5-1947

Plan of Development for Valley Gravity Project, Lower Rio Grande, Texas

United States. Department of the Interior

PLAN OF DEVELOPMENT
FOR
VALLEY GRAVITY PROJECT

Based on current information, the project presented in this report is considered by the Bureau of Reclamation to be the most suitable one from the standpoint of the lands to be benefited. However, it must be recognized that an international situation is involved. No plan can be considered final until after the international aspects have been considered and approved by both sections of the International Boundary and Water Commission. Negotiations based on studies now in progress by the Bureau of Reclamation and the United States Section of the International Boundary and Water Commission may disclose the desirability of changing the point of diversion for the project water supply, but the essential features of the project plan would in any event remain substantially the same.

UNITED STATES DEPARTMENT OF THE INTERIOR

Julius A. Krug, Secretary

PLAN OF DEVELOPMENT

for

VALLEY GRAVITY PROJECT

LOWER RIO GRANDE

TEXAS

Report by the

Department of the Interior

Sponsored by and

Prepared Under the General Supervision of

BUREAU OF RECLAMATION

Michael W. Straus, Commissioner

REGION 5

Wesley R. Nelson, Regional Director

PROJECT REPORT NO. 5-0619-0

MAY 1947

SYLLABUS

The Valley Gravity Project plan has been formulated to furnish an adequate and dependable irrigation water supply for fertile and productive area in the Lower Rio Grande Valley, Texas. It would also provide drainage works, which would remove the threat of destruction of the economy of the area due to effects of a high water table and salt accumulations. The project works would permit generation of the maximum practicable amount of electrical energy and at the same time the plan would free for imdustrial and other development of the valley electrical energy which otherwise would be required to operate irrigation pumping plants. Other incidental benefits include fish and wildlife conservation, recreation and flood control.

Most of the lands of the area are now being irrigated by pumping directly from the Rio Grande, with additional pumping lifts required for higher areas. The majority of the pumping plants are old and in need of major repairs. Operation of the river plants is expensive and subject to interruption by floods. The lack of suitable drainage outlets has in most instances prevented existing drains from being effective. As a result, about 70 percent of the area is in urgent need of drainage relief.

Construction of the gravity irrigation system has long been an objective of residents of the area. However, due principally to their limited financial ability and to the magnitude and complexity of the problems involved, the local interests have not been able to accomplish this objective. The assistance of the Federal Government was sought, and in 1941, construction of the Valley Gravity Canal and Storage Project was authorized. However, prior to construction, a treaty was ratified between Mexico and the United States which necessitates revisions of the authorized plan to consider the allocation of the waters of the Rio Grande provided for by the treaty and to utilize the Falcon Reservoir and other works to be constructed thereunder.

The revised plan of the Bureau of Reclamation provides for serving a total of 700,000 acres of land, including 552,000 acres now being irrigated, 75,400 acres of new lands within the present irrigation districts and approximately 72,600 acres of other new lands. The works contemplated include a main canal system, an outlet drainage system, an irrigation and drainage system for the new lands outside of the districts, an offstream regulating reservoir, and a hydroelectric power plant of 12,000 kilowatts capacity.

Construction of the works would cost approximately $129,700,000 on the basis of 1947 prices. The plan of development has engineering feasibility. It is economically sound as full recovery of the government's investment is contemplated. The ratio of costs to benefits is 1 to 4.53.

The plan has been integrated with known plans of the International Boundary and Water Commission for development of the Lower Rio Grande Basin, and it is consistent with presently conceived programs for the remainder of the Rio Grande Basin.

PLAN FOR DEVELOPMENT

of

VALLEY GRAVITY PROJECT - TEXAS

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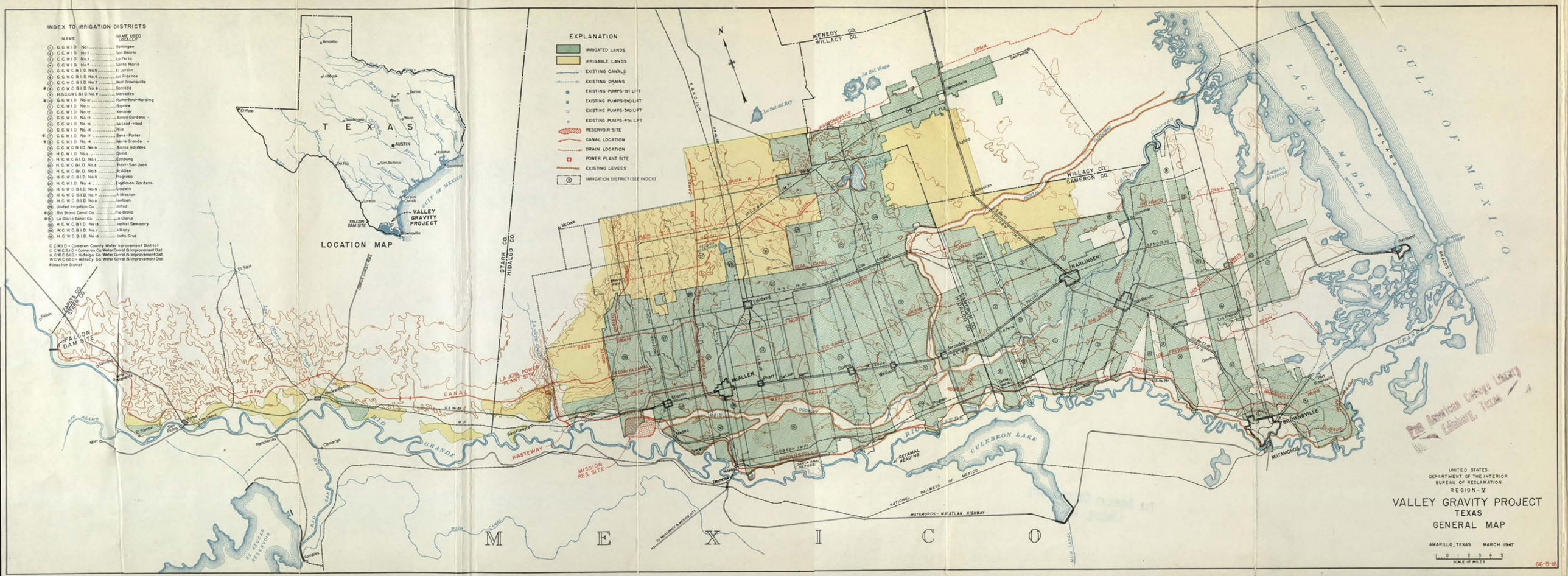
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Rio Bravo Canal Co. ..... Rio Bravo
*La Gloria Canal Co. ..... La Gloria
H.C.W.C.& I.D. No.13 ..... Baptist Seminary
W.C.W.C.& I.D. No.1 ..... Willacy
H.C.W.C.& I.D. No.15 ..... Santa Cruz
C.C.W.I.D. = Cameron County Water Improvement District
C.C.W.C.& I.D. = Cameron Co. Water Control & Improvement Dist.
H.C.W.C.& I.D. = Hidalgo Co. Water Control & Improvement Dist.
W.C.W.C.& I.D. = Willacy Co. Water Control & Improvement Dist.
*Inactive District
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66-5-18

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
AMARILLO, TEXAS
REGION 5

May 29, 1947

To: Commissioner, Bureau of Reclamation

From: Regional Director

Subject: Plan of Development for the--

V A L L E Y G R A V I T Y P R O J E C T -- T E X A S

INTRODUCTION

1. A plan of development for the Valley Gravity Project in the Lower Rio Grande Valley of Texas, is presented in this report. This plan is a revision of the Valley Gravity Canal and Storage Project (herein called Project No. 5) plan which was authorized for construction by Act of Congress June 28, 1941. Changes in the original plan were necessary to utilize water of the Rio Grande allocated to the United States under the terms of the Treaty of November 1945, and which would be made available by the storage dams authorized for construction on the Rio Grande by the Treaty.

2. The report is based on the attached substantiating materials which were prepared for the Department of the Interior under the general supervision of the Bureau of Reclamation. I recommend that you present the report for appropriate departmental action with a view to obtaining the concurrence of the State Department therein and congressional approval of the revised plan by an amendment to the Act of Congress which authorized Project No. 5. Construction of the Project works should be started immediately in order to permit their completion by the time the first dam provided under the Treaty is finished, and water becomes available for diversion from the Rio Grande.

AUTHORITY FOR REPORT

3. This report is authorized to be made by virtue of the Federal Reclamation Laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof and supplementary thereto) and by a provision in the Interior Department Appropriation Act for the fiscal year 1942 (Public Law 136, 77th Congress).

COOPERATION AND ACKNOWLEDGMENTS

4. Numerous Federal, State, and local agencies and individuals assisted in the investigations for this report. The International Boundary and Water Commission prepared the report on which Project No. 5 was authorized. That agency also furnished technical information relative to the

project as did the Soil Conservation Service, Department of Agriculture; the Corps of Engineers, War Department; and the Weather Bureau, Department of Commerce. The Geological Survey made analyses of water samples and studies of groundwater supplies. The United States Coast and Geodetic Survey extended its triangulation system in the Valley under a cooperative agreement with the Bureau of Reclamation.

5. The Texas State Board of Water Engineers and Texas General Land Office supplied maps and data on water filings along the Rio Grande.

6. The Water Conservation Association of the Lower Rio Grande Valley has given much time and assistance in developing the plans for the project. The various irrigation districts have furnished records and maps of their systems and otherwise assisted in the over-all planning for the project. The Valley Planning Board, the newspapers of the area, and many private engineers have also furnished records and other data.

DESCRIPTION OF THE AREA

Location and Climate

7. The Valley Gravity Project is located at the lower end of the Rio Grande Basin in Texas. (See General Project Map, facing page 1). It is situated in the southernmost part of the state, being bounded on the east by the Gulf of Mexico and on the south by the Rio Grande, which forms the international boundary between the United States and Mexico. The project area includes parts of Cameron, Willacy, Hidalgo, and Starr Counties. The main body of the project is contained in a section about 70 miles long and 30 miles wide, extending from the city of Brownsville on the east to a point about 10 miles west of the city of Mission. The area is locally known as the "Valley."

8. The climate of the project area is semi-tropical and semi-arid. The mean annual temperature at Brownsville is about 73 degrees. The average frost-free growing season ranges from 330 days at Brownsville to 310 days near the west end of the project area. The mild temperatures are favorable for intensive agricultural practices throughout the year. The average annual precipitation is approximately 26 inches. There are usually two periods of heavy rainfall, in the late spring and early fall, with much of the precipitation occurring as heavy downpours.

9. The project area is situated in a region that is subject to tropical hurricanes which originate in the Gulf of Mexico; the last of appreciable magnitude occurred in 1933.

Settlement and Development

10. In the year 1749, the first permanent settlements were established along the south side of the Rio Grande in the Lower Rio Grande Valley. The city of Brownsville was established and steamboat transportation was started on the Lower Rio Grande about 1847. The first irrigation development of the area was started in 1876. Irrigation development in the area was rapid after 1904 when the first railroad was completed to the Valley. Numerous companies

were formed and great energy and ingenuity were shown in the sales campaigns of the land companies. Prospective buyers were brought to the area from northern states. The mild weather, flourishing groves and profusion of flowers in mid-winter proved irresistible to many people and land was usually sold at inflated prices. A notable increase in development took place in the period 1920 to 1930 due principally to the rapid development of citrus orchards and the increase in vegetable production under irrigation.

11. The first irrigation canals extended only a few miles from the river. Pumping plants were required to lift water from the river to the head of the canals where it then flowed by gravity to the lands. As additional land was sold the systems were extended from the river. Due to financial difficulties, it became necessary for the landowners to organize irrigation districts under state laws and vote and sell bonds in order to make needed repairs to the irrigation systems. The first district was established in 1914 and others followed rapidly. Only one of the original privately owned systems is now in operation.

Existing Irrigation Facilities

12. At present there are 27 active and six inactive irrigation districts in the project area. In addition there are numerous independent operators who have developed land adjacent to these districts. A total of 552,000 acres was irrigated in 1945, of which 496,000 acres were in the districts and 56,000 acres were held by independents. Facilities for serving the lands of the districts consist of 15 major river pumping plants; some second, third and fourth lift pumps; and numerous canals, laterals and some drains. Water is pumped from the Rio Grande at the river plants into the districts' main canals, whence it flows by gravity to the irrigated lands or to the relift pumps. Pumping lifts average about 20 feet at the major plants. The independent operators either purchase water from a nearby district or obtain water by pumping directly from the river. In addition to their distribution systems, some have minor drainage facilities. In general, the pumping plants are old and in need of repairs. The distribution systems are adequate but in recent years many of the canals have been lined to reduce water losses and consequent pumping charges. The drains, for the most part, are in need of maintenance and, due principally to a lack of suitable outlets, are only partly effective.

Agricultural Production

13. The project is in one of the most highly productive agricultural areas in the United States. The favorable climate, extremely fertile soils, and available irrigation water supply have resulted in development of an intensive farming industry involving the production of high value, specialty crops including citrus fruits and vegetables. Cotton and forage crops are grown in some of the irrigated areas and the dry land areas of the project. Livestock production is the principal enterprise in the region which surrounds the project area; however, on certain of the irrigated lands a livestock program is being added to maintain a more balanced system of farming. The areas of irrigated lands devoted to production of each of the principal crops are as follows: citrus 27 percent, cotton 37 percent, and vegetables 36 percent. Two crops of practically all vegetables are raised each year.

14. In 1944 the Valley produced 25,800,000 boxes of citrus fruit valued at $40,160,000. Grapefruit has been leading, although oranges are gaining in importance each year. The principal vegetables grown in the area are tomatoes, cabbages, carrots, beets, potatoes, and green corn. In 1944, 33,883 carload shipments of vegetables were made from the project area and 95,000 bales of cotton were produced, valued at $24,152,000 and $12,134,000 respectively.

15. Crop returns for 1944 reveal an average gross income of $167 per acre for the irrigated lands. The returns per acre were approximately $287 for citrus, $120 for vegetables, and $77 for cotton.

16. The project area does not produce sufficient dairy products, poultry or eggs for its own consumption. Considerable quantities of these are shipped in.

Population

17. The four counties of the project area had a total population of 215,803 in 1940 and 268,000 in 1946. The density of the population of the project area including urban population, is about 107 persons per square mile. With the exception of the years, 1930-1940, when the demand for citrus fruits and winter vegetables declined, there has been a steady increase in population from near the beginning of the century. The estimated rural population of the area is 81,000. However, many farm operators live in urban areas.

Markets, Transportation and Industry

18. The major part of the citrus products of the Valley is sold to auction centers located at Chicago, St. Louis, Cincinnati, and Cleveland. Recently some citrus fruit and processed juice have been shipped abroad to Great Britain, Sweden, Belgium, and Canada. The principal markets for vegetables grown in the Valley are in the Middle West and Northeastern states. Cotton is shipped to all parts of the United States and to some foreign countries.

19. The local market consumes only a small part of the citrus and vegetables produced. The dairy and cattle enterprises located on the project and adjacent area use a large part of the feed crops and of raw by-products of the citrus industry.

20. The project area is well served by all types of transportation. Adequate paved highways extend from the area to the North and to the West. The Missouri Pacific and Southern Pacific railroads serve the area. More than a score of steamship lines come into Port Brownsville and Port Isabel. Three major air lines have operation bases at Brownsville and smaller lines traverse the Valley. Three points of entry provide rail and highway outlets for trade with Northern Mexico. The Arroyo Colorado has been improved near Harlingen to provide a barge canal to connect with the Intra-coastal Canal in the Laguna Madre, giving access to a very important waterway which reaches from Florida to Corpus Christi, Texas and is being extended through Laguna Madre to Port Isabel.

21. Agriculture is the principal industry in the Valley. The processing and marketing of citrus fruits and vegetables is of first importance, though there are numerous cotton gins, oil mills and compresses for handling the cotton industry. Approximately 258 firms and individual buyers handle citrus fruit and vegetables. They include the canning plants, packing plants, and buyers and shippers. With lower cost power available from the International dams, it is anticipated that costs of processing agricultural products would be reduced, and that industrial activity in general would be enhanced. The petroleum industry is probably second in importance to agriculture in the project area. In 1945 about ten million barrels of crude oil were produced. The commercial fishing industry out of Port Isabel, with an annual value amounting to several million dollars, is also important.

Community Facilities

22. The project area is served with electricity, gas both natural and butane, telephone and telegraph, and local radio stations. Electric service is supplied by the Central Power and Light Company to all municipal and to some rural areas. The remainder of the rural areas are served by Rural Electrification Administration financed projects. Municipal water supplies for domestic and industrial purposes are derived principally from the Rio Grande through the irrigation districts.

Lands of the Project

23. The project area is largely composed of the alluvial delta of the Rio Grande and a section of the adjoining coastal plain. However, a small area at the west end extends into the rolling hill section. The delta region is a comparatively flat plain with gentle slopes away from the river, broken only by several pronounced benches in the central and western part of the area. One natural drainage way, the Arroyo Colorado, extends eastward from a point near Mercedes to the Gulf.

24. Except for the limitation of water supply, approximately 950,000 acres of land in the Valley are suitable for irrigation. The greater part of this area lies in a relatively compact block in the three lower counties of the project. Some 23,000 acres of the total are scattered through Starr County along the general route of the main canal.

25. Due mainly to the lack of sufficient natural drainageways through the Valley, the groundwater is at a comparatively high level over much of the irrigated area. During periods of excessive rainfall, the water table rises to the surface in some localities and drowns crops. A general rise in groundwater levels occurs after periods of above normal rainfall and the water table recedes very slowly. Over considerable areas the water table remains so near the surface that mineralized groundwater is drawn by capillary action to the surface where subsequent evaporation leaves undesirable salt accumulations. The productivity of much of the area also is being seriously reduced by the deposition of soluble salts contained in irrigation water. These salts are being deposited over the project as a whole at a rate considerably in excess of their removal. In a few areas of better drainage, the condition is reversed, indicating that proper drainage works will remove excess salt accumulations. About 70 percent of the area is in urgent need of drainage works.

26. The lands of the Valley are largely held in small ownerships. Within the irrigation districts there are some 18,809 owners. The average size of farm including both irrigated and dry lands within the districts is 20 acres. This comparatively small average holding is accounted for by the great number of small citrus farms, many of which are in 5 and 10 acre tracts. These groves were purchased by individuals throughout the United States as investments to supplement other income. Approximately 81 percent of the irrigable lands in the present districts are held in ownerships of less than 160 acres.

AUTHORIZED PROJECT

27. Construction of a canal to bring water to the project lands by gravity and thus eliminate the high cost and uncertainty involved in obtaining the water supply by pumping from the unstable Rio Grande has long been an objective of residents of the area. However, due principally to their limited financial ability and to the magnitude and complexity of the problems involved, the local interests have not been able to construct the gravity system. Accordingly the assistance of the Federal Government was sought. The United States section of the International Boundary Commission in 1940 completed a report designated "Federal Project No. 5" for the Valley Gravity Canal and Storage Project. The project, authorized for construction by Act of Congress in 1941 as the result of that report, is referred to as Project No. 5. The Interior Department Appropriations Act of 1942 made available funds in the amount of $2,500,000 for completion of investigations and start of construction of the project.

28. The Project No. 5 plan provided for supplying water largely by gravity to an initial developed area of 583,000 acres and an ultimate area of 715,000 acres. It provided for water to be diverted from the Rio Grande at Rincon, where a good diversion site is provided by a natural rock ledge extending across the river. From Rincon the water would have been carried by gravity in a concrete lined canal system to the project area. Under the plan, the canal system would have essentially followed the Rio Grande and eliminated only the need for the river (first-lift) pumps. Total length of the authorized canal system was 169 miles. Offstream reservoirs at Los Olmos Creek and near Mission, with combined storage capacities of 405,000 acre-feet and an 18,000 kilowatt hydroelectric power plant were also included in the plan. Estimated cost of the project on the basis of 1940 prices was $59,643,000, including $5,000,000 as the proportional share of supplemental upstream storage.

29. The 1941 Act of Congress designated the Bureau of Reclamation to construct all features of the project except those portions which were international in character. The international features consisted of storage and diversion structures, including canal headworks and sluiceways, which would be built on the international boundary portion of the Rio Grande.

INTERNATIONAL TREATY

30. The Treaty between the United States and Mexico relating to utilization of waters of the Colorado and Tijuana Rivers and the Rio Grande from Fort Quitman, Texas, to the Gulf of Mexico was ratified by the two

nations and became effective November 8, 1945. The application of the Treaty, and the regulation and exercise of the rights and obligations of the two governments thereunder, were entrusted to the International Boundary and Water Commission.

31. The waters of the Rio Grande from Fort Quitman to the Gulf of Mexico are allotted under the Treaty with the United States and Mexico, to receive approximately 60 and 40 percent, respectively.

32. Construction of storage dams on the Rio Grande is provided for in the Treaty. Three general locations are specified with the final locations and exact number of dams to be determined by the Commission. The Treaty stipulates that the lowest downstream dam shall be completed within eight years from the effective date of the Treaty. This dam has been tentatively located at the Falcon site which is near the Starr-Zapata County line.

33. Power plants at the international dams are to be constructed and operated jointly by the two governments. The costs of construction, operation and maintenance and the energy, generated at the dams, are to be divided equally between the two countries.

PROJECT WATER SUPPLY

34. The water supply for the project is to be derived from the Rio Grande. The International reservoirs to be constructed under the Treaty will provide holdover storage for regulating flows of the river. The United States' share of water available to the Lower Valley will be approximately 60 percent of the total supply and will amount to an annual average of approximately 1,500,000 acre-feet. This value makes allowances for all probable upstream future uses for irrigation and industrial purposes and for evaporation from reservoir water surfaces.

35. The diversion requirements for irrigation are dependent on the condition of canal and lateral systems, type of crops and soils and on the amount and distribution of rainfall. Present annual overall uses in the Valley range among districts from about 1.5 to over 3 acre-feet per acre. With allowance for continued improvements in lining of systems, and considering the reductions in water losses which would result from the project construction, the future average irrigation diversion requirements is estimated at 2.15 acre-feet per acre. This value contains allowances for all municipal and industrial uses as most of such supplies are obtained through the districts' main canals. The dependable water supply would then be sufficient to irrigate a total of approximately 700,000 acres of project lands. There will possibly be some return flow that could be used within the project, but inasmuch as the quality and quantity of these waters is questionable, consideration of their use must be deferred until operation of the project has established their availability and suitability for irrigation purposes.

36. The quality of water for the project is classed as "good" for irrigation, with percentages of harmful salts being well within acceptable limits if proper drainage is provided.

37. Studies show that possible sources of groundwater suitable for irrigation and for public supplies are very limited. There are only a few small areas which now obtain water from wells for these purposes, and future supplies from this source appear relatively unimportant.

38. It is contemplated that rights to the waters for use of the project will be obtained through storage of flood waters in the International reservoirs, combined with existing rights held by the present districts. Vested rights along the stream have never been judicially determined. The Texas State Board of Water Engineers over a period of years has accepted applications and issued permits for the appropriation of non-riparian waters of the Rio Grande. Few of these permits have been cancelled, although in most cases only a part or frequently none of the water granted has been put to beneficial use. The irrigation districts through their representative have indicated a willingness to include in their repayment contracts with the United States a provision to effect pooling of their vested water rights, such as they might be, and to accept in lieu thereof an allocation of project waters.

NEED FOR DEVELOPMENT

39. The need for works which will provide an adequate and dependable water supply for the fertile and highly developed Valley has long been recognized. There is need for a development which will permit abandonment of the present method of pumping water from the Rio Grande, which is costly and also is uncertain due to the normal meanderings and flood hazards of the river. Also there is a need for additional water supplies for the Valley to permit its continued economic development.

40. Authorization by Congress of the Project No. 5 plan was recognition of these needs and of their concern to the nation as a whole. The International Treaty authorized storage reservoirs which, by regulation of flows of the Rio Grande, would create an additional water supply for the Valley. However, location of the storage reservoirs require the project works to make the additional water available to the Valley and to avoid the channel losses and wasting of water to the Gulf that would result from continuation of the present method of pumping from the Rio Grande.

41. The topography and soils of the Valley make drainage of the project lands imperative to permit continued productive use of those lands under irrigation. This need is urgent. Many orchards and other highly productive areas have already suffered considerable losses due to high water tables and increasing salt accumulations and are threatened with essentially total destruction unless relief is provided. Efforts have been made by the local interests to provide drainage relief for the most seriously threatened areas, but due to the complexity of the problem, such efforts have proved inadequate primarily because of lack of works to provide drainage outlets for the project area. These works are vitally needed.

42. Additional recreational opportunities, such as would be provided through the Fish and Wildlife and recreational uses of the project works are needed throughout the Valley. The game refuges in the area which are important units in the plan of the Fish and Wildlife service for preservation of

the national and local wildlife are also in need of additional water supplies to increase the capacities of the refuges.

43. Continued industrial growth of the Valley will require increasing amounts of electrical energy. Therefore any saving in power consumption or further production of electrical energy which can be economically effected is needed to further development of the area.

PLAN OF DEVELOPMENT

44. The Valley Gravity Project plan of development provides for furnishing an adequate and dependable water supply to an area of 700,000 acres of which 552,000 acres are now being irrigated, and 148,000 acres are new, undeveloped lands. The latter consist of 75,412 acres within the district boundaries, and 72,588 acres outside of the districts. The project plan contemplates conveying stored waters from the proposed Falcon Reservoir to the project area through a concrete-lined gravity canal system. This would eliminate the need for the existing river pumps, a majority of the second lift pumps and some third lift pumps. The plan contemplates that delivery from the project canals to the presently developed lands would be made through the existing distribution systems, and that these systems would be extended by the districts to serve the new lands within the districts. The plan also provides an irrigation distribution system and a lateral drainage system for the new lands outside of the districts. The plan includes the Mission Reservoir, near the west side of the project for regulating irrigation releases from the Falcon Reservoir. Another major feature of the project plan is the system of outlet drains required for the project lands. The project plan also provides for construction of a power plant at a drop in the canal line at La Joya Creek. The Mission Reservoir and the outlet drains would also serve fish and wildlife and recreational purposes.

45. The main canal from the Falcon Reservoir to the west side of the project would be 72 miles long and would have a capacity of 4,500 second feet. The canal would terminate at the Mission Reservoir. Branch canals, varying in capacity from 2,300 to 149 second feet would extend eastward through the project to serve the districts' main canals. The main and branch canals would total 239 miles in length.

46. The Mission Reservoir would have a total capacity of 65,000 acre-feet, consisting of 50,000 acre-feet for regulation of irrigation releases and 15,000 acre-feet for fish and wildlife and recreational purposes.

47. The project plan provides for construction of eleven outlet drains. Future extentions of those drains may be required but the system is considered adequate to provide early relief to the project lands. The outlet drains would dispose of normal drainage return flows and would have sufficient capacities to permit removal of most storm waters. The drains would have a combined length of approximately 290 miles.

48. The irrigation distribution system for the new lands outside of the districts would be concrete-lined. The drainage system for those lands will consist of laterals at one-half mile intervals. The plan contemplates that the necessary development work for those lands including clearing,

construction of farm ditches, leveling, farm drainage and improvements, would be performed by the land owners.

49. The La Joya power plant would have a capacity of 12,000 kilowatts and would utilize an 80 foot drop in the main canal near La Joya Creek. A short transmission line would be provided. The annual power output of this plantis estimated at about 74,700,000 kilowatt hours. The plan provides for coordination of the La Joya Plant with the hydroelectric plants at the International dams in the interest of efficient operation.

50. The plan contemplates a 10-year development period to permit the districts to effect reconstruction and improvement of their irrigation and drainage facilities so as to permit most efficient utilization of the project works. During this period, the necessary development work for the new lands would be completed and changes in the irrigated area to include the more desirable lands would be accomplished.

ESTIMATED DEVELOPMENT COSTS

51. Estimated cost of the project works as summarized below is $129,628,000. The estimate is based on 1947 prices, but the costs might be more or less at time of construction.

Feature	Estimated 1947 Cost
Examination and surveys	$ 1,300,000
Canal system	84,119,000
Main drains	20,058,000
Mission reservoir	6,469,000
Lateral system for new lands	6,170,000
Lateral drains for new lands	2,702,000
La Joya power plant and transmission line	2,560,000
Irrigable area determinations and classification of lands	750,000
Permanent improvements	1,500,000
Temporary camp and headquarters	500,000
Operation and maintenance during construction	3,500,000
Total	$129,628,000

SCHEDULE OF CONSTRUCTION AND DEVELOPMENT

52. All work is scheduled for completion by the time the first International Storage Dam (Falcon) is finished. Under the terms of the Treaty, this dam is to be finished within eight years from the time the Treaty was ratified. This would require its completion by November 1953, which would also be the desired time for completion of the Valley Gravity Project.

53. The volume of work on the project is such that at least 5 full years should be allowed for construction. This will require purchase of rights of way, issuance of specifications, and award of initial contracts and commencement of construction by 1949.

