creek stages and will provide protection from interruption during major flood periods.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDANT (AWL)
U.S. COAST GUARD
WASHINGTON, D.C.
20591

23 October 1970

Colonel J. B. Newman
Corps of Engineers
Executive Director of Civil Works
Department of the Army
Washington, D. C. 20314

Dear Colonel Newman:

This is in response to your letter of 13 October 1970 addressed to Secretary Volpe concerning the draft environmental statement of the flood control project for Beals Creek, Big Springs, Texas.

This project was previously reviewed and commented on in our letter to the Chief of Engineers dated 12 October 1970. A review of our previous comments was made in light of Section 102(2)(c) of the National Environmental Act of 1969. No additional comments are made concerning the environmental impact of this project upon transportation.

The opportunity afforded this Department to review the draft environmental statement and possibly reconsider our previous position relating to this project is appreciated.

Sincerely,

R. Y. Edwards

R. Y. EDWARDS
Rear Admiral, U.S. Coast Guard
Chief, Office of Public and
International Affairs

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

OFFICE OF THE SECRETARY

WASHINGTON, D.C. 20201

November 12, 1970

Colonel J. B. Newman
Executive Director of Civil Works
U.S. Corps of Engineers
Department of the Army
Washington, D.C. 20315

Dear Colonel Newman:

As requested in your letter of October 10, 1970, the environmental statement for "Beals Creek at Big Spring, Texas," has been reviewed by appropriate agencies of the Department that have an environmental interest.

Our review of the statement indicates that the project as proposed will have no significant adverse effect on environmental matters of concern to the Department of Health, Education, and Welfare.

Under Section 3a, page 3, the first sentence of the second paragraph should be reworded to state, "The construction of the proposed channel improvements would benefit the maintenance of public health and improve living conditions for the residents of Big Spring."

To insure proper attention to health protection with regard to this proposal, we recommend that appropriate health guidelines outlined in the following publication be employed during the development and operation of the project:

> For control of disease vector problems: Prevention and Control of Vector Problems Associated with Water Resources (Public Health Service monograph, January 1965).

Sincerely yours,

Roger O. Egeberg, M.D.
Assistant Secretary
for Health and Scientific Affairs

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

November 20, 1970

Dear General Clarke:

This responds to your letter of September 15, 1970, asking for our comments on your proposed report on Beals Creek, Big Spring, Texas, and Colonel Newman's letter of October 13, 1970, transmitting the draft environmental statement for the same project.

We have reviewed the proposed report and draft statement and in general concur with your recommendations. We offer the following comments for your information and use.

To protect water quality during the construction period in accordance with provisions of Section 21(a) of the Federal Water Pollution Control Act, as amended, and Executive Order 11507, we recommend that contract specifications require all contractors and subcontractors to:

1. Exercise care in the relocation of any petroleum product pipelines and take precautions in the handling and storage of hazardous materials, such as petroleum, herbicides, and pesticides, to prevent accidental spillage or usage that would result in water pollution.

2. Provide and operate sanitary facilities to adequately treat and dispose of domestic wastes in conformance with Federal and State water pollution control regulations.

3. Perform all construction operations so that they will keep erosion, turbidity, and siltation at the lowest level practicable.

With regard to the environmental statement, we find that it adequately describes the project's impact on the environment.

We appreciate the opportunity of presenting our views.

Sincerely,

[illegible] Secretary of the Interior

Lt. General F. J. Clarke
Chief of Engineers
U.S. Department of the Army
Washington, D.C. 20314

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

November 13 1970

Honorable Stanley R. Resor
Secretary of the Army

Dear Mr. Secretary:

This is in reply to letters from the Office of the Chief of Engineers dated October 10 and 13, 1970. The letters transmitted for our review and comment draft environmental statements for proposed project reports of the Corps of Engineers.

Enclosed are comments of the U. S. Department of Agriculture on draft environmental statements for the following individual projects:

- Alabama-Coosa River System, Selma, Alabama
- Beals Creek at Big Spring, Texas
- Des Moines River, Ottumwa, Iowa
- Ludington Harbor, Michigan
- Missouri River, N. D., S. D., and Nebraska
- Zintel Canyon, Kennewick, Washington

We appreciate the opportunity to review and comment on these statements.

Sincerely,

T. K. COWDEN
Assistant Secretary

Enclosures

November 9, 1970

U. S. DEPARTMENT OF AGRICULTURE COMMENTS

Draft Environmental Statement Prepared by
Corps of Engineers for

Beals Creek at Big Spring, Texas

The proposed project consists of channel realignment and enlargement with a complementary floodway on about 5.6 miles of Beals Creek running through the city of Big Spring, Texas.

We have reviewed the draft environmental statement and have no comment.

PRESTON SMITH

GOVERNOR OF TEXAS

November 27, 1970

Lieutenant General F. J. Clarke
Chief of Engineers
Department of the Army
Building T-7, Gravelly Point
Washington, D. C. 20310

Dear General Clarke:

Inclosed herewith is a copy of the Order of the Texas Water Rights Commission, dated November 24, 1970, following its study and public hearing, pursuant to Article 7472e, VTCS, relating to your report on Beals Creek, Big Spring, Texas.

I concur in the findings and recommendation of the Commission that the project is feasible and in the public interest. I urge the early authorization and funding of the project by the Congress.

Your comments on the five points posed under the National Environmental Policy Act of 1969 credit the proposed project as enhancing the environment and providing beneficial impact on fish, wildlife and on the public welfare.

It is respectfully requested that the Federal effort in final planning and development of the proposed project be fully coordinated with the Texas Natural Resources agencies.

With my kind regards, I am

Sincerely,

Preston Smith

Preston Smith

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
BOARD OF ENGINEERS FOR RIVERS AND HARBORS
WASHINGTON, D.C. 20315

IN REPLY REFER TO

ENGBR

27 July 1970

SUBJECT: Beals Creek at Big Spring, Texas

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

1. Authority.--This report is in partial response to the following resolution adopted 4 August 1936:

> Resolved by the Committee on Commerce of the United States Senate, That the Board of Engineers for Rivers and Harbors created under section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby requested to review the reports on Colorado River, Texas, submitted in House Document Numbered 361, Seventy-first Congress, second session, and previous reports, with a view to determining if improvement in the interest of commerce and flood control is advisable at the present time.

It is also in partial response to authorizations contained in the Flood Control Act approved 22 June 1936 and River and Harbor Acts approved 26 August 1937 and 2 March 1945, respectively. This report covers the flood and related water problems of Beals Creek at Big Spring, Texas. Other reports in response to the above authorizations will be submitted later.

2. Description.--The area under consideration in this report is Beals Creek in the vicinity of Big Spring, Texas. Beals Creek runs west to east through the city and continues generally eastward some 67 miles to its confluence with the Colorado River. The High Plains region above Big Spring is nearly level and contains numerous playas, or wet-weather

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lakes, which control most of the runoff in this area. The watershed above Big Spring covers about 9,400 square miles of which 494 square miles is considered to be the contributing drainage area. The Beals Creek channel through the city has a capacity of about 200 cubic feet per second (c.f.s.), with a depth ranging from 3 to 4 feet and widths of 15 to 30 feet.

3. Economic development.--Big Spring, the county seat of Howard County and principal trade and service center for a large surrounding area, has experienced a steady and diversified growth. Economic activity today extends beyond agriculture and the railroad, and includes oil and petrochemicals, an Air Force Jet Training Base, Howard County Junior College, two Government-owned hospitals, and a variety of industries. The 1960 census reported a population of 40,139 for Howard County, of which 31,200 resided in the city of Big Spring. The city is well developed for residential, industrial, and commercial purposes. The geographical location and easy accessibility make Big Spring an ideal distribution center for wholesale items, industrial products, and services. Big Spring is equi-distant between Fort Worth and El Paso, at the intersection of two of the longest transcontinental highways in America -- Interstate 20 (United States Highway No. 80) and United States Highway No. 87. The Texas and Pacific Railway Company uses Big Spring as a division point for rail freight service east and west.

4. Existing improvements.--The city has built nine small detention reservoirs within the city on draws entering Beals Creek from the south. There are no existing Federal improvements for flood control or water conservation on Beals Creek.

5. Floods and damages.--There have been 29 damaging floods at Big Spring since 1890. The maximum flood that has occurred since the establishment of a United States Geological Survey stream gage in February 1957 was that of 10 May 1957 when a gage height of 11.2 feet was observed on the gage at Big Spring. The total value of property in the 100-year flood plain is estimated at $18,914,000. Average annual flood damages are estimated at $269,500. It is estimated that under existing conditions an occurrence of the 100-year frequency flood (23,000 c.f.s) would cause urban damages approaching $6.7 million.

6. Improvement desired.--Local interests desire improvement of Beals Creek to reduce flood damages to Big Spring. They are willing to cooperate in the improvements along Beals Creek.

7. Plan of improvement.--The District Engineer finds that prevention of flood damages in the Beals Creek flood plain at Big Spring can be realized best from a combination of structural and nonstructural measures. The structural plan would consist of realignment and enlargement of 5.6 miles of the Beals Creek channel through the community of Big Spring. The improved channel would provide for a flow of 10,000 c.f.s. to 12,600 c.f.s. The work would require alteration of several highway and railroad bridges. The nonstructural measures include the designation of a floodway in which no future construction or land filling would be permitted if such work would restrict the passage of floodwaters.

8. Economic evaluation.--Using July 1969 prices, the District Engineer estimates the first cost of the proposed channel improvement of Beals Creek at $2,526,000, consisting of $1,578,000 for Federal construction and $948,000 for the non-Federal cost for lands, damages, and relocations. Based upon a 4-7/8 percent interest rate and a 100-year period of analysis, the total annual charges are estimated at $144,300, including $14,000 for non-Federal operation and maintenance; and the flood control benefits are estimated to average $237,400 annually, consisting of $197,000 for flood damage prevention and $40,400 for increased land utilization. The benefit-cost ratio is 1.6. The District Engineer recommends construction of the project in accordance with his plan, subject to certain requirements of local cooperation. The Division Engineer concurs.

9. Public notice.--The Division Engineer issued a public notice stating the recommendations of the reporting officers and affording interested parties an opportunity to present additional information to the Board. 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. While the channel improvements proposed by the District Engineer will

not provide complete protection against all floods, it will protect against floods with peak flows up to 12,600 c.f.s., reduce damages from larger floods, and in conjunction with flood plain regulations to be adopted and enforced by local interests, will provide a desirable and feasible solution to the flood problem. The proposed plan is economically justified, and the requirements of local cooperation are appropriate.

11. Recommendations.--Accordingly, the Board recommends the improvement of Beals Creek at Big Spring, Texas, in the interest of flood control, by enlargement and realignment of 5.6 miles of channel through the city; generally in accordance with the plan of the District Engineer, and with such modification thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated cost to the United States of $1,578,000 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 the construction, maintenance, and operation of the project;

b. Accomplish without cost to the United States all relocations and alterations to existing improvements, other than railroad bridges, which may be required for the construction of the project;

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

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

e. Provide without cost to the United States fill areas for the disposal of excess materials from the channel excavation work, the areas to be within reasonable haul distance of the project (approximately 3 miles); or bear the cost for the excessive haul distance;

f. Prevent encroachment which would interfere with the flood-carrying capacity of the improved channel and floodway;

g. At least annually, publicize and notify all interested parties that the channel will not provide protection from the occurrence of storms greater than a storm which could be expected to occur once in 50 years; and

h. Adopt and enforce appropriate flood plain regulations (non-structural measures) which in combination with the structural measures for the proposed flood control project would:

(1) Insure an unobstructed floodway, and

(2) Prevent damages to future development within the flood plain that would be inundated by a flood that could be expected to occur once in 100 years.

FOR THE BOARD:

C. H. DUNN
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

INTERIM REPORT
ON
COLORADO RIVER AND TRIBUTARIES, TEXAS
COVERING
BEALS CREEK AT BIG SPRING, TEXAS

SYLLABUS

The District Engineer finds from his investigations that a serious urban flood problem exists at Big Spring, Texas, because of floodflows on Beals Creek. He finds that urban damages have been extensive in the past. Under present conditions and values, an average annual flood loss of $269,500 can be expected. He concludes that this flood problem can best be solved by construction of an improved channel generally along the existing alignment of Beals Creek, and implementation of flood plain management techniques. He concludes further that there is an immediate need for the local protection works and that they are fully justified. The estimated average annual benefits would exceed average annual costs, with a benefit-cost ratio of 1.6.

The District Engineer recommends construction of the local protection project at Big Spring, Texas, generally as outlined in the report, at an estimated cost to the United States of $1,578,000, subject to certain conditions of local cooperation.

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
FORT WORTH, TEXAS
11 MAY 1970

SUBJECT: Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas - Flood Protection

THRU: Division Engineer, Southwestern

TO: Chief of Engineers

INTRODUCTION

1. AUTHORITY

This interim report is submitted in partial response to the following Congressional authorizations:

a. Flood Control Act, approved June 22, 1936:

> "Sec 6. The Secretary of War is hereby authorized and directed to cause preliminary examinations and, surveys for flood control at the following named localities, ... Colorado River, Texas, above the county line between Coke and Runnels Counties. . . . . Lower Colorado River, Texas."

b. Resolution by the Committee on Commerce, United States Senate, adopted August 4, 1936:

> "Resolved by the Committee on Commerce of the United States Senate, That the Board of Engineers for Rivers and Harbors created under section 3 of the River and Harbor Act, approved June 13, 1902, be and is hereby, requested to review the reports on Colorado River, Texas, submitted in House Document Number 361, Seventy-first Congress, second session, and previous reports, with a view to determining if improvement in the interest of commerce and flood control is advisable at the present time."

c. River and Harbor Act, approved August 26, 1937:

"Sec. 4. The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys to be made at the following named localities, ... Colorado River, and its tributaries, Texas, with a view to its improvement in the interest of navigation and flood control."

d. River and Harbor Act, approved March 2, 1945:

"Sec. 6. The Secretary of War is hereby authroized and directed to cause preliminary examinations and surveys to be made at the following-named localities, ... Colorado River, Texas."

2. REPORT ASSIGNMENT

Submission of an interim report was authorized by the Chief of Engineers in 2d Indorsement, dated January 16, 1968, to SWFED-B letter, dated December 8, 1967, subject: Interim Report - Beals Creek, Big Spring, Texas. Funds for preparation of the interim report were verified by Advice of Allotment C-409, dated September 17, 1968.

3. HISTORY OF INVESTIGATION

a. Initial studies.- Funds for a basinwide survey investigation and report covering the Colorado River and tributaries, Texas, were authorized in October 1958. Field investigations of the Big Spring flood problem were initiated in July 1959, in conjunction with the basinwide study. These early studies indicated that improvement of the Beals Creek channel would be an economically feasible solution for the prevention of flooding at Big Spring.

b. Public hearing.- A public hearing concerning the Colorado River Basin study, as related to the upper portion of the basin, was held at Ballinger, Texas, on May 22, 1962. The purpose of the hearing was to afford all interested parties the opportunity to express their views concerning the character and extent of imrpovements desired, and the need thereof. The Director of Public Works for Big Spring, representing the city, requested that the Corps of Engineers continue its studies of the flood control problem created by Beals Creek. As an indication of the city's interest, a storm drainage plan prepared by consulting engineers for the city was presented for the record, along with the Mayor's transmittal letter requesting the Corps' assistance. There were no other presentations for or against possible flood control improvements at Big Spring.

c. Request for interim study.- The Colorado River Basin studies were suspended in June 1966 primarily because the Texas Water Rights Commission had nullified local assurances for proposed projects so that a statewide water plan study could be completed prior to issuance of any additional water rights permits. At that time, investigations of possible flood control improvements for Big Spring were near completion. At its regular meeting on July 25, 1967, the City Commission of Big Spring enacted a resolution again requesting the assistance of the Corps of Engineers in improving the flood conditions, and reaffirming the City's willingness to meet requirements of local cooperation. This resolution was submitted to the Fort Worth District by letter dated July 27, 1967. Review of possible plans to alleviate the Big Spring flood problem indicated any feasible plan could be considered independently of the basin studies; therefore, request for authority to prepare an interim report was initiated in December 1967.

4. PURPOSE

This report is a study of the flood conditions created by Beals Creek at Big Spring, with a determination of the best solution to this problem.

5. EXTENT OF STUDIES

Engineering field work included survey cross sections of stream channel and valley, site inspections, borings at Natural Dam Salt Lake, real estate appraisals, and damage surveys. In addition to general analysis of area economics, a detailed land use study was conducted within the flood problem area. Office studies consisted of the collection and analysis of hydrologic data; preparation of project design, cost estimates, and benefit estimates; and analysis of nonstructural measures.

6. ARRANGEMENT OF REPORT

The text of this report is supplemented by maps, charts, drawings, and appendices containing technical details, analyses, and evaluation data. A map showing the recommended plan of improvement is inserted at the back of the text following the report recommendation. The appendices and one supplement are arranged as follows:

Appendix I - Engineering and Cost Data
Appendix II - Hydrology and Hydraulic Design
Appendix III - Economic Studies
Appendix IV - Flood Plain Information
Appendix V - Comments of Other Agencies
Appendix VI - Environmental Effects
Supplement - Senate Resolution No. 148

7. AREA INVESTIGATED

a. Location.- The city of Big Spring and its vicinity comprises the area investigated for this report. Big Spring, the county seat of Howard County, is located in central west Texas. It is about midway between Fort Worth and El Paso at the intersection of Interstate Highway 20 and U. S. Highway 87. Beals Creek runs west to east through the city, and continues generally eastward some 67 miles to the Colorado River. Plate 1 shows the Beals Creek watershed area, and the flood study area is shown on plate 2.

b. Streams.- The main stem of Beals Creek actually originates at the confluence of Johnson and Mustang Draws (river mile 110.0). Above this point the Mustang Draw drainage pattern extends more than 120 miles to the northwest into New Mexico, and Johnson Draw originates some 50 miles to the southwest. Historically, the Mustang Draw name has continued downstream to Sulphur Springs Draw (mile 79.07) at which point Beals Creek begins. Beals Creek is the only stream to convey flood flows originating above Big Spring, and provides drainage for 75 percent of the city's developed area. The channel through the city has a capacity of only about 200 cubic feet per second, with a depth ranging from 3 to 4 feet and widths of 15 to 30 feet. Its average gradient through the city is about 0.1%. Four small tributaries enter Beals Creek within the immediate study area: Reads Draw, Little Sandy Draw, and Big Sandy Draw from the north; and Big Spring Draw from the south. Beals Creek and its tributaries are all intermittent streams.

c. Characteristics of the drainage area.- The drainage characteristics of the Beals Creek watershed change abruptly at Big Spring. The area west of the city lies in the High Plains region, and the area east lies in the Rolling Plains and Edwards Plateau regions. In the eastern area the landscape is gently sloping to steep, and the drainageways are well defined. The High Plains area above Big Spring is nearly level to gently sloping. Playas, or wet-weather lakes, are common to the High Plains and control most of the runoff in this area. The total watershed area above the U. S. Geological stream gage at Big Spring is some 9,400 square miles; but only 494 square miles are considered as being contributing drainage area. Numerous salt lakes, caused by evaporation, lie west of Big Spring. Some are dry during the drier part of the year, but others have water all the time. About 2 miles above the mouth os Sulphur Springs Draw is Natural Dam Salt Lake. This "dam" has no outlet and has never overflowed; but there is some seepage and ground flow of salt water. From Sulphur Springs Draw, 8 miles above the stream gage, Beals Creek flows through a series of small salt lakes ending with Onemile Lake at the present western edge of the city These lakes regulate minor flood flows.

d. Geology.- The area traversed by Beals Creek in and around Big Spring is underlain by Tertiary and Quaternary sediments which, because of physical similarities, will collectively be referred to here as the Ogallala formation. The Ogallala has a wide area distribution in West Texas and serves as the region's major fresh water aquifer. Lithologically it consists of fine to coarse sand and gravel interbedded with scattered clay and caliche lenses. The formation is generally unconsolidated except for isolated areas where cementation has been affected by the concentration of these clay or caliche zones. A maximum thickness of over 400 feet has been reported for the Ogallala in some West Texas regions; however, in Howard County the thickness ranges from 82 feet to 250 feet. The Ogallala sediments lie unconformably on Triassic redbeds within the Big Spring and surrounding areas.

8. CLIMATOLOGY

a. General.- The Beals Creek watershed is subject to rapid and large temperature changes, especially during the winter months when cold fronts from the northern Rocky Mountains and Plains States sweep across the level plains at speeds up to 40 miles an hour. Temperature drops of 50 to 60 degrees within a 12-hour period are not uncommon. The Weather Bureau (ESSA) maintains first-order station at Abilene, Lubbock, Midland, and San Angelo. The first-order station at Big Spring was discontinued in November 1953. Abilene is located about 100 miles east, Lubbock about 90 miles north, Midland about 45 miles west, and San Angelo about 80 miles southeast of Big Spring. Climatological data for these stations, considered representative of the Big Spring area, are given in table 1.

b. Precipitation.- The mean annual precipitation over the Beals Creek watershed is approximately 18 inches. A weather substation was established in Big Spring, Texas, in 1891 and operated as a nonrecording station until March 1940. In March 1940, the U. S. Weather Bureau (ESSA) established a first-order station at Big Spring, and the station was operated as such until November 1953; however, a recording rainfall station has been operative at Big Spring to this date. Extremes in annual precipitation on the watershed as indicated by the Big Spring gage records have ranges from a maximum of 35.81 inches in 1919 to a minimum of 4.89 inches in 1917. The normal seasonal distribution of rainfall over the watershed indicates that the heaviest rainfall occurs during the period May through October. Hourly precipitation records of the Abilene station have been analyzed for the periods 1905-1950 and 1940-1950; Big Spring for the period 1940-1950; Midland for the period 1941-1950; San Angelo for the period 1948-1950; and Lubbock for the period 1940-1950. Maximum amounts of precipitation recorded at these stations for each month and for selected durations are published by the

TABLE 1
CLIMATOLOGICAL DATA

	Abilene, Texas	(1) Big Spring, Texas	Midland, Texas	San Angelo, Texas	Lubbock, Texas
Temperatures in degrees F.					
Average annual	64.3	64.0	64.3	66.4	59.7
Normal daily minimum	52.3	50.5	51.5	53.9	45.8
Normal daily maximum	76.3	77.4	77.2	79.0	73.6
Minimum of record	-9 Jan 1947	-7 Feb 1933	-11 Feb 1933	1 Jan 1947	-16 Jan 1963
Maximum of record	111 Aug 1943	117 Jun 1907	107 Aug 1964	111 Jul 1929	107 Jul 1958
Rainfall in inches					
Normal annual	23.32	17.89	14.24	18.63	18.08
Maximum month	15.70 Aug 1914	12.89 Jul 1902	8.18 Sep 1932	27.65 Sep 1936	8.85 Aug 1966
Maximum 24-hours	6.78 May 1908	6.77 Apr 1922	5.99 Jul 1961	11.75 Sep 1936	5.70 Jun 1967
Snowfall in inches					
Maximum month	9.5 Feb 1890	11.5 Feb 1905	7.7 Jan 1949	8.8 Nov 1968	16.8 Feb 1956
Maximum 24-hours	8.0 Jan 1919	3.5 Mar 1941	5.9 Jan 1955	5.8 Nov 1968	12.1 Feb 1961
Relative humidity in percent					
Annual average:					
Midnight CST	62	-	61	65	63
6:00 a.m. CST	71	-	74	76	74
Noon CST	49	-	42	47	46
6:00 CST	43	-	35	42	41
Wind in miles per hour					
Annual:					
Mean hourly speed	12.2	-	10.4	10.4	13.5
Prevailing direction	SSE	-	SSE	S	S
Fastest mile:					
Speed	73	-	67	69	70
Direction	N	-	W	W	N
Date	May 1949	-	Feb 1960	Apr 1957	May 1952

(1) First Order Station discontinued 11-13/53.

U. S. Weather Bureau (ESSA) as Technical Paper 15, dated 1959. The maximum all season values are shown in the following tabulation:

Duration (hours)	Maximum Precipitation				
	Abilene	Big Spring	Midland	San Angelo	Lubbock
1	3.47	1.75	2.45	2.40 (2)	2.15
2	4.42	1.90	3.05	4.80 (2)	2.60
3	4.53	1.94	3.05	6.00 (2)	2.75
6	6.26	3.84 (1)	3.47	9.90 (2)	2.95
12	6.56	6.77 (1)	3.58	11.05 (2)	3.55
24	* 6.78	6.77 (1)	5.99	* 11.75 (2)	* 5.70

(1) From Mass Curves Rainfall - Storm of April 23 28, 1922
(2) From Mass Curves Rainfall - Storm Sept.14-19, 1936
* Taken from publication: Local Climatological Data for Abilene, Big Spring, Midland, San Angelo, Lubbock, Big Spring dated 1951 - Others dated 1968 (U.S. Weather Bureau (ESSA).

c. Evaporation.- Evaporation records have been maintained at Big Spring since 1916. Evaporation records from April through September were maintained from 1916 through 1940; since 1941 evaporation records for the entire year have been recorded at the station. Based upon these records, the average annual net reservoir surface evaporation loss is 49.64 inches for the period 1916-1967.

9. RUNOFF AND STREAMFLOW DATA

The stream-gaging station in the watershed on Beals Creek at Big Spring, Texas, was first established in February 1957, on the downstream side of the lower bridge on U. S. Highway 80 and was in service until December 1958. In January 1959 a recording gage was installed on Beals Creek above Big Spring, on the left bank at the end of Channing Street, and has been in service since installation. Records of daily discharge on Beals Creek for these stream-gaging periods have been published by the U. S. Geological Survey. The maximum, minimum, and average annual runoff under existing conditions for the area above the Big Spring gage for the 1960-1968 period were 1610 acre-feet (1962), 0 acre-feet (1964), and 700 acre-feet, respectively.

ECONOMIC DEVELOPMENT

10. EXISTING CONDITIONS

Big Spring, as the county seat of Howard County and principal trade and service center for a large surrounding area, has experienced a steady and diversified growth. Economic activity today extends beyond agriculture and the railroad, long time stalwarts, to include oil and petro-chemicals, an Air Force Jet Training Base, Howard County Junior College, two Government owned hospitals, and a variety of industries. The 1960 census reported a population of 40,139 for Howard County, of which 31,200 resided in the city of Big Spring. Estimates for 1968 indicate an even greater proportion of the county population to be in the urban area. The city is well developed for residential, industrial, and commercial purposes. The geographical location and easy accessibility make Big Spring an ideal distribution center for wholesale items, industrial products and services. Big Spring is equi-distance between Fort Worth and El Paso, at the intersection of two of the longest transcontinental highways in America - Interstate 20 (U.S. 80) and U. S. 87. The Texas and Pacific Railway Company uses Big Spring as a division point for rail freight service east and west. An estimated 250 business and industrial establishments, and 350 residences are located in the 100-year flood plain. The total value of these, together with utilities, streets, and other properties is estimated at $18,914,000 based on 1969 prices.

11. FUTURE CONDITIONS

Based on studies reported in Appendix III, Economic Studies, it is expected that the city of Big Spring will continue to enjoy a steady, though perhaps somewhat slower, growth in the future. This future growth can be attributed to the existing diversification and the position of Big Spring as the seat of County Government, trade center and general focal point of a relatively large geographical area.

WATER RESOURCE DEVELOPMENTS

12. NON-FEDERAL IMPROVEMENTS

a. Flood control.- The city has built approximately nine small detention reservoirs on draws entering Beals Creek from the south. Most of these reservoirs are located along 11th Place, 3/4 mile from Beals Creek and parallel to the channel from Gregg Street to Onemile Lake. The detention reservoirs alleviate flooding from local drainage but their effectiveness with regard to flooding on Beals Creek is negligible.

b. Water supply.- In 1949, the Texas Legislature authorized the creation of the Colorado River Municipal Water District. The District is a political subdivision, organized by the Cities of Big Spring, Snyder, and Odessa, Texas, to provide adequate water for the member cities. The District is committed to supply all water needed for these cities, and surplus resources are sold to oil companies and a number of rural users. Big Spring's annual average daily consumption in 1965 was some 7 million gallons. The District has also contracted to supply from 9 million to 18 million gallons of water daily to the City of Midland beginning in 1970. The present major water supply source is Lake J. B. Thomas (204,000 acre-feet) located on the Colorado River some 30 miles northeast of Big Spring. Construction was started in 1966 on Robert Lee Dam (Lake E. V. Spence, 488,760 acre-feet) also on the Colorado River, some 60 miles southeast of Big Spring. The reservoir and distribution system are scheduled for completion by January 1970. The two reservoirs will have a combined dependable yield of about 66,000 acre-feet annually.

b. Recreation.- City Park and Big Spring State Park are located at the southwest edge of the city. The large municipal park has facilities for camping, picnicking, swimming, golf and baseball. The 343-acre state park has limited camping and picnicking facilities, but provides a winding scenic drive rising almost 400 feet above Beals Creek. Moss Creek Lake, nine miles east of Big Spring, was built in 1939 primarily for municipal water supply. However, the 2,400 acre-foot lake is very popular for afternoon outings and fishing.

13. FEDERAL IMPROVEMENTS

There are no existing Federal improvements for flood control or water conservation in the Beals Creek watershed.

14. FLOOD PROBLEMS

a. Flood history and situation. Flooding along Beals Creek through Big Spring occurs because of inadequate channel capacity. History on the study area indicates that possibly 29 damaging floods have occurred since 1890. The maximum flood that has occurred since the establishment of a U. S. Geological stream gage in February 1957 was that of May 10, 1957, when a gage height of 11.2 feet was observed on the gage at Big Spring. Utilizing the data from backwater studies, the Corps of Engineers extended the rating curve at the gage and estimated a peak discharge of 6,600 cubic feet per second for the May 1957 flood. Historical information indicates that the May 1957 flood was the highest since 1932 and that other large floods occurred in 1890, 1902, 1904, 1915, 1922, and 1945. There is insufficient data to provide a basis for reasonable estimates of peak discharges for these earlier floods. However, an analysis of limited and sometimes contradictory descriptions of these floods and a comparison of daily rainfall records has led to the conclusion that probably only two of these earlier floods (those of 1890 and 1902) produced peak discharges in excess of the flood of May 1957. The flood problems at Big Spring fall in two categories, i.e., prolonged floods originating in the contributing drainage area of Beals Creek above the city and flash floods caused by heavy local rainfall. The previously noted drainage plan prepared for the city did not include a flood control study, but did recognize the major flood threat from the Beals Creek drainage area; and concluded that unless the Beals Creek channel is improved, little can be accomplished to alleviate flooding conditions anywhere in the city. A further complication is the heavy sand load carried by Little Sandy and Big Sandy Draws during floodflows. Much of this sand is deposited in the Beals Creek valley between Interstate 20 and FM Road 700.

b. Flood damages.- Field investigations were made in 1959, 1965, and 1968 to determine the development and improvements in the flood plain. These investigations, together with subsequent office studies, were used to develop a discharge-damage curve (presented in appendix III) for the portion of Beals Creek flood plain studies for this report. Rainfall records, stream gage records, synthetic unit hydrographs, high water marks, and other data furnished by local interests or observed by personnel of the Fort Worth District were used to develop a discharge-frequency curve. Based on present conditions, these curves indicate that annual flood damages averaging $269,500 can be expected. It is estimated that an occurrence of the 100-year frequency flood (23,000 second-feet) would cause urban damages approaching $6.7 million.

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15. OTHER WATER RELATED PROBLEMS

a. Water supply.- As previously noted, Lakes J. B. Thomas and E. V. Spence would provide Big Spring and its partner cities some 66,000 acre-feet annually. The state's recently completed Texas Water Plan report indicates that an additional source of supply will be required by 1990 to support anticipated growth of these cities. During investigation of the Big Spring flood problem, it was determined that there is insufficient runoff from the Beals Creek watershed to develop a water supply; therefore, additional supply must come from outside the watershed.

b. Water quality control.- The quality of water in the Colorado River immediately below the mouth of Beals Creek is affected by brines originating from Beals Creek. Also, some pollution originates from the city's sewage disposal plant located just below FM Road 700. It was determined that any project that would improve these conditions must be located downstream of Big Spring.

16. PLANNING OBJECTIVES AND GUIDELINES

a. Basic considerations.- The basic objective of the investigations reported herein was to determine the best plan for the prevention of flood damages in the city of Big Spring. The studies contemplated all possible solutions would be investigated and the well-being of all the people would be the overriding determinant in considering the best use of water and related land resources.

b. Planning considerations.- The basic planning goal was to provide adequate flood protection for Big Spring. To achieve this goal within the above stated objectives, selection of the plan of improvement was guided by the following guidelines and constraints:

(1) The approximately 8,900 square miles of noncontributing drainage area above the city represent an indeterminate flood hazard potential. Therefore, it was considered that the use or combination of uses of structural and nonstructural measures should, at a minimum, prevent or reduce damages from a flood expected to occur once in 100 years.

(2) The proposed improvements should be compatible with existing plans for storm drainage improvements by the city.

(3) Any proposed plan of improvement must be compatible with the needs of the Colorado River Basin, and not preclude future development of water and related land resources.

c. Economic guidelines.- The basic economic formulation criteria were as follows:

(1) The project will provide tangible benefits at least equal to its cost.

(2) The scope of development must provide the maximum of excess benefits over costs insofar as practicable.

(3) The plan must be the most economical means, evaluated on a comparable basis, of accomplishing the purpose.

17. SCREENING OF SOLUTIONS

a. Relation to initial studies.- Initial studies made prior to 1966 for the Colorado River basinwide report indicated that the best plan would be an improved channel along the existing alignment to convey the 50-year flood (10,000 cubic feet per second). This channel

included a rectangular concrete section from Onemile Lake to Gregg Street. Subsequent to initiation of studies preparatory to submitting an interim report, it was recognized that previously considered alternative plans would require further investigation in addition to the consideration of nonstructural alternatives.

b. Structural alternatives.- The following subparagraphs describe the preliminary studies that were made to determine the economic feasibility of various structural alternatives:

(1) Levees.- The portion of the Beals Creek flood plain from Onemile Lake to Benton Street is almost completely occupied by railroad yard and business improvements on either side of the yard. A levee plan would either confine the railroad within the floodway or require extensive relocations. Such a plan was not considered practical, and no further consideration was given to a plan involving the use of levees.

(2) Diversion.- There are no other streams to which flood flows originating on Beals Creek can be diverted. The only diversion from the existing channel involved the channel alignment studies described below.

(3) Channel improvements.- Screening studies considered two alternate channel alignments. These studies determined that 10,000 cubic feet per second (50-year frequency) is the maximum reasonable capacity of an improved channel along the existing Beals Creek alignment through the railroad yards; any larger discharges along the existing alignment would require extensive relocation of railroad trackage and other additional improvements. This plan would require the construction of a rectangular concrete channel from Onemile Lake to Gregg Street. For protection against floods larger than 10,000 cubic feet per second, it was determined that the only feasible alignment was to divert the channel north of the railroad tracks. This alignment would require more right-of-way through the railroad property from Onemile Lake to Gregg Street; however, the use of this area has steadily declined in the last ten years. Studies indicate, as shown in table 2, the feasibility of the northerly alignment.

(4) Reservoir and channel combination.- The existing capacity of Beals Creek is only about 200 cubic feet per second; therefore, all reservoir plans considered were limited to reservoir-channel combinations because of reservoir regulation requirements. The dam site selected for feasibility studies is located about 10 miles west of Big Spring, just below Elbow Creek on Mustang Draw (Beals Creek). Any reservoir closer to the city would be located in the salt water areas, and would require extensive relocations of

Interstate Highway 20 and mainline railroad track. The only economic or beneficial advantage a reservoir in this area would have over the site selected for study would be the possibility of providing water quality control. However, investigations indicated that the major benefit provided by water quality control would be the improvement of the quality at the Colorado River. The Beals Creek streambed is saturated with brine and deposited salt for many miles below Big Spring; and a reservoir above the city would have little or no effect on the water quality at the Colorado River. Further investigation of the water quality problem was considered beyond the scope of this interim report. Hydrologic studies indicated that runoff is not sufficient to develop storage for water supply use; but a recreation pool area of 470 acres could be available about 35 percent of the time. Therefore, economic feasibility studies were made only for a single-purpose flood control reservoir and a flood control recreation reservoir, in combination with the required channel improvement to provide 50-year protection. The results of these studies are also shown in table 2 for comparison with the channel-only plans, and indicate that a plan of protection involving reservoirs is not economically feasible. The reservoirs were sized to control a 50-year flood estimated at two inches of runoff, or 48,900 acre-feet. The channel capacity required in combination with the reservoir to provide 50-year protection in Big Spring would be 8,000 cubic feet per second. This discharge can be equalled by the combined peak flows of four small tributaries entering Beals Creek within the city; therefore, additional reservoir storage other than that considered would not reduce the size of channel required.

TABLE 2

PRELIMINARY FEASIBILITY STUDIES

Plan	First cost	Benefit-cost ratio (1)
Channel improvement		
10,000 cfs (2)	$2,040,000	1.9
10,000 cfs (2) (3)	4,750,000	0.89
23,000 cfs (4)	6,950,000	0.78
Reservoir and channel (2)		
Flood control only	19,500,000	0.22
Flood control & recreation	20,600,000	0.52

(1) 100-year analysis
(2) 50-year protection
(3) Concrete from Onemile Lake to Gregg Street
(4) 100-year protection

c. Nonstructural alternatives.- Nonstructural alternatives are corrective and preventive measures which can reduce flood damages without reducing flood stages. Such flood plain management techniques are particularly useful in preventing damages to future development but generally are not effective or practical in developed areas unless used to supplement structural measures, e.g., channel improvement. The following subparagraphs describe the nonstructural alternatives considered and the reasons why they would be inappropriate or infeasible unless used in conjunction with structural measures:

(1) Permanent evacuation of flood plain.- There are approximately 350 residences and 250 businesses in the 100-year frequency flood plain under existing conditions. Most of this development is located in the reach between Onemile Lake and Benton Street. As shown on plate 2, the Texas and Pacific Railroad yards are located in this reach of Beals Creek. Preliminary economic analysis showed that it is impractical to acquire presently developed land for the purpose of moving existing developments out of the flood plain. Purchase of railroad right-of-way for use as a floodway or "conservation zone" would be extremely costly, as well as a major economic setback to the community. Purchase of use restriction easements appears to be equally impractical. The 100-year frequency flood under existing conditions would produce a water surface about eight feet above the rails in the vicinity of the T&P Railroad depot. Flood depths of that magnitude would flood contents of box cars standing in the railroad yards and any easement agreement drawn up would have to exclude the use of the flood plain for railroad lines. Easements would also necessitate undetermined and continuing future expenditures for the maintenance of control. Furthermore, a large portion of businesses, warehouses, etc., located adjacent to the railroad line depend on it for their subsistence. Dispersion of these warehouses and other businesses to outlying locations would require laying of new spur lines or trucking of products to a newly located railroad freight depot. Acquiring the already developed areas along Beals Creek for a floodway would, at best, curtail economic production in Big Spring, resulting in a possible permanent decline in the local economy. Based on the foregoing, permanent evacuation of the flood plain is an impractical plan when considered as a possible alternative to structural measures that would reduce flood stages.

(2) Flood proofing.- Existing structures located in the flood plain of Beals Creek are generally adaptable for flood proofing by raising in place; however, many of the buildings located near the creek would have to be raised eight feet to be above the 100-year frequency flood elevation under existing conditions. This would be extremely costly and would make many of the residential and commercial structures unfit for the purposes for which they were constructed. Other more conventional means of flood proofing residences and businesses include

shielding or closing of openings, anchorage of foundations to prevent floatation, reinforcement of walls to withstand horizontal pressures exerted by floodwaters and, to be effective, measures to cope with sewer backup and ground water seepage. Residential and business construction in the Beals Creek flood plain does not lend itself readily to flood proofing because of the extensive use of materials that do not impede the passage of water. Flood proofing the approximately 250 businesses and 350 residences located in the flood plain by using flood shields and other means would be difficult and costly. The use of flood shields or other means of flood proofing would be particularly impractical in the case of railroad cars. Exclusive use of flood proofing to reduce flood damages would not prevent costly disruption of commerce (railroad traffic has been halted several times by floods) or the losses associated with flooded streets and highways. Flood prevention benefits derived from flood proofing as the only means of reducing flood losses would be significantly below those benefits derived by providing flood protection for the developed areas of the city. Under present planning concepts, local interests would bear the cost of a flood proofing program. It seems unlikely that flood proofing on the scale that would be necessary at Big Spring would be desirable to local interests on the basis of cost or as the best solution to flood problems.

(3) Flood forecasting and warning with temporary evacuation.- At Big Spring the floods may be either the flash flood or longer duration type. Long duration floods are produced by extended heavy rainfall on the drainage area upstream from Onemile Lake. There are no official rain gages or stream gages located in the contributing drainage area above Big Spring. Consequently, any warning or forecast the Weather Bureau might give would be general in nature and of minimal value in forecasting flooding at Big Spring. Flash floods are caused by locally intense storm centers. These can develop so rapidly (one to four hours) that there is no possibility for advance warning or evacuation. Therefore, flood forecasting and warning for the purpose of temporary evacuation would be of little benefit under existing conditions.

18. PLAN FORMULATION

a. General.- Based on the foregoing screening studies, an improved channel generally to the north of the existing Beals Creek alignment was selected as the best solution for preventing flood damages in Big Spring. Therefore, detailed studies were made to determine the size and extent of the selected structural plan, and the need for including flood plain management techniques.

b. Selected channel capacity.- The economic efficiency of channels sized to provide various levels of protection is illustrated

by figure 1. The most economical level (point at which maximum excess of benefits over costs occurs) of improvement would be a channel to carry the 50-year flood of 10,000 cubic feet per second. As shown on figure 1, a project to provide 80-year protection would still be economically feasible. An economic comparison of the two plans is presented below.

Economic comparison	50-year protection	80-year protection
First cost	$2,526,000	$5,150,000
Annual costs	144,300	283,500
Annual benefits	237,400	287,000
Excess net benefits	93,100	3,500
B/C ratio	1.6	1.0

Because the area being protected is urbanized, it would be desirable to provide a greater degree of protection. However, selection of a plan to provide greater than 50-year flood protection does not appear warranted. The 80-year protection plan would cost twice as much as the 50-year project, with only a slight increase in efficiency as far as damages prevented are concerned. Of the $269,500 average damages which would occur under the existing channel conditions, the 80-year flood protection plan would eliminate only 71 percent ($191,000) of these damages, as compared to 60 percent ($160,200) for the 50-year protection plan. Hydrologic investigations and historical information indicate that the 50-year channel would contain all floods that have occurred in the last 80 years. Therefore, a channel sized to protect against the 50-year frequency flood has been selected as the structural plan of improvement.

c. Design alternatives.- The selected design discharge would be contained in banks from Onemile Lake to Benton Street, and from Interstate 20 overpass to FM Road 700. The most economical design for most of the remaining portions of structural improvement would utilize excavated material to raise channel banks in low areas. These areas contain few improvements, and are ideally suited for disposal of large amounts of channel excavation. There are two alternative procedures for spoil disposal in the required areas:

(1) Spoil adjacent to the channel raising low areas two feet above design water surface, and confining the 50-year frequency flood within banks.

(2) Set floodway limits as required on each side of the channel. These limits would correspond to the conservation zone defined in appendix IV. Spoil would be disposed outside these limits, and the 50-year flood would be contained within the floodway.

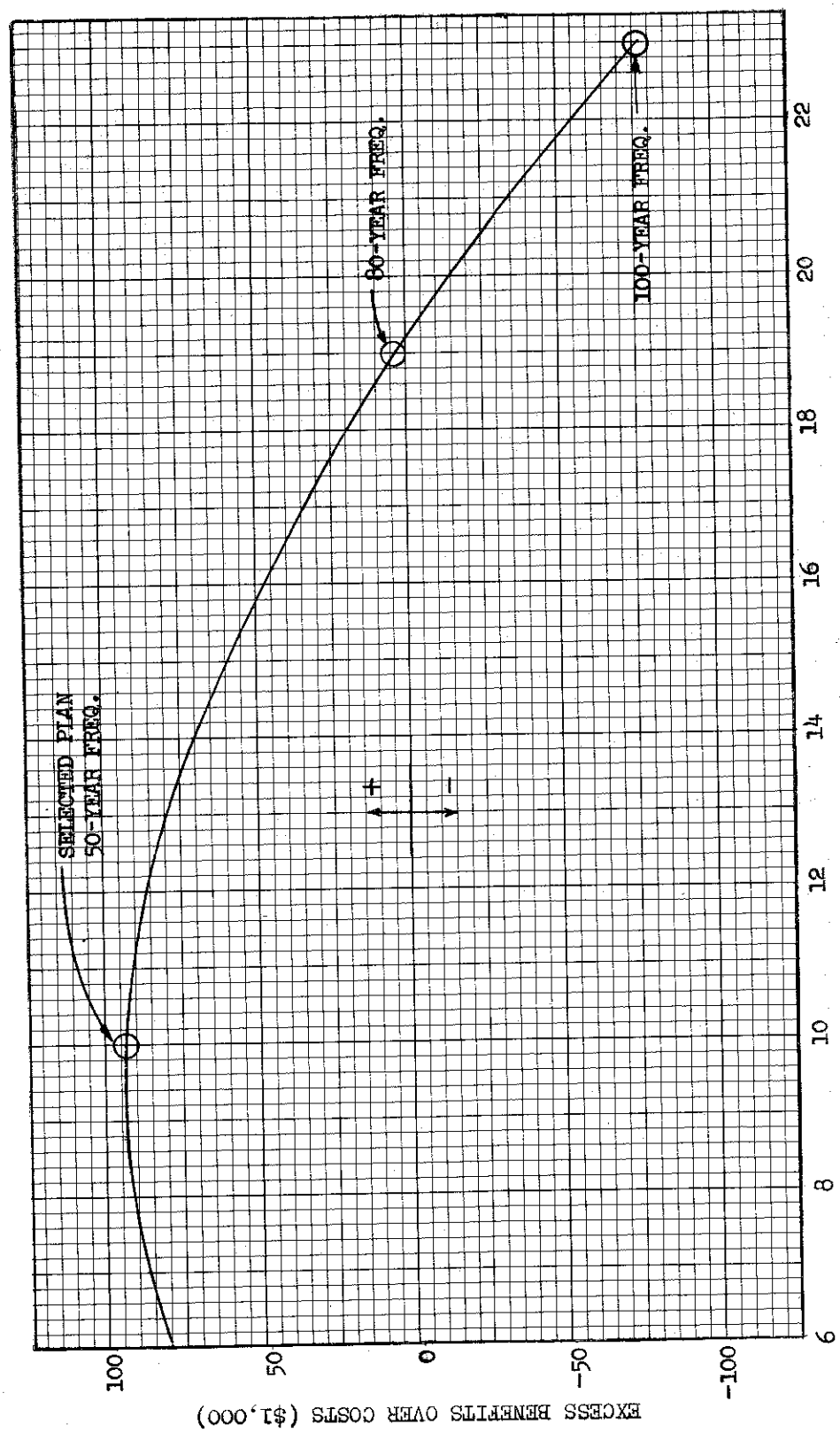

FIGURE 1
CHANNEL IMPROVEMENT
MAXIMIZATION STUDY

There would be slight, if any, difference in costs between the two alternatives. Placing the fill adjacent to the channel would be the simpliest procedure; but placingof an excessive amount of fill within the flood plain reduces the efficiency of flood stage reduction upstream of the fill area. By establishing a floodway through the low areas, the design water surface would be further reduced, and damages from floods in excess of the 50-year design frequency would be reduced. In addition, there would be sufficient channel excavation so that spoil areas outside the floodway could be raised above the 100-year frequency flood. Considering these advantages, a combination of structural (50-year channel) and nonstructural (adequate floodway) measures was selected as the best solution to the flood problem.

d. Selected plan.- The basic selected floodway, or conservation zone as described in appendix IV, would be the improved 100-year frequency flood plain. This would be an excessive area for complete regulation purposes. Therefore studies were made to determine a reduced floodway area which would represent encroachment of the 100-year flood plain without increasing flood levels. These studies indicated a floodway width not to exceed 1,000 feet (maximum of 500 feet either side of channel) would be the most feasible and practical. After construction of the proposed channel improvements, the 50-year frequency flood would be contained in banks or within the proposed floodway and the average overbank flood depth of the 100-year frequency flood would be reduced from 10 feet to 6 feet. The limits of the 100-year flood under existing and improved conditions is outlined on plates IV-1 through IV-4. Based on the preceding information, it was decided that supplemental flood plain management measures would be required to further reduce the 100-year frequency flood losses. Other nonstructural measures that could be used in conjunction with the selected 50-year channel and proposed floodway are included in the section on Plan of Improvement-Nonstructural Measures. The plan of improvement has been coordinated with the Bureau of Sport Fisheries and Wildlife. This agency indicates that the proposed plan would have no effect on fish and wildlife and would not offer feasible opportunities for improvement of these resources. The possibility of incorporating recreation and other park-like features in the proposed plan of improvement was discussed with local interests in September 1969. City officials did not request that such features be included in the proposed plan at that time.