54. It will be necessary for the individual districts to reconstruct some canals and drains and to build new drains to connect with the Bureau's outlet system. Also additional irrigation and drainage facilities must be provided to new lands within the boundaries of the districts. This work would be performed in the 10 year development period, 1954 to 1963, during which time the districts would also be able to reduce their present bonded indebtedness and would be required to pay only the Bureau operation and maintenance charges. Repayment of construction costs would start in 1964. The new lands outside the districts will require the same development period in order for the land owners to clear and level the land, construct farm ditches, provide buildings, and otherwise prepare for irrigation farming.

ANNUAL COSTS AND BENEFITS

55. The following economic analysis is presented for convenience in appraising the over-all economic justification of the project.

Annual Operation and Maintenance Costs

56. The annual cost of operating and maintaining the project works is estimated at $907,700 annually on the basis of anticipated long-time prices and conditions. This includes $630,000 for the canals, outlet drains, and Mission Reservoir, $195,000 for facilities provided solely for new lands outside the districts, and $82,700 for the La Joya power plant. These costs either might increase or decrease by the time construction is completed and the project placed in operation. However, fluctuations in crop returns and any future increase in these costs should not reflect a decrease in the ability to repay construction costs.

Project Benefits

57. Benefits from the irrigation facilities to be provided under the project plan consist of savings to the present districts in pumping and other operation and maintenance costs and the increased returns resultant from development of new lands. The saving in pumping and other operation and maintenance costs assignable to elimination of the river pumps and some second and third lift pumps would average $801,000 annually. It is estimated that, on the basis of 1939-44 prices, the average annual gross crop returns from project lands, after construction of the project works, would be $242 per acre for Class 1 lands, $161 for Class 2 lands, and $90 for Class 3 lands. Applying these values to the 148,000 acres of new lands to be served by the project indicates an annual benefit of $29,517,000.

58. Benefits to be derived from the project drainage system are measured by increased gross crop returns resulting from improvement and protection of the productivity of the presently developed lands. The drains also have some benefits for flood control and for fish and wildlife conservation.

59. Approximately 94,500 acres of lands in the project have a water table sufficiently near the surface to restrict production of these lands to low value crops. Construction of adequate drains will lower the water table on these lands and permit a more diversified crop production. There

are also about 22,500 acres which can be put into a higher productive class with adequate drainage system. The proportional part of the benefits assignable to the outlet drains for making possible such increased crop returns is estimated at an annual average of $1,484,000. Benefits derived from protection of the present crop income are represented by the difference between present gross annual crop returns and returns that can be expected if drainage works are not provided. For the present irrigated area of 552,000 acres, this annual protective value is estimated at a total of $3,936,000.

60. The outlet drains will afford limited flood control for the area by removal of storm waters. The annual flood control benefits of the drains for such protection have been tentatively estimated at $95,400. Detailed studies of the flood control benefits assignable to the project are being made by the Corps of Engineers. It is considered probable that those studies will indicate benefits considerably in excess of $95,400 annually. The drains will also have benefits to fish and wildlife conservation estimated at an annual average of $21,700. In addition, they will make possible the delivery of 41,000 acre-feet of water to two game refuges in the area. This water is estimated to have an annual value of $41,000, bringing the total benefits for fish and wildlife conservation of the drains to $62,700.

61. Benefits from the La Joya power plant were taken only as the cost of the power facilities, $182,000 annually, inasmuch as disposition of the energy produced at the plant was not certain. The estimate of 4 mills as the average value per kilowatt hour at the market of the saleable energy was based on the assumption that the dependable capacity of the La Joya plant would be equal to the installed capacity. This would be true only if La Joya is a part of a coordinated power and transmission system which would include power plants at the international dams and full credit for the installed plant capacity as "dependable capacity" could be given to La Joya. This can only be determined in a future over-all study which includes all power developed at the international dams. Since the annual revenue required to repay the La Joya power cost is approximately $182,000 as compared with an estimated revenue of $298,800 on an estimated average 4 mill/kwhr value, it is assumed the power development can be justified. If later studies indicate this is not the case, the power development can be omitted without affecting the rest of the project since power is not bearing any other than power costs.

62. Annual benefits of the Mission Reservoir are estimated at $20,200 and $39,980 for fish and wildlife conservation and for recreational purposes, respectively.

Summary of Costs and Benefits

63. The costs of the project have been converted to an annual basis for comparison with annual benefits. A summary of the estimated costs, the annual costs and benefits, and the cost-benefit ratio follows:

SUMMARY OF COSTS AND BENEFITS

First Costs		
Construction of project works		
All other than power facilities	$127,068,000	
Power facilities	2,560,000	$129,628,000
Land development (by landowners)		52,291,000
Total first costs		$181,919,000
Annual Costs		
Amortization of first costs (50 yrs. at 3%)		
All other than power facilities	$ 6,972,000	
Power facilities	99,000	$ 7,071,000
Operation and maintenance		
All other than power facilities	$ 825,000	
Power facilities	83,000	908,000
Total annual costs		$ 7,979,000
Annual Benefits		
Irrigation		
Increase in gross crop returns	$ 29,517,000	
Reduction in present districts costs	801,000	$ 30,318,000
Drainage		
Protection of present income	$ 3,936,000	
Increase in gross crop returns	1,484,000	
Flood control	95,000	
Fish and wildlife conservation	63,000	5,578,000
Mission Reservoir		
Fish and wildlife conservation	$ 20,000	
Recreation	40,000	60,000
Power		182,000
Total annual benefits		$ 36,138,000
Ratio annual costs to benefits =		1 to 4.53

Extended Benefits

64. Numerous benefits which do not lend themselves to a monetary evaluation would accrue from the project. Some of these are included in the evaluated benefits inasmuch as the gross crop income was used as a measure of all benefits.

65. Future developments in Mexico are now being planned which would divert water from the Rio Grande several miles upstream from Reynosa. Substantially all of the lands now being irrigated on the United States side of the river in the Valley obtain water by pumping below this diversion site. As the project plan provides for diversion at the Falcon Reservoir, it would insure the availability of the project water supply. It would also eliminate the possibility of any international or local controversies over rights to the project waters such as normally arise in connection with attempts to deliver stored water over long distances through natural river channels comparable to that of the Rio Grande below the Falcon Dam site.

66. As under the project plan, water would be delivered to the project by gravity, considerable amounts of electrical energy which otherwise would be required for pumping would be available for industrial and other purposes in the Valley. The availability of such energy should be conducive towards further industrial development and result in increased income to the area.

67. The principal water supply for most of the cities and towns of the Valley is obtained through the districts' canal systems. The plan of development would not change this arrangement. However, the project plan will provide a dependable delivery system for water stored in the Falcon Reservoir, and permit the delivery of water of good quality, substantially free of silt, sediment, and algae, to the districts' canals for distribution to the various urban areas.

68. The main drains through lateral extensions to the towns, will provide outlets which could be conveniently used for sewage and storm water disposal. General improvement of sanitary conditions in the Valley should result from the drainage construction.

69. Construction of the project would create an immediate requirement for construction equipment and an increased need for agricultural equipment and other manufactured products. Considerable employment in construction work also would be provided.

70. The established incomes resulting from the project would permit establishment of permanent homes and minimize future needs for relief activities in the project and surrounding areas.

71. The project would afford an opportunity for development of 3,800 new farming units and these, together with the increased values of established farms and greater incomes, would increase tax revenues which would permit development of better schools, roads and other community facilities.

REPAYMENT AND COST ALLOCATION

72. It was determined from economic studies that the amounts the landowners could pay to meet all water costs would vary with the classes of land

to be irrigated, as follows: Class 1 - $16.79 per acre, Class 2 - $10.83, and Class 3 - $6.36. The ability of each district or area to pay all water costs was established by applying these values to the acreages of the various classes of lands within such unit. Weighted values per acre were obtained ranging from $7.42 for units with a proportionately large amount of Class 3 land to $15.84 where the land is principally Class 1. The units own water and other charges and project operation and maintenance charges were considered in determining the amounts which could be applied to repay project construction costs. For the new lands outside the districts, only the project operation and maintenance costs were deducted.

73. The present annual charges assessed in each district vary. In estimating the future charges for each district, allowances were made for retirement of bonded indebtedness and for necessary new construction or rehabilitation of the irrigation and drainage systems. Savings in pumping and other operation and maintenance costs to be effected by the project construction were also considered. On this basis, the district water costs after construction were determined to range generally from about $6.50 to $8.50 per acre. The project operation and maintenance charges were estimated at $0.90 per acre for lands within the districts and $3.59 per acre for new lands outside the districts.

74. Using the above, it was determined that certain of the districts could repay up to $6.59 per acre annually on construction charges, while five of the districts would be able to make only negligible payments on construction charges unless some special assistance should be given them. The repayment ability of the new lands outside of the districts was determined to be $11.22 per acre annually.

75. Consequently, it was considered desirable that apportionment of construction costs to the project lands be made on the basis of their relative productivity, with the additional costs of the project works provided solely for the new lands outside of the districts to be borne by these lands. This would result in the entire reimbursable construction cost of the common works being charged against the 610,647 acres of class 1, 2 and 3 lands. There are now being irrigated about 89,000 acres of class 5 and 6 land which, under sustained irrigation, would not be able to meet water costs. However, these lands are considered to have a right to water and are included in the plan of development. The plan provides that charges for water supplied to class 5 and 6 lands would be sufficient to cover operation and maintenance costs and, in addition, would provide a small construction component. In the future, if the class 5 and 6 lands are retired, additional water supplies would then be available for irrigation of higher class lands.

76. Tentative allocations of costs on the basis of benefits indicate $3,816,000 and $3,316,000 could reasonably be assigned to flood control and fish and wildlife purposes as non-reimbursable costs to be borne by the Federal government. Should authority be granted for allocation of costs to recreation as a Federal benefit, an additional allocation of $1,600,000 could reasonably be made thereto. Though it is recognized that benefits assignable to the power facilities provided under the project plan would justify an allocation of construction cost thereto considerably in excess of the costs of such facilities, for purposes of analysis of the project repayment capacity, the allocation to power was considered to be only the cost of the facilities or $2,560,000. In addition, it is expected that $1,000,000 of the

total cost will be returned as collections for operation and maintenance during construction, and as credits for rent and salvage value of temporary camps and buildings. On the basis of the above, the reimbursable costs assignable to irrigation and drainage would be $117,336,000.

77. It is estimated that the project lands would be able to repay on the project construction costs about $2,665,000 annually. If no district paid more than its allocated portion of the project costs, the project lands would be able to repay about $96,661,000 over a 40-year period or 82 percent of the total cost assignable to irrigation and drainage. Excluding the new lands, an average of 64 years would be required for the districts to repay their share or 100 percent of construction costs.

78. The amount the districts have available to pay project construction charges could be increased by the Federal Government acquiring the callable bonds of the districts and performing the needed rehabilitation and improvement work within the districts. With this assistance, the five districts which cannot repay construction charges would no doubt make appreciable payments and those districts, nine in number, which require more than the average of 64 years to repay their costs would be better able to repay their costs in the average period. Additional studies and cooperation of the local interests to affect acquisition of the bonds and formulation of jointly satisfactory plans for the needed improvement or rehabilitation work would be required. Such general agreements could probably be worked out prior to final approval of the repayment contracts or as supplemental contracts with the individual districts.

AGENCIES TO CONTRACT WITH THE UNITED STATES

79. The existing districts are organized under the laws of the State of Texas and are empowered to make contracts with the United States Government in pursuance of the Federal Reclamation Laws. Owing to the large number of districts and independent operators, it would be desirable for all lands of the project to be organized into a public corporation or corporations for the purpose of contracting with the United States. The most preferable type of organization appears to be a single large water improvement district, or water power control district, either of which could be organized under State Laws.

CONCLUSIONS

80. The present method of obtaining water supply is costly. Not only must the project lands bear continuing pumping costs but, because of the high silt burden and meandering of the stream, silt removal and other maintenance costs are also high.

81. Present diversion system, which involves passage of flows through the Rio Grande channel to numerous pumping plants, results in excessive seepage, evaporation and transpiration losses and does not permit complete diversion of the flow of the river. Much water now wastes into the Gulf. Even with adequate main stream storage, these losses and waste would limit development within the Valley to about the area now irrigated, which is far below the potential area of development.

82. Flows of the Rio Grande at the Falcon storage damsite in excess of vested upstream rights, combined with existing rights of the present districts, when regulated by the Falcon Reservoir, would furnish an adequate water supply for the present project lands and sufficient additional supply, if properly utilized, to permit the development of 148,000 acres of new lands.

83. The inadequacy of present drainage ways presents a serious threat to continued productiveness of the existing development. These conditions, if continued, would cause abandonment of large areas and affect the overall economy of the entire area. The provision of adequate drainage both surface and subsurface has been shown to be physically possible at a reasonable cost for the arable lands. This is evidenced by the ground water levels found where the Arroyo Colorado and other facilities provides drainage and by the leaching accomplished by artificial drains in some of the irrigated areas. The main outlet drains supplemented by sufficient laterals and farm drains will prevent injuriously high water tables and salt accumulations.

84. Construction of the Valley Gravity Project as herein outlined would eliminate the present diversion hazards and silt problems. It would permit a material saving of water by reducing the channel losses below the Falcon damsite and by eliminating the diversion wastes. By effecting these savings, it would permit maximum utilization of the water resources available and provide for development of 148,000 acres of new lands. The plan also provides needed drainage relief for the presently deteriorated and threatened lands, and an adequate drainage system for the new lands.

85. The cost of the project works based on 1947 unit prices has been estimated at $129,628,000, of which $1,000,000 would be returned by collections during construction. The balance could reasonably be allocated as follows:

Purpose	Cost
Irrigation and drainage	$117,336,000
Flood control	3,816,000
Fish and wildlife	3,316,000
Recreation	1,600,000
Power	2,560,000
Total	$128,628,000

86. The average annual ability of the project to repay construction charges is $4.36 per acre. The project lands over 40 years would be able to repay about $96,661,000 or 82 percent of the construction costs chargeable to irrigation and drainage. If it should prove feasible for the Federal Government to acquire the callable bonds of the districts and to perform needed rehabilitation and improvement work within the districts, their capacity to repay construction charges would be increased.

87. The plan of development is justified economically by the benefits to the area, the surrounding region and the nation. The ratio of estimated costs to measurable benefits is 1 to 4.53.

88. The people of the area have evidenced their desire for the project. The plan is consistent with presently conceived plan of development for the remainder of the Rio Grande Basin.

RECOMMENDATIONS

89. It is recommended:

(a) That the plan of development, as described in this report, be approved.

(b) That the authorization for Federal Project No. 5 contained in Act of Congress dated June 28, 1941, be amended to authorize the following principal units, and such related works as may be incidental thereto, constituting the Valley Gravity Project to be constructed, operated and maintained by the Bureau of Reclamation, Department of the Interior, substantially in accordance with the plan set forth in this report, with such modifications, omissions or additions to the works as the Commissioner of Reclamation, with the approval of the Secretary of the Interior, may find proper for carrying out the project to the end of providing water for the irrigation of approximately 700,000 acres of land in the areas indicated in this report.

(1) Canal system
(2) Outlet drains
(3) Irrigation laterals and lateral drains for proposed new lands outside of existing districts
(4) Mission regulating reservoir
(5) La Joya power plant

(c) That said Valley Gravity Project, Texas, be constructed, operated and maintained in accordance with Federal Reclamation Laws (Act of June 17, 1902, 32 Stat. 388 and acts amendatory thereof or supplementary thereto.)

Provided:

(1) That this report shall be deemed to satisfy the requirements of the Federal Reclamation Laws regarding engineering feasibility;

(2) That the water users be required, by contract with the United States, to pay, during the useful life of the project and at the maximum rate which in the judgment of the Secretary they can reasonably be expected to pay that part of the estimated construction costs of the project chargeable to irrigation and drainage; and that, during the period of contract with the United States, they shall pay for or otherwise provide adequate operation and maintenance, including replacements, of project works.

Wesley R. Nelson

Attachments -
Substantiating Materials

SUBSTANTIATING MATERIALS

Report of the
BUREAU OF RECLAMATION

VALLEY GRAVITY PROJECT, TEXAS

MAY 1947

GENERAL

Description of Area

Location of Project Area

The Valley Gravity Project of Texas is located at the lower end of the Rio Grande Basin. It is situated in the southernmost part of the state, being bounded on the east by the Gulf of Mexico and on the south by the Rio Grande which forms the international boundary between the United States and Mexico. The project area includes parts of Cameron, Willacy, Hidalgo, and Starr Counties. The main body of the project area is included in a section about 70 miles long and 30 miles wide, as shown on the General Project Map.

This area, which is a rich agricultural region, is widely known as the Lower Rio Grande Valley and is called "The Valley" by most Texans. For convenience and because they are widely used, the names, Lower Rio Grande Valley or the Valley, will be used occasionally in this report when reference is made to the project area.

Physical Features

The Lower Rio Grande Basin includes the area from Fort Quitman, Texas to the Gulf of Mexico. In this section the river flows, first in deep canyons through a region of high plateaus, then through a rolling hill country until, at a point about 80 miles from the Gulf it enters the delta region known as the Lower Rio Grande Valley.

The project area is largely composed of the alluvial delta and a section of the adjoining coastal plain, but a small area, at the west end, extends into the rolling hill section.

The delta region is a comparatively flat plain with a gentle slope to the northeast, away from the river and toward the Gulf. In its natural state, it is covered with low brush and has few prounounced surface features. Because of surface characteristics and topographical features the area may be divided into three divisions; first, second, and third bench lands.

The first bench is the delta of the Rio Grande which extends eastward from a point near Penitas. From McAllen to Weslaco it averages from 6 to 7 miles in width; near Mercedes it fans out to the north and merges into the coastal plain. In the upper reaches the first bench is separated from the second by a well defined escarpment about 25 feet high which gradually disappears near Mercedes. The first bench is traversed by many old river channels. In the upper Valley, these are long, shallow depressions but east of Mercedes they are prominent topographic features. They are usually long, narrow lakes with high ridges along the banks, locally termed "resacas" the area between the channels is usually low without drainage outlets. This condition has made it necessary to construct canals with high banks across these low areas to irrigate the ridges along the channels. The Arroyo Colorado, a deeply eroded channel, is the only important watercourse in the project area and extends about 50 miles in a northeasterly direction from a point near Mercedes to the Gulf.

The second bench lies above the escarpment to the north of the first bench and extends west from a point near Mercedes. The surface is either flat or slightly undulating with a general slope to the northeast. There are many depressed areas without outlets for surface drainage.

The land to the north and west of Mission rises rapidly, forming a third bench which slopes to the east. The topography becomes more rolling to the northwest. This section contains some of the highest land in the project area which reaches an elevation of approximately 250 feet above sea level.

In Starr County the surface presents a different type of topography than that found in the lower plain. The terraced river bottom land has an average width of about three miles and north of this is an eroded upland region with alternating ridges and creek bottoms.

Climate of Area

The climate of the project area is semi-tropical and semi-arid. The mild temperatures are favorable for intensive agricultural practices throughout the year, the most important of which is the production of citrus fruits and winter vegetables.

At Brownsville the mean annual temperature is about 73 degrees Fahrenheit, the average temperatures for January and August being 61 degrees and 84 degrees respectively. The extreme maximum of record is 104 degrees and the minimum is 12 degrees. The average temperatures are about the same at Mission, near the west side of the area. However, the range between maximum and minimum temperatures is slightly greater at Mission than at Brownsville. The average frost free growing season ranges from 330 days at Brownsville to 310 days near the west end of the project area. Although frost has frequently been responsible for minor damage to crops, in most years the more susceptible vegetables are the only crops affected.

The average annual precipitation ranges from about 31 inches at Brownsville to 21 inches at Mission with a weighted average of 26 inches for the project area. Irrigation is continuous throughout the year and must be utilized to produce citrus fruits and vegetables, although some cotton and forage may be grown without irrigation during years when rainfall is normal or above. The heavy irrigation demand usually comes at the season of least rainfall. There are two periods of heaviest rainfall, May--June and September--October, with much of the precipitation occurring as heavy downpours; a rainfall of 5 inches in 24 hours is not uncommon.

The prevailing wind during most of the year is from the southeast. During the winter, cold winds occasionally blow from the north. The Lower Rio Grande Valley is situated in the region that is subject to tropical hurricanes that originate in the Gulf of Mexico. On August 4, 1933, and September 4 and 5, 1933, hurricanes swept the Valley. These are the only hurricanes that have crossed the Valley in recent years.

History and Settlement

Although one Spanish expedition had visited the mouth of the Rio Grande about 1520, the Lower Rio Grande Valley was largely an unexplored region until the middle of the 18th century. In the year 1749, permanent settlements were established along the south bank of the river at Reynosa and Camargo by the Spanish Crown and within a few years land grants were made and settlement was extended to the north bank. These small, isolated communities expanded slowly as they were governed successively by Spain and Mexico. The treaty following the Mexican War established the Rio Grande as the international boundary and the project area became a part of the United States.

About 1846, Brownsville was established and steamboat transportation was started on the Lower Rio Grande. During the Civil War, trade and commerce in the Lower Valley were greatly stimulated when ports on the Mexican side of the river became the principal outlets for cotton from the Confederate States.

From the time of the first settlement until 1876, the economy of the area was based on open range livestock production and subsistence farming of small tracts along the Rio Grande. In 1876, the first irrigation development was started when a small pump was installed to irrigate sugar cane on a plantation about 10 miles below Brownsville. However, there was little change in the economy of the area during the next two decades.

In 1904, the St. Louis, Brownsville, and Mexico Railroad was completed to Brownsville. This event had a great influence on the development of the area as the railroad provided, for the first time, rapid and easy transportation to the Lower Rio Grande Valley.

Numerous companies were soon formed for the development and sale of irrigated land. For a number of years the emphasis was on the sale of land for vegetable production but later the promoters subdivided the land into small tracts and planted it to citrus orchards. The first plantings of citrus were made about 1907, with commercial production starting about 1917. Great energy and ingenuity were shown in the sales campaigns of the land companies. They brought many prospective buyers to the Valley from northern states. The mild weather, flourishing citrus groves, and profusion of flowers in mid-winter proved irrestible to many people and land was usually sold at inflated prices.

Population

The Counties of Cameron, Hidalgo, Starr, and Willacy had a combined population in 1940 of 215,803. The area of these counties totals 4,226 square miles; however, practically all of the inhabitants lived within the gross project area which is less than one-half of the total area of the counties. The total population of the Lower Rio Grande Valley in 1946 was estimated, by newspapers and other organizations, to be 268,000. This is an increase of approximately 52,000 in six years.

There has been a steady increase in the population since good transportation facilities became available and irrigation was started near the beginning of the century. The growth of population is indicated in the following table:

Year	Population	Increase over Previous Decade
1890	20,958*	
1900	22,932*	1,974
1910	40,886*	17,954
1920	85,861	44,975
1930	176,452	90,591
1940	215,803	39,351

* Figure does not include population of Starr County.

The large increases in population before 1930 were due principally to the rapid development of citrus orchards and the increase in vegetable production. During the depression years from 1930--1940, the demand for citrus fruits and winter vegetables declined; consequently the incentive for further agricultural development was removed and the rate of increase of population was greatly reduced. Although there has been some increase in population since 1930 due to agricultrual development, the principal gain has been due to the expansion in industries which process agricultural products.

The composition of the population in 1940 according to its origin was as follows: native white, 86.0 percent; foreign born white, 13.1 percent; negro, 0.8 percent; and others, 0.1 percent. Of the 28,245 foreign born white in 1940, 92.3 percent came from Mexico. Local authorities estimate that approximately 60 percent of the population is of Mexican descent.

Transportation

The most important factor, in addition to irrigation, in the development of the Lower Rio Grande Valley has been the transportation facilities which have permitted the economical marketing of Valley produce.

Today the Valley is served by all types of transportation and related facilities. Adequate paved highways from the area permit the shipment of produce by refrigerated truck and numerous regular truck services. The Southern Pacific and Missouri Pacific railroads provide regular freight and refrigerator as well as railway express service for the area. Rail entry through Brownsville provides an outlet for trade with Northern Mexico. Truck entry is provided by highways at Brownsville, Hidalgo and Roma.

Three major airlines have operation bases at the Brownsville Municipal Airport. A new airport at Weslaco also provides facilities for air line connections with San Antonio. Plans are now being made for air transportation of highly perishable produce to Northern and Eastern markets.

More than a score of steamship lines come into Port Brownsville and Port Isabel. Construction is under way to extend the Intracoastal Canal from Corpus Christi to Brownsville. A barge canal between Harlingen and Port Isabel which will connect with the Intracoastal Canal in the Laguna Madre, is substantially complete.

Markets

Marketing of crops producted in the Valley is accomplished through cooperatives and cash buyers. The cooperatives handle approximately 43 percent of the fresh citrus fruits and processed citrus juices. The fruit and juice are shipped to 37 states. The major part of the products are shipped to and sold at auction centers located in Chicago, St. Louis, Cincinnati, and Cleveland. Recently citrus fruit and processed juice have been shipped abroad to Great Britain, Sweden, and two provinces in Canada.

Vegetables are marketed for the most part through cash buyers; only two vegetable cooperatives are located in the Valley. The major markets are situated in the Middle West and in the northeastern states although some produce is shipped to all parts of the country.

Cotton is marketed through cash buyers and cooperative gins. There are eleven cooperative cotton gins which handle 30 percent of the crop. The cotton is compressed and shipped by rail, truck, and water transportation to all parts of the United States and to some foreign countries.

The local Valley market for citrus and vegetables is small in comparison to the quantity produced. The dairy and cattle enterprises located on the project and the adjacent area comprise a market for the feed crops and raw by-products of the citrus industry. The local market consumes all of the products of the dairy industry and the major part of the cattle raising enterprises.

It is expected that continued improvements in marketing organization and techniques will permit disposal of the increased quantity of Valley products resulting from addition of new lands to the project.

Banks and Banking

There are 24 banks operating in Hidalgo, Cameron, Starr and Willacy Counties, with deposits on December 31, 1945, of $107,090,847. Deposits ranged from $911,973 in the Los Fresnos Bank to $12,251,376 in the First National Bank of Harlingen.

Public Utilities

The Valley is served with electricity, municipal water supplies, gas (natural and butane), telephone and telegraph service, and local radio stations. Electric service is supplied by the Central Power and Light Co., to all municipal and some of the adjacent rural areas. The other rural areas, extending east from near Mission, are served by a project financed by the Rural Electrification Administration with headquarters at Mercedes. Municipal water supplies for domestic and industrial purposes are derived principally from the Rio Grande

through the irrigation districts. Each municipality is served by a water system operating a filtration and chlorination plant. A few of these are operated by the Central Power and Light Co. , but most of them are municipally operated. Extensive service of natural gas is offered by the Rio Grande Valley Natural Gas Co, to both urban and rural consumers. In areas where natural gas is not supplied, butane systems are prevalent and are becoming more numerous. Valley towns are all served by telephone and telegraph.

River Floodways

The Lower Rio Grande Flood Control Project being constructed by the United States Section of the International Boundary and Water Commission will provide protection for extensive areas of agricultural lands in Hidalgo, Cameron, and Willacy Counties that have been inundated by major floods from the Rio Grande. From 1903 through 1939, there were 23 floods in the Rio Grande at Rio Grande City with discharges greater than 60,000 second feet. The floods of 1919, 1920, and 1922 covered 319,000, 19,000 and 265,000 acres, respectively, in the Counties of Hidalgo, Cameron, and Willacy. After 1922 the counties began construction of flood levee systems which had the effect of reducing the areas flooded thereafter.

The original plan for flood control was developed by engineers of the Bureau of Reclamation in 1922. Since the problem was one of international character, the International Boundary Commission was authorized in 1930 to review the original plan, to develop an international plan of flood control and, later, to initiate construction of the project.

The present plan is based on the construction by the United States and Mexico of the works located on their respective sides of the river. The International Boundary and Water Commission project consists of a system of levees along both sides of the river and interior floodways which are designed to receive floodwaters in excess of the capacity of the river channel and to conduct them to the Gulf. The plan adopted in the United States closely follows that previously proposed. The plan of operation, designed for a maximum flood of 200,000 second-feet in the river at Penitas, calls for the diversion of 120,000 second-feet into the United States floodway, leaving 80,000 second-feet in the river immediately below; and the diversion of 50,000 second-feet into the Mexican floodways, leaving 30,000 second-feet to be carried by the Rio Grande into the Gulf.

The United States portion of the I.B.W.C. project, consisting of about 85 miles of levees along the Rio Grande, 200 miles of floodway levees, improvement of 145 miles of floodway channels and other incidental work, was approximately 73 percent complete in 1945. The levee system on the North Floodway, which is about 46 miles in length, has been completed.

The Arroyo Colorado, a natural drainage channel, is a part of the I.B.W.C. flood control project. It is also utilized as a main outlet for drainage water from agricultural lands and drainage from sewage treatment plants of the towns between Mission and Rio Hondo.