19. NONSTRUCTURAL MEASURES

a. General.- The general problem of preventing flood damages has no complete solution. The Federal Government is actively engaged in a widespread flood control construction program, but the extent of protection provided by these facilities is limited by location, economic considerations, and the cooperation of local authorities. In spite of these projects, no low-lying area is completely free of a flood threat, and many areas are unable to qualify for any flood protection works. By development of flood plain information, flood damages can be reduced by indicating flood hazards and encouraging proper use of the flood plains. The Corps of Engineers is authorized to provide flood plain management services by Section 206 of the 1960 Flood Control Act, PL 86-645, as amended (33 USC 709a). Flood plain management services (FPMS) will be provided upon request to states, local governmental agencies and Federal agencies. The purpose of the FPMS is to provide flood plain information and technical assistance needed for planning the best use of land subject to flooding by streams and lakes. The following paragraphs outline a program of nonstructural measures that would become a part of the plan of improvement for the prevention of future flood damages. More detailed information is presented in appendix IV, Flood Plain Information.

b. Proposed plan.- Prevention of flood damages in the Beals Creek flood plain at Big Spring can best be realized from a combination of structural and nonstructural measures. These nonstructural measures include the designation of a floodway in which no future construction or land filling would be permitted if such works would restrict the passage of floodwaters. The channel improvement and floodway plan proposed in this report is considered the most feasible means to provide adequate flood protection and minimize damages from floods up to the magnitude of the flood expected to occur on the average of once in 100 years. This plan proposes a floodway width not to exceed 1,000 feet. The proposed plan and improved 100-year flood plain are shown on plate 2. Natural and improved water surface profiles are also shown in appendix IV; with additional guidance concerning the proposed floodway limits. The following paragraphs describe supplemental measures which can be used in combination with the proposed plan.

c. Supplemental measures.-

(1) Flood proofing.- Flood proofing consists of those adjustments to structures and building contents which are designed or adapted primarily to reduce flood damages. Such adjustments can be undertaken in existing buildings, or they can be incorporated into new buildings during initial construction. The type of flood proofing to be carried out depends upon the type of structure, stage of flooding, velocity of flow, and duration of flood.

(2) Urban redevelopment.- Urban renewal can be used in flood blighted areas that are a drain on the economic life and welfare of the community and do not lend themselves to other methods of regulation and control.

(3) Flood plain regulations.- Flood plain regulations as an integral part of an overall program for community development are considered the most useful of the preventive tools for reducing loss of life, property damage, and the ultimate cost of flood control to prevent flood damages. They involve the use of powers available to a state or community to guide and control the use and development of flood hazard areas. Zoning, subdivision regulations, channel and other encroachment statutes, and building codes are examples of the type of flood plain regulations that can be used to regulate the flood plain and prevent future flood damages.

(4) Development policies.- Resistance to the extending of utilities and to the construction of local streets will deter development in flood plains, as will many other day-to-day policy and action decisions. Construction of schools and other public facilities outside the flood plain would wield a negative influence on flood plain exploitation.

(5) Creating open spaces.- Great emphasis is being placed on the growing need for vastly increased areas for recreational and other open space uses. Areas adjacent to streams and other bodies of water have a natural attraction and are readily adaptable to recreation and other open areas. Parks, playgrounds, and picnic areas can utilize lands which would not be suitable for facilities with a high damage potential. Development rights, easements, or fee title to undeveloped flood prone areas could be acquired to provide the needed open space areas at reasonable costs.

(6) Tax adjustments.- Tax adjustments for land dedicated to agricultural, recreation, conservation, or other open space uses may be effective in preserving existing floodways along streams.

(7) Warning signs.- A method which may be used to discourage development in a flood hazard area is the erection of flood warning signs in prominent places that have experienced high water levels. These signs would carry no enforcement but would serve to inform prospective developers that a flood hazard exists.

20. STRUCTURAL MEASURES

a. General.- The proposed structural plan consists of channel improvement on Beals Creek to provide protection against a 50-year frequency flood. Pertinent data for the proposed plan are shown in

table 3. Plate 2 shows the general plan and 100-year improved flood plain. Detailed information on the plan of improvement is presented in appendix I.

b. Channel.- Realignment and enlargement of Beals Creek would begin just below the mouth of Big Spring Draw at stream mile 66.6 and extend 29,600 feet westward into Onemile Lake. From station 0+00 to 180+00 near Benton Street the improved channel generally follows the existing alignment. In this reach, channel excavation will be spoiled in low areas not closer than 500 feet of the centerline of the channel. Minimum height of spoil would be two feet above design water surface and maximum would be one foot above the improved 100-year flood profile. From Benton Street to the east edge of Onemile Lake (station 257+00) the improved channel would lie just north of the existing alignment. Transition of the improved channel to natural ground would extend to station 296+00, draining Onemile Lake.

c. Highway alterations.- New structures would be provided at 11th Place and Birdwell Street. Alterations to piers and pilings of bridges at F.M. Road 700, Interstate 20 overpass, and Gregg Street overpass would be required.

d. Railroad alterations.- Two new railroad bridges would be provided at Federal expense. Alteration of trackage and access bridges in the railroad yards due to the channel improvement would be provided at non-Federal expense.

e. Real estate requirement.- It would be necessary to acquire fee title to about 137 acres of land for the channel right-of-way. Permanent easements or use restrictions would be required in the floodway, and temporary easements would be required for spoil areas.

f. Landscaping.- An expenditure of $16,000 has been included to provide suitable sodding and plantings to enhance the appearance of the channel. This work would be in addition to the seeding and turfing for erosion control.

21. FIRST COSTS

The estimated first costs for the plan of improvement are summarized in table 4. Details are given in appendix I.

TABLE 3

PERTINENT DATA - PROPOSED CHANNEL IMPROVEMENT
BEALS CREEK, BIG SPRING, TEXAS

Location			
Stream			Beals Creek
River mile limits			66.6-72.2
Drainage area (square miles)			
At head of improvement			482
At USGS gage above Big Spring			494
At beginning of improvement			539
Channel improvements			
Existing capacity, cfs			100-200
Improved capacity, cfs			10,000-12,600
Length of improved channel, miles			5.6
Length of improved channel, feet			29,600
Channel enlargements:		Bottom width	Side slopes
0+00 to 68+00	V-bottom, unlined	100'	1 on 3
68+00 to 180+00	V-bottom, unlined	75'	1 on 3
180+00 to 214+00	V-bottom, unlined	50'	1 on 3
214+00 to 257+00	V-bottom, unlined	40'	1 on 3
257+00 to 296+00	Pilot channel	20'	1 on 3
Channel excavation, thousands of cubic yards			1,517.6
Average depth of excavated channel, feet			13
Bridge alterations			Station
11th Place			2+70
Farm-Market Road 700			50+70
Interstate Highway 20			119+00
Birdwell Street			130+00
Gregg Street (U. S. 87)			215+00
Texas and Pacific Railway			140+00
Texas and Pacific Railway			237+00
Rights-of-way			
Fee simple acquisition, acres			136.5
Flood plain management			
Average floodway width, feet			800
Area in floodway (excluding right-of-way):			

From	To	Acres
0+00	50+00	62
50+00	120+00	58
120+00	185+00	70

TABLE 4

FIRST COSTS
(1 July 1969 prices)

Feature	Federal	Non-Federal	Total
Land and damages	$ -	$340,000	$ 340,000
Relocations	86,000	528,000	614,000
Channel	1,286,000	-	1,286,000
Engineering and design	126,000	49,000	175,000
Supervision and administration	80,000	31,000	111,000
Total	$1,578,000	$948,000	$2,526,000

22. ANNUAL COSTS

The estimated annual costs are summarized in table 5. These costs are based on an interest rate of 4-7/8%, two-year construction period, and amortization period of 100 years.

TABLE 5

ANNUAL COSTS

Feature	Federal	Non-Federal	Total
Interest on investment	$80,700	$48,500	$129,200
Amortization	700	400	1,100
Operation and maintenance	-	14,000	14,000
Total	$81,400	$62,900	$144,300

23. ANNUAL BENEFITS

a. General.- Flood control benefits credited to the proposed plan are based on control of the 50-year flood and a 100-year period of analysis. These benefits include damage reduction benefits for existing and future development, and benefits from increased land utilization.

b. Flood losses prevented.- Average annual benefits for flood damage reduction accruing to the proposed channel improvement were determined by use of discharge-damage and discharge-frequency relationships. The average annual flood damages of $269,500 for 1968 conditions of economic development in the flood plain area would be reduced by the improved channel to $109,300, thus resulting in benefits of $160,200. An allowance to reflect the economic trends and future development anticipated in the flood plain area during the period 1975-2075 would increase these flood control benefits to a total of $197,000.

c. Increased land utilization.- Flood protection provided by the project would result in benefits from changed use of land in the urban flood plain. About 36 percent of the total area, currently idle or in limited agricultural use at locations higher than the residual 100-year storm elevation, will increase in value, based on potential, commercial and industrial uses. Benefits from such increased land use, evaluated on an annual basis, are estimated at $40,400. These benefits would be realized on relatively small tracts of land held by a considerable number of individual owners.

d. Area redevelopment.- Howard County, in which the Big Spring project is located, has not been designated as eligible for assistance under provisions of the 1965 Public Works and Economic Development Act (Public Law 89-136). Consequently, no redevelopment benefits were evaluated.

e. Summary of tangible benefits.- The estimated average annual flood control benefits credited to the plan of improvement based on 1 July 1969 prices are summarized in table 6.

TABLE 6

TANGIBLE ANNUAL BENEFITS
(100-year period, 4-7/8% interest rate)

Item	Benefits
Flood damages prevented	
Present development	$160,200
Future development	36,800
Subtotal	$197,000
Increased land utilization	40,400
Total	$237,400

24. PROJECT JUSTIFICATION

The estimated tangible benefits credited to the plan of improvement are $237,400, and the annual costs are estimated at $144,300. The resultant benefit-cost ratio is 1.6.

25. EFFECTS OF THE PLAN

The proposed channel improvement will provide a high degree of flood protection for a large segment of the business and industrial area of Big Spring. The proposed flood plain management measures will minimize residual flood damages and prevent damages to future development from floods up to the magnitude of the flood expected to occur on the average of once in 100 years. Prevention of flood damages will permit the use of available economic resources for development rather than for replacement of losses. The improved channel will allow the City of Big Spring to proceed with storm drainage plans in other areas of the city without adverse effects along Beals Creek. Significant public health benefits will accrue due to the protection from flooding. Further benefits will be derived by the reduction of ponding areas which are conducive to mosquito breeding. The improved channel will provide a cleaner and more aesthetic drainageway through the city. Detailed statements on the environmental impact of the proposed plan have been prepared in response to the National Environmental Policy Act of 1969, Public Law 91-190, and are presented in appendix VI.

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26. LOCAL COOPERATION

a. Coordination.- Local interests expressed their desires for flood control investigations at a public hearing for the upper Colorado River Basin in 1962. Subsequent informal meetings and contacts with local interests aided development of the structural and nonstructural channel plan. In September 1969, the City Commission of Big Spring approved a new zoning ordinance which generally supports the proposed nonstructural measures. Pertinent parts of the ordinance are quoted below:

> "To provide for the appropriate use of land which has a history of inundation or is determined to be subject to flood hazard, and to promote the general welfare and provide protection from flooding portions of certain districts are designated with a Surface Drainage Prefix, "SD". Areas designated on the Zoning District Map by an "SD" Prefix shall be subject to the following provisions:
>
> A. USES PERMITTED
>
> The permitted uses in that portion of any district having a Surface Drainage, "SD", Prefix shall be limited to the following:
>
> (1) Agricultural activities including the ordinary cultivation or grazing of land and legal types of animal husbandry.
>
> (2) Off-street parking incidental to any adjacent main use permitted in the district.
>
> (3) Electrical substation.
>
> (4) All types of local utilities including those requiring Specific Use Permits when approved as provided in Section 8 (5).
>
> (5) Parks, community centers, playgrounds, public golf courses.
>
> (6) Private commercial open area amusements such as golf courses, driving ranges, archery ranges and similar uses when approved by Specific Use Permit as provided in Section 8 (5).

(7) Private open space as part of a Community Unit Development or Planned Residential Development.

(8) Heliport when approved by Specific Use Permit as provided in Section 8 (5).

B. No building or structure shall be erected in that portion of any district designated with a Surface Drainage, "SD", Prefix until, and unless, such building or structure has been approved by the Director of Public Works, who will ascertain that such building or structure is not subject to damage by flooding and would not constitute an encroachment hazard or obstacle to the movement of flood waters and that such construction would not endanger the value and safety of other property or the public health and welfare.

C. Any dump, excavation, storage, filling or mining operation within that portion of a district having a Surface Drainage, "SD", Prefix shall be approved in writing by the Director of Public Works before such operation is begun.

D. An area may be removed from the Surface Drainage, "SD", Prefix designation when by the provision of drainage works, grading flood protection or specific drainage study, it is determined by the Director of Public Works that the flood hazard has been alleviated. Removal of the Surface Drainage, "SD", Prefix shall be accomplished by resolution of the City Commission after written notification from the Director of Public Works advising of the removal of the flood hazard."

b. Cost sharing.- As shown in tables 4 and 5, the non-Federal first cost is estimated at $948,000. Annual costs to local interests for operation and maintenance of the project is estimated at $14,000, which includes an allowance of $5,000 for sediment removal.

c. Proposed local cooperation.- If the plan of improvement described in this report is authorized for construction, local interests would be required to meet certain requirements of local cooperation as set forth in paragraph 30, Recommendations.

d. Assurances.- The project plan and local participation requirements were presented at a regular meeting of the Big Spring City Commission on February 24, 1970. A copy of local interests' assurance of their intent to participate in development of the project is exhibited in appendix V.

27. COORDINATION WITH OTHER AGENCIES

Coordination was effected with interested Federal and State agencies at various stages during the study. Draft copies of this report were forwarded to other Federal agencies at field level and to the Director of Coordination, Division of Planning Coordination, State of Texas, for their preliminary views and comments. Letters from these agencies are presented in appendix V. The following paragraphs summarize these comments and cite actions taken in response to them.

a. Bureau of Reclamation stated that the plan of development will have no known effect on any existing or proposed Bureau of Reclamation projects.

b. Bureau of Mines, Bartlesville Office of Mineral Resources, has no objection to the proposed works of improvement.

c. Bureau of Outdoor Recreation indicated that it had no comments, stating that they lack adequate resources to review effectively all reports currently being received.

d. Federal Water Quality Administration stated that it is not anticipated that a project of this type will have any adverse effect upon the quality of the waters.

e. Bureau of Sport Fisheries and Wildlife letter report stated that the project works would have no effect on fish and wildlife, and would not offer feasible opportunities for the improvement of these resources. Their report was concurred with by the Texas Parks and Wildlife Department.

f. U. S. Geological Survey recommended the rebuilding of the gaging station Beals Creek at Big Spring, and the establishment of a peak-stage station at the location Beals Creek above Big Spring.

After authorization of the project, these gages will be included in our cooperative stream gaging program with the U. S. Geological Survey.

g. Southwestern Power Administration noted that the project area is outside of their area of operations and will not affect their interests.

h. Soil Conservation Service advised that the works of improvement will not be significantly affected by, or have any effect upon, any existing or proposed Soil Conservation Service watershed project or program in the area.

i. Department of Health, Education, and Welfare indicated that significant public health benefits would accrue due to the protection from flooding damages, and further benefits may be anticipated from channel improvement, as it will minimize the occurrence of ponding areas which would be conducive to mosquito breeding.

j. Department of Housing and Urban Development concurred in the proposed plan of improvement and suggested that consideration be given to the following:

(1) Requirements of the development of flood insurance maps if there is an interest in the Flood Insurance Program.

(2) A Watershed Treatment Program above the city and HUD's Open Space and Urban Beautification Program.

Implementation of the proposed plan will not preclude the participation in these programs at such time as local interests express a desire to do so. Appendix IV, Flood Plain Information, contains maps of the flood hazard area which could be adopted for use in the Emergency Flood Insurance Program.

k. Bureau of Public Roads. No comment received.

l. Federal Power Commission states that the proposed improvements are not adaptable for the development of hydroelectric power and will not affect existing or potential hydroelectric resources.

m. State of Texas, Division of Planning Coordination, indorses the proposed plan of improvement. The following comments were made:

(1) Texas Water Rights Commission stated the Commission may consider the project under Article 7472e when the final report is made to the Governor of Texas.

(2) Texas Water Quality Board stated that adequate measures should be provided so that the sewerage facilities of the city will not be adversely affected.

Implementation of the proposed plan will not affect operation of sewerage facilities during normal creek stages and will provide protection from interruption during major flood periods.

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

28. DISCUSSION AND SUMMARY

a. Flood problem.- The city of Big Spring, county seat of Howard County, Texas, is subject to flooding by Beals Creek, which bisects a major portion of the city. The Texas and Pacific Railroad yards and numerous businesses and residences located along either side of the channel sustain repeated flooding because of inadequate channel capacity. The economy of the area has extended beyond agriculture and the railroad to include oil and petrochemicals, a junior college, jet training base, hospitals, and a variety of industries. Based on present conditions and values, annual flood damages averaging $269,500 can be expected.

b. Proposed plan of improvement.- Various plans to provide flood protection to the study area were investigated. The most practical and economically feasible plan involved a combination of structural and nonstructural measures which will provide protection from a 50-year frequency flood and minimize damages from floods up to and including the 100-year frequency flood. This project will not adversely affect any existing or foreseeable future water resource development in the Colorado River Basin, nor will the frequency or magnitude of flooding be increased downstream of the project.

c. Flood plain management.- A zoning ordinance approved by the City Commission of Big Spring in September 1969 generally supports the proposed nonstructural measures.

d. Local cooperation.- Local interests have reviewed the plan and have indicated their willingness to comply with the terms of local cooperation.

e. Project cost and justification.- The first cost of the proposed project is currently estimated at $2,526,000, of which $948,000 would be non-Federal cost. The estimated annual costs are $144,300, and evaluated average annual benefits are $237,400. The resultant benefit-cost ratio is 1.6.

f. Senate Resolution 148, 85th Congress.- Additional information called for by Senate Resolution 148, 85th Congress, adopted January 28, 1958, supplements this report.

29. CONCLUSIONS

A serious and continuing flood problem exists in Big Spring, Texas, from flooding on Beals Creek. The most feasible plan of improvement consists of an improved channel, supplemented with the use of designated floodway areas and other nonstructural flood plain management techniques.

The plan is economically justified. Local interests concur in the plan and have indicated their willingness to cooperate in the construction, operation, and maintenance of the project. Participation by the United States in the project is warranted.

30. RECOMMENDATIONS

I recommend construction of improvements for local flood protection on Beals Creek at Big Spring, Texas, generally in accordance with the combination structural and nonstructural plan described in this report, and with such modification thereof as, at the discretion of the Chief of Engineers, may be advisable, at an estimated total Federal construction cost of $1,578,000. The recommendation is subject to the provision that no construction shall be undertaken until local interests have given 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 the construction, maintenance, and operation of the project;

b. Accomplish, without cost to the United States, all relocations and alterations to existing improvements, other than railroad bridges, which may be required for the construction of the project;

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

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

e. Provide without cost to the United States fill areas for the disposal of excess materials from the channel excavation work, the areas to be within reasonable haul distance of the project (approximately three miles); or bear the cost for the excessive haul distance;

f. Prevent encroachment which would interfere with the flood-carrying capacity of the improved channel and floodway;

g. At least annually, publicize and notify all interested parties that the channel will not provide protection from the occurrence of storms greater than a storm which could be expected to occur once in 50 years; and

h. Adopt and enforce appropriate flood plain regulations (nonstructural measures) which in combination with the structural measures for the proposed flood control project would:

(1) Insure an unobstructed floodway.

(2) Prevent damages to future development within the flood plain that would be inundated by a flood that could be expected to occur once in 100 years.

R. S. KRISTOFERSON
Colonel, CE
District Engineer

[First endorsement]

SWDPL-F
SUBJECT: Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas

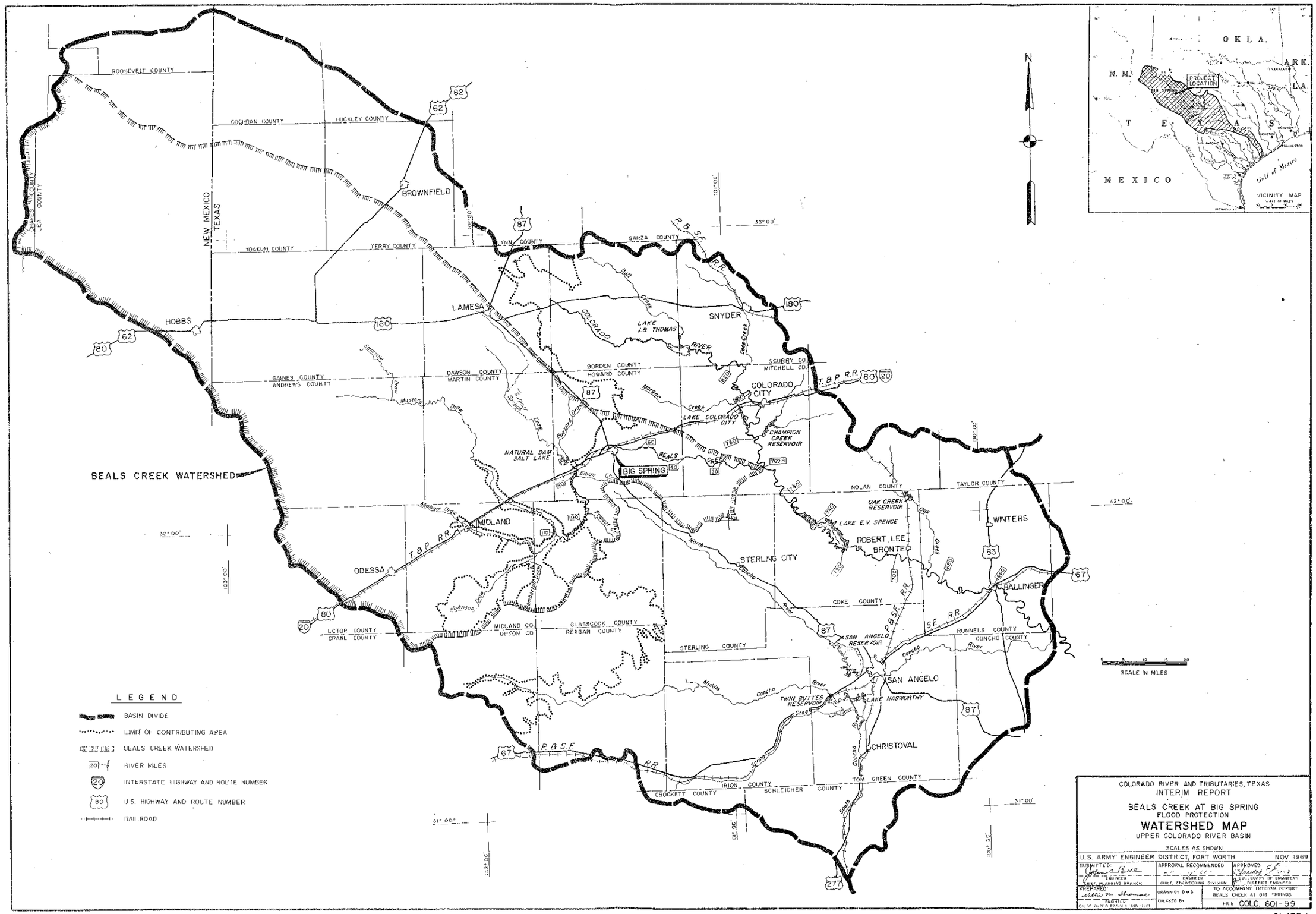
DA, Southwestern Division, Corps of Engineers, 1114 Commerce Street, Dallas, Texas 75202 22 May 70

TO: Chief of Engineers

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

H. R. Parfitt

H. R. PARFITT
Brigadier General, USA
Division Engineer



COLORADO RIVER AND TRIBUTARIES, TEXAS
INTERIM REPORT
BEALS CREEK AT BIG SPRING
FLOOD PROTECTION
WATERSHED MAP
UPPER COLORADO RIVER BASIN

SCALES AS SHOWN

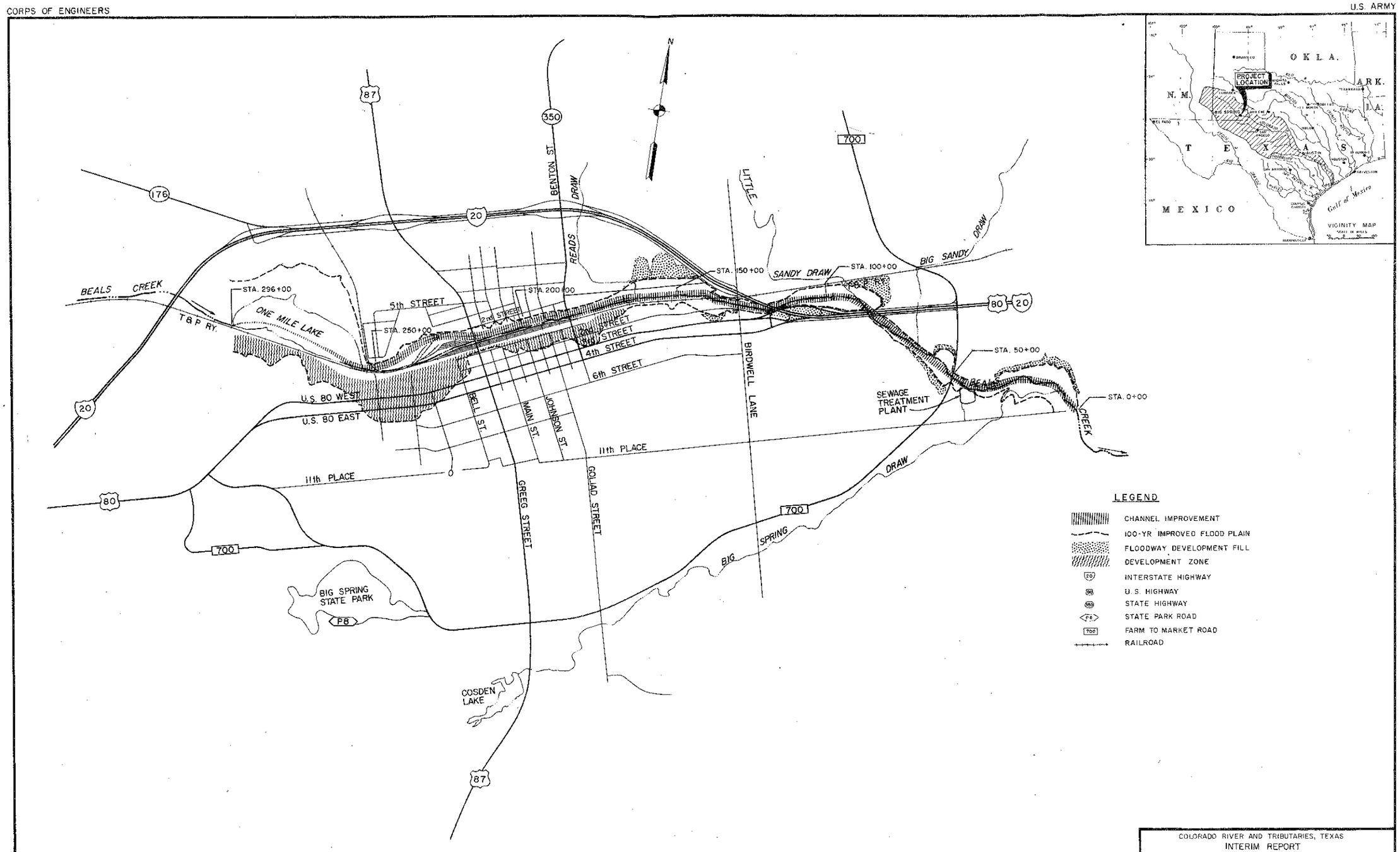
U.S. ARMY ENGINEER DISTRICT, FORT WORTH — NOV 1969

SUBMITTED:	APPROVAL RECOMMENDED	APPROVED
ENGINEER, CHIEF, PLANNING BRANCH	ENGINEER, CHIEF, ENGINEERING DIVISION	COL, CORPS OF ENGINEERS, DISTRICT ENGINEER
PREPARED: ENGINEER ASSISTANT (OR OTHER DESIGNATION IF NOT ENGR.)	DRAWN BY: D.W.D. CHECKED BY	TO ACCOMPANY INTERIM REPORT BEALS CREEK AT BIG SPRING
		FILE COLO. 601-99

PLATE 1

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

- CHANNEL IMPROVEMENT
- 100-YR IMPROVED FLOOD PLAIN
- FLOODWAY DEVELOPMENT FILL
- DEVELOPMENT ZONE
- 20 INTERSTATE HIGHWAY
- 80 U.S. HIGHWAY
- 350 STATE HIGHWAY
- P8 STATE PARK ROAD
- 700 FARM TO MARKET ROAD
- RAILROAD

COLORADO RIVER AND TRIBUTARIES, TEXAS

INTERIM REPORT

BEALS CREEK AT BIG SPRING

GENERAL PLAN

1000 0 1000 2000 3000

SCALE OF FEET

U.S. ARMY ENGINEER DISTRICT, FORT WORTH

SUBMITTED:	APPROVAL RECOMMENDED:	APPROVED:
John C. Bale, ENGINEER, CHIEF, PLANNING BRANCH	ENGINEER, CHIEF, ENGINEERING DIVISION	COL. CORPS OF ENGINEERS, DISTRICT ENGINEER
Walter W. Thomas, ENGINEER, CHIEF, COLORADO BASIN STUDY SECT.	DRAWN BY: CHECKED BY:	FILE COLO. 801-99

PLATE 2

62-221 O-71 (Face blank p. 60) No. 2

APPENDIX III

ECONOMIC STUDIES

FLOOD CONTROL EVALUATION

1. FLOOD PROBLEMS.- The flood problems at Big Spring are caused by overflows from Beals Creek, which extends across the north-central portion of the city. The estimated capacity of this creek channel at present is about 100 to 200 cfs.

2. AREA SUBJECT TO FLOODING. The flood plain areas investigated in detail for this report consist of the areas subject to overflow from floods up to the magnitude of the standard project flood. This reach of the Beals Creek flood plain extends from just below F. M. 700 to stream mile 71.6 in Onemile Lake.

3. CHARACTER OF FLOOD PLAIN AREAS.- Urban damages account for all of the damages along the portion of Beals Creek studied in connection with this report. Of these urban damages, about 89 percent are damages to business and industrial property and 11 percent are damages to residential property.

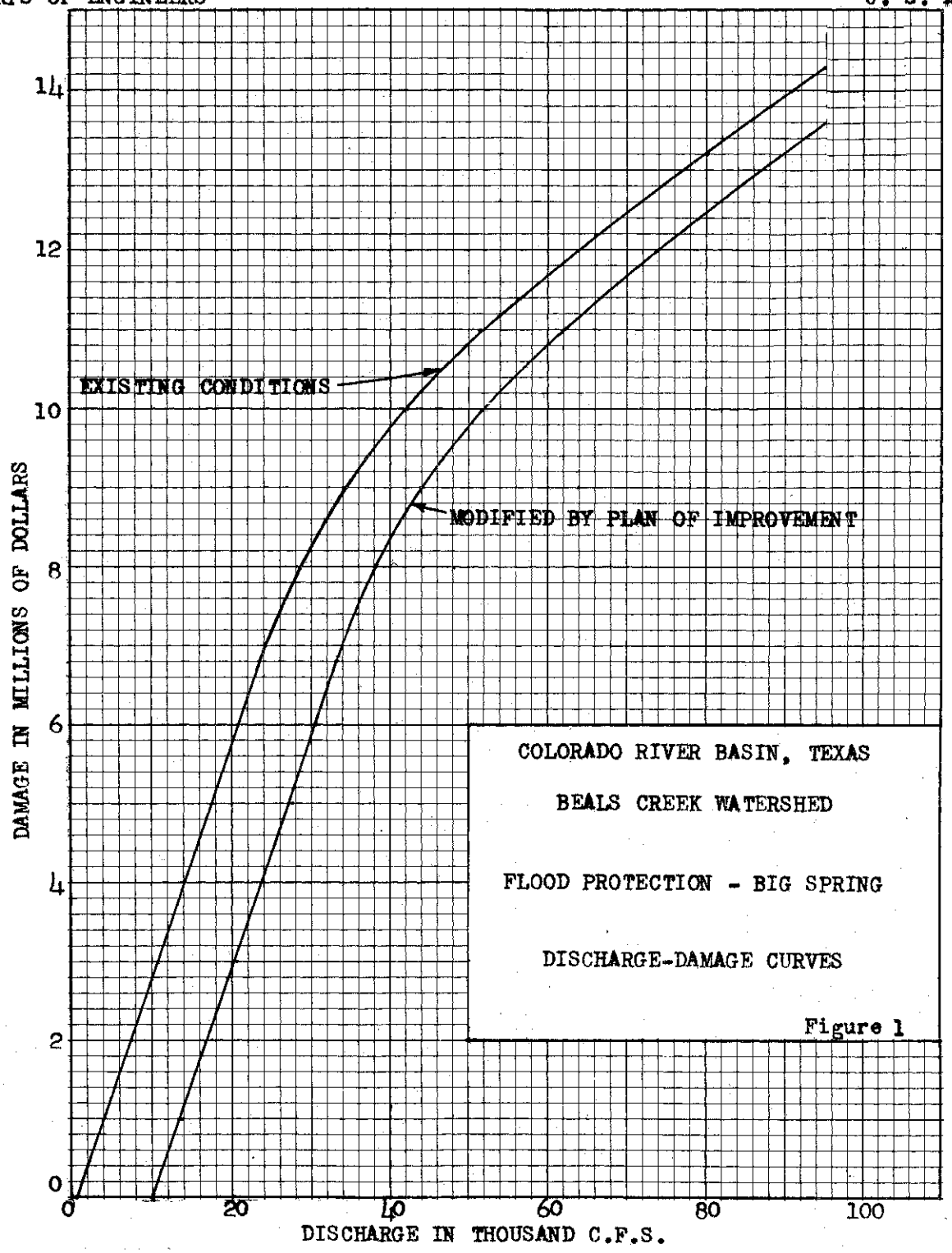
4. DETERMINATION OF VALUES AND DAMAGES. Field investigations were made in 1959, 1965 and 1968 to determine the development and improvements in the flood plains of Beals Creek. During these investigations, interviews were held with local governmental officials; state highway officials; officials of railroads, businesses, and industries; and other local residents to obtain information on property values and experienced or potential flood damages.

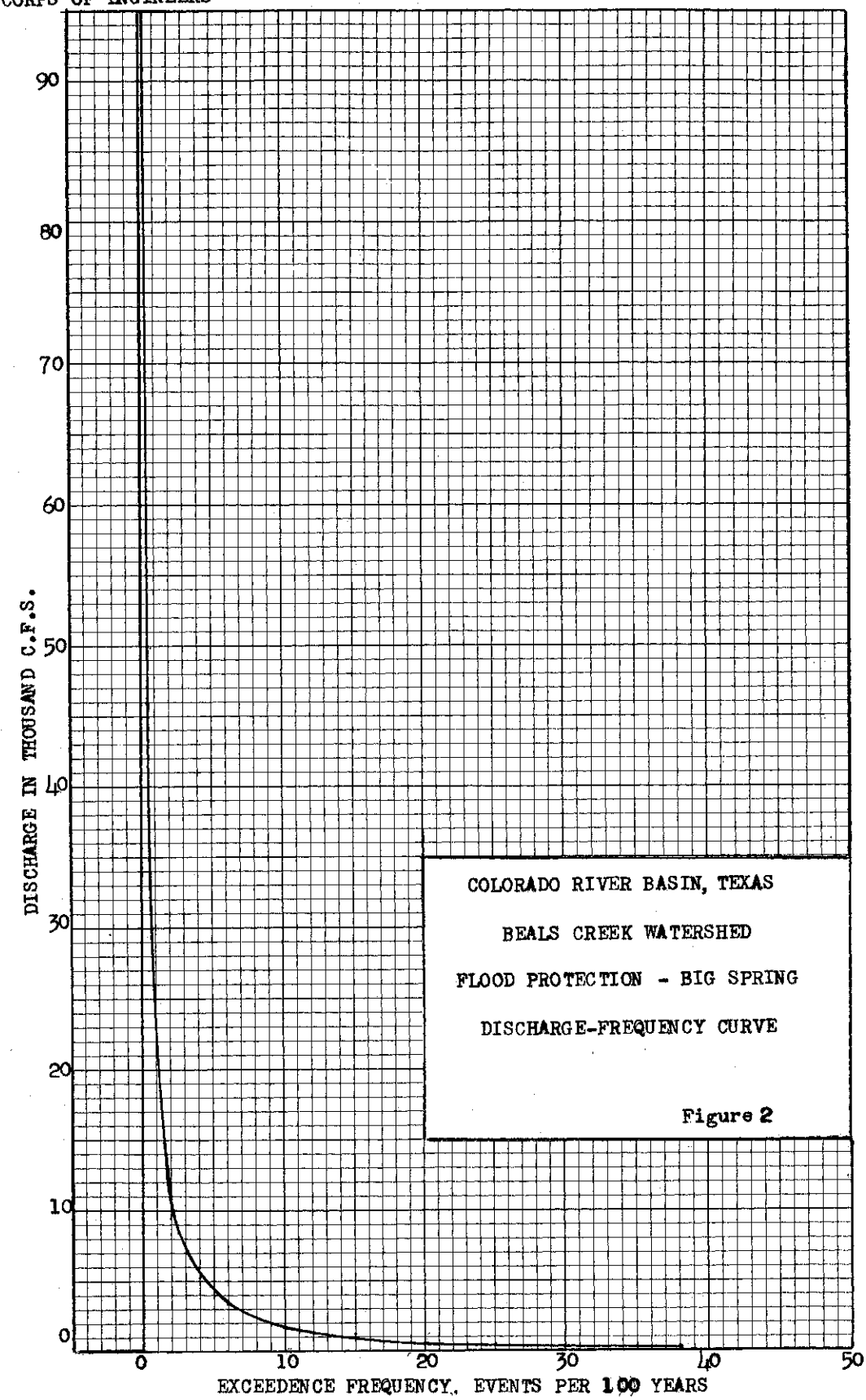
5. VALUE OF PHYSICAL PROPERTY IN THE FLOOD PLAIN.- The selected flood plain for flood plain management porposes is that area subject to overflow from the 100-year frequency flood. The total value of physical property in this portion of the Beals Creek flood plain is estimated at $18,914,000, based on 1 July 1969 price levels. This amount includes an estimated $1,951,000 for residential property, $491,000 for churches and schools, $10,310,000 for business and industrial property, $2,336,000 for railroads, $1,654,000 for streets and highways, and $2,172,000 for utilities and sewer system.

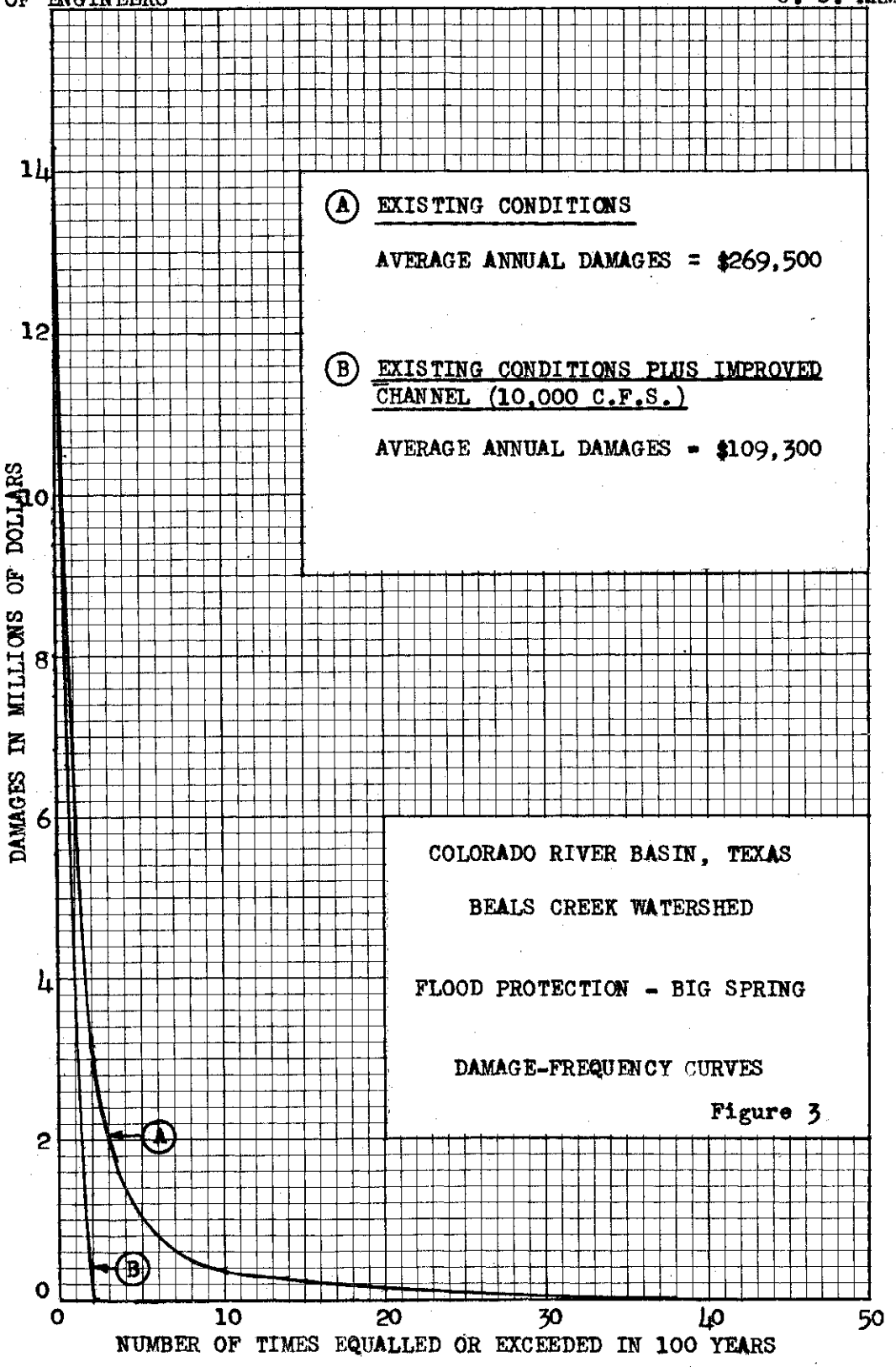
6. DAMAGES FROM 100-YEAR FLOOD.- The total damages that would be caused by an occurrence of the 100-year frequency flood in the Beals Creek flood plain are estimated at $6,687,000, based on 1 July 1969 price levels.

7. DETERMINATION OF AVERAGE ANNUAL DAMAGES.- The field investigation made in 1959 and reviewed in 1968, together with subsequent office studies, were used to develop a discharge-damage curve for the portion of Beals Creek flood plain studied for this report. By use of rainfall records, stream gage records, synthetic unit hydrographs, and other data furnished by local interests or observed by personnel of the Fort Worth District, relationships between discharge and frequency were developed as shown by the discharge-frequency curve presented in this report. Using these curves, a computation of average annual damages was made, and the result of this computation is presented graphically in the form of a damage-frequency curve. These curves are shown as figures 1, 2, and 3. These exhibits are furnished as being representative of the method used to determine the average annual damages in the flood problem area considered in this report.

8. BENEFITS DUE TO REDUCTION OF DAMAGES.- The average annual damages due to flooding were computed using the procedure outlined in paragraph 7 of this appendix. The computations were first based on the condition that now exists - - with no flood control improvements operating to diminist flooding. Under these conditions, the average annual damages were found to be $269,500. Similar computations were made based on conditions which would exist after construction of the recommended improvements, and average annual damages under these conditions were found to be $109,300. By deduction, the average annual damages prevented in the areas subject to flooding were found to be $160,200, based on 1968 conditions of development in the flood plain and 1 July 1969 price levels. These damages prevented were then converted to average annual benefits for the period 1975-2075 by applying the appropriate development factor of 1.23 as developed in paragraph 26 of this appendix. This resulted in total flood damage prevention benefits of $197,000.