Agriculture and Industry

Irrigation Development

The earliest recorded irrigation in the Lower Rio Grande Valley was in 1876 when a small pump was installed on a plantation ten miles below Brownsville to irrigate sugar cane. Several other small pumps were installed along the river in the late eighties and early nineties. However, little progress was made until after the St. Louis, Brownsville, and Mexico Railroad to Brownsville was completed in July 1904, which afforded the opportunity for colonizers to enter the area and start land development. These men obtained options on large tracts of land with frontage on the river. The original title to the lands dates back to the time of Spanish occupation when the King of Spain made grants to the first settlers. The original grants had later been subdivided into smaller tracts or "Porciones" with river frontage from one-half to one mile wide and extending from the river ten to fifteen miles. The colonizers and promoters of these early irrigation districts obtained several "Porciones" or parts of a grant and the boundary of these subdivisions usually determined the boundary of the present districts.

Before irrigation works were started, declarations were filed in the office of the County Clerk stating the acreage to be irrigated, the quantity of water to be diverted, and the cross-sectional area of the supply canal. The descriptions of these features were generally vague; numerous discrepancies and overlappings of water filings occurred. After the land had been secured and water filing made, it was the general practice to employ engineers to subdivide the land and locate the canals and pumping plant. Canal construction was begun on land nearest the river and proceeded to the north as the land was sold. Because of the topography, the main canal was usually located near the west line of the tract and laterals were built to the east to serve blocks of 40 to 160 acres. The first canals extended only a few miles from the river and were built to serve lands immediately adjacent. As additional land was sold and the system expanded, higher fills and larger canals were required. As a result of such practices the earthen canals had large sections with very flat gradients when the canals were first constructed, losses by seepage were usually excessive. Several of these original unlined canals are still in operation, the largest being in the Mercedes district.

In this manner about twenty pumps were installed and irrigation systems started. The colonizers paid for the construction and operation of the systems by selling land and by charging the landowner for irrigation water. Development continued until about 1915, when many of the colonizers went bankrupt and were unable to continue operation of the systems. Pumping plants, canals, and structures were in poor condition and in order for the farmers to continue to obtain water, it became necessary for them to organize districts under state laws, vote and sell bonds, and buy the systems from the colonizers. The first organized district was established in 1914 and by 1920 only four privately owned systems remained. Of these, the United Irrigation Company is the only one now in existence. A later reorganization took place under new laws which gave the districts more latitude in issuing bonds. By 1933, a total of thirty-two districts had been organized under the Texas Statutes; in 1938, the same number were organized, but four had become inactive.

For a number of years there have been twenty-six active and six inactive districts in the Valley. As shown in Table 1, the gross area of these districts is 701,804 acres of which approximately 496,000 acres were irrigated in 1945. One new district has been recently organized and one old district is now extending its boundaries, the total increase in area amounting to approximately 28,000 acres. Fifteen of the districts have river pumps. These districts furnish water to the other eleven active districts and parts of six inactive districts in which some land is irrigated. Second lift pumps are required in all districts west of Adams Gardens, except Edinburg, and also in a few districts east of Adams Gardens. Third and fourth lift pumps are required in some areas at the northwest side of the Valley. In all of the districts several small relift pumps, stationary or portable, are required. In addition to these large systems, there are many small independent pumps in the project area, mostly along the river, which irrigated a total of 56,000 acres in 1945. A total of 552,000 acres was irrigated in the Valley in 1945.

Information obtained from the various districts discloses that they have a total of 1,484 miles of earthen canal, 930 miles of lined canal, 705 miles of concrete pipe line, 1,766 miles of open drain, and 46 miles of pipe drain. The present value of the irrigation and drainage works as carried on the books of the districts is approximately $31,000,000.

At present fifteen major pumping plants which are situated on the Rio Grande serve the irrigated area. Combined capacity of the plants is approximately 5,000 second-feet. Second, third, and fourth lift pumps are also required in certain districts. Total capacity of the second lift pumps is 2,600 second-feet and of the major third and fourth lift pumps combined is 360 second-feet. Location of the major plants is shown on the general project map.

The approximate irrigated area within the districts served under the various lifts for 1945 was as follows:

Served by the 1st lift	266,637 Acres
Served by the 2nd lift	191,740 Acres
Served by the 3rd lift	33,386 Acres
Served by the 4th lift	4,000 Acres
Total	495,763 Acres

Farms and Farmers

Available information indicates that the total rural farm population of the project is approximately 81,000 of which about 88 percent are native white. This figure includes those of Latin-American descent which comprise approximately 70 percent of the total farm population of the area. However, a large number of farm operators do not live on the land they operate, and the figure given is not a true estimate of the population which obtains its livelihood from farming operations

TABLE 1

EXISTING DEVELOPMENT
AREAS IN IRRIGATION DISTRICTS
AND SOURCE OF IRRIGATION WATER

No. on Map	District Name of District	Local Name	(1) Total Area Dist. Acres	(2) Area Irrig. 1945 Acres	Source of Irrigation Water
1	C.C.W.I.D. No. 1	Harlingen	47,542	34,410	River Pump
2	C.C.W.I.D. No. 2	San Benito	70,131	45,676	River Pump
3	C.C.W.I.D. No. 3	La Feria	32,982	27,433	River Pump
4	C.C.W.I.D. No. 4	Santa Maria	5,003	3,423	Mercedes
5	C.C.W.C.& I.D. No. 5	El Jardin	24,341	11,061	River Pump
6	C.C.W.C.& I.D. No. 6	Los Fresnos	38,343	15,365	River Pump
7	C.C.W.C.& I.D. No. 7	West Brownsville	2,677	712	River Pump (3)
8	C.C.W.C.& I.D. No. 8	*Barreda	11,076	4,074	Los Fresnos
9	H.& C.C.W.C.& I.D. No. 9	Mercedes	91,016	65,733	River Pump
10	C.C.W.I.D. No. 10	*Rutherford-Harding	7,173	810	Los Fresnos
11	C.C.W.I.D. No. 11	Bayview	11,250	4,086	Los Fresnos
12	C.C.W.I.D. No. 12	Kempner	1,135	631	Los Fresnos
13	C.C.W.I.D. No. 13	Arroyo Gardens	6,235	1,377	Los Fresnos
15	C.C.W.I.D. No. 15	McLeod-Hood	1,834	1,603	Harlingen and Drain
16	C.C.W.I.D. No. 16	Rice	2,203	645	Gravity from River and Drain
17	C.C.W.I.D. No. 17	*Sams-Porter	1,959	855	Rice
18	C.C.W.I.D. No. 18	*Monte Grande	3,803	886	San Benito and Resacas
19	C.C.W.C. & I.D. No. 19	Adams Gardens	9,713	8,147	River Pump
20	H.C.W.I.D. No. 1	Donna	41,978	27,456	River Pump
21	H.C.W.C. & I.D. No.1	Edinburg	37,261	33,611	River Pump
22	H.C.W.C. & I.D. No. 2	Pharr-San Juan	70,792	56,427	River Pump
23	H.C.W.C. & I.D. No. 3	McAllen	7,641	6,021	Pharr-San Juan
24	H.C.W.C. & I.D. No. 5	Progreso	6,500	5,418	River Pump
25	H.C.W.I.D. No. 6	Engleman Gardens	11,652	9,386	Donna and County Drain
26	H.C.W.C. & I.D. No. 6	Goodwin	23,629	21,178	River Pump
27	H.C.W.C. & I.D. No. 7	N. Mission	17,508	17,209	United
28	H.C.W.C. & I.D. No. 11	Bentsen	1,908	1,727	N. Mission and Edinburg
29	United Irrigation Co.	United	20,670	15,121	River Pump
30	Rio Bravo Canal Co.	*Rio Bravo	4,242	1,888	Pump from Wells and McAllen
31	La Gloria Canal Co.	*La Gloria	4,136	682	
33	H.C.W.C. & I.D. No. 13	Baptist Seminary	2,387	2,122	Edinburg and Drain
34	W.C.W.C. & I.D. No. 1	Willacy	83,084	70,590	River Pump
	Sub-Total - Present Districts		701,804	495,763	
	(2) Independents	Hidalgo Co.	20,663	20,663	Generally River Pumps
		Cameron Co.	25,244	25,244	River Pumps and Adjacent Districts
		Starr Co.	3,679	3,679	Generally River Pumps
		Willacy Co.	6,840	6,840	Adjacent Districts
	Sub-Total - Independents		56,426	56,426	
	Totals Present Development		758,230	552,189	
	New Dist. & Extension of Present Districts				
27	H.C.W.C. & I.D. No. 7	N. Mission	17,214	0	Not developed
35	H.C.W.C. & I.D. No. 15	Santa Cruz	10,464	375	Edinburg and Drain
			27,678	375	
	TOTALS		785,908	552,564	

(1) From table E - 4 Appendix Project Lands

(2) From Land Classification Survey Summaries

(3) City of Brownsville

* Inactive District

NOTE: Table does not include river pump for Port Isabel domestic water supply.

Investigations of the land ownership records of the local irrigation districts for 1943 revealed a total of 622.641 acres of land having 18,809 owners. The size of the typical farm in this area is less than 20 acres and is accounted for by the large number of small citrus holdings. Records of five of the most representative irrigation districts gave the following results as to type of ownership and size of holdings for the Valley:

Number of Acres	Resident	Non-resident	Number of Farms Percent of Total
40 or less	55%	45%	86
41 - 80	68%	32%	8
81 - 120	83%	17%	2
121 - 160	84%	16%	1
161 - 320	91%	9%	1
321 - 640	70%	30%	*
641 - 1280	91%	9%	*
Over 1280	57%	43%	*

* Less than 1%.

The large percentage of non-resident owners having 40 acres or less is an important segment in the economy of this area. This condition was brought about through the activities of land development organizations. Many owners did not purchase land in the Valley with the idea of forming a subsistence type of farmstead as is readily evidenced by the large number of small citrus groves. These groves were purchased as investments to supplement other income and have in general, been operated as such. The large number of absentee owners require. grove caretakers which accounts for a considerable part of tenancy in the area.

The land and buildings of all farms in the Valley, as shown in the 1940 Census, had a total value of approximately $62,000,000. About 80 percent of the farms are under irrigation. Census data for 1940 show the following values for irrigated farms:

	Average Value per: Farm*	Acre
Buildings	$ 996	$14.66
Land	6,732	99.15
Implements & Machinery	573	8.43
Total Investment	$8,301	$122.44

*Average size - 68 acres

The Valley labor supply is obtained from both domestic and alien sources. There are about 15,000 Mexican aliens in the Valley, but this number may change in the future due to strict immigration enforcement, fencing of the border or unionizing of all labor.

Excess Lands Investigations of land ownership records for 1944 reveal that 81 percent of the land in the present irrigation districts is held by owners who do not possess more than 160 acres of the paying Classes 1, 2, and 3. The land ownership in 1947 will doubtless vary somewhat from the 1944 records. However, the proportion of excess lands probably has not greatly changed. Of the 116,573 acres of excess lands in the present districts, 52,663 acres were held by 137 individuals. The remainder of lands held in excess of 160 acres were owned by corporations and companies, partnerships, estates, and by individuals in excess in more than one district.

Texas is a community property state which would permit a husband and wife to receive water for an ownership of 320 acres. Data are not available as to the marital status of landowners, however it may be assumed that a large number of these landowners are married which would reduce the area of excess lands substantially. Acreages in excess of 160 acres per individual owner could receive water providing recordable contracts were signed agreeing to disposal of such excess holdings within a reasonable period of time.

Substantially all lands outside of the present irrigation district, proposed for development as new lands are in holdings larger than 160 acres.

Crops and Crop Returns

Crop Distribution In 1944, the areas devoted to the production of each of the principal crops in the irrigated lands were as follows: citrus 27 percent, cotton 37 percent, and vegetables 36 percent. Cropping practices include an extensive system of double cropping of practically all vegetables. There is also some double cropping of vegetables with non-bearing trees. In some instances where double cropping is not practiced, a system of summer-fallow during the month of August is employed. Forage crops are of extreme importance in the dry land areas of the project but are not grown as extensively in the irrigated area. Grapefruit has been the principal citrus crop heretofore with oranges constituting a smaller part of the crop, the ratio of the two being five to one. However, the situation is changing with new plantings and the future citrus production of the Valley will doubtless have a much larger proportion of oranges. A wide variety of vegetables is grown in the Valley, with climatic conditions permitting production of a winter crop which usually finds a ready market.

Citrus Of first importance in this area is the citrus crop. The citrus industry in recent years has given special attention to markets, quality and varieties of fruit, and by-products. With a proper combination of these factors, which is now being obtained, it is anticipated that the citrus industry will continue to adequately support its share of the local economy. Approximately 43 percent of the citrus fruits are marketed through grower-owned and controlled organizations. In 1944 approximately 25,800,000 boxes of citrus valued at $40,160,000 were produced in the Valley.

Vegetables The principal vegetables grown in the area are tomatoes, cabbage, carrots, beets, potatoes, and green corn. Some fifteen other vegetables are also produced but usually in considerably smaller quantities. Many of these are specialty crops raised by individual growers for special shipment and have not proved economically sound for general production. The steady returns per acre for vegetables have been a stabilizing factor in comparison with other crops produced in the Valley. Experience has been

obtained on adaptation of various vegetables to the different classes of soil and proper cognizance taken thereof. Thus, farmers are producing early spring tomatoes on the light soils and fall tomatoes on the heavy soils. Other vegetables are similarly adapted. In 1944, 33,883 car load shipments of vegetables valued at $24,152,000 were made from the area.

Cotton The growing season of cotton in perfectly adapted to double cropping with vegetables, and it is one of the major crops produced under both dry land and irrigated farming in the Valley. Another important factor in the adaptation of cotton to this area has been a low water requirement, thereby allowing water conservation during times of shortages. Results of exhaustive experiments are reflected by the improved class of cotton produced and by the higher yields obtained in recent years. In 1944, approximately 95,000 bales of cotton valued at $12,134,000 were produced in the Lower Rio Grande Valley.

Forage Crops A considerable amount of research has been done at the Texas Agricultural Experiment Station to determine the kinds of sorghums that are adapted to the local soils and climate, and the varieties of clover and other legumes that are most profitable. There is also an active interest in the varieties of grass best adapted for cultivated pastures. Excellent yields of sorghum cane have been produced in the non-irrigated areas. Some corn is grown for livestock feed, but generally the production of forage crops has not received the attention warranted by the favorable climate and soils that exist in the area.

Crop Returns Crop returns for 1944 reveal an average gross income of $167 per acre for irrigated lands of the project area. The returns per acre were approximately $287 for citrus, $120 for vegetables, and $77 for cotton. It is expected that the yields now prevalent throughout the area will be sustained with project development. Anticipated income would then fluctuate only in accordance with unit price changes for commodities produced. As further development and settlement is made in the Valley, it is anticipated that subsistence type farming will require larger units than are now prevalent and will incorporate a better balanced cropping practice including livestock enterprises where adapted.

Livestock Production

The development of irrigation in the Valley forced the once prominent livestock industry into a minor position in the irrigated areas. However, it is the principal enterprise in the region which surrounds the project area. The importance of a balanced system of farming, which includes a livestock program, is gradually being realized and farmers desiring a more economic enterprise are doing much towards adopting a program of irrigated pasture and some type of livestock production.

The search for a breed of beef cattle that is entirely adaptable to this locality has caused lengthy and costly investigations. Herefords, Brahman, Shorthorn, and crosses of the Brahman and Shorthorn are the principal breeds of beef cattle in the Valley.

The Jersey has been well established in the Valley and is by far the predominating dairy breed. Neither milk nor dairy products are produced in the Valley in sufficient quantity to supply local needs, and supplemental shipments from other sources are required.

The area is also deficient in the production of poultry and eggs. Poultry production has apparently increased very little since 1943 and is not expanding in proportion to the increase in population.

Public Indebtedness

All lands within the project are subject to state, county, and school taxes. Various parts of the project area are also subject to one or more of the following special taxes: irrigation district, road district, drainage district, and navigation district.

The 1944 audit reports of Hidalgo and Cameron Counties and data from Willacy County showed that the three counties were in good financial condition. The property valuations for state and county taxes have a wide range in accordance with the productive ability of and improvements upon the land. The methods of assessing land valuations for taxation varies considerably between the counties.

The taxing body having the most effect on the agricultural operations in the project area is the irrigation district, of which there are two types: (1) districts formed under the Water Improvement District Act, and (2) districts either originally organized or subsequently reorganized under the Water Control and Improvement Act, the latter having the greater powers. Both types of districts, for the purpose of repaying bonds and other obligations, are required to levy taxes upon all property within the district subject to state and county taxation. These taxes are levied on an ad valorem basis. The charges made by the irrigation districts are classed as bond tax, flat rate, and toll charge. The bond tax is a charge based on an assessed valuation and an adopted tax rate to facilitate the amortization of the bonded indebtedness of the districts. The flat rate is a charge per acre of irrigable land to defray the cost of maintenance; the toll is an operation charge payable in advance for water for each irrigation on a per acre basis.

The bonded indebtedness of most irrigation districts reached a peak in 1932, after large sums of money had been borrowed from bonding companies and used both for construction of new projects and to remodel some of the older systems. During the ensuing years much of this indebtedness was defaulted, and the irrigation districts began refunding their bonds on the basis of 35 cents to 50 cents on the dollar with the assistance of the Reconstruction Finance Corporation. At the same time, land owners were given the opportunity to settle their delinquent tax indebtedness at about the same rate. New loans and grants were also made under the National Recovery Act, Works Progress Administration, and Public Works Administration, allowing the districts to do much needed maintenance and new construction. Due to the recent increased income of the land owners, the present financial condition of the districts is very favorable. The recent records of the districts show a high percentage of taxes paid.

Farm Mortgage Indebtedness

The increase in farm income during the past six years has greatly accelerated the liquidation of farm mortgage indebtedness. The large number of farms being sold for cash or for an appreciable cash payment with the remaining debt amortized over a short period has also been a determining factor in alleviating the situation.

Industries

The principal industries in the Valley are those dealing with the processing and marketing of citrus fruits and vegetables, both fresh and canned, and industries related to such enterprises.

In 1932, the Department of Agriculture established the Texas Citrus Products Station Laboratory at Weslaco. Seven pioneer canners were in operation at that time, packing beans, tomatoes, and spinach. This number has increased to more than forty firms at the present time which can and freeze a wide variety of food products. From experiments made at the Citrus Products Laboratory, profitable outlets for the increasing quantities of grapefruit culls were found through juice products. Methods were developed for preparing a grapefruit beverage base and for juice canning that resulted in a product which retained an excellent flavor for two years. The laboratory also developed methods for preparing grapefruit vinegar of excellent flavor, marmalades, marmalade bases, and grapefruit wine, and made considerable improvements in methods of canning grapefruit.

Vegetable canning activities have also expanded rapidly due to the fact that the South Texas season follows the Northern seasons, thus permitting adjustments of pack to supply shortages. The Texas Agricultural Experiment Station at Weslaco and the Citrus Products Laboratory made a comparative study of the growing, canning, and freezing of the principal vegetables produced in the Valley. The results of this study, made available to the local packers, assisted considerably in advancing this field of industry.

Development of marketing organizations for citrus fruits and vegetables has reached such proportions in the Valley that it is considered an industry. At present there are several grower-owned citrus marketing organizations, the largest of which is the Tex-Sun Citrus Exchange at Weslaco. This organization has ten affiliated member packing plants located throughout the Valley, and handles approximately 30 percent of the citrus fruit processed in the area. Besides the marketing of fresh fruit, a juice plant and dehydration plant are also operated. In the entire Valley there are approximately 258 firms and individual buyers that handle citrus fruit and vegetables. This includes the canning plants, packing plants, and buyers and shippers.

The industry supported by the production of cotton in the Valley consists of cotton gins, oil mills, and compresses. Protein feeds, hulls, fat, and linters are by-products of the cotton seed. The hulls and protein feeds have a ready local market in the livestock industry, while the linters and fat are sold to producers of finished and semi-finished products.

The petroleum industry is probably second in importance to agriculture. The first definite record of oil activity was in Starr County in 1910. In 1934, the first producing well was drilled in Hidalgo County. Since that time other discoveries have been made in Starr, Hidalgo, and Willacy Counties until there are now 26 oil fields and 8 gas and distillate fields in production. In 1945, there were 878 wells in the three counties which produced over ten million barrels of crude oil. There are five refineries and one recycling plant in operation. Most of the crude oil is piped to the ports of Brownsville and Port Isabel, and to refineries along the northern coastal area of the Gulf of Mexico, only a small part being consumed by local refineries.

In addition to the agricultural and petroleum industries in the Valley, there is also the commercial fishing industry out of Port Isabel which is extensive. The value of fish caught and shipped through commercial channels for the year ending April 1945 was $3,484,000. Approximately 200 licensed fishing boats operate out of Port Isabel during the shrimp season. Port Isabel also has a yacht harbor and is a center for pleasure boats.

Authorized Project

Report on Federal Project No. 5

In October 1938 the United States Section of the International Boundary Commission was authorized to investigate ways of relieving critical water shortages in the Lower Rio Grande Valley. The investigations to this end and the resulting plan for the Valley Gravity Canal and Storage Project were designated as Federal Project No. 5 in the report of January 1940.

The plan provided for serving 583,000 acres of lands which had been developed for irrigation and 132,000 acres of additional lands, a total of 715,000 acres, by diverting water from the Rio Grande into a canal at Rincon, about 8 miles upstream from Zapata. The diversion was to be made above a natural rock ledge extending across the river and would not have required a dam.

The water was to be carried in this canal 72 miles downstream to a reservoir at the Los Olmos Site, which would have a capacity of 315,000 acre-feet. There the water was to be dropped 85 feet through a power plant into a feeder canal. This canal was to carry the water 29 miles farther downstream to the Mission Reservoir, with a proposed capacity of 90,000 acre-feet. Below this reservoir the water would have been carried through a distribution canal 68 miles long. The course of this canal would have paralleled the river, intersecting the district main canals near the river pumps and diverting to the various district systems at those intersections.

This plan did not provide for water storage on the Rio Grande; storage was to be provided at Los Olmos Reservoir with supplemental storage on the Devils River or at other locations upstream. The estimated construction cost of the Project No. 5 plan was $59,643,000, on the basis of 1940 prices and conditions, which included $5,000,000 as the proportional share of supplemental storage.

Authorization

The Valley Gravity Canal and Storage Project, Texas, as originally authorized under Act of August 19, 1935, C. 561 (49 Stat. 660) and specifically under Interior Department Appropriations Act 1942 of June 28, 1941 (55 Stat. 303,331). This authorization was based on the Federal Project Report No. 5.

Funds Appropriated

The Interior Department Appropriations Act 1942 made available funds in the amount of $2,500,000:

> "For the completion of investigations and commencement of construction of the Valley Gravity Canal and Storage Project, Texas, in substantial compliance with the engineering plan described in a report dated February 3, 1940, entitled 'Report of Conference of Engineers to the American Commissioner, International Boundary Commission, United States and Mexico, on the Valley Gravity Canal and Storage Project (Federal Project Number 5)' and report appended thereto, $2,500,000, to be immediately available and to remain available until expended."

The Act provided for $250,000 of the above sum to be made available to the Secretary of State for continuing investigations of the project.

Interest of International Boundary (and Water) Commission

> "Jurisdiction of the construction and operation of the potential works along the Rio Grande by agencies of the United States is set forth in the appropriation act for the year ending June 30, 1942, which states in part that 'the Secretary of State, with the approval of the President, shall designate the features of the project which he deems international in character, and shall direct such changes in the general project plan which he deems advisable with respect to such features; and the features so designated shall be built, after consultation with the Bureau of Reclamation as to general design, by the American Section of the International Boundary (and Water) Commission, and shall be operated and maintained by said Commission insofar as their operation and maintenance is, in the opinion of the Secretary of State, necessary because of their national character.'"

The Secretary of State, on February 9, 1942, designated the following as international features: "All storage and diversion structures and their appurtenant works including canal heads and sluiceways, which may be built on the international boundary portion of the Rio Grande."

Other requirements are that:

1. "The works to be constructed or used on or along the boundary, and those to be constructed or used exclusively for the discharge of

treaty stipulations, shall be under the jurisdiction of the International Boundary (and Water) Commission or of the respective section, in accordance with the provisions of the treaty.

2. "The Bureau of Reclamation shall exercise or continue to exercise jurisdiction, and shall perform functions and construction, where new construction may be involved, and operation and maintenance, within the principles stated herein, as to facilities and works as follows:

   (a) "All facilities and works in the United States constituting the Valley Gravity Canal and Storage Project, as provided in the act of June 28, 1941, except those portions of the project designated by the Secretary of State, under the authority of the act, as being international in character.

   (b) "The International Boundary (and Water) Commission would consult with the Bureau of Reclamation relative to locations, plans and designs for construction, operation and maintenance of international storage dams and power plants, and distribution of power."

Treaty with Mexico

Allotment of Water

The Treaty between the United States and Mexico, relating to utilization of waters of the Colorado and Tijuana rivers and the Rio Grande from Fort Quitman, Texas, to the Gulf of Mexico, was ratified by the two nations and became effective November 8, 1945.

The application of the Treaty, the regulation and exercise of the rights and obligations of the two governments thereunder, were entrusted to the International Boundary and Water Commission.

The waters of the Rio Grande are allotted by article 4 of the Treaty as follows:

1. waters contributed to Rio Grande by Pecos and Devils Rivers, Goodenough Spring, and Alamito, Terlingua, San Felipe and Pinto Creeks, to the United States.

2. of waters contributed to Rio Grande by Rio Conchos, San Diego, San Rodrigo, Escondido, and Salado Rivers and the Las Vacas Arroya, one third but not less than an average, in any 5-year period, of 350,000 acre-feet annually, to the United States and the balance to Mexico.

3. all waters of San Juan and Alamo Rivers to Mexico.

4. of all other flows occurring in main channel of Rio Grande, including unmeasured tributaries not heretofore named, between Fort Quitman and Salinero (or Falcon); one-half to each country.

5. of Rio Grande flows below Salineno (or Falcon), not otherwise allotted, one-half to each country.

The location Salineno (or Falcon) above used is the site of the "lowest major international storage dam," the term used in the Treaty. Except as Mexico agrees to a 5-year progressive average delivery of 350,000 acre-feet annually from certain streams (item 2), neither nation is obligated to limit its uses of the water of any tributary before the same enters the Rio Grande. Neither is there any limitation on Rio Grande waters arriving at Fort Quitman.

Rio Grande Storage Reservoirs

The treaty provides further for construction of three storage dams on the Rio Grande and division of the water between the United States and Mexico, with construction, maintenance, and operation of international features to be under the jurisdiction of the International Boundary and Water Commission. The three dams are to be located in the following reaches of the river: between Santa Helena Canyon and the mouth of the Pecos River; in the section between Eagle Pass and Laredo, Texas; and between Laredo and Roma, Texas. The Treaty stipulates that the lowest dam shall be completed within a period of eight years from the effective date of the treaty.

Division of Power

The Treaty provides that plants which are constructed at the international dams for the generation of hydro-electric energy shall be operated and maintained jointly by the two governments. Each government shall pay half the cost of construction, operation and maintenance, and receive half of the energy generated.

PLAN OF DEVELOPMENT

Need for Revision of Original Plan

The authorized Project No. 5 plan did not contemplate early construction of storage dams on the Rio Grande and made provisions for diverting water from the river into a 72 mile long inlet canal heading at Rincon. The Los Olmos and Mission offstream reservoirs were to be constructed for storage and regulation of the project's water supply.

The Treaty between the United States and Mexico ratified in November 1945 provides for, among other things, allocation of the waters of the Rio Grande and construction of storage dams on the Rio Grande. These dams, particularly the Falcon or lowest dam downstream, would permit elimination of certain costly features of the Project No. 5 plan. The intake works at Rincon, the desilting basin, and approximately 35 miles of the inlet canal, all of which lie above the Falcon Damsite, would be eliminated. The Los Olmos Reservoir would not be required. The Falcon Dam is so situated that stored water can be diverted at the dam and conveyed in a canal to the project area.

In the Project No. 5 plan, only the river pumping plants would have been eliminated. Further studies by the Bureau of Reclamation indicated the desirability of providing works to eliminate most of the second lift pumping plants and several of the third lift pumps. With the river storage dams assured for construction and the waters of the Rio Grande allocated between the two countries, it became possible to plan for utilization of the United States' full share of such waters. The project plan makes such provisions and includes facilities for serving new lands. Also studies, subsequent to authorization of Project No. 5, disclosed an urgent need for outlet drains for the project lands.

Project Lands

Soils

The influence of the semi-arid climate of the Lower Rio Grande Valley on the soil-parent material resulted in the formation of soils with somewhat distinct physical and chemical properties, which in turn reflect on the adaptability of these soils for irrigation practices. The lands most suitable for sustained irrigation are, in general, located in the northern part of the project area, while lands with limited possibilities are, for the most part, found in the southern and eastern portions. The northern portion is composed of upland soils (second and third lift lands) while the southern part contains the alluvial soils of the Rio Grande Delta. The upland soils have been developed from light to medium textured calcareous material, chiefly marl, while the Delta soils have been developed from fine textured alluvial deposits of the Rio Grande.

The upland soils are extremely productive under irrigation, and except in areas of deficient drainage, are well suited for irrigation practices. The soils range in color from light to red. They usually absorb water readily and there is little runoff.

The alluvial soils are mostly dark to gray in color, calcareous, and contain relatively large amounts of organic matter. These soils are devoted principally to production of general farm and truck crops. Drainage condition of these soils is generally poor due to the relatively flat topography of the area and to the heavy types of subsoil.

A comparatively large area of semi-marshy soils occur as a fluviatile delta bordering the coast. The surface is practically flat, so that water stands for a long time after rains. The soils generally contain a rather high percentage of salt, and support a characteristic salt-lime vegetation.

Land Classification

Classification of the lands of the project was undertaken for the purpose of ascertaining the acreage of arable lands suitable for irrigation practices.

Lands termed arable are those with characteristics desirable for irrigation development, with all indications pointing toward sustained production after a prolonged period of irrigation. Included in this group are classes 1, 2, and 3. The non-arable, class 6 lands, are those which are too low in productive ability to produce sufficient revenue to meet the cost of irrigation assessment and also provide the farmers' subsistence. Class 5 lands were placed in this non-arable group inasmuch as they are subject to periodic flooding.

In rating the land and its adaptability for irrigation, special consideration is given to inherent soil qualities, expressed in such terms as: (a) character of soil profile; its depth; character of parent material from which the soil profile developed; the degree of modification of soil material by weathering, and its mode of formation, etc; (b) soil texture; (c) chemical properties of the soil which are expressed in terms of salinity or alkalinity; and (d) external and internal drainage. Other than the soil, the topography is the most important characteristic that influences land classification, particularly with respect to slope and surface. A deficiency of any one of these factors of soil or topography is a basis for grading land down into the next lower class.

Class 1 Lands. Class 1 or first quality lands include areas having those favorable physical and chemical properties of soil and subsoil which allow great diversification of crops, easy cultivation and management, and a very restricted or no drainage problem. These soils usually consist of friable material in both surface and subsoil, which favorable characteristics provide the most desirable conditions for growing crops. The absence or near absence of soluble salts, not only in the soil itself but also in the substratum (to a depth of 8 to 10 feet), contributes as well to the many favorable factors of these soils. Class 1 lands constitute 314,700 acres or 21 percent of the total surveyed area of 1,505,000 acres.

Class 2 Lands. Class 2 lands are those which are not as desirable or do not have the value of class 1 land for a variety of reasons, as: textures of subsoils, nature of substratum, topographical features, deficiency in external or internal drainage, etc. Usually, the tracts in this class,

under present irrigation practices, require more care and maintenance for a good irrigation status than those in class 1. The class 2 lands constitute 485,700 acres or 32 percent of the surveyed area.

Class 3 Lands. Class 3 lands consist of those areas which are now being cultivated or may have potential value for cultivation of certain shallow rooted truck crops, cotton, general farm crops, etc. These lands were placed in class 3 because of the following characteristics: heavy texture of soils (40 percent to 60 percent clay) necessitating the use of heavy machinery with sufficient power for their operations; restricted crop adaptation; unfavorable topographical position (land either level or slightly depressed); slow permeability of soil and subsoil especially where lateral water movement is concerned; and presence of soluble salts either in the soil column itself or in the underlying parent material, etc. In case of the presence of soluble salts, the content should not exceed 0.6 percent in the third foot of the soil profile, though in the fifth foot it may approach 1.0 percent limit. Class 3 lands total 150,100 acres or 10 percent of the surveyed area.

Class 5 Lands. Class 5 lands are those lands which are subject to periodic flood inundation because of their location between the river and constructed levees, in the floodway between the levees or at other locations which are not yet protected from floods. At the present time some tracts are in native brush and dry-farmed while others are under irrigation (water is pumped from the river by individuals or small independent companies). Because of the character of the soils, topography and drainage conditions, they are in general well adapted to irrigation practices. However, for the reason that they are subject to periodic floodings, these lands have been put in a non-arable class. Class 5 lands total 22,200 acres or 2 percent of the surveyed area.

Class 6 Lands. The class 6 lands, of relative low utility for irrigation farming, contain areas with very uneven topography, poor drainage, high salts content, heavy, very slowly permeable clays or other undesirable qualities. In this class are also included lands which are too high for delivery of water or small isolated areas which, due to their position, are not considered feasible in the development of farm units. Class 6 lands comprise a total of 457,000 acres or 30 percent of the surveyed area.

In addition to non-arable land shown in classes 5 and 6, a total of 75,300 acres of non-irrigable land or 5 percent of the total project area is included in rights-of-way for roads, railroad, canals and reservoir, towns, airports, resacas, etc. The total acreages surveyed of the arable and non-arable classes are summarized by counties in table 2, by districts in table 3. The acreage of arable land given in the summary represents the maximum possible under the present survey. The actual acreage would depend upon the location of the irrigation canals and laterals as well as upon the consideration of other limiting factors.

Land classification data for the project area have been assembled on maps on a scale of 1 inch equals 2,000 feet, 51 sheets being required to cover the total area. The attached General Land Classification Map has been prepared from these detail maps.

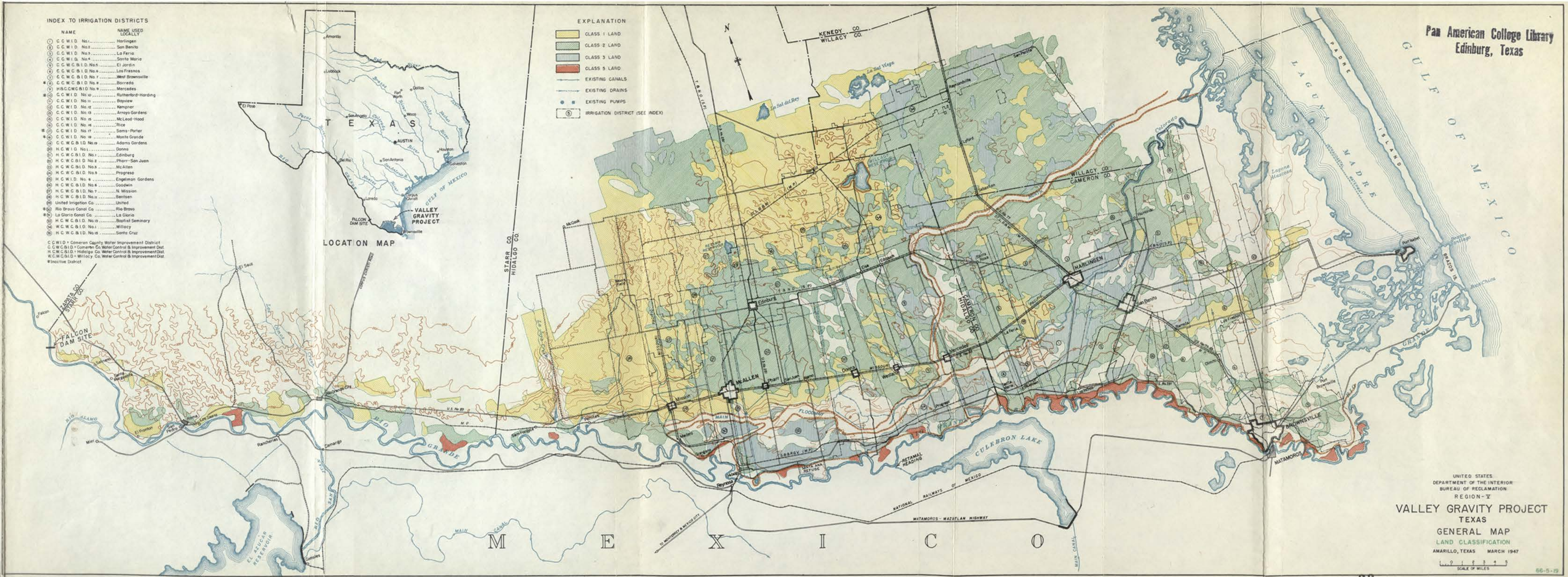
TABLE 2

LAND CLASSIFICATION SUMMARY

Unit-Acres

County	Arable Land				Non-Arable Land			* Right of-way, etc.	Total All Classes
	Class 1	Class 2	Class 3	Sub-Total	Class 5	Class 6	Sub-Total		
Cameron	33,600	141,700	55,300	230,600	11,400	204,100	215,500	40,900	487,000
Hidalgo	223,900	238,900	61,500	524,300	6,900	132,200	139,100	27,500	690,900
Starr	10,000	10,400	3,000	23,400	2,100	59,200	61,300	1,200	85,900
Willacy	47,200	94,700	30,300	172,200	1,800	61,500	63,300	5,700	241,200
Total	314,700	485,700	150,100	950,500	22,200	457,000	479,200	75,300	1,505,000

* The figures in this column represent acreages in right-of-way, resacas, towns, airports, etc.



Project Water Supply

International Reservoir Capacities

Studies indicate that the reservoir at the Falcon (Salineno) site will probably have a live storage capacity of approximately 2,300,000 acre-feet and that the three reservoirs authorized would have a combined capacity of 8,000,000 acre-feet.

Final studies of the capacities to be allotted for irrigation, flood control, silt storage and power regulation will be made by the International Boundary and Water Commission, which agency will establish the total capacities and need for the individual reservoirs.

River Flows

Run-off records are available for numerous gaging stations on the Rio Grande and some of the tributaries for the periods 1900 - 1915 and 1924 - 1942, inclusive, or for various portions of these years. Inspection of available records and estimated run-off indicated that the run-off for the 5 and 10 year periods immediately preceding August, 1932, was lower than for other periods of corresponding length since stream gaging was started along this stretch of the river in 1900. Because it included one of the most critical periods of record and better run-off records were available, the period 1924 - 1942, inclusive, was used in the preliminary water supply studies conducted by the Bureau of Reclamation.

The total average annual discharge of the Rio Grande at the Zapata gaging station for the period 1924 - 1942, inclusive, was 4,111,000 acre-feet. Irrigated areas on the Rio Grande and its main tributaries (exclusive of the Pecos River) between Fort Quitman and Zapata amounted to 426,000 acres in 1942. Of this total, 40,000 acres were located in the United States and 386,000 acres in Mexico. It is estimated that the irrigated acreages in this reach of the river will ultimately be increased to about 655,000 acres.

The Bureau's investigations included a study of estimated future run-off, based on actual run-off for the period 1924 - 1942 less the estimated increased depletions due to additional irrigation development upstream. Based on estimated ultimate upstream depletion, the average annual run-off at Zapata gage for the period 1924 - 1942 would have been 3,043,000 acre-feet. This value is in general agreement with preliminary studies made by the International Boundary and Water Commission, which showed an estimated average future unregulated flow at Falcon Reservoir of approximately 3,238,000 acre-feet for the same period. The average annual run-off for the critical period of low flow, January 1927 to August 1932, would have been 1,781,000 acre-feet. The run-off in the Rio Grande at Falcon Dam site would be substantially the same as at Zapata gage.

The United States' share of the depleted flow (unregulated - prior to deduction of water that will be lost by evaporation from the reservoirs) as allotted by treaty, would have averaged 1,865,000 acre-feet per year for the period 1924 - 1942. This represents approximately 60 percent of the total depleted flow at Falcon site.

Reservoir Operation Studies

An operation study of Falcon and Martin Reservoirs with assumed irrigation storage capacities of 2,300,000 and 3,500,000 acre-feet, respectively, was made under future conditions of depleted stream flow. This study indicates that, for a period similar to 1924 - 1942, average release of 2,450,000 acre-feet annually could be made to meet irrigation demands in the United States and Mexico below Falcon Dam. Because of high carry-over storage preceding 1927, there would have been an estimated average of about 2,500,000 acre-feet per year available for use during the critical period of low river flow, January 1927 - August 1932. The United States' share of water available would be approximately 60 percent of the total or 1,500,000 acre-feet per year.

Irrigation Requirements

Diversion requirements for irrigation are affected not only by type of crops and soils, and condition of canal and lateral systems, but also by the amount and distribution of effective rainfall. The weighted average annual rainfall for the Valley was 26.25 inches for the period 1924 - 1942. The effective rainfall is estimated to range from 100 percent effective for the first inch to 5 percent for the seventh inch, all over 7 inches being ineffective. The effective annual rainfall by this method averaged 20.76 inches (1.73 feet), or 79 percent of the total rainfall for the 1924 - 1942 period.

The average annual diversion to irrigation districts for the four years, 1938, 1939, 1940, and 1942, was 2.57 acre-feet per irrigated acre. The diversions to individual districts ranged from 1.5 to 3.3 acre-feet per acre, caused largely by the difference in amount of canal lining. Systems which were 100 percent lined averaged 1.80 acre-feet per acre, while those with only 10 percent lining averaged 3.00 acre-feet per acre. It is estimated that in the future, with a considerably higher percentage of lined canals, the diversion requirement will be 2.15 acre-feet per acre. This figure includes an allowance for approximately 10 percent loss in lined canals and the regulating reservoir.

A dependable water supply of 1,500,000 acre-feet annually, with an average diversion requirement of 2.15 acre-feet per acre, would permit serving approximately 700,000 irrigated acres in the project. The studies indicate that this area would have received a full water supply for all years during the period of record. This conservative assumption should provide protection against more severe droughts than in the past or possibly greater diversion demands for the project than computed.

Quality of Water

The total salt content of the river at Rio Grande City averaged 654 parts per million during the period 1935 - 1942. Sulphates and chlorides constituted the greater part of the total cations with 30 and 20 percent respectively. In future conditions of run-off it is estimated the average salt content will be approximately 1000 parts per million with a "percent sodium" of 60 and a chloride content of 200 parts per million. These values indicate that the water will be satisfactory for sustained irrigation.

Return Flow

At present some drainage return flow, mixed with river water, is used for irrigation in the upper Valley. In districts near the Gulf the return flow usually has too high a salt content for continued agricultural use. With a dependable water supply and adequate drainage, it is possible that the project area may eventually be expanded by as much as 50,000 acres through use of return flow. However, no such use is provided for in the project plan. It is considered that determination of the availability and quality of return flows will have to be established through operation of the project.

Groundwater

A cooperative investigation of groundwaters of the Lower Rio Grande Valley was made by the Geological Survey and the Bureau of Reclamation in 1945. These studies disclosed that water is obtained from wells in several localities in quantities from 100 to 500 gallons per minute. This water is usually too highly mineralized for public supply, most industrial uses, or sustained irrigation.

Exceptions to the general rule occur locally, principally in the northern part of Hidalgo County where a few shallow wells yield water of good quality, and in a portion of the river flood plain south of the Main Floodway in Hidalgo County and in southwestern Cameron County. With these exceptions, the groundwaters are relatively unimportant as sources of water supplies for the project area.

Water Rights

It is contemplated that the waters for the use of the project will consist either of storage of flood waters in International reservoirs after filling vested rights on the American side of the river below Fort Quitman, or in the event that lands of the owners of any such vested rights are included in the project the water rights of the project will consist of such vested rights delivered to such lands by means of project works, under contract with the United States, and stored waters in such International reservoirs in addition to such vested water rights.

Vested rights in number and extent have never been judicially determined. Such rights on the American side below Fort Quitman are governed by the laws of the State of Texas as construed by decisions of the State courts, the most notable of which is that of Motl vs. Boyd (286 S. W. 458).

Riparian waters are not subject to administrative control by the State Board of Water Engineers in pursuance of laws of the State of Texas governing the appropriation and use of waters of the State. Non-riparian waters as inadequately defined in Motl vs. Boyd are subject to the administrative control of said State Board, under state laws which provide for the appropriation and use of such non-riparian waters in the manner usual to that in

vogue in states which have adopted the appropriation doctrine in toto, including the provision that the first in time of appropriation is first in right. Texas laws, however, (See Art. 7472 (a) Vernon's Civil Statutes Annotated) appear to except the waters of the Rio Grande from that doctrine of appropriation. The excepting legislation has never been construed by the State Supreme Court. However, notwithstanding said apparent excepting legislation, the State Board of Water Engineers has, over a long period of years, accepted applications and issued permits for the appropriation of the non-riparian waters of the Rio Grande. While under Texas laws, as a condition to such appropriation, adequate storage works are required, these permits remain validly of record until affirmative action is taken by the Board or by someone having an interest in the waters of the Rio Grande to cancel the same. If all such permits for the use of the non-riparian waters of the Rio Grande are recognized as constituting vested water rights in the stream, it is apparently over appropriated, and there is no water remaining in the stream subject to appropriation and use.

Before a project can be constructed on the basis of unappropriated waters in the Lower Rio Grande it will be necessary to have either (a) an independent limiting agreement among water right claimants in the Lower Rio Grande Valley with respect to quantities and priorities of vested water rights on the American side of the Rio Grande below Fort Quitman, and a confirmatory decree on the basis of such an agreement, or (b) a limiting agreement among the claimants of such vested water rights in the project area by provisions of repayment contract proposed to be entered into with the municipal corporations comprising the lands of claimants to such vested water rights, to the effect that such claimants pool their vested water rights, such as they may be, and agree to accept the allocation of project waters proposed in such repayment contract, in lieu of their present vested water rights. A confirmatory decree confirming such a repayment contract will confirm the limiting agreement comprised in such repayment contract. Discussions had with representatives of the operating districts in the Lower Rio Grande Valley indicate that such contract provisions would be acceptable to present water users in the Project area.

If all the present water users in the Lower Rio Grande Valley claiming vested water rights come under an executed repayment contract with the limiting provisions aforementioned, all other claimants of water rights, claiming under applications made to the State Board of Water Engineers or otherwise, and who have not proceeded under such applications or otherwise to place the waters claimed, to beneficial use, should be required to assume the burden of establishing the validity of the rights so claimed, failing in which, their claimed rights should not be recognized by the agency having administrative jurisdiction of the waters of the Lower Rio Grande, including those stored in international reservoirs, and allocated for beneficial use on the American side of the Rio Grande below Fort Quitman.

There is no priority of time as between vested riparian water right owners who would each be entitled to a reasonable proportion of such riparian waters in the ratio and proportion as their respective riparian lands bear to the total of available riparian waters on the American side of the Rio Grande below Fort Quitman.

If the said apparent excepting legislation to appropriative rights on the Rio Grande is held in law as uneffective, appropriations made of non-riparian waters, if adequate storage facilities are provided, hold a priority in the order of time of appropriation under state laws. Stream storage, or diversion works for off-stream storage may not be effected without appropriate treaty arrangements with the Republic of Mexico.

In the event that vested water rights on the American side of the Rio Grande below Fort Quitman are made the subject of an adjudication suit, it is probable that a court having jurisdiction might hold that such rights have no priority in point of time, one as against the other, and the extent of such vested rights would be in the ratio and proportion as the past beneficial use of such respective vested right claimants bears to the total supply of water available on the American side of the Rio Grande below Fort Quitman for use of all riparian owner-users and all lawful appropriator owner-users.

Drainage

Drainage investigations disclose that project soils are becoming water laden to a dangerous height and salt accumulations are increasing rapidly. These conditions are caused primarily by lack of adequate drainage facilities over the project area as a whole, and especially by the lack of adequate outlet drains.

History of Drainage in the Project Area

The area first began to be "drainage conscious" near the beginning of this century when rice and sugar cane growers found that farm yields declined after the first few years of irrigation. Around 1920 the lack of drainage facilities began to be felt to a marked degree, and about 1927 the situation became so serious as to require immediate action in order to keep some lands in production. The first attempts to check the rising water table and increasing salt content of the sub-surface waters resulted in a program which included lining of existing canals, installing sub-surface irrigation pipelines, and some construction of open ditches to carry off the accumulated sub-surface waters and storm water runoff. These measures, while they were effective to some extent, did little more than check the deterioration of lands in a few areas. This work has continued but it has never offered an adequate solution to the drainage problem. The hurricane in September 1933, showed that drainage works completed up to that time were inadequate to handle the 12-inch precipitation that accompanied the storm.

Data indicate that at least 70 percent of the area now being irrigated is in urgent need of drainage relief to correct or avoid abnormally high or fluctuating sub-surface water, excessive salts content of the soils, or both.

Topography

The topography of the project area is that of a typical delta and flat coastal plain, and natural drainage is poor. The Arroyo Colorado is the only important natural drain within the project area. The resacas, or old river channels, have little value for drainage as their banks are usually higher than the areas between them.

Rainfall and Groundwater Levels

There are periods when intensities of rainfall are such as to cause considerable damage to crops and developments. A Department of Agriculture Bulletin by D. L. Yarnell gives Rainfall Intensities over the project area as follows: for a five minute storm from 0.45 inches for two year frequencies up to 0.95 inches for 100 year frequency; the values for a one hour storm range from 2.0 inches for the two year frequency to 4.4 inches for the 100 year frequency; and for a twenty-four hour storm from 5 inches to five year frequency to 11.0 inches for 100 year frequency.

Fluctuations of Groundwater Levels

Investigations indicate that groundwater levels are quite sensitive to and fluctuate approximately in proportion to precipitation and irrigation. In a representative area comprising about 106,000 acres, an increase of only 13 percent over the normal precipitation during a nine months period resulted in a rise of the groundwater level to a depth less than six feet below the surface over about 25 percent of this area. (The area with groundwater depths greater than eight feet decreased in the same amount). This area has a comparatively high concentration of drains by existing Valley standards.

Records available on groundwater fluctuations due to storms of hurricane intensity (about 10 inches in 24 hours) show a 39 percent increase in the area having depths to water table of four feet or less, where no means of surface drainage exists. A marked improvement was noted on the same area after some drains were constructed.

Studies of the water table position over a ten year period indicate that increased drainage construction has prevented the water table from rising permanently, and for periods of normal precipitation it is at about the same average depth that it was ten years ago. However, the Valley is not in a static condition with respect to deterioration of lands due to water table position, since this depth is critically high over a large portion of the project. In large areas the water table is so high that, during periods of excessive precipitation, it rises to the surface, drowns crops. and recedes very slowly; a general rise in groundwater levels always occurs during periods of above normal rainfall. Over other large areas the water table remains constantly at such a level as to permit capillarity to draw the highly mineralized groundwaters to the surface where subsequent evaporation leaves salt accumulations. This process renders much valuable land unfit for production in a comparatively short time. It can be expected that each successive wet period will be more harmful than the one preceding, until such time as adequate drainage facilities are provided.

Project Soil Profile

No uniformity exists with respect to the recent deposits of Valley soils, as profiles of the soil column show great variations of clay, clay loam, sandy clay, sandy clay loam, silt and sand.

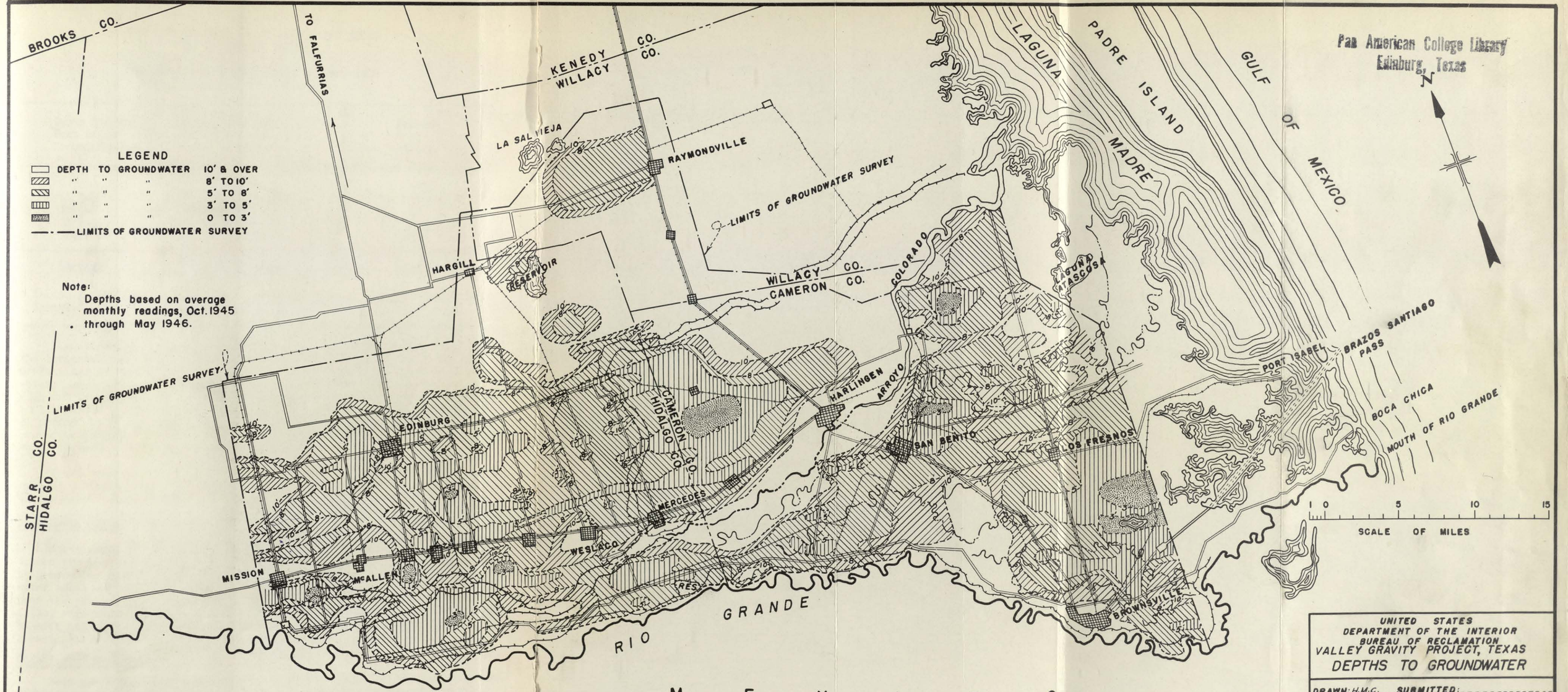
The area south and east of the Arroyo Colorado in Cameron County appears to be a more active and modern delta, the soils are more variable, and subsurface sands and other high water-bearing soils such as the loams and sandy loams are usually encountered above sea level. These soils in the flood plain section of Hidalgo County are also found near the surface, and to some extent this is true of Willacy County.

Underlying shallow clays are generally more continuous in Hidalgo County than in Willacy and Cameron Counties. In the latter two, the clays appear more often in lensed form. In most areas, however, the clay deposits are of such magnitude as to make their treatment with respect to drainage construction the same over all of the project area. These clays are generally considered as being impervious, particularly to downward percolation, as free vertical movement of water through them is very slow. The clays are usually underlain by sands or soils containing a high proportion of sands.

No large area of the project appears to be free of sand, or soil which is unstable when saturated, to a depth necessary for drainage construction. These deposits generally are encountered at not less than five feet from the surface. Often they exist as thin lenses, but usually they extend to an undetermined depth and are always found in a saturated condition in the irrigated areas, usually overlain by relatively impervious material. The Bureau investigations disclose that, in general, a waterbearing deposit, or one capable of retaining injurious quantities of water when insufficient drainage facilities exist, is to be found within ten feet of the surface over most of the project area. In many areas the water bearing deposits have a relatively impervious overburden and as the lower soils become filled with water, the clays prevent it from rising higher. As this filling process continues, the water is being put under pressure in the lower areas. A differential pressure of five feet is not uncommon between the free water encountered at the top of a water bearing bed and its static level as found several days after drilling through the higher, overbearing, impervious deposits.

Depths to Groundwater

The map, "Depths to Groundwater," shows general groundwater depths over the project area. It will be noted that most of the area has a water table ten feet or less from the surface with the exception of a portion of the Mission Ridge, the high banks of the Rio Grande, unirrigated areas, the area which comes within the drainage influence of the Arroyo Colorado, and the newly irrigated areas between Elsa and Hargill and between Hargill and Raymondville areas within the investigation limits which are being irrigated at the present time, with their respective depths to groundwater are as follows:



LEGEND

DEPTH TO GROUNDWATER	10' & OVER
" " "	8' TO 10'
" " "	5' TO 8'
" " "	3' TO 5'
" " "	0 TO 3'
LIMITS OF GROUNDWATER SURVEY	

Note:
Depths based on average monthly readings, Oct. 1945 through May 1946.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
VALLEY GRAVITY PROJECT, TEXAS

DEPTHS TO GROUNDWATER

DRAWN: H.M.C. SUBMITTED:
TRACED: H.M.C. RECOMMENDED:
CHECKED: APPROVED:
3-GD-104 | McALLEN, TEX. 7-15-46

DEPTH TO GROUNDWATER IN *IRRIGATED AREAS
OF RIO GRANDE VALLEY

Monthly Averages Oct. 1945 to May 1946

Depth Range. Feet Below Ground Surface	Area in Acres	Percent of Total	
0-3	8,040	2	
3-5	86,490	19	69
5-8	216,165	48	
8-10	77,540	17	31
over 10	65,655	14	
TOTALS	453,890	100	

* Includes only that portion of the irrigated area within groundwater study limits.

Investigations indicate that for periods of average precipitation on the irrigated portion of the area studied, 2 percent is entirely out of production; 19 percent is in very poor condition due to the fact that groundwaters are definitely within the range of capillarity with its resulting high and increasing salt content at the surface; 48 percent is in an insecure condition due to possible excess fluctuations or rise of groundwaters; and 31 percent is beyond danger of the effects of excess water on crop roots, providing fluctuations are not great enough to place them within the danger zone following periods of excessive rainfall.