14
12
10
8
6
4
2
0
DAMAGE IN MILLIONS OF DOLLARS
EXISTING CONDITIONS
MODIFIED BY PLAN OF IMPROVEMENT
0
20
40
60
80
100
DISCHARGE IN THOUSAND C.F.S.
COLORADO RIVER BASIN, TEXAS
BEALS CREEK WATERSHED
FLOOD PROTECTION - BIG SPRING
DISCHARGE-DAMAGE CURVES
Figure 1


DISCHARGE IN THOUSAND C.F.S.
0
10
20
30
40
50
60
70
80
90
0
10
20
30
40
50
EXCEEDENCE FREQUENCY, EVENTS PER 100 YEARS
COLORADO RIVER BASIN, TEXAS
BEALS CREEK WATERSHED
FLOOD PROTECTION - BIG SPRING
DISCHARGE-FREQUENCY CURVE
Figure 2


Ⓐ EXISTING CONDITIONS
AVERAGE ANNUAL DAMAGES = $269,500
Ⓑ EXISTING CONDITIONS PLUS IMPROVED CHANNEL (10,000 C.F.S.)
AVERAGE ANNUAL DAMAGES = $109,300
COLORADO RIVER BASIN, TEXAS
BEALS CREEK WATERSHED
FLOOD PROTECTION - BIG SPRING
DAMAGE-FREQUENCY CURVES
Figure 3
DAMAGES IN MILLIONS OF DOLLARS
0
2
4
6
8
10
12
14
0
10
20
30
40
50
NUMBER OF TIMES EQUALLED OR EXCEEDED IN 100 YEARS
A
B

9. PURPOSE.- A detailed land use study was conducted within the flood plain of Beals Creek in Big Spring, Texas, to develop supplemental economic data pertinent to physical properties, flood damages, and potential project benefits.

10. GENERAL.- Howard County, of which Big Spring is the county seat and principal trade center, lies at a geographic crossroad in central west Texas. Terrain consists of rolling plains with occasional peaks and grassy prairie with mesquite and cedars. Predominant soils are sandy and sandy loams. Big Spring, founded near a natural spring from whence came its name, is located between two foothills of the Cap Rock Escarpment which divides the High Plains of west Texas from the lower Rolling Plains. Near the southern edge of the county is located the upper or northernmost rim of the Edwards Plateau.

11. Big Spring enjoys a climate moderate in temperature but dry. The altitude, 2,450 feet above sea level, generally low humidity, and absence of cloud cover result in a wide temperature range. Especially in summer, the temperature at night usually is much lower than during daylight hours. Average temperatures range from 44 degrees Rahrenheit in January to 87.7 degrees in July. Annual precipitation at Big Spring averages 17.39 inches and the growing season is 227 days.

12. Big Spring is equi-distance between Fort Worth and El Paso, at the intersection of two of the longest transcontinental highways in America - Interstate 20 (U. S. 80) and U. S. 87. The geographical location and easy accessibility make Big Spring an ideal distribution center for wholesale items and industrial products. One-day transportation service is possible to and from Houston, El Paso, Amarillo, Fort Worth, and Dallas. The Texas and Pacific Railway provides rail freight service to points east and west. Four common carrier motor truck lines have 23 regular trips daily and four bus companies have a total of 48 arrivals and departures. Texas International Airlines serves the area with four flights daily east and west with good connections to other points.

13. Big Spring has enjoyed a steady and diversified growth. At one time, ranching and farming were the major contributors to the local economy. Then the Texas and Pacific Railway, which uses Big Spring as a division point, came into being. Today the economic activity of Big Spring encompasses not only agriculture and the railroad but also a diversity of wealth-producing elements including oil and petrochemicals, Webb Air Force Jet Training Base, Howard County Junior College,

Veterans Hospital, and a State Mental Hospital. Existing industries include petroleum refining, carbon black production, paint manufacturing, bottling plants, and sand and gravel mining operations.

14. POPULATION.- The city of Big Spring has experienced a sporadic but above average growth over the past four decades (1920-1960). Population historical data for the city and county are tabulated below.

POPULATION

Year	Big Spring (number)	Average Annual Change (percent)	Howard County (number)	Average Annual Change (percent)
1920	4,273		6,962	
		12.38		12.64
1930	13,735		22,888	
		-0.86		-0.86
1940	12,604		20,990	
		3.21		2.46
1950	17,286		26,772	
		6.09		4.13
1960	31,230		40,139	
		1.47		-0.20
1968	35,100 **		39,500 *	
1920-1968		4.49		3.68

Source: U. S. Census except as noted.
*Texas Business Review, January 1969, p. 5.
**Texas Almanac, 1968-69, p. 290.

Big Spring population increased at an average annual rate of 4.49 percent during the 48-year period, compared with a 3.68 percent rate for Howard County. Changes in the economy brought about by the railroad activity and the petroleum industry resulted in rapid population growth. More recent increases can be attributed to industry diversification to include petrochemicals and carbon black, and operation of Webb Air Force Base. Approximately 2,360 of the 1968 population were Armed Forces personnel stationed at the air base. Exclusive of this element, the average annual change in population during the 1920-1968 period was 4.16 percent for Big Spring and 3.40 percent for Howard County.

15. EMPLOYMENT.- Employment distribution in Howard County changes significantly during the 1940-1960 period as revealed in the following data.

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EMPLOYMENT BY CATEGORIES EXPRESSED AS A
PROPORTION OF TOTAL EMPLOYMENT FOR HOWARD COUNTY

Employment category	1940		1950		1960	
	Number	Percent	Number	Percent	Number	Percent
Total commodity producing	2,283	32.38	2,960	29.87	2,943	19.61
Agriculture, forestry and fisheries	1,327	18.82	1,212	12.23	866	5.77
Manufacturing	465	6.60	795	8.02	1,493	9.95
Mining	491	6.96	953	9.62	584	3.89
Total noncommodity producing	4,121	58.45	6,386	64.43	8,118	54.10
Construction	315	4.47	785	7.92	935	6.23
Other noncommodity producing (total)	3,806	53.98	5,601	56.51	7,183	47.87
Transportation, communications, and public utilities	720	10.21	1,150	11.60	1,304	8.69
Wholesale and retail trade	1,640	23.26	2,383	24.05	2,798	18.65
Finance, insurance and real estate	157	2.23	256	2.58	416	2.77
Business and personal services	1,289	18.28	1,812	18.28	2,665	17.76
Government (total	646	9.17	565	5.70	3,945	26.29
Civilian government	646	9.17	553	5.58	1,589	10.59
Armed forces	-	-	12	.12	2,356	15.70
Total	7,050	100.00	9,911	100.00	15,006	100.00

SOURCE: U. S. Census

16. The total employment for Howard County has increased from 7,050 in 1940 to 15,006 in 1960, a 3.85 average annual percent change for the 20-year period. Total employment in Howard County for April 1966 was 12,700 according to the Texas Employment Commission.

17. The change in proportion of total employment occurred between total commodity producing and Government. Total commodity producing total employment decreased from 32.38 to 19.61 percent, but Government increased from 9.17 to 26.29 percent during the 20-year period. Agriculture, forestry and fisheries is accountable for the major decrease and the armed forces for the major increase.

18. Those persons engaged in public emergency work were included with Government employment in 1940. Employees engaged in public education also were included in the Government category of industry not reported and distributed proportionally to all other employment categories.

19. MAJOR OCCUPATIONS OF THE LABOR FORCE.- In agreement with employment trends, there have been significant changes in the percentages of people employed in certain occupations in Howard County as shown in the following tabulation.

EMPLOYED WORKERS BY MAJOR OCCUPATION EXPRESSED AS A PROPORTION OF TOTAL EMPLOYMENT FOR HOWARD COUNTY

Major occupation	1940 Percent	1950 Percent	1960 Percent
Professional	6.80	8.06	10.16
Farmers and farm managers	11.81	7.04	3.82
Proprietors and managers, except farm	13.86	11.20	11.67
Clerical, sales and kindred	15.08	17.30	12.65
Craftsmen, foremen and kindred	11.93	14.24	21.25
Operatives and kindred	14.70	18.27	15.38
Domestic service	3.82	2.14	3.63
Services except domestic	9.11	9.45	10.16
Farm laborers	7.23	4.22	1.69
Laborers except farm	5.07	5.18	4.62
Occupation not reported	.59	2.90	4.97
Total	100.00	100.00	100.00

SOURCE: U. S. Census

20. The largest employment changes were in the farmers and farm managers and the farm laborers categories. In 1940, these two categories comprised 11.81 percent and 7.23 percent of total employment, respectively. By 1960, farmers and farm managers dropped to 3.82 percent of total employment and farm laborers decreased to 1.69 percent. A significant change also occurred in craftsmen, foremen and kindred category, increasing from 11.93 percent in 1940 to 21.25 percent in 1960. The relative percentages indicated in 1960 are expected to remain about the same for the next 40 or 50 years.

21. The following tabulations show manufacturing employment as a proportion of the total number of persons engaged in manufacturing in Howard County and a classification of manufacturing firms in Big Spring.

EMPLOYMENT IN EACH OF THE MANUFACTURING SECTORS EXPRESSED AS A PROPORTION OF TOTAL MANUFACTURING EMPLOYMENT - HOWARD COUNTY

Manufacturing employment category	1940		1950		1960	
	Number	Percent	Number	Percent	Number	Percent
Food and kindred products	124	26.67	175	22.01	146	9.78
Textile mill products	-	-	2	.25	-	-
Apparel	1	.20	2	.25	-	-
Lumber, furniture and wood products	4	.86	15	1.89	21	1.41
Printing and publishing	48	10.32	72	9.06	95	6.36
Chemical and allied products	15	3.23	7	.88	140	9.38
Petroleum and coal	222	47.74	190	23.90	432	28.93
Primary metals	9	1.94	4	50	-	-
Fabricated metals	-	-	9	1.13	7	.47
Electrical and other machinery	28	6.02	24	3.02	36	2.41
Transportation equipment	5	1.08	21	2.64	16	1.07
Other and miscellaneous	9	1.94	274	34.47	600	40.19
Total	465	100.00	795	100.00	1,493	100.00

SOURCE: U. S. Census

1969 CLASSIFICATION OF MANUFACTURING FIRMS BY PRODUCT TYPE, EMPLOYEE SIZE-GROUP AND PRODUCT DISTRIBUTION AREA - BIG SPRING, TEXAS

Standard Industrial Code	Employee Size-Group 1	2	3	4	5
13 - Products recovered from natural gas				R,N	
20 - Food and kindred products	D,D,L,R	S,C	D		
23 - Apparel and related products	D				
24 - Lumber and wood products, except furniture			N		
25 - Furniture and fixtures	D	N			
27 - Printing and allied products	L,D,L,S	D		L,L	
28 - Chemicals and allied products		R	N		I,I
29 - Petroleum refining and related industries					R
31 - Leather and leather products	S,S				
32 - Stone, clay and glass products		D,D			
34 - Fabricated metal products	C,D	S			
35 - Machinery, except electrical	C,D	N			
36 - Electrical and electrical machinery			N		
38 - Professional, scientific, photographic, watches			N		
39 - Miscellaneous manufacturing industries	D,L	S			

Employee size-group:
Group 1 - under 8
2 - 8 to 24
3 - 25 to 49
4 - 50 to 99
5 -100 to 249

Area of product distribution:
L - Local
C - County
D - District
S - State
R - Regional
I - International
N - National

SOURCE: Directory of Texas Manufacturers, 1969

22. FLOOD PLAIN DEVELOPMENT.- Information and data obtained during detailed land use studies of the Beals Creek flood plain were analyzed to determine past trends in utilization, existing occupancy and expected future use of properties subject to flood damage. At the present time, it is estimated that 350 residences and 250 business and industrial establishments are located in the flood problem area below the 100-year elevation. The total value of these, together with utilities, streets, and other properties in the flood plain was estimated to approximate $18,914,000, based on 1969 prices.

23. City officials have become acutely aware of the flood hazard existing in the area, most of which is ideally located relative to access roads, rail transportation facilities and major highway arteries. In an effort to combat the problem, city officials recently have employed "spot zoning" to control development on the flood prone lands.

24. Applicants for permits to build in the flood plain are accompanied to the site by the City Building Inspector who points out the flood hazard and outlines precautionary measures required by the city. Final approval is subject to action by the City Commission.

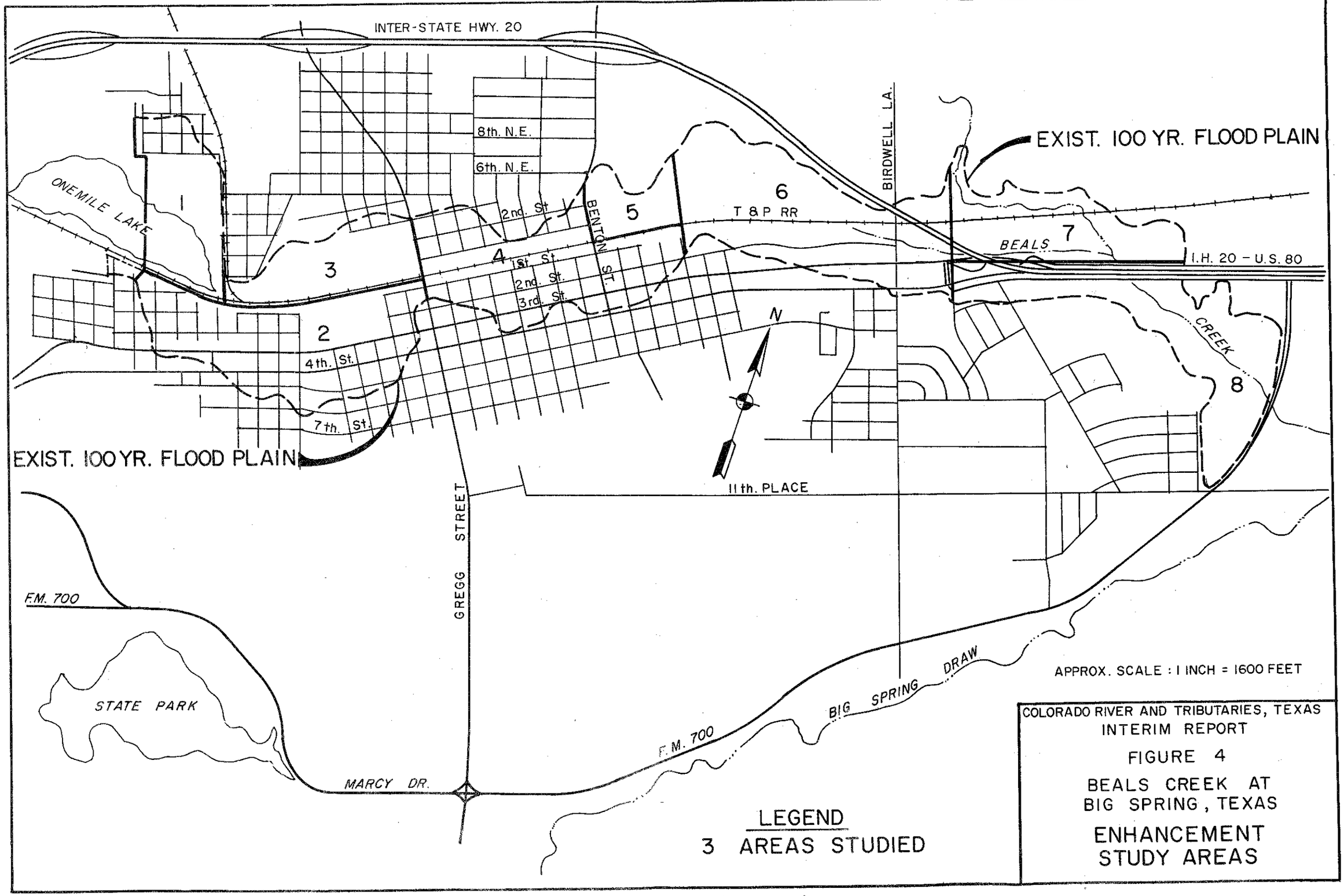
25. Historical trends in development indicated in study data obtained were reviewed and analyzed. Land owners, city officials, and local professional real estate appraisers were interviewed regarding land uses tabulated during the study and for information on expected flood plain use without a flood protection project. This information was utilized in the preparation of average levels of development expected to prevail during the project analysis or evaluation period.

26. FUTURE DEVELOPMENT.- Results of the land use study clearly indicated that future development in the flood problem area along Beals Creek in the main will be limited to redevelopment and upgrading of existing improvements to maintain their usefulness. This will extend to the interior and contents of existing structures and will increase the estimated value of flood plain property by approximately $150,000 per year. When replacements are needed, their construction will have to conform with ordinances which are expected to require flood-proofing. The average value of physical properties was projected to exceed the existing value by only 22 percent and 23 percent, respectively, for the 50- and 100-year periods of analysis, when discounted at 4.875 percent interest. This estimate of future development expected to occur in the absence of flood protection is considered appropriate also for use in estimates of average annual damage at elevations between the 100-year storm event and the standard project flood. Flood protection, through project development, is essential to permit utilization of some of the more desirable flood plain land.

27. INCREASED LAND UTILIZATION.- Flood protection provided by the project will result in benefits from some changed land use in the urban flood plain where flooding will be eliminated from all damage-producing storms up to and including the 50-year frequency event. The land to be enhanced in value represents about 36 percent of the total area and is currently idle or in limited agricultural use at locations higher than the residual 100-year storm elevation. Dominant uses after protection will be for commercial and industrial purposes. These changes are compatible with zoning set forth in the city's long range plan for development.

28. The flood plain area within the city limits was divided into subareas to facilitate evaluation (figure 4). The growth period to full enhancement for each subarea will vary. Area 3 will be enhanced within five years, area 6 within 10 years, areas 5 and 7 within 15 years, and areas 2 and 8 within 20 years. Areas 1 and 4 will continue to develop but no change is expected in the level of land use.

29. The land was appraised at its present market value and its expected market value at the time of full enhancement. The annual net income or yield was determined by application of a 5 percent interest rate to the increase in market value. The yield value was multiplied by the appropriate average annual equivalent compound interest factor and the product adjusted to reflect the estimated added damage to the increased values. The following tabulation summarizes by subarea the higher land utilization benefits attributable to the flood protection project.



COLORADO RIVER AND TRIBUTARIES, TEXAS
INTERIM REPORT

FIGURE 4

BEALS CREEK AT
BIG SPRING, TEXAS

ENHANCEMENT
STUDY AREAS

62-221 O-71 (Face p. 74)

LAND ENHANCEMENT
BIG SPRING, TEXAS

Flood plain area	Increase in capital value 1/ (dollars)	Yield or net return 2/ (dollars)	Average annual equivalent factor 3/	Gross average annual value 4/ (dollars)	Net average annual benefit (dollars)
			50-year analysis period		
1	None	-	-	-	-
2	12,600	630	.62592	390	390
3	100,000	5,000	.90218	4,510	4,470
4	None	-	-	-	-
5	164,500	8,220	.70457	5,780	5,730
6	342,000	17,100	.79586	13,610	13,490
7	185,000	9,250	.70457	6,520	6,460
8	279,000	13,950	.62592	8,730	8,650
Total				39,540	39,190
			100-year analysis period		
1	None	-	-	-	-
2	12,600	630	.65776	410	410
3	100,000	5,000	.91049	4,550	4,550
4	None	-	-	-	-
5	164,500	8,220	.72969	5,980	5,930
6	342,000	17,100	.81321	13,910	13,790
7	185,000	9,250	.72969	6,750	6,690
8	279,000	13,950	.65776	9,180	9,100
Total				40,780	40,430

1/ Value attributable to flood protection; excludes future development expected without project.
2/ Capitalized at 5 percent interest rate
3/ Average annual equivalent compound interest factors for 5, 10, 15, 20 years (growth period to maximum annual benefit), 4-7/8 percent interest rate.
4/ Includes net average annual benefit plus residual damage to increased value after protection.

30. Lands expected to benefit from increased utilization with the project installed involves about 75 parcels owned by 72 individuals, a railroad, a foundation and an estate. The average size ownership of the individually owned tracts is approximately 2 acres. The largest is 20 acres. The individually owned land comprises about 67 percent of the total and will receive about 64 percent of the benefits. No single owner will receive a windfall or a disproportionate share of benefits provided by the flood protection project. The most advantaged landholder is expected to receive benefits estimated at $6,200, on an average annual basis, which is approximately 15 percent of the total.

APPENDIX IV

FLOOD PLAIN INFORMATION

INTRODUCTION

1. GENERAL.- This study is based on investigations of the flooding characteristics of Beals Creek in Big Spring, Texas. A channel improvement project along Beals Creek is proposed by the Fort Worth District Corps of Engineers. Basically, the plan of improvement consists of an enlarged channel extending from the vicinity of Onemile Lake following generally the present alignment of Beals Creek and terminating in the vicinity of East 11th Place. This appendix presents a picture of flood plain conditions as they exist today and as they will be upon completion of the aforementioned improvements.

2. PURPOSE.- The purposes of this appendix are to (a) provide factual data to the City of Big Spring on flooding conditions along Beals Creek in a manner understandable to the layman, (b) provide additional related information that can be used to interpret and put to best use the data presented for the purpose of reducing future flood damages, (c) encourage the use and dissemination of the data and related information by the City of Big Spring for the purpose of guiding private citizens and interests on the use and hazards of the Beals Creek flood plain under existing and improved conditions.

3. SCOPE.- Guidelines and information are presented herein for the wise use of flood plains. These can be used in the interim period before completion of the proposed channel improvements and after the project becomes a reality. Before the start of project construction, the City of Big Spring must provide assurances that they will regulate the remaining flood plain. In recognition of the legislative responsibilities of local authorities with regard to zoning and regulating land use, specific recommendations for regulating the flood plain are outside the scope of this appendix and therefore, not included. General information on flood plain zoning ordinances, explanations of planning terms and concepts, flood proofing and other related flood plain management techniques are presented.

FLOOD PROBLEMS AND PROPOSED IMPROVEMENTS

4. AREA DESCRIPTION.- The Big Spring project is located in Howard County, Texas, in the Beals Creek watershed, the largest tributary of the Colorado River from the standpoint of the total watershed area. Beals Creek joins the Colorado River at river mile 769.8.

However, the watershed lies principally in the High Plains area, a high, flat region of low annual rainfall, which contributes very little to the flow of the stream. A total of 1,039 square miles of the Beals Creek watershed is considered as contributing. The contributing drainage area of the USGS gage above Big Spring on Beals Creek is 494 square miles and the drainage area of the discontinued gage on Beals Creek at Big Spring is 515 square miles. Beals Creek watershed is shown on plate 1 of the main report.

5. A series of natural salt lakes are located west of the city. Onemile Lake, located at the present western edge of the city, partially regulates ordinary floods originating in the western area of the city. Tributaries of significance entering Beals Creek from the north below Onemile Lake are Reads Draw, Little Sandy Draw, and Big Sandy Draw. Lake Cosden, located on Big Spring Draw, regulates the minor floods originating above the dam.

6. FLOOD PROBLEMS.- Floods along Beals Creek through the city occur because of inadequate channel capacity. Throughout the last 80 years damaging floods have occurred on Beals Creek. Under present-day conditions, average annual flood damages are estimated at $269,500. The maximum flood that has occurred since the establishment of a U. S. Geological Survey stream gage in February 1957 was that of May 10, 1957, when a gage height of 11.2 feet was observed on the gage at U. S. Highway 80. The peak discharge was estimated to be 6,600 second-feet. This gage was moved from U. S. 80 to just below Onemile Lake in January 1959. Historical flood data indicates the earliest flood of considerable size occurred in 1890 when water was four feet deep in the Texas and Pacific Railway Station at Big Spring. Other major floods occurred in 1902, 1904, 1915, 1922, and 1945. There is insufficient data to provide a basis for reasonable estimates of peak discharges for these earlier floods. However, an analysis of limited and sometimes contradictory descriptions of these floods and a comparison of daily rainfall records has led to the conclusion that probably only two of these earlier floods (those of 1890 and 1902) produced peak discharges in excess of the flood of May 1957.

7. EXISTING IMPROVEMENTS.- There are no existing Federal improvements for flood control or water conservation in the Beals Creek watershed above Big Spring. However, the efforts of local interests to alleviate the flood problem at Big Spring dates back to 1954 when they constructed five detention reservoirs within the city on small streams entering Beals Creek from the south. Four additional detention reservoirs have been built since 1961, when a drainage study was made for the city by consulting engineers. These detention reservoirs have helped in the alleviation of some local minor floods, but serious flood problems remain along Beals Creek. At the present time the Soil Conservation Service has no plans for the flood retarding structures in the Beals Creek watershed.

8. PROPOSED IMPROVEMENTS.- The recommended structural improvement consists of an improved channel which would convey a 50-year frequency flood (varying between 10,000 and 12,600 cfs). From Onemile Lake to the Benton Street overpass the improved channel would leave the existing Beals Creek alignment to the north of the railroad area. From this point the improved channel would then generally follow the existing Beals Creek alignment to the termination of the improved channel project just below 11th Place. Flood plain management techniques are to be used in conjunction with the improved channel in the overall plan of improvement. This combination of structural (channel) and nonstructural (flood plain management) measures will prevent damages from all floods up to the magnitude of the flood expected to occur on the average of once in 50 years and prevent damages to future development from floods expected to occur on the average of once in 100 years.

9. The proposed plan indicates that a floodway with a maximum width of 1,000 feet will convey the overbank flooding of the 100-year frequency flood. The area outside the floodway could be developed with the limitation that structures be flood proofed or built on fill or foundations to a specified flood safe elevation (to be explained later). Plates IV-1 through IV-4 show the 100-year frequency flood plain under existing and improved conditions (50-year frequency channel in place). Plate IV-5 shows the existing and improved 100-year frequency flood profiles.

FLOOD PLAIN MANAGEMENT

10. GENERAL.- The general problem of preventing flood damages has no complete solution. The Federal Government is actively engaged in a nationwide flood control construction program, but the extent of protection provided by these facilities is limited by location, economic considerations, and other factors. Despite the expenditure of tax funds running into billions of dollars for flood control works, the increase in flood damages has led to a new approach for reducing these damages. This approach is the application of control over the use of land lying in the flood plain through the planned development and management of flood-hazard areas.

11. The approach to flood damage reduction includes both structural and non-structural measures. Structural measures include the construction of protective works such as flood control reservoirs, channel improvements, diversion channels, walls, and levees. Non-structural measures include flood plain regulations, flood forecasting, temporary evacuation, permanent evacuation, flood proofing, and flood insurance.

12. One purpose of this report is to assist planners and officials charged with the responsibility of utilizing non-structural techniques to better understand flood plain management techniques. These concepts are indispensable in the preparation of reasonable and acceptable flood plain regulations which will encourage only such development of flood prone areas as is appropriate in light of the probability of flooding.

13. Certain technical terms have been selected for precise definition because of their importance in connection with discussions which follow. These definitions are given on page IV-20, Supplement A, Glossary of Terms.

14. The utilization and zoning of flood plains generally involves three basic considerations: providing an adequate floodway; assuring maximum utilization of land; and identifying exact zoning limits. To accomplish these goals, a flood magnitude is selected which delineates reasonable economic balance between excessive losses and undue restrictions on land productivity. The flood plain of this "Selected Flood" is then categorized into several use zones to obtain the maximum potential economic value of the land.

15. SELECTED FLOOD.- An adequate floodway, hereafter also referred to as the "Conservation Zone", would include the stream channel of "Channel Zone" and adjoining land area required to convey a Selected Flood. Reference 1, Supplement B, states:

> "The selection of floods to be used for regulatory purposes is one of public policy and is dependent on many non-engineering as well as engineering considerations. In the final analysis, they are selected and adopted by the elected public officials who will be responsible for the enforcement of the regulations..... Because of the many variable conditions encountered throughout the United States, no specific guidelines can be established for the selection of such floods. It is largely a matter of judgement based on local conditions. Probably the most important engineering considerations in the choice of such floods, between various alternatives being considered, are their relative expected occurrences, relative areas inundated, and the differences in the depths of inundation."

16. A sampling of Federal, State, and local program administrators indicates, that although floods of other magnitudes are sometimes used, there is general agreement that the 100-year frequency flood more nearly represents a reasonable balance between excessive

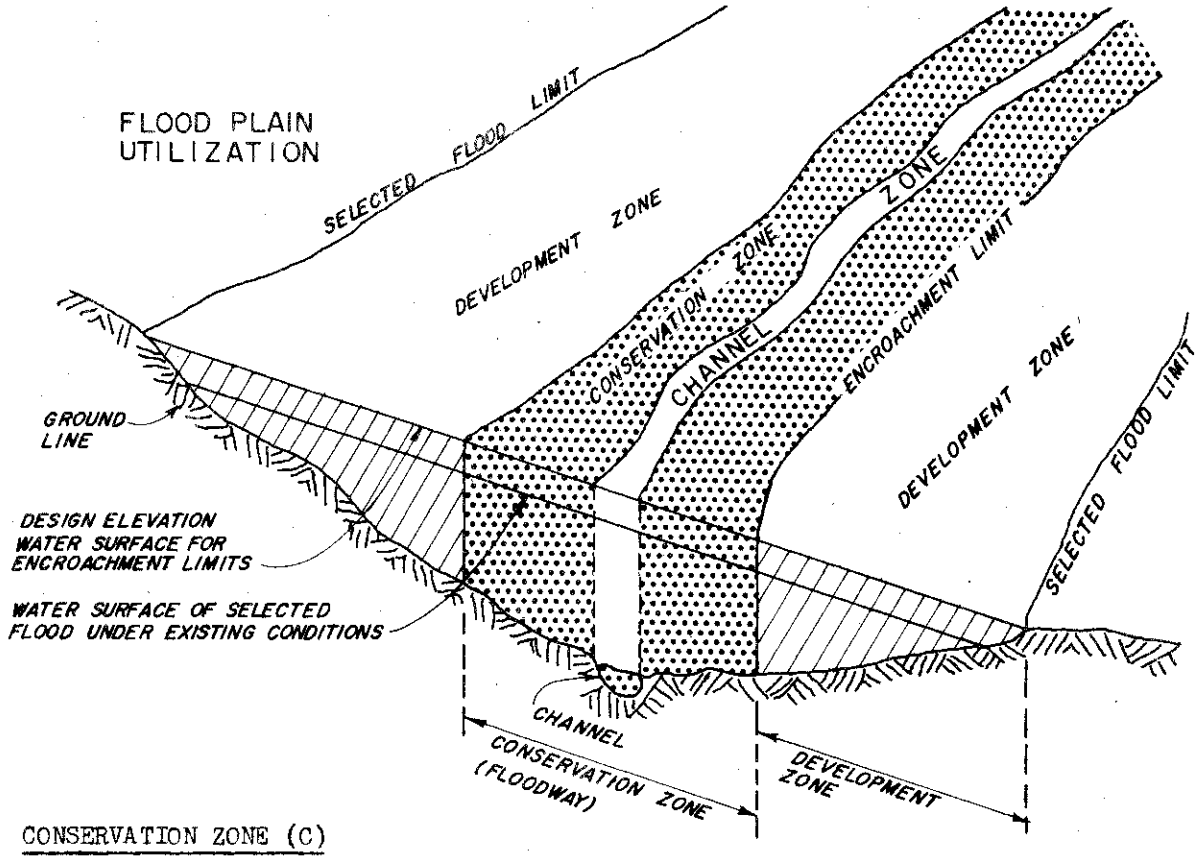
flood losses and excessive conservatism for most uses. The 100-year frequency flood is hereafter also referred to as the "Selected Flood."

17. CONSERVATION ZONE.- Reference 1, Supplement B, states also:

> "The designated floodway (or Conservation Zone) to be reserved, by zoning or the establishment of encroachment lines, should be adequate for the passage of the Selected Flood of a specific size or magnitude, without unduly raising upstream water surface elevations. Its size must be based on sound hydraulic and economic criteria and on computations uniformly applied throughout the length of the stream being studied.... It is neither sound engineering nor effective area control to set the flood standard so low as to produce regulations that condone existing encroachments and invite more. When the size of flood is set too low, there is, in effect, little regulation and only small benefits can be expected. On the other hand, if the flood selected is too large or insufficiently supported by engineering facts, the regulation may be uneconomical restriction of land use and an unreasonable invasion of private property rights."

18. The Conservation and Channel Zones, and limits thereof, are illustrated in figures 1 and 2. Plates IV-1 through IV-4 show the Conservation Zone (Selected Flood Plain) along Beals Creek under existing and improved conditions. Plate IV-5 shows the Selected Flood profiles under existing and improved conditions. The elevations shown on plate IV-5 and the overflow areas on the ground may vary from those shown on the 1968 photographs because the 5-foot contour interval (from 1959 mapping) and scale of the photograph do not permit precise plotting of the flooded area boundaries. To more accurately define a Conservation Zone along Beals Creek, overflow limits should be determined by comparing flood profile elevations shown on plate IV-5 with ground elevations.

19. DEVELOPMENT ZONE.- In the case of the proposed plan of improvement for Beals Creek, the Selected Flood for regulatory purposes is the 100-year frequency flood. Subsequently, the basic "Conservation Zone" corresponds to the improved 100-year frequency flood plain. This area may be considered excessive in some cases, precluding economical use of portions of the Conservation Zone.



CONSERVATION ZONE (C)

Suggested Uses

- Farms, Truck Gardens & Nurseries
- Livestock
- Other Agriculture
- Non-obstructive structures
- Parking Lots
- Playgrounds & Parks
- Golf Courses
- Open Recreation
- Preserves & Reservations

Uses Not Appropriate

- Land Fills
- Obstructive Structures
- Floatable Storage
- Feeding or Disposal of Garbage, Rubbish, Trash or Offal
- All uses precluded from the D Zone.

DEVELOPMENT ZONE (D)

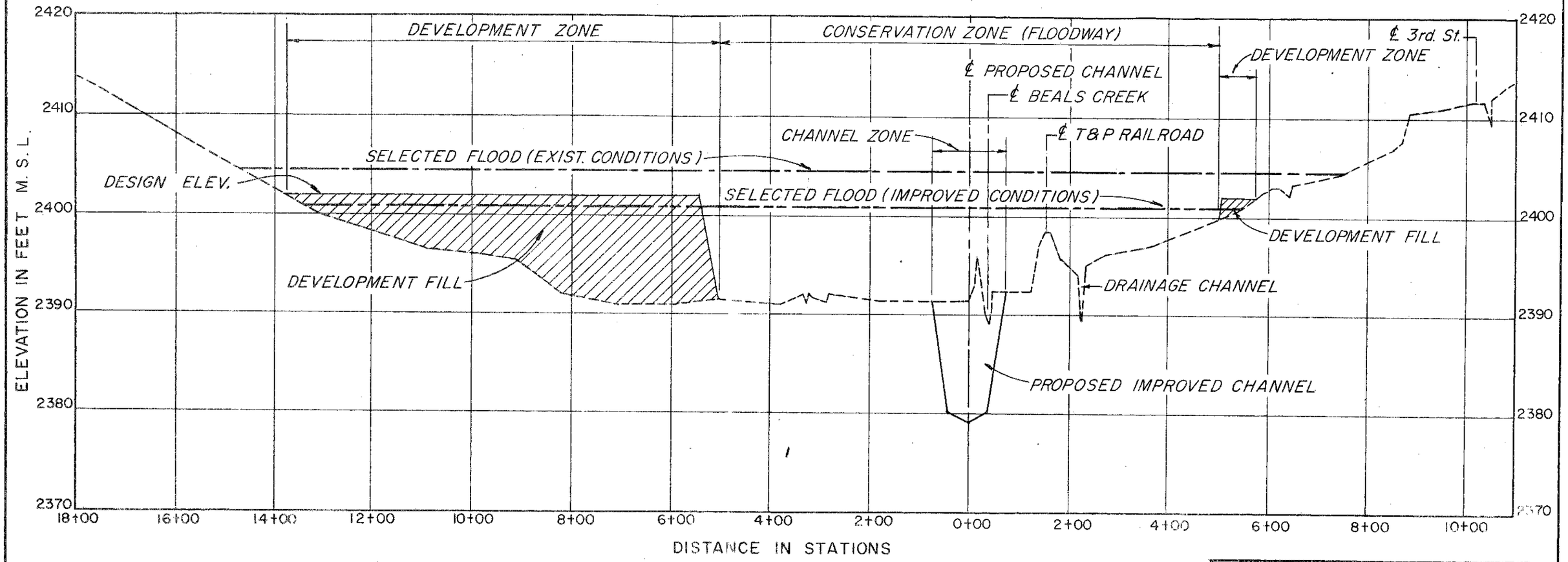
Suggested Uses

- Uses permitted in the C Zone
- Residential, Commercial, Industrial, Public & Other development with floodwater entry points at or above design elevation for encroachment.

Uses Not Appropriate

- Hospitals
- Boarding Schools
- Nursing Homes
- Sanitariums
- Detention Facilities
- Refuge Center
- Orphanages

Figure 1



U. S. ARMY ENGINEER DISTRICT
FORT WORTH, TEXAS

FIGURE 2
FLOOD PLAIN REGULATION ZONES
CROSS SECTION AT IMPROVED
CHANNEL SECTION 149+70
BEALS CREEK

62-221 O-71 (Face p. 82)

For example, reference is made to the sample cross section at improved channel station 149+70 between Reads Draw and the IH-20 overpass, as shown in figure 2. If the entire improved flood plain is designated as a "Conservation Zone" with development therein limited to that which will not restrict the flow of floodwaters, then considerable area will be denied or require permanent evacuation that might otherwise be economically utilized. Before economical or other usage may be determined, however, due consideration should be given to floodwater velocities and depths that may be expected. Information on damaging velocities is limited in current technical literature. In a report issued by the USGS, (Reference 4, Supplement B), it has stated:

> "Average and maximum velocities of 1 and 4 feet per second, respectively, for an overflow section would not be conducive to serious scour in an unobstructed cross section. However, velocities to 4 feet per second in depths of 3 feet or more might easily sweep individuals off their feet, thus creating definite danger of drowning. Where the passage of overflows is more seriously restricted, point velocities in the order of 7 to 10 feet per second could reasonably be expected. Velocities of this magnitude could definitely cause scour leading to failure of building foundations."

Flood depths and related elevations can be obtained from profile plate IV-5.

20. It is quite probable that economical use can be made of a portion of the Conservation Zone along Beals Creek. For example, it becomes apparent that by allowing encroachment on the Conservation Zone that will not raise the elevation of the Selected Flood water surface by more than one foot, considerable additional area can be made available for development. Plates IV-1 through IV-4 show areas that are considered to be potential Development Zone areas. The areas marked on the plates are approximations based on site inspections and the proposed floodway limits. This additional area is referred to as the "Development Zone" on the cross section shown in figure 2. Additional Development Zone area could be gained by allowing encroachment that would increase the Selected Flood water surface elevation more than one foot; however, the effect of this encroachment on adjacent reaches of the watercourse must be considered.

21. OTHER MEANS OF OBTAINING DEVELOPMENT AREAS.- The permanent removal of all existing obstructions to floodflows in the Conservation Zone, such as structures, dense vegetation, etc., serves as another

means of obtaining additional area for development. The removal of such obstructions would improve flow conditions in the Conservation Zone and thereby lower the Selected Flood elevations. This would reduce the width of the Conservation Zone and thus provide additional area for development.

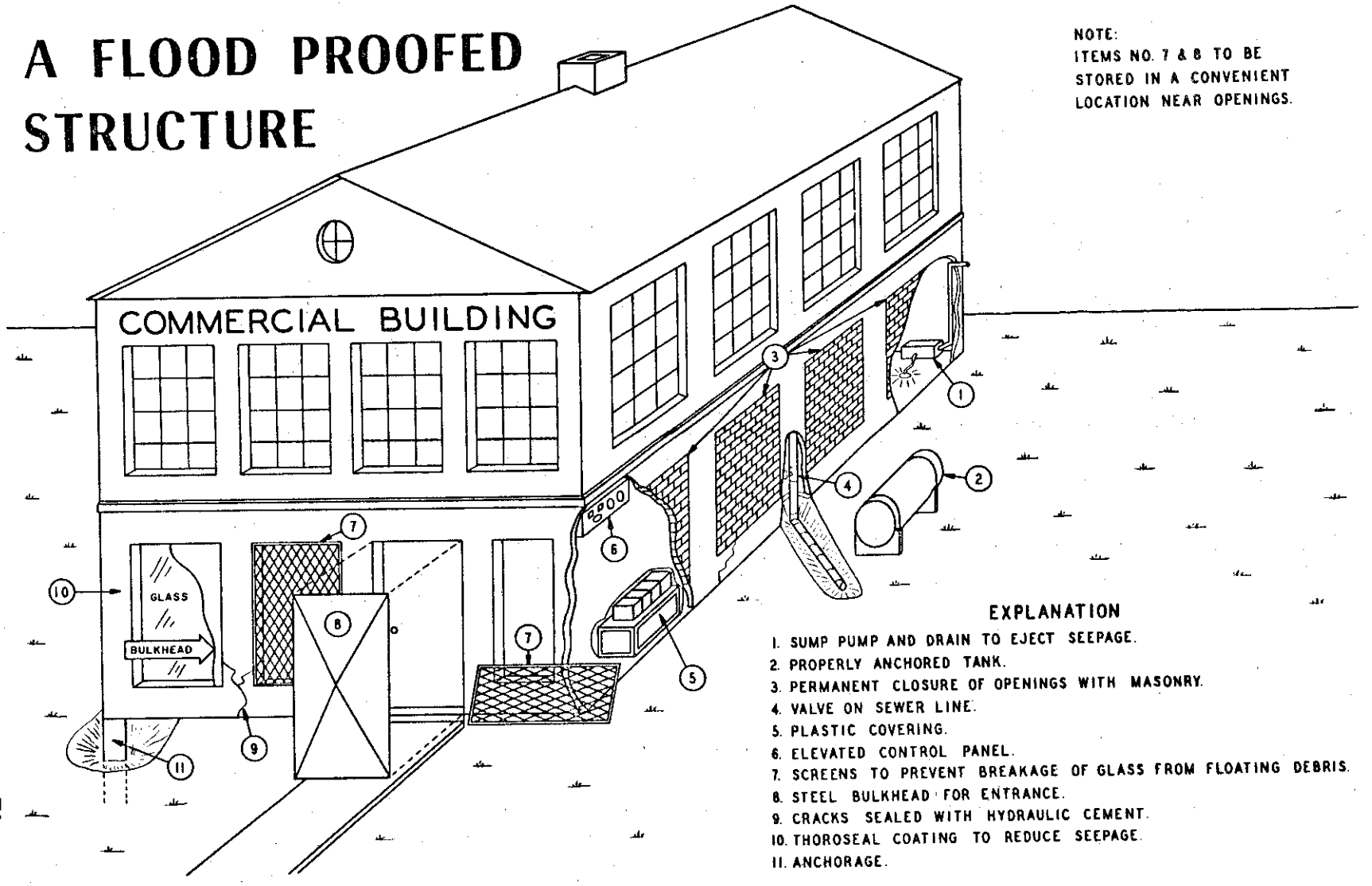
22. DESIGN ELEVATION.- Regulations for use of the Development Zone should establish minimum elevations for first floods of permitted buildings or structures and should require flood proofing of all flood-water entry points below this minimum elevation. This elevation is shown in figures 1 and 2 as the Design Elevation and should be a minimum of one foot above the improved Selected Flood elevation.

23. ENCROACHMENT LIMIT.- Plates IV-1 through IV-4 illustrate how encroachment limit lines might be shown. Assuming the limits of the Selected Flood are used as the basic "Conservation Zone," then the area between these limits and the encroachment limit lines becomes the "Development Zone." The encroachment limit lines then become the revised Conservation Zone limits.

24. ZONE IDENTIFICATION.- When sufficient data have been acquired to reasonably locate the floodway of the Selected Flood and the extent of permissible encroachment has been determined, then limits of the Conservation and Development Zones should be shown on city and county maps in sufficient detail to permit easy location on the ground; and also, be recorded in the office of the agency designated to administer the ordinance. In urban areas, encroachment lines should be related to blocks, lots, and streets. In open or undeveloped areas, especially, warning signs may be appropriate to ensure public awareness of encroachment limits. In rural or unplotted areas, those lines should be related to land with legal descriptions and, where feasible, to road and streambed centerlines. In those instances of areas which have reasonaly uniform flood plain cross sections, it may be practicable to define encroachment lines to be a specified distance from, or height above, the thalweg of the mean low water channel opposite the area under construction.

25. FLOOD PLAIN REGULATIONS.- The Fort Worth District of the Corps of Engineers will, upon request, provide technical assistance to the City of Big Spring in the interpretation and use of the information contained herein and will provide other available data related thereto. Detailed information on regulatory measures are available. The recent passage (June 14, 1969) of S. B. 668, FLOOD CONTROL AND INSURANCE ACT, by the Texas legislature gives all types of local units of government, including conservation districts, the power to set building restrictions and to zone flood plains within their boundaries. It gives them a wide range of planning and land-use

A FLOOD PROOFED STRUCTURE



NOTE:
ITEMS NO. 7 & 8 TO BE STORED IN A CONVENIENT LOCATION NEAR OPENINGS.

EXPLANATION

1. SUMP PUMP AND DRAIN TO EJECT SEEPAGE.
2. PROPERLY ANCHORED TANK.
3. PERMANENT CLOSURE OF OPENINGS WITH MASONRY.
4. VALVE ON SEWER LINE.
5. PLASTIC COVERING.
6. ELEVATED CONTROL PANEL.
7. SCREENS TO PREVENT BREAKAGE OF GLASS FROM FLOATING DEBRIS.
8. STEEL BULKHEAD FOR ENTRANCE.
9. CRACKS SEALED WITH HYDRAULIC CEMENT.
10. THOROSEAL COATING TO REDUCE SEEPAGE.
11. ANCHORAGE.

Figure 3

controls as long as they are related to areas which are subject to floods. Useful references pertaining to flood plain regulations are contained in the Bibliography of Reference 1, Supplement B.

26. FLOOD INSURANCE.- The aforementioned law is also designed to let local units of government, which want to make Federal flood insurance available to their people, have the powers to comply with the Federal law. The following excerpt from HUD Bulletin No. 68-2434 explains the National Flood Insurance Program and what it is designed to do:

> "The program was established under the Housing and Urban Development Act of 1968 to make flood insurance available, eventually throughout the Nation, through a cooperative effort of the Federal Government and the private insurance industry. A fundamental part of the Act requires that State and local government also cooperate by adopting and enforcing land use provisions so as to restrict future development of land in flood-prone areas, including coastal areas, which over the years private industry has been unable to meet without assistance. Through a cooperative Federal-business-local community effort and sharing of risks and losses, the new program is expected to provide the needed insurance."

Further information on flood insurance can be obtained by writing the Federal Insurance Administrator, Department of Housing and Urban Development, Washington, D. C. 20410

28. FLOOD PROOFING.- It is realized that in many already developed areas along Beals Creek, preventative measures such as flood plain regulations would not be practical. Built up areas such as those just downstream from Onemile Lake and near the T&P Railroad Depot, should wherever possible, be flood proofed. Flood proofing would be a positive step towards preventing future flood losses in the undeveloped areas in the Development Zones.