These data show that approximately 70 percent of the area studied is in need of drainage relief and that the area is not confined to one locality but is distributed over the Valley as a whole.

Groundwater Flow

Sub-surface flow is generally from west to east across the project area, toward the Laguna Madre and the Arroyo Colorado northeast of Harlingen. It is generally parallel to the surface slope and the hydraulic gradient of the water table varies from eight feet per mile near Mission to 1½ feet per mile near the coast. Due to flat hydraulic gradients and to the nature of Valley soils, velocities of sub-surface waters are so low as to make their drainage benefit negligible with respect to mass movement of waters across the project area to the coast.

Quantity of Groundwaters

Measurements of return flow in existing drains average about 0.3 second-feet per square mile but this value does not hold equally over the Valley. Greatest measured return flows into open drains are those discharging into

the Arroyo Colorado between Mercedes and Harlingen, the average being about 0.7 second-feet per square mile. However, there are large tracts of land which have no drains and return flows into drains over the Valley as a whole are obviously very low. Unknown outlets for groundwaters in the area doubtless permit some water to pass unmeasured.

Quality of Groundwaters

Soluble salts concentration of drainage return flows as measured at approximately 50 different locations varied from 500 parts per million to 27,500 parts per million for the last six months of 1945. The average concentration, weighted against discharge, was 2,955 parts per million for the year beginning May 1945; the arithmetic average was 3,718. The salts were predominatly alkaline sulphates and chlorides. Greatest mineralization of groundwaters occurs in lower Cameron County and least in the vicinity of Harlingen where the drainage influence of the Arroyo Colorado is great, (see Map, Depths to Groundwater) indicating the extensive reclamation value to be expected from adequate drainage construction.

Salts Removed by Drainage

Investigations disclose that soluble salts are being deposited on Valley soils as a whole at a rate considerably greater than they are being removed. At the present time it is indicated that average salt accretions are about one ton per acre per year. Total applications of salt are about 2.1 tons per acre per year and total removals, 1.2 tons.

This high rate of soluble salt accretion can be lessened or eliminated by construction of adequate drainage works. This is illustrated by Bureau investigations in one of the oldest irrigation districts within the project, having an area of 106 square miles, soils considered difficult to drain, and having had a considerable part of its lands at one time unfit for cultivation due to high salts concentration. This district has constructed 375 miles of open, well maintained drains, about one mile of drain per 180 acres. The present ratio of salt application to salt removal is 0.75. Total salt applications are about 0.9 ton per acre per year and removals are 1.2 tons.

Existing Drainage Development

Drainage construction has been performed by four agencies during Valley development: irrigation or water districts, drainage districts, the International Boundary and Water Commission, and individual property owners. Generally each agency has done only limited work within its own boundaries.

The International Boundary and Water Commission has constructed approximately 75 miles of flood control channels in the Valley. Its works are of the highest type and the maintenance program is excellent. However, the works are of no great value as a part of a permanent drainage system as they were constructed primarily to protect the area from floodwaters of the Rio Grande and are generally too shallow to provide outlets of sufficient depth for lateral drains.

Drainage works constructed by irrigation and drainage districts constitute the bulk of agricultural drainage facilities in the Valley. The

history of all districts shows neglect of drainage needs and only in recent years has the acute need for drainage relief forced their attention toward new and increased drainage construction. Total drainage channels reported by the various districts in 1946 averaged only one mile of drain for each 377 acres. It is estimated that less than 25 percent of this total is kept in efficient operating condition which makes the overall existing drainage system entirely inadequate.

Drainage works now constructed by individual property owners are a negligible factor in the existing Valley drainage system. A total of only 46 miles of such sub-surface concrete or tile drains was reported by the various districts in 1946.

Feasibility of Drainage

The provision of adequate drainage both surface and subsurface has been shown to be physically possible at a reasonable cost for the arable lands. This is evidenced by the ground water levels found where the Arroyo Colorado and other facilities provides drainage and by the leaching accomplished by artificial drains in some of the irrigated areas: The main outlet drains supplemented by sufficient laterals and farm drains will prevent injuriously high water tables and salt accumulations.

Project Plan

The Valley Gravity Project plan of development provides for furnishing an adequate and dependable water supply to an area of 700,000 acres of which 552,000 acres are now being irrigated, and 148,000 acres are new, undeveloped lands. The latter consist of 75,412 acres within the district boundaries, and 72,588 acres outside of the districts. The project plan contemplates conveying stored waters from the proposed Falcon Reservoir to the project area through a concrete-lined gravity canal system. The canal system would consist of a main canal from the Falcon Reservoir to the Mission Reservoir and branch canals which would extend eastward through the project to serve the districts' main canals. This would eliminate the need for the existing river pumps, a majority of the second lift pumps and some third lift pumps. The plan contemplates that delivery from the project canals to the presently developed lands would be made through the existing distribution systems, and that those systems would be extended by the districts to serve the new lands within the districts. The plan also provides an irrigation distribution system and a lateral drainage system for the new lands outside of the districts. The plan includes the Mission Reservoir, near the west side of the project for regulating irrigation releases from the Falcon Reservoir. Another major feature of the project plan is the system of outlet drains required for the project lands. The project plan also provides for construction of a power plant at a drop in the canal line at La Joya Creek. The Mission Reservoir and the outlet drains would also serve fish and wildlife and recreational purposes.

Irrigation Works

The main canal for conveying water from the Falcon Dam to the west side of the project will be approximately 73 miles long and will have a capacity of 4,500 second-feet for the first 60 miles or to the wasteway at La Joya Creek. From the wasteway it is reduced to 3,900 second-feet for the remaining distance to the Mission Reservoir. The canal will have a lining 3-1/2 inches thick and a freeboard of 1.9 feet. Most of the canal is located in whole or partial cut and where any fill is required a maintenance roadway will be provided along one bank. All right-of-way is to be fenced. The location requires several deep cuts of considerable length and two siphons of major importance. These siphons, across Los Olmos and Garcias Creeks, will have lengths of 7,100 and 5,500 feet, respectively. Each will require

2 barrels, 21 feet in diameter, operating under heads of 73 and 83 feet, respectively.

The capacity of the main and other canals was based on a curve of actual diversions plotted against irrigated areas, the figures being based on International Boundary Commission reports for the 7 year period 1938-1944. This curve was extrapolated to the assumed ultimate 700,000 acres for the project. As a check, the monthly diversions for the 7 year period and the one day and six day maximums were plotted. Using the acreage under irrigation each year and taking from the assumed curve the canal capacity required to serve that acreage, it was found that the assumed size would meet all monthly demands, with shortages in only two of the six day maximum demands and 12 of the daily maximum demands.

Studies show that in order to meet expected demands without regulatory storage, a canal of 5,400 second-feet capacity would be needed. By providing 50,000 acre-feet of live storage (65,000 acre-feet total) in Mission Reservoir to meet high weekly and daily demands, the size of the main canal was economically reduced to 4,500 second-feet.

The Monte Christo Canal, which would be the highest branch canal, would diverge from the main canal on the west side of La Joya Creek. A siphon of 1,100 second-feet capacity, 3,500 feet long would convey water across the creek. Turnouts would be provided to serve areas between the main canal and the Goodwin District. Near the Goodwin west boundary, the La Lomita branch canal would take out to serve most of the United, North Mission, and Goodwin Districts. At this point, also, the Monte Christo Canal would turn north to serve areas north of the present districts and west of the proposed Edinburg Canal.

At a point north of the Mission Reservoir, the Edinburg Canal, of 2,318 second-foot capacity, would branch from the main canal to serve an area of 302,500 acres. Near McAllen, it would turn north and at this location the Weslaco Canal of 994 second-foot capacity would diverge to serve most of the present development now under second lift pumps.

The Edinburg Canal would continue north and branch into the Linn and Hargill Canals. The Hargill Canal, of 938 second-foot capacity, would serve the Willacy District, some new land, and, through the Elsa Canal of 149 second-foot capacity, would serve the Engleman District. The Linn Canal, 474 second-foot, would continue on north from its origin at the junction of the Edinburg and Hargill Canals to serve new lands.

The Brownsville Canal will originate at the east side of the Mission Reservoir and extend to a few miles east of Brownsville. The capacity at the upper end would be 2,318 second-foot; the canal would serve 295,000 acres of first lift land in Hidalgo and Cameron Counties.

All canals are to have a concrete lining with a minimum thickness of 3-1/2 inches; all right-of-way would be fenced and a maintenance road would be built on top of one canal bank where practicable.

The Mission Reservoir would be located southwest of and near the town of Mission for regulating flows from the main canal. It would be formed by a dike about 8.5 miles in length with a maximum height of 39 feet. The dike would encircle the reservoir area, be protected on the water side by a layer of dumped riprap, and have a 20 foot roadway on top. The reservoir would have a maximum water surface area of 3,250 acres and a capacity of 65,000 acre-feet allocated as follows:

15,000 acre-feet -- Fish and Wildlife and Recreation
50,000 acre-feet -- Irrigation

Although no storage has been assigned to power, the reservoir would probably have some benefit for power production by permitting more uniform releases from Falcon Reservoir.

The canal sizes were based, for each area, on the sum of all class 1, 2 and 3 lands plus the acreage of class 5 and 6 land now irrigated. In addition to areas in the organized districts, it was assumed that lands now being irrigated by independent operators should also be served by the project canals. Table 3 shows areas considered for initial development.

Drainage Works

The project plan provides for construction of a system of main drains and for lateral drains on new lands outside of the districts. The plan recognizes that future extensions of the main drains may be required, and that the works to be constructed initially are designed to provide immediate relief only. The principal purpose of the drainage system is to dispose of normal drainage waters brought to it by irrigation and drainage district works. The main drains would also have appreciable benefits of a flood control nature, in permitting the early removal of storm waters which now stand in some areas for long periods of time.

Locations of the outlet drains were based principally on the following considerations: topography, location of existing drainage development, water table conditions, sub-surface strata, land classification, water district boundaries, location of outlets, and rights-of-way.

The proposed main drains, as shown on the General Map, are designated as follows: Rado, Tio Cano, North Floodway, Progreso, West San Benito, East San Benito, Rio Hondo, Los Fresnos, Brownsville, El Jardin and Raymondville. These drains would discharge into the Arroyo Colorado, the Laguna Madre, the Brownsville Ship Channel or the Floodway. All outlets would be at sea level, except those of the Rado and Progreso Drains, which would discharge into the Floodway. Total length of all outlet drains is 288 miles.

For estimate purposes, a fifteen-foot depth of main drain was used, and side slopes of 1-1/2 : 1. A minimum bottom width of six feet was used, and where greater capacities were required, the bottom width was increased. A 250-foot right-of-way strip is proposed for the outlet drains. The major structures required in the outlet drainage system comprise two concrete

TABLE 3

AREAS TO BE SERVED BY DISTRICTS AND NEW LAND AREAS

FOR DETERMINING CANAL CAPACITIES

Unit-Acres

No. on Map	District Name of District	Local Name	Area to be Irrigated (3) Class 1,2,&3	(4) Class 5	(4) Class 6	Total	Not Irrigated (4) Class 6	(3) Right-of-way	(3) Total Area Dist.	(4) Area Irrig. 1945
1	C.C.W.I.D. No. 1	Harlingen	31,102	0	5,688	36,790	5,478	5,274	47,542	34,410
2	C.C.W.I.D. No. 2	San Benito	37,983	92	11,651	49,726	14,295	6,110	70,131	45,676
3	C.C.W.I.D. No. 3	La Feria	27,267	34	1,780	29,081	2,341	1,560	32,982	27,433
4	C.C.W.I.D. No. 4	Santa Maria	1,935	366	1,403	3,704	929	370	5,003	3,423
5	C.C.W.C. & I.D. No. 5	El Jardin	8,166	298	3,683	12,147	7,747	4,447	24,341	11,061
6	C.C.W.C. & I.D. No. 6	Los Fresnos	15,533	0	4,529	20,062	15,676	2,605	38,343	15,365
7	C.C.W.C. & I.D. No. 7	West Brownsville	670	0	272	942	856	879	2,677	712
8	C.C.W.C. & I.D. No. 8	Barreda	6,019	33	870	6,922	3,820	334	11,076	4,074
9	H.&C.C.W.C.&I.D.No. 9	Mercedes	60,140	900	10,279	71,319	13,576	6,121	91,016	65,733
10	C.C.W.I.D. No. 10	Rutherford-Harding	2,094	0	57	2,151	4,478	544	7,173	810
11	C.C.W.I.D. No. 11	Bayview	4,239	0	644	4,883	5,351	1,016	11,250	4,086
12	C.C.W.I.D. No. 12	Kempner	395	0	287	682	210	243	1,135	631
13	C.C.W.I.D. No. 13	Arroyo Gardens	3,395	0	432	3,827	2,209	199	6,235	1,377
15	C.C.W.I.D. No. 15	McLeod-Hood	1,539	0	138	1,677	39	118	1,834	1,603
16	C.C.W.I.D. No. 16	Rice	1,378	0	73	1,451	735	17	2,203	645
17	C.C.W.I.D. No. 17	Sams-Porter	1,150	0	229	1,379	566	14	1,959	855
18	C.C.W.I.D. No. 18	Monte Grande	2,008	0	420	2,428	1,330	45	3,803	886
19	C.C.W.C.& I.D. No. 19	Adams Gardens	7,580	0	977	8,557	517	639	9,713	8,147
20	H.C.W.I.D. No. 1	Donna	20,912	181	8,082	29,175	10,769	2,034	41,978	27,456
21	H.C.W.C.& I.D. No. 1	Edinburg	31,615	0	2,939	34,554	749	1,958	37,261	33,611
22	H.C.W.C.& I.D. No. 2	Pharr-San Juan	54,800	120	4,540	59,460	8,253	3,079	70,792	56,427
23	H.C.W.C.& I.D. No. 3	McAllen	6,102	128	154	6,384	497	760	7,641	6,021
24	H.C.W.C.& I.D. No. 5	Progreso	4,789	377	447	5,613	568	319	6,500	5,418
25	H.C.W.I.D. No. 6	Engelman Gardens	10,886	0	265	11,151	284	217	11,652	9,386
26	H.C.W.C.& I.D. No. 6	Goodwin	22,215	0	450	22,665	493	471	23,629	21,178
27	H.C.W.C.& I.D. No. 7*	N. Mission	16,590	0	619	17,209	0	299	17,508	17,209
28	H.C.W.C.& I.D. No. 11	Bentsen	1,744	0	38	1,782	70	56	1,908	1,727
29	United Irrigation Co.	United	16,311	0	556	16,867	2,556	1,247	20,670	15,121
30	Rio Bravo Canal Co.	Rio Bravo	2,619	0	98	2,717	1,241	284	4,242	1,888
31	La Gloria Canal Co.	La Gloria	1,557	184	151	1,892	2,115	129	4,136	682
33	H.C.W.C.& I.D. No. 13	Baptist Seminary	2,016	0	184	2,200	11	176	2,387	2,122
34	W.C.W.C.& I.D. No. 1	Willacy	73,164	427	3,007	76,598	1,887	4,599	83,084	70,590
	Sub-Total - Present Districts		477,913	3,140	64,942	545,995	109,646	46,163	701,804	495,763
	(4) Independents	Hidalgo Co.	14,541	2,685	3,437	20,663	0	0	20,663	20,663
		Cameron Co.	12,118	7,980	5,146	25,244	0	0	25,244	24,244
		Starr Co.	2,758	147	774	3,679	0	0	3,679	3,679
		Willacy Co.	5,781	678	381	6,840	0	0	6,840	6,840
	Sub-Total - Independents		35,198	11,490	9,738	56,426	0	0	56,426	56,426
	Totals Present Development		513,111	14,630	74,680	602,421	109,646	46,163	758,230	552,189
	New Lands									
	New Dist. & Extension of present Districts									
27	H.C.W.C.& I.D. No. 7*	N. Mission	15,253	0	0	15,253	1,961	0	17,214	0
35	H.C.W.C.& I.D. No. 15	Santa Cruz	9,695	0	43	9,738	726	0	10,464	375
	New Lands		72,588	0	0	72,588	0	0	72,588	0
	Sub-Total		97,536	0	43	97,579	2,687	0	100,266	375
	TOTALS		610,647	14,630	74,723	700,000	112,333	46,163	858,496	552,564

(3) From Tables E-4, E-5 and E-6, Appendix E - Project Lands.

(4) From Land Classification Survey Summaries.

* Shown on new lands also.

siphons under the North Floodway, flumes where the drains would cross existing main canals, and bridges at crossings of main highways and railroads.

Under the project plan, the lateral drains on new lands include one mile of lateral drain per 320 acres; the drains to have a depth of ten feet, bottom width of four feet, side slopes of 1-1/2 : 1, and a right-of-way 150 feet in width.

Land Development

The project would permit irrigation of an additional 148,000 acres of land most of which is now covered by brush. Included in the area are 72,588 acres outside of the districts. The remaining acreage is scattered through the various districts, district extensions, and new districts.

The project plan would permit forming of approximately 3,800 additional farm units. This is based on the development of the 148,000 acres of land not now irrigated and assumes reduction of excess land holdings within the districts to family size units. These 3,800 units would support an increase of 17,200 in the farm population. The possibilities for creating additional farm units are summarized as follows:

Settlement Possibilities Provided by	Size of Unit			
	40 Acres* Class 1	80 Acres* Class 2	160 Acres* Class 3	Total
	(Number of farm units)			
(1) New lands and extensions of districts	1,975	737	62	2,774
(2) Old lands	641	355	60	1,056
Total	2,616	1,092	122	3,830

* Economic size farm unit for class of land.

Development of these farm units would require land improvements which would be done by the landowners. These improvements would include: clearing, leveling, construction of farm laterals and drainage, buildings, and water supply.

Power

Studies of alternate plans for delivering irrigation water from the proposed Falcon Reservoir to the irrigable areas below Rio Grande City established the desirability of an 80 foot drop in the main canal at La Joya Creek to lower the irrigation waters from about elevation 220 feet to 140 feet. The project plan provides for utilization of this drop for the generation of hydroelectric energy. An installation of 12,000 kilowatts was adopted, as it would produce the greatest annual net revenue. The project plan contemplates coordination of the La Joya plant with the hydroelectric plants to be provided at the international dams to firm the La Joya plant

output. Consideration was given to developing firm power at the La Joya plant by providing additional storage capacity at the Mission Reservoir. This would permit the release of a constant flow from the Falcon Reservoir through the La Joya power plant. However, the cost of the additional capacity at the Mission Reservoir for power purposes was not found justified.

About 20 miles of transmission facilities would be required to connect the La Joya plant to the existing transmission facilities in the market area.

Fish and Wildlife Conservation

The project plan proposes that the Santa Ana and Laguna Atascosa National Wildlife Refuges be furnished annually 1,000 and 40,000 acre-feet of water, respectively. The Santa Ana Refuge would be supplied water which must necessarily be wasted from the Brownsville Canal; the Laguna Atascosa Refuge would be served with water from the East San Benito and Rio Hondo Drains. With the delivery of these quantities of water the two refuges can be brought to full development by the Fish and Wildlife Service. The project plan provides for use of the Mission Reservoir and outlet drains for Fish and Wildlife conservation purposes.

Recreation

The project plan provides recreational facilities including a boat harbor and landing, parking area, picnic area, swimming beach, and necessary utilities at the Mission Reservoir. Construction of these facilities by the National Park Service would be of aid in alleviating some of the present deficiency of public park and recreational areas in the Lower Rio Grande Valley.

Other Plans Considered

Prior to selecting the project plan, several alternate plans for irrigation were considered. These differed principally in the point of diversion and the location of the main canal. In all plans, the system below Mission Reservoir remained the same.

Of the various alternates considered, the "low-line" plan was the second choice to the adopted plan. In the "low-line" plan, water would be released into the river channel from the Falcon Reservoir and delivered into the 4,500 second-foot main canal by means of a diversion dam at the Garza Ranch or the Roma site. Water would be carried in this low canal to near La Joya Creek, where 1,000 second-feet would be diverted to the higher project lands by pumping. The main canal below the pumps would follow the original alignment to Mission Reservoir with reduced capacity.

Several serious construction difficulties would be encountered in the "low-line" plan. If the Roma site should be used, a long dike would be required on the Mexican side to protect the village of San Pedro; the diversion into the main canal would require a tunnel under or a deep cut around Roma; and a tunnel around Rio Grande City would be required. Available information on foundation conditions at the Garza Ranch site indicates that rock formation lies about 60 feet below low water, which would necessitate construction of a dam 90 feet high and 3,600 feet long. A long cut-off wall on the left abutment would probably be required. The dam site at Roma

appears more favorable, but the costs of the first 9 miles of canal between Roma and the Garza Ranch site would about offset the saving in cost of the diversion dam at this upper site. In either of these plans a serious consideration is the location around Rio Grande City. The most feasible appears to be a 3,000-foot long tunnel north of town. A possible location on the flood plain south of the town is undesirable because of flood danger and river erosion. Another location on high ground at the south edge of the town involves a very difficult right-of-way problem because of numerous residences and industrial buildings. Any of these locations would still require protection works from flooding by the river for about 15 miles of canal below Rio Grande City.

Preliminary cost estimates indicated that annual costs of the low-line plan would be about the same as for the adopted plan. However, the project plan was selected because it would:

a. Provide an estimated 5 percent greater water supply than the "low-line" plan through saving the water that would be lost under that plan by use of the Rio Grande Channel for transmission of the project water supply from the Falcon Reservoir to the point of diversion and by the possible need for sluicing silt at the point of diversion.

b. Most satisfactorily permit expansion of the project area to include desirable lands lying west of the Monte Christo Canal if additional water supplies should become available through use of drainage return flows or by the volume of Rio Grande waters available to the project exceeding present estimates.

c. Release, for industrial and other use, electrical energy which otherwise would be required for pumping.

d. Be free from hazard of flooding by the Rio Grande.

e. Involve fewer construction difficulties.

f. Eliminate the possibility of any international or local controversy over rights to water such as normally arise in connection with attempts to deliver stored waters through natural channels comparable to that of the Rio Grande below the Falcon Dam site.

ECONOMIC ANALYSIS

Project Costs

Construction Costs

The project construction would be of impressive magnitude. In the 239 miles of canals and 288 miles of outlet drains, there would be a total of approximately 104 million cubic yards of excavation, 1,220,000 cubic yards of concrete for lining of canals and for structures, and 115 million pounds of reinforcing steel. Other major items would include compacted embankment, trimming foundations for concrete lining, bridges, structures, fencing, etc.

In estimating the cost of project works, present unit costs were analyzed for similar work throughout the Southwest and in the general project area. Due to the magnitude of the project, involving large construction quantities, favorable year-around working conditions, and general accessibility of work, the unit prices adopted were generally lower than the average for other projects now being constructed. Table 4 summarizes the unit costs used in the project estimate.

The various canals, drains, and related structures were projected on topographic maps, profiles were taken from the maps, and quantities computed therefrom. Maps were generally on a scale of 1 inch equals 2,000 feet with 1 or 2 foot contour intervals, although detail topography on a scale of 1 inch equals 1,000 feet and 1 inch equals 400 feet were used where available for the main canal and important structures.

Estimates of costs of irrigation laterals for new lands were made for a typical area of 3,000 acres. Quantities were then calculated and unit prices in Table 4 were applied which resulted in an average estimated unit cost of $85 per acre for the lateral system. Lateral drains for new lands were laid out on the topographic maps at approximately 1/2 mile intervals. Excavation and related quantities for these laterals were based on typical sections of drains assumed with 10 foot depth and 4 foot minimum base width; unit prices from Table 4 were applied to determine total costs.

Capacities of the main drains for the project report were based on a curve prepared in the Project Office in March 1946. In July 1946, the Project Board of Review, after a study of probable rain-fall and storm-run-off, recommended that the capacities of the drains be increased, particularly toward their lower end. In a further conference on the drainage problem held in October 1946, representatives of the Chief Engineer's Office, and Regional and Project offices agreed on an increase in cost of approximately 20 percent over the preliminary project estimate for the main drains until such time as actual run-off data for the project area could be obtained.

The project costs include, besides the regular construction features, estimates for the following items: examinations and surveys for investigations and preparation of a report; irrigable area determination and classification of new lands and preparation of a base map of the entire project

area; permanent improvements consisting of an office building, shops, warehouses, and housing and storage facilities for operation and maintenance forces; temporary camp and field headquarters; and operation and maintenance during construction.

The summary of project costs in Table 5 gives the total cost of irrigation works, including Mission Reservoir, as $96,758,000; drainage works, $22,760,000; La Joya Power Plant, $2,560,000; $7,550,000 for examination and surveys, permanent improvement, etc., and a total estimated project cost of approximately $129,628,000.

Operation and Maintenance Costs

Cost of operating all project works except those required for serving the new lands alone, is estimated at $630,000 annually. The estimate is based on operating costs and experiences obtained on similar projects constructed by, or now being operated by, the Bureau of Reclamation. Operation and maintenance costs of project works to serve the 72,588 acres of new land outside the districts are estimated at $195,000 annually. Presumably this cost would be chargeable entirely to the new lands, and the $630,000 cost divided between the new and old lands on the basis of water delivered. Operation and maintenance costs and reserves for replacements for the power facilities to be constructed on the project are estimated at approximately $82,700. The estimated total annual operation and maintenance costs amount to $907,700 for the project works.

Land Development Costs

The 3,800 additional farm units, which the project could provide, would require expenditures for improvements to put them into proper condition for operation. The general land improvements would include clearing, leveling, and construction of farm laterals at an estimated cost of $45 to $100 per acre. Farm drainage is estimated at $35 to $100 per acre, depending on the class of land and type of crop grown. Other improvements would include farm buildings, and water supply, costing $8,800 and $1,200, respectively. The total land development costs for approximately 3,800 farm units on 148,000 acres is estimated at $52,291,000. These expenditures would be made by the landowners with private capital.

Project Benefits

The continued prosperity of the entire Lower Rio Grande Valley is contingent upon agriculture, which in turn is largely dependent upon an adequate and dependable water supply for the irrigated lands and on a drainage system sufficient for removal of harmful sub-surface and storm waters.

The Valley Gravity Project would conserve and put to beneficial use the United States' share of Rio Grande waters made available by the treaty with Mexico; the project works would convey the United States' share of water from the authorized Falcon storage dam to the project lands in a canal located entirely within this country, eliminating the possibility of international disagreements which might occur if water of both countries were released into the river below the dam, for later re-division downstream;

TABLE 4

UNIT COSTS - 1947 BASIS

Item	Unit	Unit Cost
Excavation, common, for canal and drains	C.Y.	$ 0.13 - 0.17
Excavation, rock, for canal and drains	C.Y.	0.85
Excavation for structures	C.Y.	0.55 - 1.00
Compacting embankment	C.Y.	0.14 - 0.25
Trimming foundation for concrete lining	S.Y.	0.50
Backfill	C.Y.	0.30 - 0.40
Compacting backfill	C.Y.	1.25
Concrete in structures	C.Y.	45.00 - 60.00
Concrete in canal lining	C.Y.	18.00 - 19.00
Reinforcement bars in place	Lb.	0.07 - 0.09
Timber bridges	S.F.	5.00
Concrete bridges	S.F.	8.25
Railroad bridges	L.F.	365.00
Gates and hoists	Lbs.	0.40 - 0.50
Fencing	Canal Mi.	1,200.00
Clearing and grubbing	Acre	40.00
Pre-cast concrete pipe in place		
Size - 24"	L.F.	4.65
Size - 30"	L.F.	6.85
Size - 36"	L.F.	8.50
Size - 42"	L.F.	11.50
Size - 48"	L.F.	12.50
Size - 60"	L.F.	20.00
Right-of-way		
Saltgrass land	Acre	25.00
Brush land	Acre	70.00
Vegetable land	Acre	220.00
Poor Citrus	Acre	680.00
Young Citrus	Acre	670.00
Good Citrus	Acre	1,140.00

TABLE 5
SUMMARY - ESTIMATED COSTS

VALLEY GRAVITY PROJECT, TEXAS
1947 Costs

Examination and Surveys (Investigation and Report)		$ 1,300,000
Regulating Reservoirs		
Mission Reservoir		$ 6,469,000
Canal System		
Main Canal	$50,913,000	
Brownsville Canal	14,707,000	
Weslaco Canal	3,441,000	
Edinburg Canal	5,516,000	
Hargill Canal	5,022,000	
Elsa Canal	359,000	
Linn Canal	378,000	
Monte Christo Canal	3,352,000	
La Lomita Canal	431,000	
Sub-total		$84,119,000
Lateral system, irrigation on 72,588 acres new lands		$ 6,170,000
Drainage system		
Main Drains		
Tio Cano	$ 3,557,000	
North Floodway	3,075,000	
Raymondville	4,670,000	
Rado	2,931,000	
Progreso	206,000	
Brownsville	729,000	
El Jardin	1,230,000	
Rio Hondo	620,000	
West San Benito	621,000	
East San Benito	728,000	
Los Fresnos	1,691,000	
Sub-total	$20,058,000	
Lateral drains on 72,588 acres new lands	$ 2,702,000	
Total drainage works		$22,760,000
Power system - La Joya plant and transmission line		$ 2,560,000
Irrigable area determinations and classification of lands		$ 750,000
Permanent improvements		$ 1,500,000
Temporary Camp and Headquarters		$ 500,000
Operation and maintenance during construction		$ 3,500,000
TOTAL ESTIMATED COST		$129,628,000

irrigation works would be provided which would eliminate the costly and many times hazardous method now employed of pumping from the river; most of the second lift and some third lift pumps would also be eliminated; and a system of main drains would be constructed to provide the present districts with much needed drainage outlets.

Water supply studies indicate that the present irrigated area of 552,000 acres can be increased to approximately 700,000 acres under the project plan. This increased area could provide several thousand additional farms for production of the highly specialized citrus fruits and vegetable crops grown in the area.

The project would have appreciable benefits for fish and wildlife conservation, and for recreation. The drains could be utilized by the towns and cities of the Valley for disposal of domestic and sanitary sewage and storm waters, although stringent requirements would need to be placed on sewage disposal systems emptying into the drains.

Irrigation Benefits

Saving in Water by Concrete Lined Canal. If the project is not constructed, studies of available water supplies indicate that the Valley has probably reached its maximum safe development. The present irrigated area requires for irrigation use, an annual average of about 1,100,000 acre-feet of water, in addition to the normal rainfall. The Rio Grande between Falcon Damsite and the lower end of the project area is a wide meandering stream about 200 miles long. Seepage and evaporation losses in this reach, based on similar measured losses in the Rio Grande between Fort Quitman and Upper Presidio and losses in long, unlined earthen canals, are estimated at 30 percent of the normal flow. There will be very little usable inflow between the Falcon Dam and the project area in future years, inasmuch as all waters of the only two streams of any consequence, the San Juan and Alamo Rivers, are allotted to Mexico and full development of such streams will likely be made. Preliminary water supply studies show that the United States' dependable share of water available for the Lower Valley amounts to an annual average of 1,500,000 acre-feet. A loss of 30 percent would then leave only 1,050,000 acre-feet annually delivered in the river to the pumping plants which is barely sufficient to meet the demand of the present area.

Increase in Gross Crop Returns. The project would make possible the irrigation of 700,000 acres or an increase of 148,000 acres. Most of this area is now covered by brush, yielding only meager pasturage and making present returns negligible when compared with those from the irrigated lands.

Based on cropping practices and yields of similarly classed lands in the adjacent irrigation districts, and the 1939-1944 average unit price, the gross annual crop income which is used as a measure of benefits, would amount to approximately $29,517,000 for this 148,000 acres:

Class 1 - 79,000 acres at $242 per acre	=	$19,118,000
Class 2 - 59,000 acres at $161 per acre	=	$ 9,499,000
Class 3 - 10,000 acres at $ 90 per acre	=	900,000
Total		$29,517,000

Elimination of Major Pumping Plants. Fifteen major pumping plants, situated on the Rio Grande, serve the present irrigated area. Second, third, and fourth lift pumps are also required for certain of the districts. Operation of the fifteen river pumping plants is costly and subject to many hazards. The Rio Grande is constantly changing its course and in the past has shifted, leaving some plants far from the main channel while in other locations it has cut in behind and washed out the plants. Seven such plants have been destroyed and others have several times been in danger. At present seven of the plants must maintain inlet channels, ranging up to 3/4 mile in length between the plants and present river channel. Even with the construction of the storage dams on the Rio Grande, this threat to the safety of the plants and operational difficulty will not be removed since there is considerable area below the dams which could produce flash floods of dangerous proportions. Furthermore, the spillways of proposed dams on the Rio Grande and the spillway on the existing Azucar Dam on the San Juan River in Mexico, have capacities of several hundred-thousand second-feet and discharges of great magnitude can be expected in future years from unusual storms.

Pumping costs vary considerably throughout the Valley. Several of the districts have settling or desilting basins which are enlarged as they become silted up. Those districts which do not have settling basins necessarily have higher canal cleaning costs. To determine savings in or reduction in district pumping costs which may be effected by the project works, such items as desilting basins, removing silt from canals, maintaining inlet channels to pumps, protecting pumping plants from Rio Grande floods, and the actual operation and maintenance, depreciation and some overhead costs of the pumping plants must be considered.

Pumping costs were determined from information contained in the Project No. 5 Report, compiled by the International Boundary Commission, and data on actual costs obtained from the County Auditor's Reports of the Districts. These studies show an average cost of $0.53 per acre-foot for ten river pumps and $0.47 per acre-foot for two second lift pumps. For the purpose of estimating savings in pumping costs to the present lands, an average cost of $0.50 per acre-foot per lift has been used.

With an estimated future average irrigated area within the present districts of approximately 550,000 acres requiring approximately 1,100,000 acre-feet of water, the total acre-foot-lifts for all first, second, third, and fourth lifts would be approximately 1,702,000. The project works would eliminate

approximately 1,602,000 of this total which, evaluated at $0.50 per acre-foot lift, would result in an annual saving of $801,000 to the districts in future years. Actual reduction for years similar to 1944 and 1945, when the irrigated area amounted to 435,000 and 495,000 acres, would have amounted to approximately $602,000 and $744,000, respectively.

Drainage Benefits

The outlet drains would permit the districts to make effective improvements to the lateral drainage systems within their boundaries. In turn, this would permit the individual landowners to construct such drains as are desirable at the farm level. This overall drainage construction would lower the present high water table of certain areas and permit growing of higher valued crops. If these drainage works are not constructed, studies disclose that an increasing loss in crop income of the Valley as a whole will occur. The changes in gross crop income have been used as a measure of all benefits to the nation, and the value from the outlet drains appraised thereon. The outlet drains would also have appreciable benefits of a flood control nature and for fish and wildlife conservation. An analysis of these benefits follows:

Increase in Gross Crop Returns. Studies show that approximately 70 percent of the irrigated area is in need of drainage relief. Generally, areas having depths to groundwater of 3 feet or less are at present out of production, those having depths of 3 to 5 feet are in poor condition, and those having depths of 5 to 8 feet appear to be in an insecure position. Areas having depths over 8 feet are apparently safe, at least for the present.

To obtain maximum benefits from the outlet drainage system, it would be necessary for most districts to construct additional drains within their own boundaries. Individual farms in many cases would need tile or shallow surface drains to convey excess waters to the districts' laterals. Drainage which may ultimately be required for project lands is estimated at an average cost of $175 per acre, including cost of outlet drains and laterals. The approximate cost of the main drains is $30 per acre or 17 percent of the total drainage cost.

Benefits have been estimated by assuming full drainage development and assigning a percentage of these benefits to the outlet drain. On the basis of cost alone, the benefits assignable to the drains as outlets would be 17 percent. However, the drains would have additional local benefits. The net area of such lands directly benefited is estimated at 57,000 acres or 8 percent of the total project area. This direct benefit would be in addition to the 17 percent assumed value of the drains as outlets bringing the total benefit of the outlet drains to 25 percent of the total derived from a complete drainage system.

The increase in gross crop returns made possible by the drainage system is indicated by the wider diversification of crops which can be produced on lands having greater depths to water table. Based on generalized land classification and groundwater maps, the following areas have a water table less than 5 feet: 1,500 acres of class 1 land; 73,260 acres of class 2 land; and 19,770 acres of class 3 land.

The 1,500 acres of class 1 land which now produce only cotton and vegetables could be used for production of citrus fruits at an increased return of $30 per acre, assuming full drainage development, or a total annual increase in gross crop income of $45,000. Likewise, returns from the 73,260 acres of class 2 land could be increased $25 per acre or a total of $1,831,500. For the 19,770 acres of class 3 land, now producing only cotton, with lowering of water table, both cotton and vegetables could be produced at an increased gross crop return of $40 per acre or a total of $790,800. These annual increases total $2,667,300 and represent the possible increased returns from the approximate 453,000 acres covered in the drainage study. Adjusted to full project development of 700,000 acres this sum would be increased to $4,114,000. The annual amount assigned as benefits from outlet drain construction is taken at 25 percent of the total, the proportion of total drainage costs represented by the outlet drains, or $1,028,000.

Lands that might be reclassified into a higher productive class as a result of drainage works are those now classed as 2D which total approximately 22,500 acres. These lands in their present state have yields which average $161 per acre. With improved drainage conditions, these lands would doubtless attain the productiveness of class 1 lands, $242 per acre income, or an increase of $81 per acre. For 22,500 acres this would amount to a total increase of $1,822,000 of which 25 percent or $456,000 annually would be assignable to the outlet drains.

The annual benefits of the outlet drains as measured by increased gross crop returns of the project area would then amount to $456,000 plus $1,028,000 or a total of $1,484,000.

Protection of Present Income. If the required drainage work in the Valley is not performed, indications are that much of the area now with a water table less than 8 feet depth will yield lower returns or go out of production entirely. A comparison of results of the Bureau of Reclamation's land classification survey, completed in 1945, with a survey in 1925 by U. S. Department of Agriculture, indicates that the average salt content for the irrigated lands of the Valley has more than doubled. The average salt content of an area of 155,000 acres situated north of the main Valley highway and extending from Mission to Mercedes, as measured in 1925 by 138 test holes, was 0.13 percent. By the end of 1945, the salt content in the same area had increased to 0.28 percent. To appraise the benefits of the outlet drains for protection of the present income, it was assumed that the increase in salt content, as shown by the surveys in 1925 and 1945 is indicative of changes in land classification, and that further deterioration at the same average rate as for the 21-year period will occur if the drains are not built. The estimated income for the 155,000 acres, if based on the 1925 survey, would amount to $34,683,000. In 1945 the income would have been reduced to $28,824,000 as a result of the increased salt content or a loss of $5,859,000. This is an annual average of $279,000 or a rate of approximately 0.97 percent based on the 1946 income.

This annual rate of loss in the 21-year period was applied to the area now irrigated in the districts, resulting in an average annual benefit, assignable as protection afforded by the outlet drains, of $3,936,000 as follows:

Estimated Future Returns from Present Irrigated Area

Class	Acres	Returns per Acre	Total Returns
1	131,000	$242	$31,702,000
2	248,000	161	39,928,000
3	84,000	90	7,560,000
Subtotal	463,000		$79,190,000
5 & 6	89,000	*None	None
Total	552,000		$79,190,000

*Actually some returns but these lands are not considered to be in a paying class.

Indicated rate of increase of loss of income per year 0.97 percent x $79,190,000 =	$ 768,000
Annual loss computed in the 40th year $768,000 x 40 =	$30,720,000
Average annual loss during 40-year period =	$15,744,000

Of this amount, 25 percent or $3,936,000 would be assignable as protection afforded by the outlet drains.

Flood Control The outlet drains will have appreciable benefits of a flood control nature. At present, following periods of heavy rainfall, water stands for long periods over certain low areas of farm lands, highways and towns, owing to a lack of drainage outlets. In 1941, over 20,000 acres southeast of Edinburg were covered with water and in 1946, 8,000 acres in Cameron County were under water for some time. Crops were destroyed and other appreciable damage occurred. Practically every year some areas are so affected. The minimum section of the main drains which is feasible for construction would provide more capacity than is required for removal of normal or drainage return flows. By building structures of a type and clearance capacity that will permit utilization of this minimum section for removal of storm runoff and by enlarging the drains toward their lower ends, greatly increased benefits can be obtained. The expenditure of $3,816,000 beyond that required for constructing the drains to the minimum section, would permit enlargement of the drains sufficiently to provide capacities for removal of runoff from storms occurring with a frequency of about once in ten years, which appears to be the practical limit of protection that should be afforded at this time. This added expenditure of $3,816,000 has been taken as benefits from the main drains for flood control, and assumed for a 40-year period or $95,400 annually.

Fish and Wildlife. Net benefits to fish and wildlife conservation for the main drains as estimated by the Fish and Wildlife Service amount to $21,700 annually. In addition, the drains would permit furnishing approximately 40,000 acre-feet of water annually to the Laguna Atascosa Refuge and 1,000 acre-feet to the Santa Ana Refuge, at a value of $1.00 per acre-foot or a combined total of $41,000, annually. The total annual benefits of the drains for fish and wildlife conservation amount ot $62,700 or over a 40-year period, $2,508,000.

Summary Outlet Drain Benefits. Summing up the benefits of the outlet drains to which a monetary value can be definitely assigned gives the following:

	Annual Benefits
Protection of present income	$3,936,000
Increase in gross crop return	1,484,000
Flood control	95,400
Fish and wildlife conservation	62,700
Total	$5,578,100

The indirect benefits of the outlet drains include protection and stabilization of the numerous industries of the Valley which are dependent on agricultural production, and general improvement of sanitary conditions by removing waters from depressed or low areas of the Valley.

Power

The project will permit generation of an annual total of 74,700,000 kilowatt-hours of electrical energy at the La Joya Power Plant. This energy is valued at 4 mills per kilowatt-hour or an annual total of $298,800. Deducting annual costs of the plant (repayment of construction, operation and maintenance, and replacement reserves) leaves a net annual value of $116,600. This sum over a 40-year period would amount to $4,664,000. With addition of the cost of the power plant, $2,560,000, which is repaid, the total benefits of the project for power would amount to $7,224,000. However, inasmuch as disposition of the power produced at the La Joya plant is not definitely known, only that cost, $182,200, which would retire the power plant and pay operation and maintenance charges is included in the estimate of benefits.

The area included in the power market study is that designated as Area VII in the "Power Requirements Survey of Texas," published by the Federal Power Commission in April 1945 shown on the attached Area Power Map. This area was chosen as the Market Area for sale of power from the proposed La Joya Power Plant, as power facilities in this area are tied into an integrated system and connection to this system at any point would make the entire Area (VII) the Market Area for power.

The installed generating capacity for the area under study was 625,356 kilowatts on December 31, 1941. It is assumed that no appreciable changes have taken place since then. Of this capacity, 74.3 percent was in steam plants, 1.8 percent was in internal combustion plants, and 23.9 percent was in hydro plants. The Federal Power Commission estimated that the dependable capacity for 1944 was 618,030 kilowatts and the net assured capacity was 454,413 kilowatts which, with a peak demand of 542,900 kilowatts in that year, indicating a deficiency of 88, 487 kilowatts.

The Federal Power Commission estimated that by 1950 the loss of war time loads in the area will have been regained. Estimates for the Market Area for the year 1950 indicate a deficiency of 13,870 kilowatts. The estimates for 1965 indicate a deficiency of 656,070 kilowatts. Additional capacity requirements are shown on the attached drawing, Additional Power Capacity Requirements. New steam-electric plants would constitute the principal alternative future source of power supply if hydroelectric plants were not built. The total value of the dependable generating capacity and usable energy that could be made available from the hydroelectric plants at proposed multiple-purpose projects is computed on the basis of the cost of producing equivalent power at alternative steam-electric plants adjusted for the advantages of hydroelectric power over steam.

The annual "at market" value of the hydroelectric power, if its output can be firmed from power of the future up-site developments at the international storage dams to fit into the season load-factor of this area, would equal the installed kilowatts times $14.90 plus the annual kilowatt hours times 1.35 mills. For the project plan this will equal a total unit value for both capacity and energy of approximately 4 mills per kilowatt hour.

The estimate of 4 mills as the average value per kilowatt hour at the market of the saleable energy is based on the assumption that the dependable capacity of the La Joya plant would be equal to the installed capacity. This will be true only if La Joya is a part of a coordinated power and transmission system which would include power plants at several of the international dams and full credit for the installed plant capacity as "dependable capacity" could be given to La Joya. This can only be determined in a future over-all study which includes all power developed at the international dams.

Since the annual revenue required to repay the La Joya power cost is approximately $182,000 as compared with an estimated revenue of $298,800 on an estimated average 4 mill/kwhr value, it is assumed the power development can be justified. If later studies indicate this is not the case, the power development can be omitted without affecting the rest of the project since power is not bearing any other than power costs.

Mission Reservoir

Annual benefits of the Mission Reservoir for fish and wildlife conservation and for recreational purposes as estimated by the Fish and Wildlife Service and the National Park Service, respectively, would amount to the following:

Fish and Wildlife Conservation	$ 20,200
Recreation	39,982

These annual sums would amount to approximately $808,000 for fish and wildlife conservation and $1,600,000 for recreation over a 40-year period. These benefits are in addition to benefits for Fish and Wildlife Conservation from drainage.

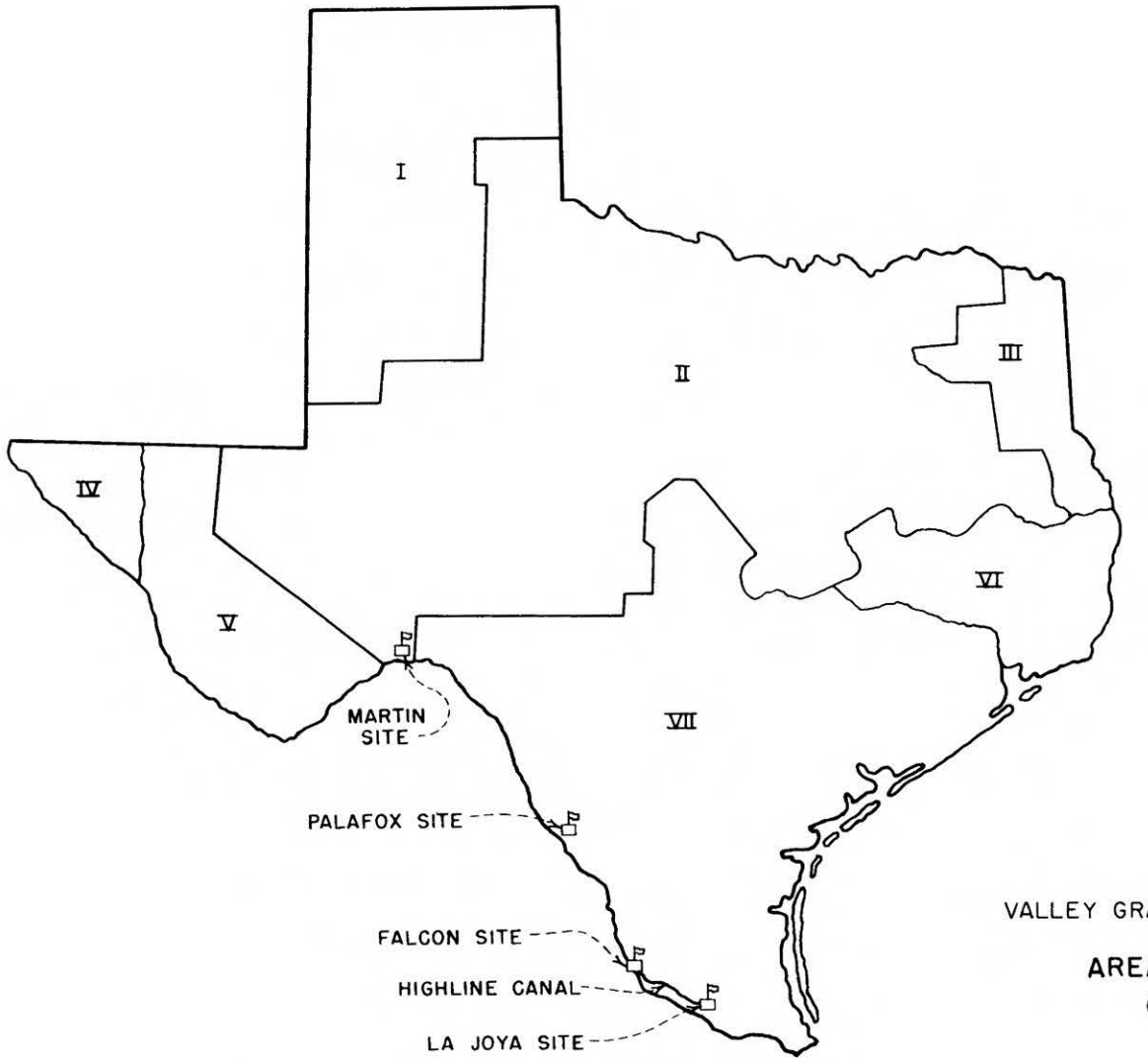
Allocation of Costs

Tentative allocations of costs on the basis of benefits indicate $3,816,000 and $3,316,000 could reasonably be assigned to flood control and fish and wildlife purposes, as non-reimbursable costs to be borne by the Federal government. In addition, should authority be granted for allocation of costs to recreation as a Federal benefit, an additional allocation of $1,600,000 could reasonably be made thereto. Though it is recognized that benefits assignable to the power facilities provided under the project plan would justify an allocation of construction cost thereto considerably in excess of the costs of such facilities, for purposes of analysis of the project repayment capacity, the allocation to power was considered to be the cost of the facilities or $2,560,000. In addition, it is expected that $1,000,000 of the total cost will be returned as collections for operation and maintenance during construction, and as credits for rent and salvage value of temporary camps and buildings. On the basis of the above, the reimbursable costs assignable to irrigation and drainage would be $117,336,000. Following is a summary of the tentative cost allocations:

Collections or Credits	$ 1,000,000
Power	2,560,000
Fish and Wildlife Conservation	3,316,000
Recreation	1,600,000
Flood Control	3,816,000
Irrigation and Drainage	117,336,000
Total	$129,628,000

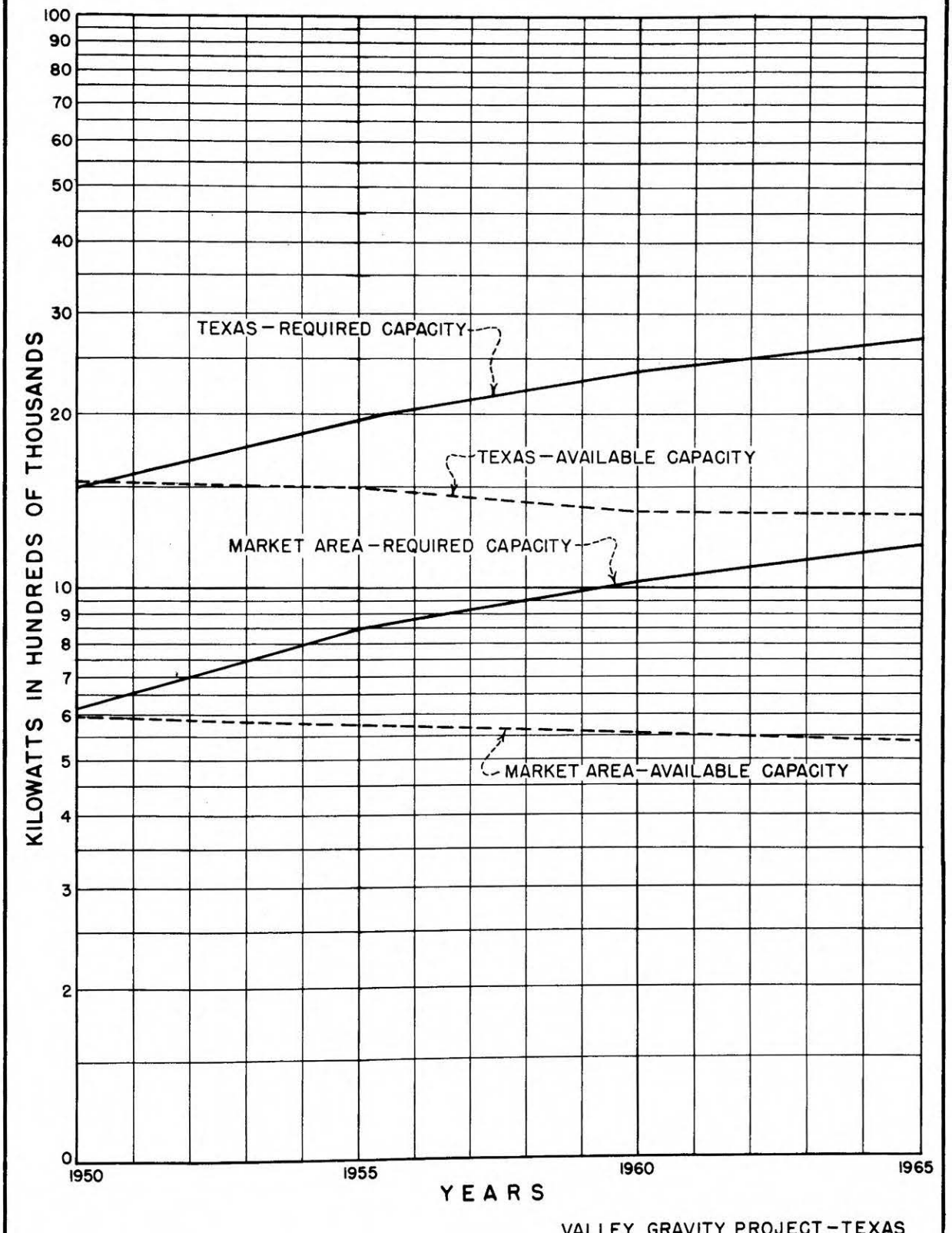
Summary of Costs and Benefits

To compare costs and benefits of the project, the total capital cost was determined, which amounts to $181,919,000. This sum includes all construction and land development costs. The land development costs include clearing, leveling, construction of farm laterals, farm drainage, buildings, and water supply, for the 148,000 acres of additional lands to be irrigated amounting to $52,291,000.



VALLEY GRAVITY PROJECT – TEXAS

AREA POWER MAP
OF TEXAS



VALLEY GRAVITY PROJECT – TEXAS

ADDITIONAL POWER CAPACITY REQUIREMENTS

The total capital cost, was amortized over fifty years at 3 percent interest to obtain annual costs. Operation and maintenance charges were added thereto. As shown in the attached Table 6, these annual costs amount to $7,978,900 which, compared with annual benefits of $36,138,000, give a ratio of costs to benefits of 1 to 4.53.

Extended Benefits

Numerous benefits which do not lend themselves to a monetary evaluation would accrue from the project. Most of these are included in the evaluated benefits inasmuch as the gross crop income was used as a measure of all benefits.

The water supply for domestic and industrial purposes in the Valley is derived principally from the Rio Grande via the irrigation districts' irrigation systems. Water for the cities and towns is obtained from the nearest canal, treated and delivered to storage tanks. These tanks are large enough for only a few days supply, and under present conditions, fairly steady pumping is required. It is not contemplated that the project works would change the existing arrangement between the water districts and towns. However, the project canals would provide dependable carriage works for water stored in the Falcon Reservoir. Water of good quality, substantially free of silt, sediment, and algae would be delivered to the district canals for distribution to the various cities.

Disposal of sanitary and industrial sewage and municipal storm waters is a major problem in the Valley. At present, most sewage is directed toward the only available outlets, the Main Floodway and the Arroyo Colorado, through somewhat inadequate channels. Due to the location of the towns it is generally difficult and expensive to maintain adequate disposal facilities to the Floodway and Arroyo. The main drains through lateral extensions to the towns, would provide outlets which could be conveniently used for sewage and storm water disposal. General improvement of sanitary conditions in the Valley should result from the drainage construction.

Future developments in Mexico are now being planned which would divert water from the Rio Grande several miles upstream from Reynosa. Substantially all of the lands now being irrigated on the United States' side of the river in the Valley obtain water by pumping below this diversion site. As the project plan provides for diversion at the Falcon Reservoir, it would insure the availability of the project water supply. It would also eliminate the possibility of any international or local controversies over rights to the project waters such as normally arise in connection with attempts to deliver stored water over long distances through natural river channels comparable to that of the Rio Grande below the Falcon Dam site.

As under the project plan, water would be delivered to the project by gravity, considerable amounts of electrical energy which otherwise would be required for pumping would be available for industrial and other purposes in the Valley. The availability of such energy should be conducive toward further industrial development and result in increased income to the area.

Construction of the project would create an immediate requirement for construction equipment and an increased need for agricultural equipment and

TABLE 6

SUMMARY OF COSTS AND BENEFITS

First Cost	
Construction Cost	$129,628,000
Land Development Cost	52,291,000
Total	$181,919,000
Annual Cost	
Amortization of First Costs (50 yrs. @ 3%)	
$181,919,000 x .03887 =	$ 7,071,200
Operation and Maintenance	907,700
Total Annual Costs	$ 7,978,900
Annual Benefits	
Irrigation	
Increase in Gross Crop Returns	$ 29,517,000
Reduction in Pumping Costs - Present Districts	801,000
Drainage	
Protection of Present Income	3,936,000
Increase in Gross Crop Returns	1,484,000
Flood Control $3,816,000 ÷ 40 years	95,000
Fish and Wildlife Conservation	63,000
Fish and Wildlife Conservation - from Irrigation Works	20,000
Recreation	40,000
Power	182,000
Total Annual Benefits	$ 36,138,000
Ratio Annual Costs to Benefits =	1 to 4.53

other manufactured products. Considerable employment in construction work also would be provided.

The established incomes resulting from the project would permit establishment of permanent homes and minimize future needs for relief activities in the project and surrounding areas.

Repayment

General

The owner-renter relationship provides a means of determining repayment ability in a manner which avoids detailed studies of the many separate items comprising the cost of production. With some variation, the repayment analisis of the project was based on this method in which the owner's share of the total gross crop income is computed and from which certain costs to the owner pertaining to farm costs, returns on investments, etc., are deducted to determine the amount available to the owner to meet all water charges.