29. Flood proofing is a combination of structural changes and adjustments to properties subject to flooding primarily for the reduction or elimination of flood damages. An example of a flood proofed building is shown on figure 3. Although it is more simply and economically applied to new construction, flood proofing is also applicable to existing facilities. Temporary flood proofing with sandbags, plastic and lumber bulkheads can be effective if floods are anticipated. See the Bibliography, Supplement B, for flood proofing references. Flood proofing has promise in one or more of the following situations.

a. Where moderate flooding with low stage and short duration is experienced.

b. Where the traditional type of flood protection is not feasible.

c. Where individual desire to solve their flood problems without collective action, or where collective action is not possible.

d. Where activities dependent on riverine locations need some degree of protection.

e. Where a resource manager desires a higher degree of protection than that which is provided by a flood-control project.

30. RELATED INFORMATION. In certain cases, flood losses and flood related tragedies can be minimized or eliminated by taking simple precautions. The U. S. Weather Bureau has recently published the following practical advice for those threatened by flooding:

BEFORE THE FLOOD:

Keep on hand materials like sandbags, plywood, plastic sheeting and lumber.

Keep first aid supplies at hand.

Keep your automobile fueled; if electric power is cut off, filling stations may not be able to operate pumps for several days.

Keep a stock of food which requires little cooking and no refrigeration; electric power may be interrupted.

Keep a portable radio, emergency cooking equipment, lights, and flashlights in working order.

WHEN YOU RECEIVE A FLOOD WARNING:

Store drinking water in clear bathtubs, and in various containers. Water service may be interrupted.

If forced to leave your home and time permits, move essential items to safe ground; fill tanks to keep them from floating away; grease immovable machinery.

Move to a safe area before access is cut off by flood water.

DURING THE FLOOD:

Avoid areas subject to sudden flooding.

Do not attempt to cross a flowing stream where water is above your knees.

Do not attempt to drive over a flooded road - you can be stranded, and trapped, -- or you may drop off into a wash-out.

AFTER THE FLOOD:

Do not use fresh food that has come in contact with flood waters.

Test drinking water for potability; wells should be pumped out and the water tested before drinking; boil any questionable water before drinking.

Seek necessary medical care at nearest hospital. Food, clothing, shelter, and first aid are available at Red Cross shelters.

Do not visit disaster area; your presence might hamper rescue and other emergency operations.

Do not handle live electrical equipment in wet areas; electrical equipment should be checked and dried before returning to service.

Use flashlights, not lanterns or torches, to examine buildings; flammables may be inside.

Report broken utility lines to appropriate authorities.

<u>During any flood emergency, stay tuned to your radio or television station. Information from the Weather Bureau and civil emergency forces may save your life</u>.

SUPPLEMENT A - GLOSSARY OF TERMS

Channel - A natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water. The top of the banks form the dividing lines between the channel and the flood plain.

Conservation Zone - The portion of a floodway to include the stream channel and that portion of the adjoining flooding plain designated by a regulatory agency to reasonably provide for passage of flood flows (See Figures 1 and 2).

Design Elevation - The elevation at which the ground floor level of buildings and other structures will be at or above, or to which protection by levees or other flood proofing will be provided. (See Figures 1 and 2)

Development Zone - The portion of the flood plain on which development may be permitted provided that upstream water surface elevation of the selected flood is not increased excessively.(See Figures 1 and 2)

Encroachment Lines - Lateral limits or lines beyond which, in the direction of the stream or body of water, no structure or fill may be added without permission from the regulatory agency that established them. Their purpose is to preserve the floor carrying capacity or the flood plain of the stream or body of water. Their location should be such that the designated floodway between them, including the channel, will handle a designated flood-flow or condition. (See Figure 1)

Flood Plain Regulations - A general term applies to the full range of codes, ordinances, and other regulations relating to the use of land and construction within the channel and flood plain areas. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment line statutes, open-area regulations, and other similar methods of control affecting the use and development of the areas.

Flood Proofing - A combination of structural changes and adjustments to properties subject to flooding primarily for the reduction of flood damages.

Mean Low Water Channel - Channel within banklines defined by the average low water elevations.

Natural Floodway - The channel of the stream or body of water and that portion of the flood plain that is inundated by a flood and therefore used to carry the flow of the flood.

Selected Flood - The flood magnitude selected and adopted by public officials to be used for regulatory purposes.

Zoning Ordinance - An ordinance adopted by a local governing body, with authority from a state zoning enabling law, which divides an entire local governmental area into districts and, within each district, regulates the use of land, the height, bulk, and use of buildings or other structures, and the density of population.

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COLORADO RIVER AND TRIBUTARIES, TEXAS

INTERIM REPORT
COVERING
BEALS CREEK AT BIG SPRING, TEXAS

APPENDIX V

COMMENTS OF OTHER AGENCIES

U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

THE CITY OF BIG SPRING

BIG SPRING, TEXAS 79720

OFFICE OF THE MAYOR

March 26, 1970

Colonel R. S. Kristoferson
District Engineer
Fort Worth District, Corps of Engineers
Post Office Box 17300
Fort Worth, Texas 76102

Dear Colonel Kristoferson:

At a regular meeting of the City Commission of the City of Big Spring, Texas, on February 24, 1970, members of your staff discussed the results of the Corps of Engineers' studies and investigation made in connection with the preparation of an interim report covering the local flood problem at Big Spring on Beals Creek, Colorado River Basin.

The Corps of Engineers is hereby advised that the City of Big Spring concurs with the proposed plan of flood protection for Big Spring, and has authorized its designated officials to sign a letter of intent indicating a desire to cooperate in the Corps of Engineers proposed plan of improvement consisting of structural and nonstructural measures.

We understand the City would generally participate in the proposed plan as follows:

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

b. Accomplish, without cost to the United States, all relocations and alterations to existing improvements, other than railroad bridges, which may be required for the construction of the project.

c. Hold and save the United States free from danages due to construction, maintenance and operation of the project.

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

e. Provide, without cost to the United States, fill areas for the disposal of excess materials from the channel excavation work, the areas to be within reasonable haul distance of the project (approximately three miles); or bear the cost for the excessive haul distance.

f. Prevent encroachment which would interfere with the flood-carrying capacity of the improved channel and floodway.

g. At least annually, publicize and notify all interested parties that the channel will not provide protection from the occurrence of storms greater than a storm which could be expected to occur once in fifty years.

h. Adopt and enforce appropriate flood plain regulations (non-structural measures) which in combination with the structural measures for the proposed flood control project would:

(1) Insure an unobstructed floodway.

(2) Prevent damages to future development within the flood plain that would be inundated by a flood that could be expected to occur once in 100 years.

Sincerely,

J. ARNOLD MARSHALL, Mayor
City of Big Spring, Texas

JAM:rs

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGIONAL OFFICE - REGION 5
P. O. BOX 1609
AMARILLO, TEXAS 79105

IN REPLY
REFER TO:
5-730

April 6, 1970

Col. R. S. Kristoferson
District Engineer
Corps of Engineers
Post Office Box 17300
Fort Worth, Texas 76102

Attention: Mr. R. H. Berryhill

Dear Mr. Kristoferson:

Thank you for your letter of March 26 furnishing a draft copy of your "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas" for review and comment.

The report has been reviewed by this office and our Austin development office. The plan of development will have no known effect on any existing or proposed Bureau of Reclamation projects.

We appreciate the opportunity to review your report. As requested, we are returning the draft copy of the report.

Sincerely,

Leon W. Hill
Regional Director

Enclosure

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Bartlesville Office of
Mineral Resources

ROOM 204 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA 7400

April 23, 1970

Refer to: SWFED-P

Mr. R. H. Berryhill, Chief
Engineering Division
Fort Worth District, Corps of Engineers
Department of the Army
P. O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Berryhill:

We have reviewed the "Interim Report on Colorado River and Tributaries, Tex., Covering Beals Creek at Big Spring, Texas" for involvement with mineral resources and installations.

An examination of office material without benefit of field investigation revealed that mineral deposits in Howard County yielded petroleum, natural gas liquids, natural gas, sand and gravel, and stone valued at about $51.5 million in 1968.

Evidently no oil or gas is produced from within the area of proposed channel improvement. Stone and sand and gravel are produced from various unidentified sources in the county.

The Bartlesville Office of Mineral Resources has no objection to the proposed works of improvement.

Sincerely yours,

Floyd D. Everett

Floyd D. Everett, Chief
Bartlesville Office of Mineral
Resources

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
MID-CONTINENT REGION
BUILDING 41, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

IN REPLY REFER TO:
D6427-TG

April 22, 1970

Mr. R. H. Berryhill
Chief, Engineering Division
Department of the Army
Fort Worth District
Corps of Engineers
Post Office Box 17300
Fort Worth, Texas 76102

Dear Mr. Berryhill:

At this time we have no comments on your March 26, 1970 letter regarding the "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas". By this statement, we do not wish to imply that we are not interested, but rather that we lack adequate resources to review effectively all reports currently being received.

John E. Baybarn
for Maurice D. Arnold

62-221 O-71—8

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
POST OFFICE BOX 1306
ALBUQUERQUE, NEW MEXICO 87103

March 31, 1970

In reply refer to: RB

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 17300
Fort Worth, Texas 76102

Dear Sir:

Mr. R. H. Berryhill's letter of March 26, 1970, your reference SWFED-P, requested our comments on the "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas."

We have reviewed your draft report and note that our report of November 21, 1969, is attached in Appendix V. Our views on the proposed work remain as presented in the report of November 21, 1969, and we have no additional comments.

The draft report Serial No. 26 is herewith returned as requested.

Thank you for the opportunity to review the report.

Sincerely yours,

R. F. Stephens

Robert F. Stephens
Assistant Regional Director
Cooperative Services

Enclosure

cc:
Field Supervisor, BSFW, Div. of River Basin Studies, Fort Worth, Texas

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
POST OFFICE BOX 1306
ALBUQUERQUE, NEW MEXICO 87103

November 21, 1969

In reply refer to: RB

District Engineer
Corps of Engineers, U. S. Army
Post Office Box 17300
Fort Worth, Texas 76102

Dear Sir:

As requested in Mr. R. H. Berryhill's letter of September 23, 1969, your reference SWFED-P, we have reviewed the working draft of your Interim Report on Colorado River and Tributaries, Texas, covering Beals Creek at Big Spring, Texas. This letter is our report on the fish and wildlife resources in relation to your interim report on the above project. It was prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). It has received concurrence from the Texas Parks and Wildlife Department by letter from Executive Director J. R. Singleton, dated October 27, 1969, a copy of which is enclosed.

The proposed plan of improvement includes a combination of structural and nonstructural measures. Structural measures would include realignment and enlargement of about 29,600 feet of Beals Creek through the city of Big Spring from the entrance of Big Spring Draw upstream to Onemile Lake. In the lower 18,000 feet, the improved channel generally would follow the existing channel. Thereafter the improved channel would be slightly north of the existing channel. Nonstructural measures would include the designation of a floodway in which no future construction or land filling would be permitted if such works would restrict the passage of floodwater.

Beals Creek is an intermittent stream. Onemile Lake is a natural lake which often dries up in the summer. Water collected in the lake following runoff has high salinity concentrations. Neither Beals Creek in the project area nor Onemile Lake supports fish. Project works on Beals Creek would have no effect on fish and wildlife and would not offer feasible opportunities for the improvement of these resources.

The opportunity to comment on your draft report is appreciated. Please advise our Bureau if major changes are made in the project

plan so that we may reevaluate their effects on fish and wildlife and prepare a revised report if necessary.

Sincerely yours,

William T. Krummes
Regional Director

Enclosure

Copies (10)

Distribution:

(5) Executive Director, Texas Parks and Wild. Dept., Austin, Texas
(2) Regional Director, BCF, Reg. 2, St. Petersburg, Fla.
(2) Laboratory Director, Biol. Lab., BCF, Galveston, Texas
(2) Regional Director, FWPCA, South Central Reg., Dallas, Texas
(2) Regional Director, BOR, Mid-Continent Reg., Denver, Colo.
(1) Regional Coordinator, USDI, SW Reg., Houston, Texas
(2) Field Supervisor, BSFW, Div. of R. Basins Studies, Fort Worth, Texas

PARKS AND WILDLIFE DEPARTMENT

J. R. SINGLETON
EXECUTIVE DIRECTOR
ROBERT G. MAUERMANN
DEPUTY DIRECTOR

JOHN H. REAGAN BUILDING
AUSTIN, TEXAS 78701

October 27, 1969

Mr. Robert F. Stephens
Assistant Regional Director
Bureau of Sport Fisheries and Wildlife
P. O. Box 1306
Albuquerque, New Mexico 87103

Dear Mr. Stephens:

This is in response to your letter of October 22, 1969, and the attached review draft of a report concerning the Corps of Engineers proposed plan for Beals Creek at Big Spring, Texas.

We have reviewed this draft and concur with the report as presented.

Yours sincerely,

J. R. Singleton

J. R. Singleton
Executive Director

JRS:cw

cc: Mr. John Degani

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
FEDERAL BUILDING
300 EAST 8TH STREET
AUSTIN, TEXAS 78701

April 27, 1970

District Engineer
Department of the Army
Fort Worth District, Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Atten: Mr. R. H. Berryhill, Chief, Engineering Division - SWFED-P

Dear Sir:

Thanks for the opportunity to review the Corps of Engineers' report "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas."

The report is extremely interesting, particularly the Hydrologic Section in connection with the methods used in arriving at the design storm. It is apparent that your technical staff utilized every bit of data and the best methods in reaching your conclusions.

The Geological Survey recommends that the project provide for the rebuilding of the gaging station Beals Creek at Big Spring, and the establishment of a peak-stage station at the location Beals Creek above Big Spring.

Returned herewith is the report.

Sincerely yours,

Trigg Twichell

Trigg Twichell
District Chief

Encl.
TT:fsp

UNITED STATES
DEPARTMENT OF THE INTERIOR
SOUTHWESTERN POWER ADMINISTRATION
POST OFFICE DRAWER 1619
TULSA, OKLAHOMA 74101

IN REPLY REFER TO:

SPA-EXS

April 8, 1970

Mr. R. H. Berryhill
Chief, Engineering Division
Department of the Army
Fort Worth District, Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Dear Sir:

Thank you for your letter of March 26, 1970, enclosing a draft copy of your "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas" for this Administration's review and comments.

The area under review is outside the area of the Southwestern Power Administration's operations; consequently, the proposed improvements will not affect our interests.

We are returning your draft copy of the above report in accordance with your request.

Sincerely yours,

Alva J. Hickerson

Alva J. Hickerson
Hydraulic Studies and
Planning Staff Assistant

Enclosure

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 648
Temple, Texas 76501

April 15, 1970

Mr. R. H. Berryhill
Chief, Engineering Division
Department of the Army
Fort Worth District, Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Berryhill:

We have completed our review of the draft copy of "Interim Report on Colorado River and Tributaries, Texas,Covering Beals Creek at Big Spring, Texas." The report presents the results of your study of the flood conditions at Big Spring, Texas, along with your determination of the best solution of this problem based on the engineering feasibility and economic justification of the selected plan.

It is our understanding that the recommended plan of improvement provides for a combination of structural and nonstructural measures which will provide protection from a 50-year frequency flood and minimize damages from floods up to and including the 100-year event. Structural measures would include realignment and enlargement of 29,600 feet of Beals Creek beginning just below the confluence of Big Spring Draw and extending westward through the city of Big Spring into Onemile Lake, including needed appurtenances. In addition, new structures for two street crossings, alterations of piers and pilings for one bridge and two overpasses; new structures for two railroad bridges; and alteration of trackage and access bridges in the railroad yards would be provided. Channel excavation will be spoiled in low areas not closer than 500 feet of the centerline of the channel with a minimum height of 2 feet above design water surface and maximum would be one foot above the improved 100-year flood profile. Landscaping of the completed project would be carried out so as to enhance the appearance of the channel. Nonstructural measures would include the designation of a floodway not to exceed 1,000 feet in width and a flood plain management plan, including floodproofing, flood plain regulations, creation of open spaces, and warning signs.

The total first cost of the project is about $2,526,000 of which $1,578,000 will be Federal and $948,000 will be non-Federal. The total annual cost is $144,300 which includes $14,000 for operation and maintenance. The estimated total annual monetary benefit is expected to be $234,400, making a benefit-cost ratio of 1.6:1.0.

The Soil Conservation Service can provide technical and cost-sharing assistance in carrying out soil and water conservation practices on farms and ranches within the drainage area of the proposed project. This assistance is available to eligible landowners and operators of the local soil and water conservation district. The works of improvement proposed by the plan will not be significantly affected by, or have any effect upon, any existing or proposed Soil Conservation Service watershed project or program in the area.

We appreciate the opportunity afforded us to review and comment on this report. Copy number 29 of this report is enclosed. We will appreciate receiving a copy of the final report when it is available.

Sincerely,

Clyde W. Graham
State Conservationist

Enclosure as stated

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE
1114 COMMERCE STREET
DALLAS, TEXAS 75202

April 16, 1970

PUBLIC HEALTH SERVICE
ENVIRONMENTAL HEALTH SERVICE

Your reference: SWFED-P

Mr. R. H. Berryhill
Chief, Engineering Division
Fort Worth District, Corps of Engineers
Department of the Army
P.O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Berryhill:

Your letter dated 26 March 1970 enclosed a draft copy of "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas" for our review and comments.

It is noted that the report recommends construction of a local flood protection project at Big Spring, Texas that would include construction of an improved channel generally along the existing alignment of Beals Creek, implemented with flood plain management techniques.

The report shows that significant public health benefits would accrue due to the protection from flooding damages. Further benefits may be anticipated from channel improvement as it will minimize the occurrence of ponding areas which would be conducive to mosquito breeding.

The opportunity to review this report was appreciated. We trust that the Texas State Department of Health will be kept apprised of the proposed project, and public health mesures will be practiced in accordance with that Department's policy.

Draft Copy Serial No. 33 is returned herewith.

Sincerely yours,

Charles W. Northington

Charles W. Northington, P.E.
Water Hygiene Representative
Environmental Control Administration

Enclosure

cc: Mr. G. R. Herzik, Jr.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
819 TAYLOR STREET, FORT WORTH, TEXAS 76102

April 24, 1970

REGION V

IN REPLY REFER TO:

Mr. R. H. Berryhill
Chief, Engineering Division
Department of the Army
Fort Worth District, Corps of Engineers
P. O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Berryhill:

As requested in your memorandum of March 26, 1970 we have reviewed the draft copy (serial number 34) of the "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas."

The report appears to be a thorough and complete analysis of the problems and we concur in the proposed plan of improvement. We suggest that consideration be given to the requirements of the development of flood insurance maps in accordance with 1909.1 of the National Flood Insurance Act of 1968, enacted as Title XIII of the Housing and Urban Development Act of 1968, as amended to further support the flood plain management phase of the plan of improvement if there is an interest in the Flood Insurance Program.

We would also recommend that consideration be given to the Watershed Treatment Program above the City of Big Springs and the development of Open Space areas as a part of flood plain management with possible support from HUD's Open Space and Urban Beautification Program.

Sincerely yours,

H. Earl Rosamond
Assistant Regional Administrator
Program Coordination and Services

Enclosure

FEDERAL POWER COMMISSION
REGIONAL OFFICE
819 Taylor Street
Fort Worth, Texas 76102
April 6, 1970

In reply refer to:
PWR-FW

The District Engineer
U. S. Army Engineer District, Fort Worth
P. O. Box 17300
Fort Worth, Texas 76102

Dear Sir:

This is in reply to your letter of March 26, 1970, inclosing a draft copy of your "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas" for our review and comments.

Beals Creek runs east to west through the city of Big Spring and continues generally eastward some 67 miles to the Colorado River. The main stem of Beals Creek and small inflowing tributaries within the city cause serious urban flood problems. The plan proposed for local protection includes construction of an improved channel and implementation of flood plain management techniques. These features are not adaptable for the development of hydroelectric power and will not affect existing or potential hydroelectric resources. Therefore this office will not have a statutory interest in further development of the plan.

Your courtesy in contacting us is appreciated. Please note that these comments are prepared at field level and are not to be construed as an official opinion of the Federal Power Commission.

The draft copy of the report is returned herewith as requested.

Sincerely yours,

Donald L. Martin

Donald L. Martin
Regional Engineer

Enclosure No. 4719:
As stated

EXECUTIVE DEPARTMENT
AUSTIN, TEXAS 78711

PRESTON SMITH
GOVERNOR

April 24, 1970

Mr. R.H. Berryhill
Chief, Engineering Division
Fort Worth District
Corps of Engineers, U.S. Army
P.O. Box 17300
Fort Worth, Texas 76102

Dear Mr. Berryhill:

The various state agencies cooperating with the Division of Planning Coordination have studied your "Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas" forwarded by you on March 26, 1970. No objections have been offered to the proposed plan of development.

The following comments were made:

1. Texas Water Quality Board: "Adequate measures should be provided so that the sewerage facilities of the city will not be adversely affected."

2. Texas Water Rights Commission: "The Commission may consider this project under Article 7472e when the final report is made to the Governor of Texas."

The State of Texas is pleased to endorse, as submitted, your plan for improvement of Beals Creek at Big Spring, Texas. When the final report is released, please furnish us twelve copies so that all State agencies participating in the review of the draft report will have a copy for their reference and files.

Sincerely,

Dan S. Petty
Director, Division of
Planning Coordination

UNITED STATES
DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
SOUTH CENTRAL REGION
1402 ELM STREET, 3RD FLOOR
DALLAS, TEXAS 75202

May 20, 1970

Ref: SWFED-P

District Engineer
U. S. Army Engineer District, Fort Worth
P. O. Box 17300
Fort Worth, Texas 76102

Attention: Mr. R. H. Berryhill
Chief, Engineering Division

Dear Sir:

As requested in your letter of March 26, 1970 this office has reviewed the draft copy of the Interim Report on Colorado River and Tributaries, Texas, Covering Beals Creek at Big Spring, Texas.

The report proposes to improve and control the flood damages on a 50 year bases by flood plain management and channel rectification and improvement through the City of Big Spring, Texas.

For compliance with Executive Order 11507 we recommend that the construction specifications require contractors to:

a. Take precautions in the handling and storage of hazardous materials to prevent spillages that would result in degradation of the water quality.

b. Provide and operate sanitation facilities that will adequately treat sanitary wastes to conform with Federal or state health regulations.

c. Schedule and perform clearing, snagging and channel excavation operations to reduce siltation and turbidity to the lowest practicable level.

It is not anticipated that a project of this type will have any adverse affect upon the quality of the waters.

Sincerely yours,

Mac A. Weaver

for KENTON KIRKPATRICK
Director, Office of Planning

INTERIM REPORT
ON
COLORADO RIVER AND TRIBUTARIES, TEXAS
COVERING
BEALS CREEK AT BIG SPRING, TEXAS
FLOOD CONTROL

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

1. PROJECT DESCRIPTION AND ECONOMIC LIFE

a. Description. The plan of improvement provides for the construction of an improved channel to prevent damages from all floods up to the magnitude of a flood expected to occur on the average of once in 50 years. Flood plain management techniques would prevent damages to future development from floods expected to occur once in 100 years.

b. Project life. The plan of improvement was evaluated on the basis of a 100-year economic life.