Two types of land tenure are established in the Valley: citrus production, and a combination of vegetables and cotton. Citrus production is usually a cash maintenance type of tenure while the tenure common to the production of vegetables and cotton provides that the owner receives 1/4 of the gross crop income.

The repayment analysis was made for each paying class of land based on suggested economic size units of 40 acres for Class 1, 80 acres for Class 2, and 160 acres for Class 3. Studies indicate that units of these acreages should adequately support an average size farm family and pay reasonable water charges.

Crop Yields and Values by Land Classes

A survey of 667 farm enterprises was made to collect data on the productive ability of different land classes and their adaptability to crops grown in the Valley area. This survey, supplemented by data from the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, provided the following generalized pattern of major crop distribution for the arable lands in the area:

Distribution of Major Crops Expressed in Percentage of Acreage on Different Land Classes

	Class 1	Class 2	Class 3
Citrus	37	23.4	3.7
Cotton	10	36	64
Tomatoes	27	30	19
Carrots	5	5	11
Cabbage	3	10	3
Corn	6	--	--
Beans	8	--	--
Pasture	0	0	10

As evidenced in the above table, double cropping is practiced in the growing of practically all vegetables. Although some Class 3 land is devoted to citrus, the data collected disclosed that low yields of this crop do not warrant its continued production of this class land. Accordingly, in the repayment studies, it was assumed that Class 3 land would be devoted to production of crops other than citrus. This assumption is further supported by the number of groves that are being removed on Class 3 land and the fact that the majority of new groves are being planted on Classes 1 and 2 land.

The anticipated income per acre for the arable classes of land was based on the crop distribution as obtained from the farm survey, assumed stable yields, and the six-year average prices (1939-1944). With this basis, a weighted value per acre for the various classes of land was prepared as shown in Tables 7, 8, and 9, the results of which are summarized as follows:

	Class 1 Land	Class 2 Land	Class 3 Land
Citrus	$278.66	$237.60	$ None
Other Crops	211.50	105.69	89.71
Weighted Average	$241.70	$160.98	$ 89.71

Owner's Share of Income and Amount Available to Pay All Water Charges

The determination of the owner's share of gross crop income was made on the basis of the combination of enterprises set forth in the economic size of unit for each class of land. Due to the cash maintenance system of tenure for citrus, a straight owner-renter method could not be used. Accordingly, the owner's share of the income was determined by the following steps:

(1) Determination of the total returns from citrus

(2) Determination of 1/4 of the total returns from vegetables and cotton

(3) Total returns from citrus and 1/4 of returns from vegetables and cotton to give gross returns to the owner

(4) Determination of the total expenses to the owner

(5) Total returns to the owner less total expenses to the owner to determine the net returns to the owner or the amount available to pay total water charges.

These computations are summarized for the different units as follows:

	Size of Unit		
	40 Acres Class 1	80 Acres Class 2	160 Acres Class 3
Acres in citrus	14.8	18.74	0
Acres in other crops	25.2	61.26	160
Income per acre from citrus	$ 278.66	$ 237.60	$
Income per acre from crops	211.59	135.69	89.71
Owner's share of income per acre			
Citrus	$ 278.66	$ 237.60	$
Crops ($\frac{1}{4}$)	52.90	33.92	22.43
Owner's total income			
Citrus	$4,124.17	$4,452.62	$
Crops	1,333.08	2,077.94	3,588.80
Total	$5,457.25	$6,530.56	$3,588.80
Less costs paid by owner	4,785.60	5,664.00	2,571.20
Amount available to pay total water charges	$ 671.65	$ 860.09	$1,017.60
Amount available to pay total water charges per acre	$ 16.79	$ 10.83	$ 6.36

Costs to be paid by the owner from his share of the income are those costs pertaining to land and capital which include taxes, insurance, maintenance, and depreciation, land improvement and ditching, drainage, interest on investment and management. Additional items of cost to the owner which apply only to citrus are grove care or cash maintenance, replacement of grove, and major pruning. These items are summarized in the following table. It will be noted in this analysis that all items of cost to the landowner were spread over the entire number of acres of the unit. The total costs per acre is a weighted average cost for the total acreage of each unit. Values used in the study included improvements in each unit consisting of a house at $6,200, farm buildings $2,600, and domestic water supply $1,200, or a total investment of $10,000 for all farm improvements.

Costs to be Paid by Owner

Item	40 Acres Class 1	80 Acres Class 2	160 Acres Class 3
Taxes ($4.00 per $100 valuation)	$ 2.74	$ 2.13	$ 0.80
Insurance on house and bldgs. House @ $1.90 per $100 Bldgs. @ $2.15 per $100	4.34	2.17	1.09
Maintenance and depreciation of home, bldgs., and domestic water supply @ 3%	7.50	3.75	1.88
Land improvement and ditching @ $0.60 per acre	0.60	0.60	0.60
Replacement of grove	12.39	7.84	0
Fertilizer	12.69	5.87	1.00
Drainage amortized @ 3½% for 20 years	4.82	4.34	2.46
Pruning	2.59	1.64	0
Orchard Care	26.27	16.63	0
Interest on Investment @ 5%	38.88	21.75	7.12
Management	6.82	4.08	1.12
Total cost per acre to owner	$119.64	$70.80	$16.07

Amounts Available to Meet Project Water Charges

From the amount available to meet all water costs, the districts own charges and Bureau operation and maintenance costs must be deducted to determine amounts that can be applied against the Bureau construction costs.

There is a wide disparity in the present district water charges, due to various reasons, both physical and institutional. In estimating the districts' future water charges, allowances have been made for retirement of the present bonded indebtedness and for probable new construction or rehabilitation of the districts' irrigation and drainage systems. Savings in the districts' present operation costs to be effected by Bureau construction such as elimination of pumping plants, were also considered.

The estimated future water charges for the independent lands was set at the same figure as the average charge of all districts since cost of independents will be approximately the same as that of the districts. Charges for operation and maintenance of the irrigation and drainage systems

for the Bureau's new lands have been estimated at $2.69 per acre. This is in addition to the estimated cost of $0.90 per acre for operation and maintenance of the Bureau's main canals and outlet drainage systems which sum is to be applied to all lands of the project.

The annual amount available for repayment of construction costs considering these charges is $2,664,856. For the 610,647 acres of paying class lands this would be an average of $4.36 per acre. The amount that can be repaid in 40 years is approximately $96,661,000 or 82 percent of the total cost charged to irrigation and drainage. In establishing this value no district was assumed to pay more than its allocated cost.

The studies disclose that substantially all districts, if granted sufficient time, could pay 100 percent of the Bureau construction costs chargeable to irrigation and drainage. Excluding the new lands, an average of 64 years would be required for these districts to pay their construction charge. Five small districts, totaling 9,167 acres, which have either high water costs or a large percentage of Class 3 land or a combination of both could not pay construction charges or could make only very small payments. In the case of three of the districts, even the Bureau's operation and maintenance charges could not be met. Some special assistance, such as taking over the district's bonds or financing new work with interest-free money, can possibly be given these districts to put them in condition to pay Bureau charges.

Apportionment of Construction Cost to Various Districts

There are 33 irrigation districts in the project area of which 27 are now active. Lands within the districts are Classes 1, 2, 3, 5, and 6, (See Appendix E - Project Lands). The districts deliver water to and collect charges from all classes of lands within their boundaries. However, the Classes 5 and 6 lands have a comparatively low valuation for the purpose of assessing bond taxes and accordingly pay a smaller rate than the better lands. As proposed, the project area of 700,000 irrigable acres will consist of the following: 610,647 acres of Classes 1, 2, and 3 lands which are designated as paying classes; and a non-paying class composed of 14,630 acres of Class 5 and 74,723 acres of Class 6 land. Included in the paying classes are 72,588 acres of new lands proposed for development by the Bureau and 538,059 acres situated within the district boundaries, or owned by independent operators.

The entire reimbursable construction cost was charged to the 610,647 acres of paying class lands. The apportionment of the construction costs to the individual districts was computed on the basis of charging the cost of the main canals and drains common to all lands on a per acre income basis, and making an additional charge to the new lands for the cost of irrigation laterals and lateral drains constructed solely for these lands. This apportionment of total cost to the various districts is summarized in Table 10.

From 3 Sheets of Detail

TABLE 7

Class 1

SUMMARY OF 1944-1945 CROP YIELDS-1939-1944-AVERAGE PRICE
ACTUAL YIELDS AND ACREAGES FROM CROP REPORTS TAKEN IN THE FIELD

No. of Farm Units 274 — Corrected to Jan. 1947

Crop	Acres in Crop	Unit of Yield	Total Yield	Yield Per Acre	Average Unit Value 1939-44		Total Value	Value Per Acre
Cotton	709.5	lb.	212,075	299	.155		$ 32,871.63	$ 46.33
Cotton Seed	709.5	lb.	323,742	456	.02		6,474.84	9.12
Carrots	359	crate	95,464	266	.52		49,641.28	138.28
Tomatoes	1,929.5	lug	325,389	169	1.71		556,415.19	288.37
Corn	428.5	sack	35,307	82	.88		31,070.16	72.51
Cane	117	ton	389	3	10.00	Est.	3,890.00	33.25
Beans	5,355	bu.	24,108	45	1.52		36,644.16	68.43
Broccoli	1,005	crate	10,755	107	1.00		10,755.00	107.01
Cabbage	181	ton	1,088	6	23.95		26,057.60	143.96
Peppers	43.36	bu.	15,055	347	1.14		17,162.70	395.82
Beets	144.5	crate	27,625	191	.45		12,431.25	86.03
Peas	65	bu.	1,487	23	1.18		1,754.66	26.99
Parsley	20	crate	3,030	152	.62		1,878.60	93.93
Egg Plant	2	bu.	353	176	.77		271.81	135.90
Cantaloupes	3	crate	189	63	1.00		189.00	63.00
Watermelons	1	melon	148	148	.13		19.24	19.24
Hot Peppers	.2	lb.	1,250	6,250	.08	Est.	100.00	500.00
Radishes	18	crate	1,347	75	.32		431.04	23.95
Cucumbers	.5	bu.	5	10	1.54		7.70	15.40
Citrus (Bearing)	4,398.44	box	1,705,727	387	.90		1,535,154.30	349.02
	9,765.80							
Acres Counted Twice	- 709.5							
	9,056.30							
Citrus	-4,398.44							
	4,657.86							
Double Crop.	- 931.57							
Vegetables & Cotton*	3,726.29							
Citrus (Bearing)**	2,405		930,735	387	.90		837,661.50	348.30
Citrus (Non-Bearing)#	601							
Total Citrus	3,006							278.66
Vegetables & Cotton	3,726						788,065.86	211.50
Total Cropped Acres	6,726						$1,625,727.36	$241.70

* Vegetable and Cotton acreage reduced 20% to allow for double cropping.
\# Citrus acreage increased to include non-bearing acreage.
** Citrus acreage adjusted to 37% of cropped area of Class 1 land.

From 3 Sheets of Detail Class 2

TABLE 8

SUMMARY OF 1944-1945 CROP YIELDS-1939-1944-AVERAGE PRICE
ACTUAL YIELDS AND ACREAGES FROM CROP REPORTS TAKEN IN THE FIELD

No. of Farm Units 124 Corrected to Jan. 1947

Crop	Acres in Crop	Unit of Yield	Total Yield	Yield Per Acre	Average Unit Value 1939-44	Total Value	Value Per Acre
Cotton	703	lb.	171,584	245	.155	$ 26,595.52	$ 37.83
Cotton Seed	703	lb.	306,862	437	.02	6,137.24	8.73
Radishes	3	crate	136	45	.32	43.52	14.51
Beans	46	bu.	1,777	39	1.52	2,701.04	58.72
Broccoli	31	crate	1,723	56	1.00	1,723.00	55.58
Tomatoes	588.9	lug	78,951	134	1.71	135,006.21	229.25
Cabbage	195.1	ton	581	3	23.95	13,914.95	71.32
Carrots	92	crate	9,865	107	.52	5,129.80	55.76
Turnips	12.5	crate	222	18	.46	102.12	8.17
Squash	5	bu.	107	21	1.12	119.84	23.97
Hot & Chili Peppers	13	lb.	7,757	597	.08	620.56	47.74
Corn	65.5	sack	2,187	33	.88	1,924.56	29.38
Parsley	6	crate	866	144	.62	536.92	89.49
Cane	18.5	ton	44.5	2.5	10.00 Est.	445.00	24.05
Potatoes	14	bu.	498	32	1.55	771.90	55.14
Peppers	10.5	bu.	1,072	102	1.14	1,222.08	116.39
Peas	13.5	bu.	254	19	1.18	299.72	22.20
Citrus	552.21	box	182,256	330	.90	164,030.40	297.04
	3,072.71						
Acreage Counted Twice	- 703.00						
	2,369.71						
Citrus	- 552.21						
	1,817.50						
Double Cropping	- 363.50						
Vegetables & Cotton	1,454.00						
Citrus Bearing*	384.00		126,720	330	.90	$114,048.00	$297.00
Citrus (Non-Bearing)#	96.00						
Total Citrus**	480.00						237,60
Vegetables & Cotton	1,454.00					197,293.98	135.69
Total All Crops	1,934.00					$311,341.98	$160.98

* Vegetables and Cotton acreage reduced 20% to allow for double cropping.
\# Citrus acreage increased 20% to include non-bearing acreage.
** Citrus acreage adjusted to 24% of acres of Class 2 land.

From 2 Sheets of Detail Class 3

TABLE 9

SUMMARY OF 1944-1945 CROP YIELDS-1939-1944-AVERAGE PRICE
CLASS 3-6SC

No. of Farm Units 117 Corrected to Jan. 1947

Crop	Acres in Crop	Unit of Yield	Total Yield	Yield Per Acre	Average Unit Value 1939-44	Total Value	Value per Acre
Beans	37	bu.	1,409	38	1.52	$ 2,141.68	$ 57.88
Beets	45	crate	16,447	365	.45	7,401.15	164.47
Broccoli	127.5	crate	12,069	95	1.00	12,609.00	98.89
Cabbage	108	ton	337.6	3	23.95	8,085.52	74.86
Carrots	385.5	crate	42,929	111	.52	22,323.08	57.91
Corn (Green)	66.5	sack	1,675	25	.88	1,474.00	22.16
Cotton (lint)	2,139	lb.	566,891	265	.155	87,868.10	41.08
Cotton Seed	2,139	lb.	963,714	451	.02	19,274.28	9.01
Peppers	10	bu.	2,909	291	1.14	3,316.26	331.63
Tomatoes	308	lug	51,006	166	1.71	87,220.26	283.18
Cane	21	ton	31.8	1.5	10.00 Est.	318.00	15.14
Spinach	11	bu.	2,272	207	.62	1,408.64	128.06
Egg Plant	1	bu.	72	72	.77	55.44	55.44
Onions	4.5	sack	900	200	2.45	2,205.00	490.00
Squash	3	bu.	140	47	1.12	156.80	52.27
Peas	93	bu.	563	6	1.18	664.34	7.14
Potatoes	3	bu.	258	86	1.55	399.90	133.30
Turnips	8	crate	506	63	.46	232.76	29.09
Lettuce	4	crate	110	28	1.10	121.00	30.25
Alfalfa	10	ton	60	6	15.00 Est.	900.00	90.00
Parsley	10	crate	1,200	120	.62	744.00	74.40
Mustard	6	bu.	560	93	.50 Est.	280.00	46.67
Radishes	4	crate	672	168	.32	215.04	53.76
Pasture	334	acre			15.00 Est.	5,010.00	15.00
Citrus	295.5	box	41,113	139	.90	37,001.70	125.22
	6,173.50						
Acres Counted Twice	-2,139.00						
	4,034.50						
Less Citrus	- 295.50						
	3,739.00						
Less 20% Double Cropping	- 748.00						
Vegetables & Cotton*	2,991.00						
Citrus**	369.00						
Total All Crops	3,360.00						

Value Vegetable and Cotton	264,424.25	88.41
Value Citrus	37,001.70	100.28
Average Value All Crops	$301,425.95	$ 89.71

* Vegetable and Cotton acreage reduced 20% to allow for double cropping.
** Citrus acreage increased 20% to include non-bearing acreage.

ORGANIZATION AND ADMINISTRATION

The existing irrigation districts are organized under the laws of the State of Texas and are empowered to impose charges for retirement of bonds, maintenance and operation of canals, and a charge for delivery of water. They are also empowered to make a contract with the United States Government in pursuance of Federal Reclamation Laws.

In the present operating districts, each acre has a right to the use of water upon payment of district charges, consequently a considerable acreage of land classified by the Bureau as classes 5 and 6 is being irrigated and would doubtless continue to be irrigated after construction of the project, unless land or water rights are purchased. The same right is held by privately owned tracts that now pump from the river or purchase water from existing water user's organizations.

The project construction would eliminate the river pumps and some of the second and third lift pumps. Water would be delivered to the district canals at their head gates, leaving the distribution of water and maintenance of the lateral canals and drains within the districts to the water users. The Federal Government would be responsible for the maintenance and operation of the main drains and gravity canals only.

It would be necessary for the districts to reconstruct some canals and drains and to build new drains and irrigation works to lands not now served within the boundary of the various districts. Therefore, a 10-year development period should be allowed for rehabilitation and changes in the irrigated area to include the more desirable lands would be accomplished.

SCHEDULE OF CONSTRUCTION AND DEVELOPMENT

The schedule of construction and development is presented in the bar diagram on the following page. It is estimated that the overlapping construction and development period would require about seven years.

During the first year, 1948, the examination and survey work would be completed and preconstruction work on the canal system would be initiated.

During the second year, 1949: The construction of the Mission Reservoir, the canal system, and the drainage system would be started. The construction of the permanent improvements would be started. The temporary camp and headquarters would be constructed. The major portion of the work in connection with irrigable area determination and classification of lands would be performed. The operation and maintenance during construction activities would be initiated.

During the third year, 1950: The construction of the Mission Reservoir would be completed. The construction of the canal system, the drainage system, and the permanent improvements would be continued. Work in connection with irrigable area determination and classification of lands and the operation and maintenance during construction activities would be continued.

During the fourth year, 1951: The construction of the canal system, the drainage system, and the permanent improvements would be continued. Work in connection with irrigable area determination and classification of lands and the operation and maintenance during construction activities would be continued.

During the fifth year, 1952: The construction of the canal system, the drainage system, and the permanent improvements would be continued. The construction of the lateral system and the power system would be started. Work in connection with irrigable area determination and classification of lands and the operation and maintenance during construction activities would be continued.

During the sixth year, 1953: The construction of the canal system, the drainage system, and the lateral system would be continued. The construction of the power system and the permanent improvements would be completed.

During the seventh year, 1954, all construction activities would be completed.

VALLEY GRAVITY PROJECT

SCHEDULE OF CONSTRUCTION AND DEVELOPMENT

Feature	Prelimi-nary	F.Y. 1948	F.Y. 1949	F.Y. 1950	F.Y. 1951	F.Y. 1952	F.Y. 1953	F.Y. 1954	
Examination and Surveys	--------	---------							
Mission Reservoir			--------	---------					
Canal System		--------	--------	--------	--------	--------	--------	--------	
Lateral System						--------	--------	--------	
Drainage System			--------	--------	--------	--------	--------	--------	
Power System - La Joya Plant and Transmission Line						--------	--------		
Permanent Improvements			--------	--------	--------	--------	--------		
Temporary Camp and Headquarters			--------						
Irrigable Area Determination and Classification of Lands			--------	--------	--------	--------	--------	--------	
Operation & Maintenance During Const.			--------	--------	--------	--------	--------	--------	
		COST IN NEAREST $1,000							
Cost of Construction	939	400	11,300	26,650	26,650	26,550	26,150	6,739	Total
Irrigable Area Determination and Classification of Lands			500	50	50	50	50	50	750
Operation & Maintenance During Const.	0	0	200	300	300	400	800	1,500	3,500
TOTALS	939	400	12,000	27,000	27,000	27,000	27,000	8,289	129,628

VALLEY GRAVITY PROJECT
SCHEDULE OF CONSTRUCTION AND DEVELOPMENT
Costs in $1,000

Feature	Est. Total Cost	Est. Expend to 6-30-47	F.Y. 1948	F.Y. 1949	F.Y. 1950	F.Y. 1951	F.Y. 1952	F.Y. 1953	F.Y. 1954
Examination and Surveys	$ 1,300	$ 939	$ 361	$ 0	$	$	$	$	$
Mission Reservoir	6,469	0	0	2,400	4,069				
Canal System	84,119	0	39	4,800	17,181	22,000	20,000	19,000	1,099
Lateral System	6,170	0	0				1,000	2,940	2,230
Drainage System	22,760	0	0	3,000	5,000	4,350	4,000	3,000	3,410
Power System - La Joya Plant and Transmission Line	2,560	0	0				1,450	1,110	
Permanent Improvements	1,500	0	0	600	400	300	100	100	
Temporary Camp and Headquarters	500	0	0	500					
Irrigable Area Determination and Classification of Lands	750	0	0	500	50	50	50	50	50
Operation and Maintenance During Const.	3,500	0	0	200	300	300	400	800	1,500
TOTALS	$129,628	$ 939	$ 400	$ 12,000	$ 27,000	$ 27,000	$ 27,000	$ 27,000	$ 8,289

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
CHICAGO 54, ILLINOIS

A PRELIMINARY REPORT ON FISH AND WILDLIFE RESOURCES IN RELATION TO THE PROPOSED VALLEY GRAVITY PROJECT, MISSION RESERVOIR RIO GRANDE BASIN, TEXAS

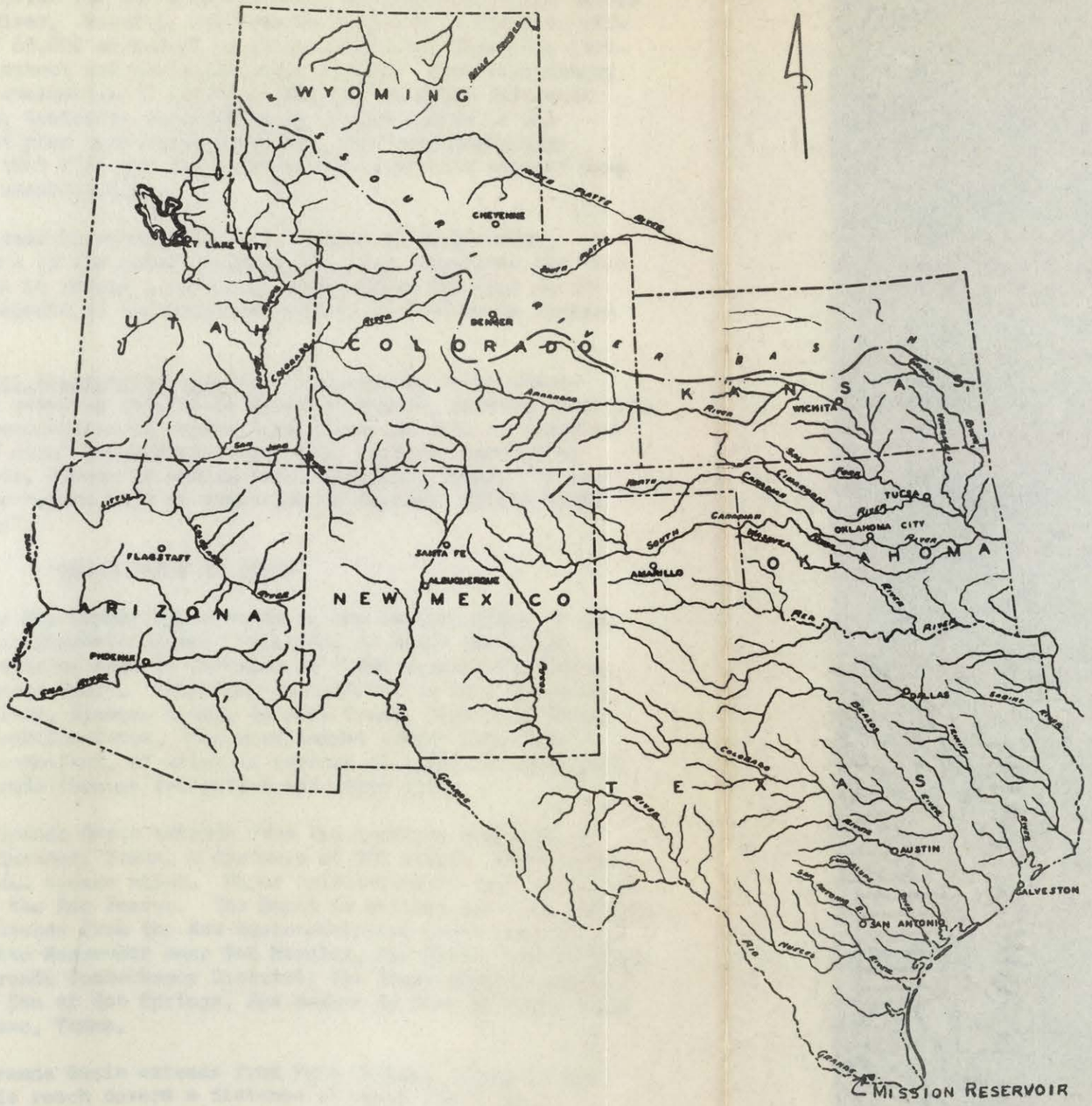
SPONSORED BY: BUREAU OF RECLAMATION
SITUATED IN: TEXAS
DATED: MAY, 1946
REVISED: JANUARY, 1947

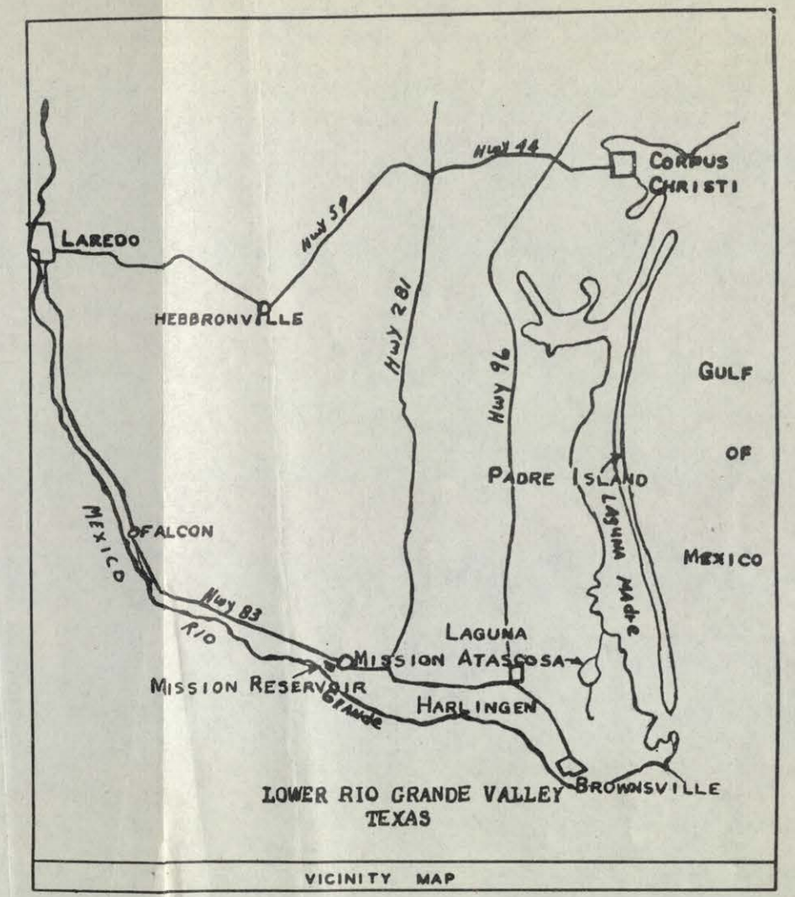
SYLLABUS

The Valley Gravity Project, Mission Reservoir, Rio Grande River Basin, sponsored by the Bureau of Reclamation, is a plan designed to provide for the more efficient utilization of waters of the Rio Grande through construction of a regulating reservoir and canals and drainage ditches, for the purposes of irrigation, power development and municipal water supply in the vicinity of Mission, Texas.

At the request of the Bureau of Reclamation, the Fish and Wildlife Service has investigated fish and wildlife aspects of the project, evaluated existing resources, investigated the proposed plan of improvement, recommended means of enhancing fish and wildlife values in the area to be affected by the project, and estimated the benefits which would obtain from fish and wildlife.

The findings of the Fish and Wildlife Service indicate that the present value of fisheries in the project area is low; that the present value of upland game habitat is high; that there are no furbearer values of significant economic importance, and that the project area is of high value to migratory waterfowl due to its strategic location on the Central Migratory Waterfowl Flyway, and its proximity to major wintering grounds. The estimated total annual losses to fish and wildlife through construction and operation of the project amounts to $3,250 and the gross annual benefits amount to $45,150, leaving a net annual benefit of $41,900 resulting from development of the project as planned by the sponser.