2. PROJECT COST AND BENEFITS

The estimated cost of construction of the improved channel is $2,526,000. The first cost and annual charges are shown below. Details of estimates are given in Appendix I of this report.

a. First cost (July 1, 1969 prices)

	Federal	Non-Federal	Total
Lands and Damages	-	$340,000	$ 340,000
Relocations	$ 86,000	528,000	614,000
Channel	1,286,000	-	1,286,000
Engineering and design	126,000	49,000	175,000
Supervision and administration	80,000	31,000	111,000
TOTAL	$1,578,000	$948,000	$2,526,000

b. Annual charges

(1) Based on 50-year life.

Item	Federal	Non-Federal	Total
Interest (4 7/8 percent)	$ 80,700	$ 48,500	$129,200
Amortization (50 years)	8,200	4,900	13,100
Operation and Maintenance	-	14,000	14,000
TOTAL	$ 88,900	$ 67,400	$156,300

(2) Based on 100 year life.

Item	Federal	Non-Federal	Total
Interest (4 7/8 percent)	$ 80,700	$ 48,500	$129,200
Amortization (100 years)	700	400	1,100
Operation and Maintenance	-	14,000	14,000
TOTAL	$ 81,400	$62,900	$144,300

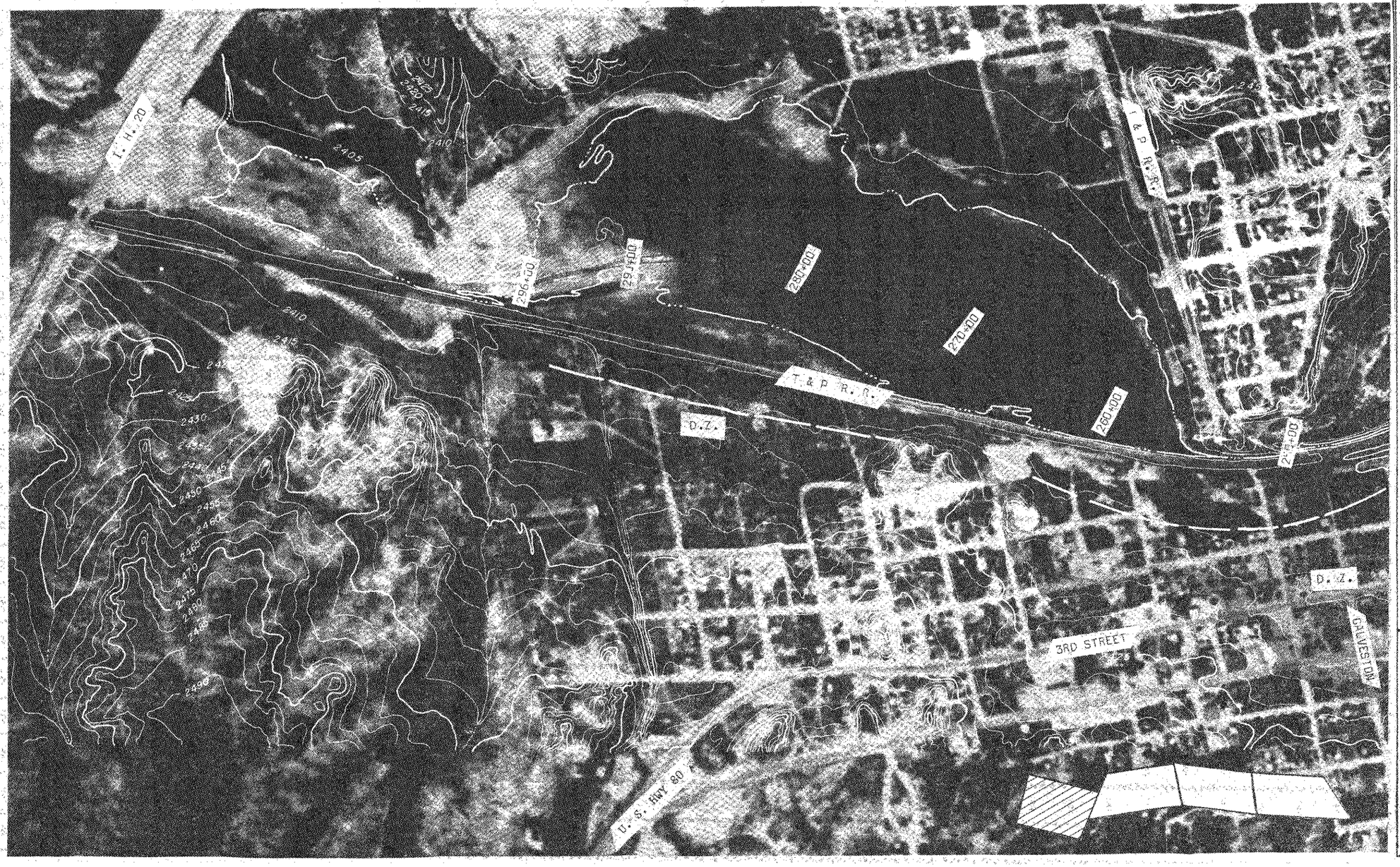
3. The benefit-to-cost ratio, based on economic life of 50 and 100 years for the plan of improvement are as follows:

COMPARISON OF BENEFITS WITH ANNUAL CHARGES

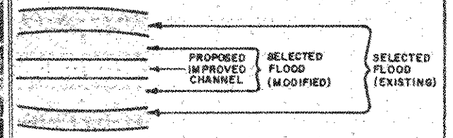
Item	50-year life	100 year life
Annual charges	$156,300	$144,300
Annual benefits	234,600	237,400
Benefit-cost ratio	1.5	1.6

4. ALTERNATIVE PLANS

Sufficient preliminary consideration was given to alternative improvements such as multiple- and single-purpose reservoirs, levees, and non-structural measures, to indicate that a plan of improvement consisting of a 50-year improved channel with a 100-year controlled flood plain was the most acceptable plan.



LEGEND



180 + 00 — PROPOSED IMPROVED CHANNEL STATIONING

2390 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

D. Z. — POSSIBLE DEVELOPMENT ZONE

FLOODWAY LIMITS

NOTES

1. LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE APPENDIX.
2. AERIAL PHOTOGRAPHS FLOWN 1968.
3. CONTOUR INTERVAL 5 FEET. (1959 MAPPING)

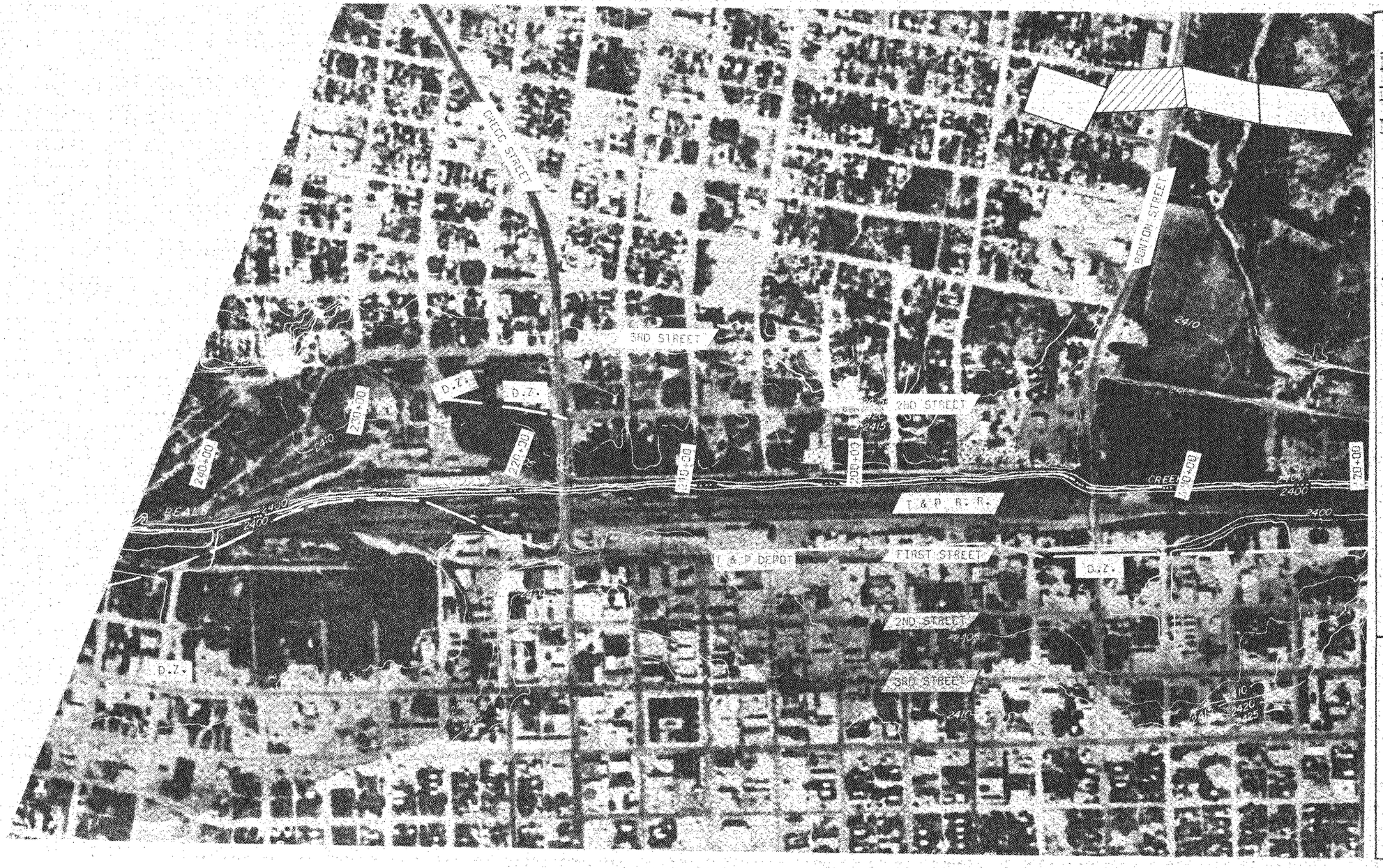
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

FLOODED AREAS

BEALS CREEK

PLATE IV-1

62-221 O-71 (Face p. 114) No. 1



LEGEND

PROPOSED IMPROVED CHANNEL — SELECTED FLOOD (MODIFIED) — SELECTED FLOOD (EXISTING)

180 + 00 — PROPOSED IMPROVED CHANNEL STATIONING

2390 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

D.Z. — POSSIBLE DEVELOPMENT ZONE

FLOODWAY LIMITS

NOTES

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2. AERIAL PHOTOGRAPHS FLOWN 1968.
3. CONTOUR INTERVAL 5 FEET. (1959 MAPPING)

N

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

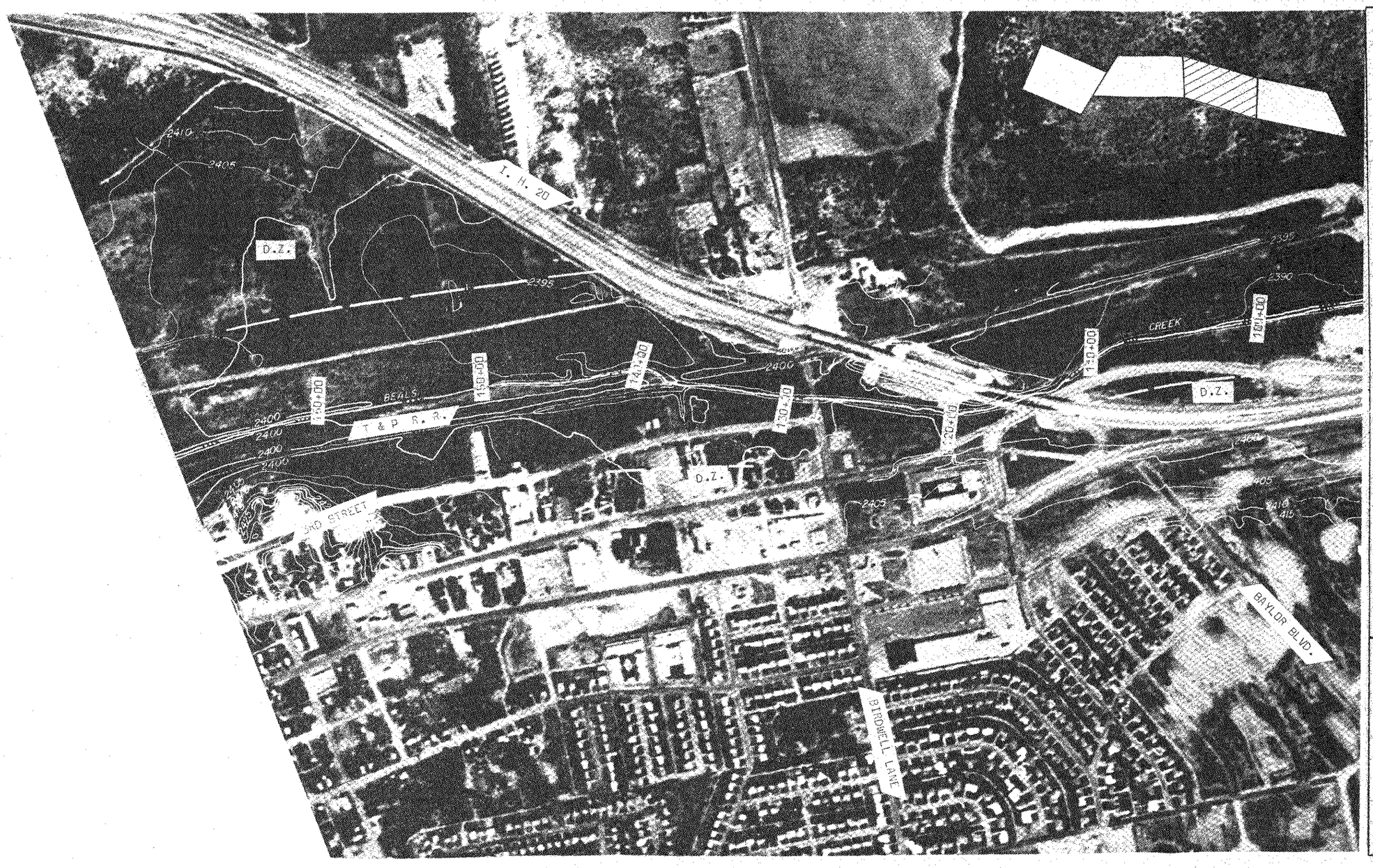
FLOODED AREAS

BEALS CREEK

SCALE OF FEET
0 500 1000

PLATE IV-2

62-221 O-71 (Face p. 114) No. 2



LEGEND

PROPOSED IMPROVED CHANNEL — SELECTED FLOOD (MODIFIED) — SELECTED FLOOD (EXISTING)

180 + 00 — PROPOSED IMPROVED CHANNEL STATIONING

2390 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

D.Z. — POSSIBLE DEVELOPMENT ZONE

FLOODWAY LIMITS

NOTES

1. LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE APPENDIX.
2. AERIAL PHOTOGRAPHS FLOWN 1968.
3. CONTOUR INTERVAL 5 FEET. (1959 MAPPING)

N

CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

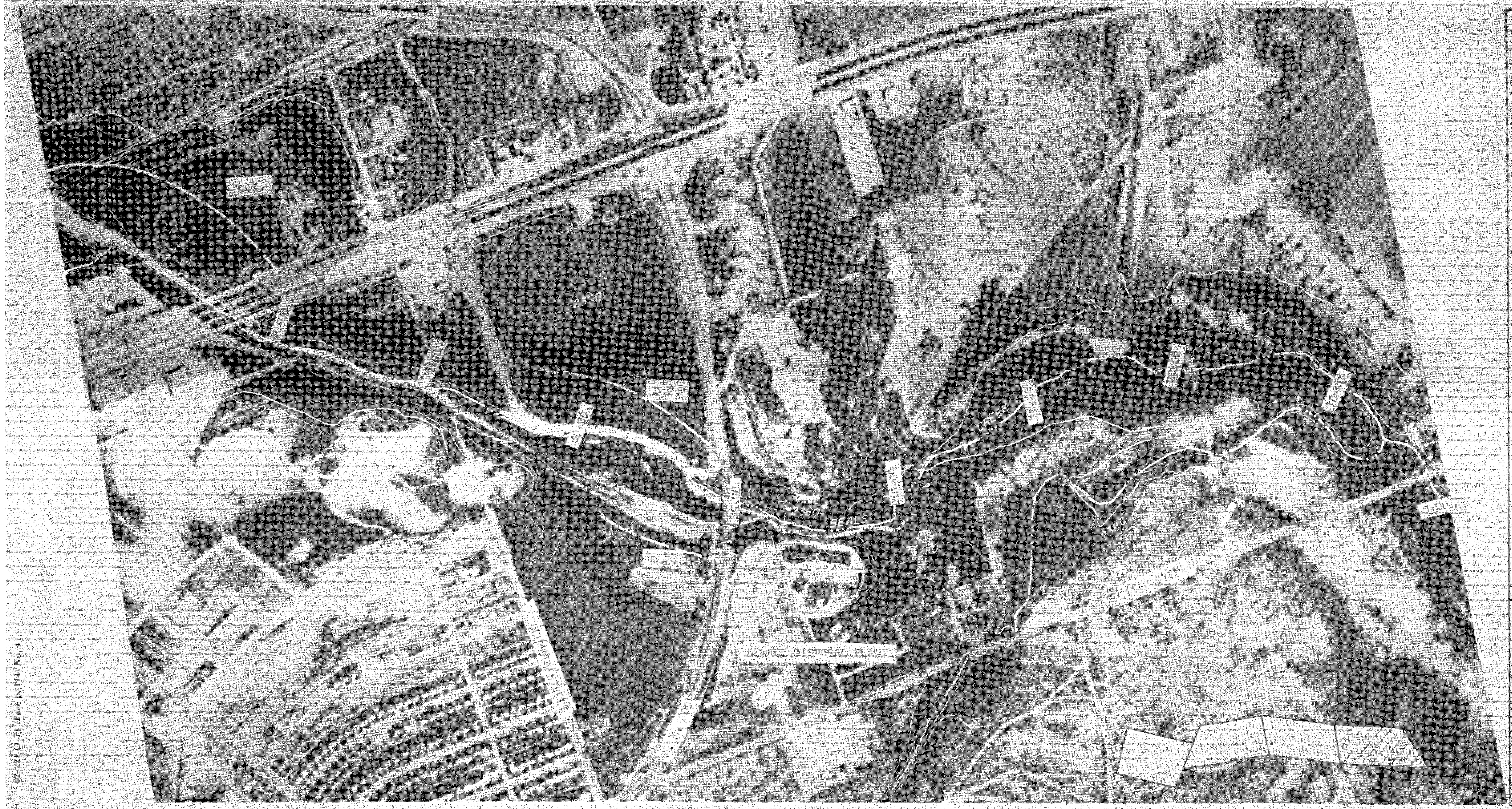
FLOODED AREAS

BEALS CREEK

SCALE OF FEET
0 500 1000

PLATE IV-3

62-221 O-71 (Face p. 114) No. 3



LEGEND

PROPOSED IMPROVED CHANNEL / SELECTED FLOOD (MODIFIED) / SELECTED FLOOD (EXISTING)

180 + 00 — PROPOSED IMPROVED CHANNEL STATIONING

2390 — GROUND ELEVATION IN FEET, USC & GS 1929 M.S.L. DATUM

D.Z — POSSIBLE DEVELOPMENT ZONE

— — — FLOODWAY LIMITS

NOTES

1. LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE APPENDIX.
2. AERIAL PHOTOGRAPHS FLOWN 1968.
3. CONTOUR INTERVAL 5 FEET. (1959 MAPPING)

N

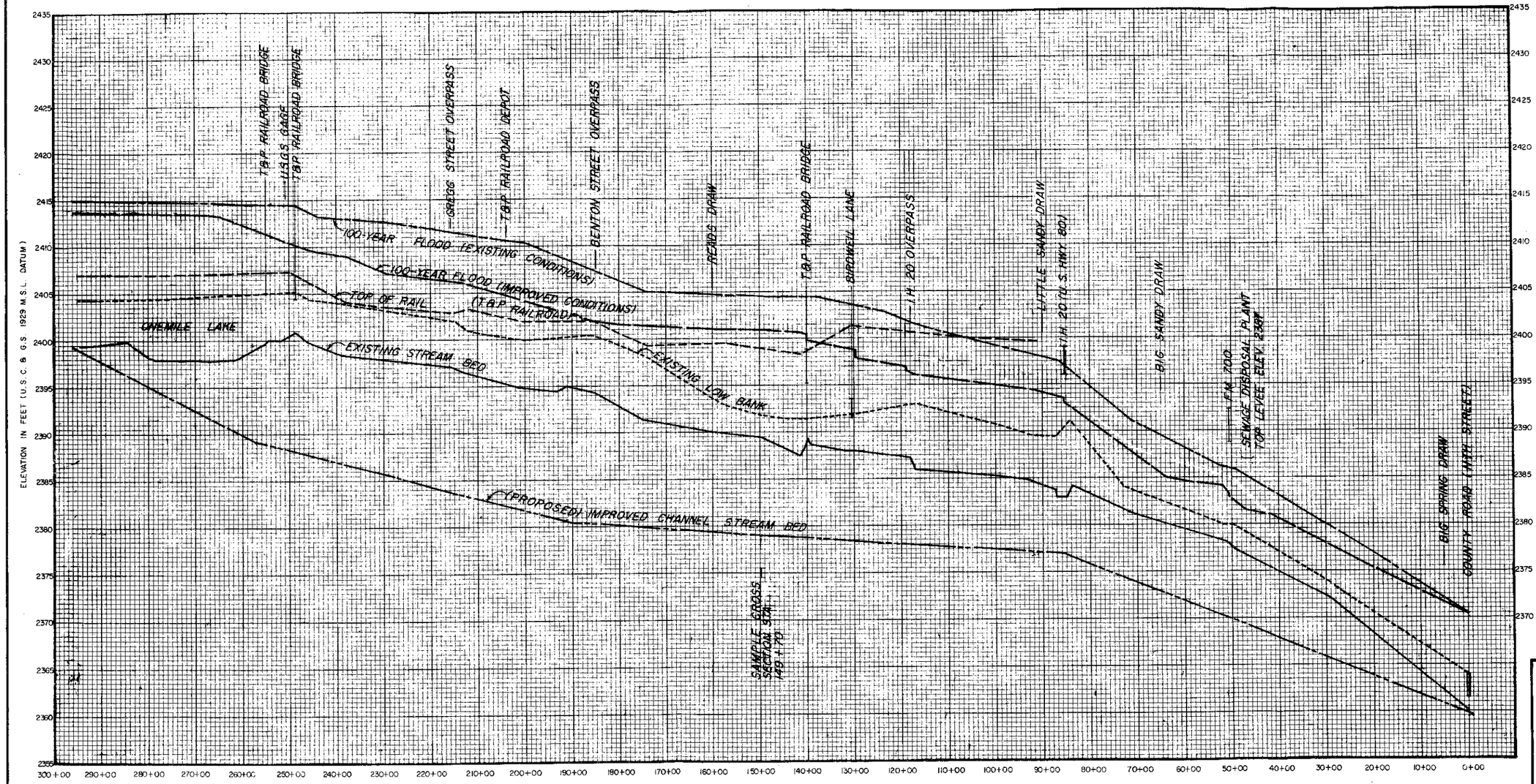
CORPS OF ENGINEERS, U.S. ARMY
FORT WORTH, TEXAS, DISTRICT

FLOODED AREAS

BEALS CREEK

SCALE OF FEET
0 500 1000

PLATE IV-4



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HIGH WATER PROFILE

BEALS CREEK

62-221 O-71 (Face p. 114) No. 5