VICINITY MAP

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

DRAINAGE MAP – REGION 2

RIVER BASIN STUDIES DIV. MARCH 1946

INTRODUCTION

1. Purpose.- The proposed Mission Reservoir, Valley Gravity Project, Texas, Rio Grande Basin, sponsored by the Bureau of Reclamation, is a plan designed to provide for the more efficient utilization of the waters of the Rio Grande River. Briefly, the sponsor proposes to build an off-stream reservoir of 65,000 acre-feet capacity to provide water for irrigation, power development and municipal water supply. This preliminary report presents an evaluation of existing fish and wildlife resources in the project area, tentative conclusions as to the effect of the proposed development plan upon these resources, and recommendations designed to insure that fish and wildlife values within the project area will be given full consideration.

2. Need.- The Regional Director, Region V, Bureau of Reclamation, Amarillo, Texas, in a letter dated December 16, 1946, requested the Fish and Wildlife Service to revise a previous report dated May 1946 on the fish and wildlife aspects of the proposed project to conform to changed engineering plans.

3. Status of Project Engineering Report.- Preparation of an inter-departmental Report covering the Valley Gravity Project, Mission Reservoir, is now underway. Development of engineering plans, as well as coordination of interest of other departmental agencies, is being handled by the Regional Director, Bureau of Reclamation, Amarillo, Texas. It is anticipated that the report will be completed at Regional Office level about January 1, 1947.

DESCRIPTION OF BASIN

4. Watershed.- The Rio Grande River heads on the eastern slope of the San Juan Mountains in Hinsdale County, Colorado, at about elevation 14,000 feet. It drains an area in Colorado of 7,890 square miles known as the Upper Rio Grande Basin. Principal tributaries in this Basin include the Conejos River, Alamosa River, La Jara Creek, Trinchera Creek, Culebra Creek and Costilla Creek. The mean annual runoff from this Basin is 1,570,000 acre-feet, of which an average of 1,057,000 acre-feet is consumed in Colorado through irrigation and other uses.

5. The Middle Rio Grande Basin extends from the northern boundary of New Mexico to Fort Quitman, Texas, a distance of 550 miles. This drainage area covers 26,244 square miles. Major tributaries in this Basin are the Chama River and the Rio Puerco. The Basin is divided into two portions. The upper portion extends from the New Mexico-Colorado state line to the head of Elephant Butte Reservoir near San Marcial, New Mexico and is known as the Middle Rio Grande Conservancy District; the lower portion extends from Elephant Butte Dam at Hot Springs, New Mexico to Fort Quitman, Texas, 80 miles below El Paso, Texas.

6. The Lower Rio Grande Basin extends from Fort Quitman, Texas to the Gulf of Mexico. This reach covers a distance of about 1200 miles, forming the International Boundary between the United States and Mexico from El Paso, Texas, at elevation 3,678, to the Gulf. At Fort Quitman,

the river flow is normally small due to depletions above this point for irrigation and other uses. The Rio Conchas entering from Mexico brings new life to the river which passes through the deep narrow canyons of Santa Helena, Mariscal, and Boquillas in the Big Bend area. The drainage area of this Basin covers an area of 105,000 square miles, exclusive of the Pecos River drainage, varying greatly in topography and vegetation from the mouth to elevation over 9,000 feet on the headwaters of the tributaries. Of the total drainage area below Fort Quitman, 26,000 square miles are in the United States and 79,000 square miles are in the Republic of Mexico. Tributaries entering the River from the United States are the Pecos River which enters near Langtry, Texas and the Devil's River which enters near Del Rio, Texas. The average annual discharge of the Pecos River is 385,000 acre-feet and the average annual salt concentration is 4.12 tons per acre-foot. The Devil's River is a stream of relatively pure water which originates principally from springs. The average annual discharge is 460,000 acre-feet from a drainage area of 4,000 square miles. The high salt content of the Pecos River is offset by the spring-fed Devil's River and lesser tributaries downstream. In addition to these two main streams, the Alamito, Terlingua, San Felipe, and Pinto Rivers, and Goodenough Spring enter from the United States. These streams have a combined total drainage area of 2,800 square miles and an average annual discharge of about 239,000 acre-feet. Tributaries entering the Rio Grande from the Mexican side include the Rio Conchas, Rio Salado, Rio San Juan, Rio Alamo, and the smaller streams, Rio San Diego, San Rodrigo Escondido, and Las Vacas Arroyo. Together these streams discharge around 2,990,000 acre-feet to the main stream flow. Other smaller tributaries and the drainage of the area directly along the Rio Grande bring the total unused flow from Mexico to about 3,340,000 acre-feet or 64 percent of the total runoff at Rio Grande City, Texas. The total average annual discharge of the River at Rio Grande City is 5,000,000 acre-feet and at Brownsville, Texas, 3,760,000 acre-feet. This difference is due to pumping and diversions to irrigate the farm lands in the Lower Rio Grande Valley. The average annual silt content of the Rio Grande at Brownsville, Texas is 12,960 acre-feet. The chemical content is 1.16 tons per acre-foot of which about 25 percent are alkalies. Low flows are much higher in chemical content than flood flows.

7. Climate.- A wide range of climatic conditions prevail in the Lower Rio Grande Basin. From the arid upper reaches, the rainfall, humidity and average temperatures increase successively downstream. Rainfall at Presidio averages 8 inches annually, while at Brownsville the average is about 24 inches. Precipitation varies both in time of occurrence and amount. Rainstorms amounting to 5 inches in 24 hours in the valley are common. Protracted droughts are also common. The mean annual temperature at Brownsville is 72° F., and the maximum average variation in January and July is only 12° F. Therefore, semi-tropical conditions prevail. At Fort Davis, in the higher elevations, extremes of 111° F. and 3° F., have been recorded. The growing season at Brownsville extends for almost the entire year, while 200 days in the upper portion is average. Recorded evaporation ranges from 55 inches in the humid lower valley to over 100 inches in the arid upper reaches of the Basin.

8. Vegetation.- Natural vegetation in the Lower Rio Grande Valley, along the banks of the Rio Grande, consists of medium to dense stands of mesquite, ebony, hackberry, mimosa, huisache, horse bean and other species of trees with an understory of weeds and grasses which grow in profusion. This area is subject to overflow when the river floods. In areas not subject to flooding, vegetation occurs in more open stands with more of a brush aspect consisting mainly of mesquite, ebony, hackberry, huisache, and other species. There is an interspersion of these brush types with more or less open stands of grass composed mainly of cordgrass, grama grass, and Bermuda grass. In the vicinity of the Gulf and inland from Laguna Madre, the mesquite-ebony type is interspersed with many other grass and brush types dependent upon soil composition and moisture content. Clearing of brush lands for agricultural purposes is being done rapidly. It is reported that an average of 50,000 acres is cleared annually. Some of these cleared lands have not been brought under cultivation. Some areas have been cleared of brush to reduce competition with native grasses for the purpose of increasing the grazing capacity. Vegetation in the reservoir area is composed of 2000-3000 acres of mesquite-ebony in rather open stands with 1100 to 2000 acres under cultivation or cleared for cultivation. Exact figures cannot be given because some areas are now being cleared.

9. Land Use.- The area above Zapata, Texas in the Lower Rio Grande Basin is chiefly a ranching area producing goats, sheep and cattle. Below Zapata lies one of the principal vegetable and citrus regions of the United States. In 1943 approximately 562,000 acres in Mexico and 530,000 acres in the United States were irrigated. In addition, there is a considerable acreage of land being dry-farmed, with cotton and sorghum grains being the principal crops. There is no Public Domain in this region, all lands being privately or state owned. The Bentsen State Park is located about one and one-half miles southwest of Mission, Texas, but this area has not as yet been developed as a recreation park.

ENGINEERING DEVELOPMENT PLAN

10. Plan of Improvement.- The plan of improvement prepared by the Sponsor originates with the proposed Falcon Dam and Reservoir which would be constructed on the Rio Grande near Falcon, Texas, under supervision of the International Boundary Commission. The proposed Falcon Dam would be the lowest downstream of any of the International dams. The Mission Reservoir section of the Valley Gravity Project originates at the Falcon Dam where waters are diverted through a concrete-lined high line canal, measuring 73 miles in length, which runs to a point near La Joya, Texas. At this location, the main delivery canal would divide and a siphon or flume would carry an average of 1,000 c.f.s. across La Joya Creek to irrigate lands just west of Mission, Texas. The remaining flow from the division point would be dropped about 80 feet from the main canal to a hydro-electric power generator, from whence a canal would deliver a portion of the water to the Mission Reservoir for storage and the remainder would be delivered to existing irrigation systems. A concrete lined main canal 75 miles in length would be constructed from the Mission Reservoir to near Brownsville, Texas, for irrigation purposes. Waters delivered by

the high line canal and waters stored and regulated by the Mission Reservoir would replace the present system of pumping from the Rio Grande for irrigation uses on about 500,000 acres of farm lands and would provide water for 200,000 acres of new lands now in brush. The total annual amount of water passed through the Mission Reservoir would be 470,000 acre-feet. In addition, the sponsor proposes to construct 250 miles of main drainage ditches. Two main ditches would empty into the Laguna Atascosa National Wildlife Refuge and two into San Martin Lake. The remainder would empty into existing floodways and the Arroyo Colorado and the Brownsville Navigation Channel. Construction of Mission Reservoir will necessitate the building of a dike with a maximum height of 37 feet around almost all of the reservoir perimeter. This is necessary because of the relatively flat topography of the site. The dike will be tied into high points wherever possible. The inside slope of the dike will be faced with concrete. Soils in the reservoir site consist of a top layer of clay loam varying in depth from 6 feet to 15 feet underlain by sand and gravel. Because of this condition, the sponsor plans to clear all vegetation from the reservoir area. The sponsor also plans to purchase a strip of land 200 feet out from the perimeter of the reservoir for maintenance purposes and to provide public access, and to construct a road around the entire perimeter of the reservoir.

11. Pertinent engineering data.- Reservoir and canal capacities and other pertinent engineering data are given in the following table:

TABLE I

Operating Levels - Mission Reservoir

	Elevation Feet M.S.L.	Surface Area (Acres)	Capacity Acre-Feet
Stream bed	103	0	0
Conservation pool	119	2,900	15,000
Irrigation pool	125	3,250	50,000
Total capacity			65,000

Dike - (around reservoir)

Type - earthfill
Length - 8.5 miles
Height - 37 feet (maximum)
Elevation ft. m.s.l. - 140 feet (at crest)
Slope (upstream) - 2 to 1 - (concrete faced)
Slope (downstream) - 3.1

Canal - Falcon Reservoir to Mission Reservoir

Type - concrete lined
Length - 73 miles
Capacity - 4500 c.f.s. for first 58 miles; 3900 c.f.s. for last 15 miles.

Canal - Mission Reservoir to Brownsville, Texas

Type - concrete lined
Capacity - 2000c.f.s. (maximum at head)
Length - 75 miles

Drains - (main drainage ditches)

Depth - 15 feet
Length - 280 miles
Slope - 1-1/2 to 1
Velocity - 3' to 4' per second (maximum)
Average width of water - 20 feet
Average depth of water - 3.7 feet
Average water surface area - 770 acres

EVALUATION OF EXISTING FISH AND WILDLIFE RESOURCES

12. Fish. - In general, fishery values in the project area are low. Species in the order of their importance in the various streams in the project area are as follows:

(a) Rio Grande River: Channel catfish, yellow catfish, fresh water drum, buffalo, largemouth black bass, shad and gar. Fishing is poor due to turbulance, low flows at times, heavy salt concentrations of low flows, and flood flows. Some commercial fishing is done.

(b) Arroyo Colorado and Laguna Atascosa: These streams empty into Laguna Madre, a bay separated from the Gulf of Mexico by Padre Island. Arroyo Colorado previous to the War was a good fishing area for bass, green sunfish, Texas bluegill, sunfish, red ear sunfish, drum and buffalo, but industrial pollution during the War years destroyed most of the fish. These same species are found in Laguna Atascosa together with redfish. Some commercial fishing is done on these streams.

(c) Irrigation canals, irrigation drains and various resacas: Lateral irrigation canals where the water is fairly clear, drainage ditches, and old resacas (oxbows of former channels of the Rio Grande) provide fair fishing for bass, various sunfishes, catfish and drum. Fishing would be better in drainage ditches were it not for the growth of cattails and rushes along the side which make it difficult to cast lures or drop baits.

(d) Laguna Madre: This water area consists of a large shallow coastal lagoon separated from the Gulf by Padre Island. Fishery values of this area are mentioned here, although it will not be affected by the project, to show the importance of its fisheries. A great amount of commercial fishing is done, the industry operating from Port Isabel, Texas. Redfish, oysters, shrimp, drum and mackerel are the principal species taken. The area is also important for sport fishing. In addition, Laguna Madre is an important spawning ground for Gulf fishes which enter through the narrow coastal passes.

13. Upland Game. - Upland game values in the project area are high. The Eastern white-winged dove is abundant and is the most important upland game species in this area due to its extreme popularity with the hunter. It is estimated that 226,000 of these birds were taken during the 1945 hunting season in the Lower Rio Grande Valley. Mourning doves are very abundant but are not as popular as the white-winged dove. The redbilled pigeon, white-fronted dove and chachalacas (Mexican game cocks) are found in numbers. Texas bobwhite quail are fairly abundant especially in the irrigated areas. Scaled quail are scarce, being found only in areas not under cultivation. Cottontail rabbits are relatively scarce.

14. Non-game insectivorous and song birds.- This region is especially noted for its wide variety of common birds. A list of these would be very extensive, including most passerines. Interesting and rare species include the following: Audubon's oriole, hooded oriole, zone-tailed

hawk, Merrill's pauraque, groove-billed ani, Sennett's thrasher, green jay, derby flycatcher, and red-eyed cowbird.

15. Fur animals.- In general, fur animal values in the project area are low. Beaver and mink are scarce, and jaguarundi are rare. Texas bobcats are fairly abundant in dense brushy thickets. Common skunks and civet cats are also fairly abundant. Revenue from all fur animals is relatively small.

16. Migatory Waterfowl.- The entire reach of the Rio Grande serves as a part of the central migratory waterfowl flyway. The Rio Grande, various ponds, lakes, and resacas in the project area provide feeding, resting, and shooting grounds for ducks and geese on their spring and fall flights. Laguna Madre provides one of the most important waterfowl wintering grounds in the United States, and is the most important wintering ground for redhead ducks. Virtually all species common to both the Central and Mississippi flyways winter here. The most common species in addition to the redhead, include pintails, baldpates, ring-necked ducks, gadwalls, shovelers, lesser scaups, ruddy ducks, white-fronted geese, lesser snow geese, and lesser Canada geese. Resident species include the mottled ducks, black-bellied tree ducks, the fulvous tree duck, and the rare masked duck. Thousands of ducks, chiefly redheads and pintails, are taken by hunters from Laguna Madre and adjacent bays and islands each year. Ducks and geese feed extensively in Laguna Madre and adjacent tidal flats and fly inland to Laguna Atascosa and into water areas in Mexico to secure fresh drinking water.

17. Migratory game birds, other than ducks and geese, exist in profusion in the above area. These include: Long-billed curlews, willets, clapper rails, dowitchers, plovers, sandpipers, jacksnipes and yellowlegs. Some of these are resident species.

18. Wading birds also occur in large numbers in Laguna Madre and Laguna Atascosa. These include American egrets, snowy egrets, great blue herons, little blue herons, Louisiana herons, common bitterns, and least bitterns. Rare resident species are the reddish egret, the wood ibis, and the Mexican jacana.

PROBABLE EFFECTS OF THE PROJECT ON FISH AND WILDLIFE

19. Fish.- Construction of the project will not result in losses to existing fishery values. There are no fishery values in the area to be impounded as no fish habitat exists. No effect on fishery values of the Rio Grande River, Laguna Atascosa, Arroyo Colorado, or any other existing stream or pond in the project area can be foreseen. The area to be impounded takes advantage of a shallow depression which will require a dike tied into various high points. Operation studies of the reservoir indicate that the greatest drawdown for irrigation will occur in the months of March and August, that only 11 percent of the time would the reservoir be required for irrigation, and that only four times out of a 20-year study would the reservoir be drawn down to the conservation pool level. However, data are not available in this office to determine the average minimum pool. Consequently, the surface acres at conservation pool level are taken to determine fishery value of the reservoir. Largemouth black bass spawn in this region during the latter part of December, January,

and the early part of February. A careful study of the topography of the reservoir, reservoir operation, and design of the dike necessary to impound water reveals that suitable conditions for spawning of largemouth black bass will not exist because water will be too deep in the reservoir during the spawning period. This condition will necessitate an annual stocking with bass if the reservoir is to be assigned a fishery value. It does not appear practical or desirable to construct spawning beds. The reservoir will provide suitable spawning conditions for sunfish which spawn during the entire year in this region. Because of the relatively shallow depth of water in the reservoir (maximum 32 feet) and the semi-tropical climate which prevails, together with an inflow of relatively clear water, it is believed that ample food for fishes will be produced. The construction of 280 miles of main drainage ditches will be beneficial to fish with an estimated annual value of $50 per mile. Stocking of drains will not be necessary as this will result from the joining with lateral drains which now support fish. Construction of 130 miles of main concrete-lined canals may provide some habitat for fishes but it appears that very little food will be produced. Therefore, only an incidental benefit, not possible of evaluation, will result. Annual benefits to fish provided by the reservoir and by drainage ditches and the cost of annual stocking of the reservoir with bass are shown in Table II:

TABLE II

Annual Benefits to Fish - Reservoir and Drainage Ditches

Reservoir	Annual Value
Acres in conservation pool - 2,900	$22,000
Drainage Ditches	
280 miles at value of $50 per mile	14,000
Gross annual benefits to fish	$36,000
Annual Cost of Stocking reservoir	
Acres to be stocked - 2,900	
Cost of stocking at rate of 200 largemouth bass fry per acre ($1 per acre)	$ 2,900
Gross annual cost for fish	$ 2,900
Net annual benefits to fish	$33,100

20. Upland Game.- Construction of Mission Reservoir will result in a loss of 3,250 acres of upland game habitat. Of this area, between 2,000 to 3,000 acres are in brush mesquite, about 1100 acres are under cultivation with cotton and sorghum grains being produced, and 28 acres are in citrus fruits. Exact figures cannot be given as considerable lands have been cleared and are now being cleared since the last surveys and aerial photos were made. This area does not provide any appreciable

nesting grounds for white-winged doves. However, it does provide habitat for mourning doves and bobwhite quail. The estimated loss to upland game is estimated at $3,250 annually based upon an estimated harvest of one upland game bird to each five acres. The bringing under cultivation of 200,000 acres of new lands on which irrigation will be practiced will result in a loss to scaled quail habitat, supporting light populations. Cultivation of this area will provide a more suitable habitat for bobwhite quail and will make more food available to mourning doves. Therefore, it is believed that losses to scaled quail will be compensated by benefits to bobwhite quail and mourning doves.

21. Fur animals.- It appears that construction of the project will neither benefit nor adversely affect fur animals.

22. Migratory Waterfowl.- Construction of the project will be of considerable benefit to migratory waterfowl. No losses to migratory waterfowl can be foreseen as there is no existing habitat in the reservoir area, nor does it appear that any other waterfowl habitat will be adversely affected. The construction of 280 miles of drainage ditches with an average water surface of 770 acres will provide excellent habitat for wading birds, and will provide resting feeding, and shooting grounds for waterfowl. Estimated annual benefits to migratory waterfowl and wading birds are summarized in Table III:

TABLE III

Annual Benefits to Migratory Waterfowl and Shorebirds

Reservoir		Annual Value
Surface acres in conservation pool	2,900	- - -
Average value per acre	$ 1.50	$4,350
Drainage Ditches		
Area of water surface-acres	770	- - -
Value per acre to waterfowl	$5.00	3,850
Value per acre to shorebirds	$5.00	3,850
Total annual benefits		$12,050

23. A summary of annual losses and benefits to fish and wildlife, resulting from the plan of construction and operation of the project as proposed by the sponsor, is shown in Table IV:

TABLE IV

Summary of Net Annual Losses and Benefits to Fish and Wildlife

	Losses	Benefits
Fish	0	$33,100
Upland game	$3,250	0
Fur animals	0	0
Migratory waterfowl	0	8,200
Shorebirds	0	3,850
Totals	$3,250	$45,150

The net annual benefits from fish and wildlife to accrue to the project as proposed by the sponsor, therefore, amounts to $45,150 less $3,250 or $41,900.

MEANS OF DERIVING MAXIMUM BENEFITS TO FISH AND WILDLIFE

24. Fish.- The sponsor proposes to clear all vegetation from the reservoir area to prevent leakage around the roots. It appears that fishery values will be enhanced if no vegetation is cleared above elevation 120 feet m.s.l., on the comparatively abrupt slopes of small knolls on the western and northern shores of the reservoir. Prevailing winds are from south and southwest, and it is believed that leaving vegetation on these points would reduce wave action, stabilize soils and protect sunfishes during their spawning periods. In addition, angler success would probably be increased. The Texas Game, Fish and Oyster Commission has indicated that they prefer that no clearing of vegetation be done in such areas as this. No evaluation can be made of this suggestion because of the various intangibles involved.

25. It does not appear practicable or feasible to recommend screening of the reservoir outlet or of the lateral irrigation canals because of the well known attitude of the farmers against this and because of the difficulty in designing and operating satisfactory screens. Were this possible, greater values could be assigned to lateral canals which contain water at all times.

26. Migratory Waterfowl, Migratory Game Birds and Wading Birds.- Greatly increased values resulting from construction and operation of the project will accrue to the above species if the sponsor can deliver, by drainage ditch or diversion canal, sufficient water to permit full development of the Santa Ana and Laguna Atascosa National Wildlife Refuges. These refuges are an extremely important part of the refuge system of the Fish and Wildlife Service and both are planned for enlargement and development. If the sponsor can provide the necessary water of good quality, low concentration of salts and fairly clear, the benefits resulting from the use of such water could rightly be allocated as a portion of the costs of project construction. The Fish and Wildlife Service plans development

of the Santa Ana and Laguna Atascosa National Wildlife Refuges regardless of the possibility of securing sufficient water from the sponsor, but if the sponsor can supply the needed water, a portion of the increased economic benefits to wildlife will accrue to the project.

27. The sponsor reports that as much as 20,000 to 40,000 acre-feet of water might reach Laguna Atascosa annually by way of two main drains which would empty directly into Laguna Atascosa. However, the amount of water reaching this area will be dependent upon the amount of water pumped by farmers from these drain ditches for irrigation purposes. Therefore, no definite amount can be determined. This necessitates that a definite annual allocation, to be supplied either by drainage ditches, canal diversion or both, be made to these two Refuges. The amount of water which could be used annually at the Santa Ana and Laguna Atascosa National Wildlife Refuges is shown in Table V:

TABLE V

Amount of Water Which Could be Used Annually at Santa Ana and Laguna Atascosa National Wildlife Refuges.

Refuge	Annual Water Needed (Acre-feet)
Santa Ana	1,000
Laguna Atascosa	40,000

VIEWS OF COOPERATING AGENCIES

28. Field investigations were made in company with a local representative of the Texas State Game, Fish and Oyster Commission, Mr. Charles Jones, District Warden, Weslaco, Texas. His personal opinion of the project was that some upland game habitat would be destroyed by inundation, but the net result should be of considerable benefit to fish and migratory birds.

RECOMMENDATIONS

29. Inasmuch as this report is based on the sponsor's plans for the development of the Valley Gravity Project, Mission Reservoir, Rio Grande Basin, Texas, made prior to January 1, 1947, the Fish and Wildlife Service should be advised of any changes in plans for structures or methods of operation, so that a new fish and wildlife report can be prepared.

30. The net effect of the project will be beneficial to wildlife resources if the project is built and operated as proposed by the sponsor. The net annual value of this benefit is estimated to be $41,900. Additional values can be derived from the project, however, if the following recommendations are followed:

a. No clearing of vegetation be done on the slopes of high points on the northern and western sides of the reservoir above elevation 120 feet m.s.l.

b. No part of the reservoir area, nor of the buffer strip surrounding that area, be leased for the exclusive benefit of any corporation, individual, or group of individuals for any purpose which will prevent or interfere with the use of that area for recreation, hunting, or sport fishing by the general public.

c. All fish and wildlife resources inherent in or resulting from the project remain under the jurisdiction of the Texas State Game, Fish and Oyster Commission.

31. It is further recommended that the sponsor provide an allotment of 1,000 acre-feet of agriculturally suitable water annually to the Santa Ana National Wildlife Refuge, and 40,000 acre-feet of agriculturally suitable water annually to the Laguna Atascosa National Wildlife Refuge by drainage ditches and canal diversion. This allotment will provide an annual wildlife benefit to the project, which, we tentatively believe, will be equal to the prevailing rate for 41,000 acre-feet of water. Reduction in the amount or quality of water from the project available to these refuges would result in diminished benefits and, consequently, diminished value.

RIVER BASIN STUDIES COMMITTEE, REGION II

By (Sgd.) K. C. Kartchner

PROJECT REPORT

RECREATIONAL USE AND DEVELOPMENT

LOWER RIO GRANDE

VALLEY GRAVITY PROJECT

Prepared by

NATIONAL PARK SERVICE

REGION THREE

DEPARTMENT OF THE INTERIOR

For

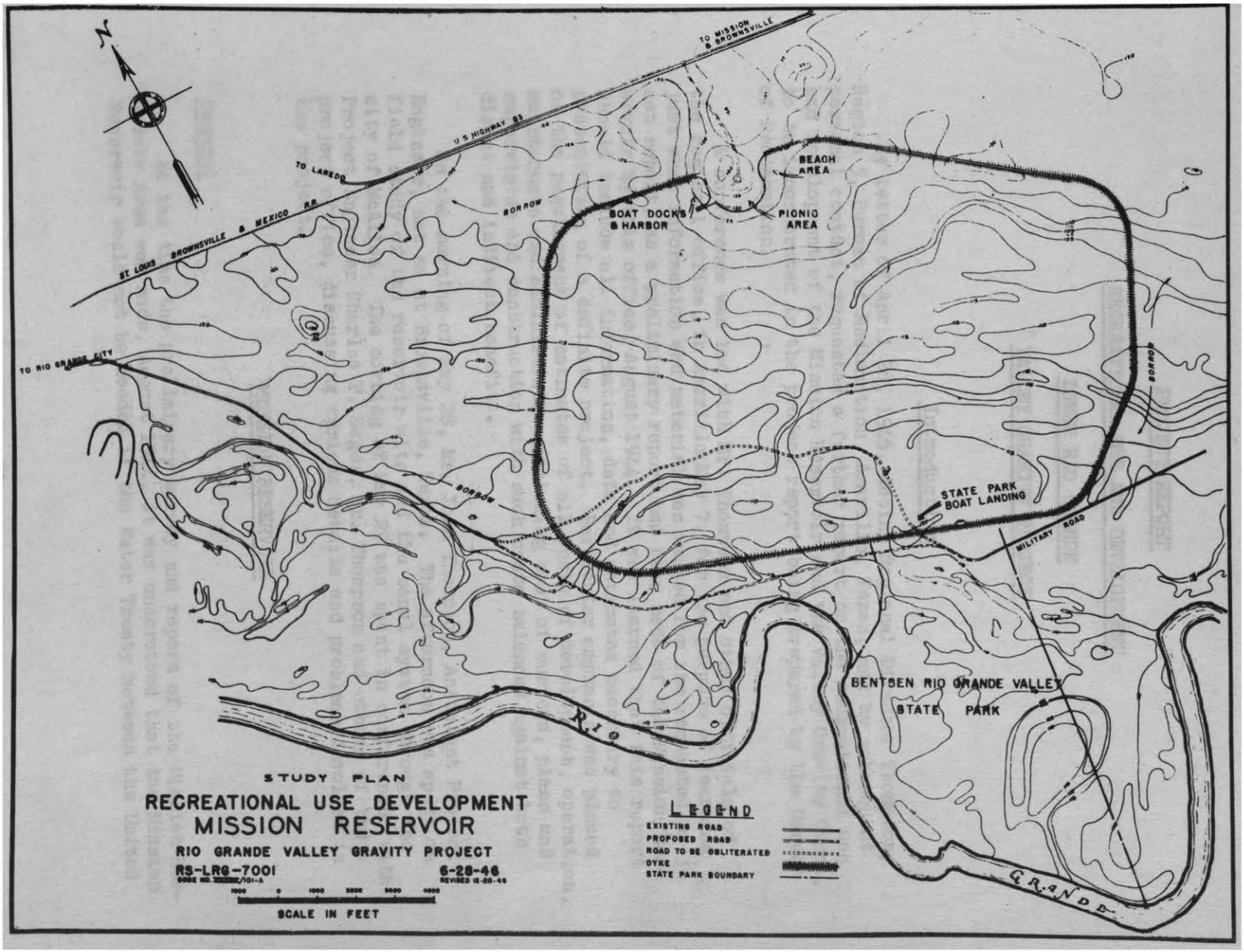
REGION 5, BUREAU OF RECLAMATION,

AMARILLO, TEXAS.

Survey and Report by:

Milton J. McColm,
July 1946.

Revised December 1946.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TO MISSION & BROWNSVILLE
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BORROW
BEACH AREA
BOAT DOCKS & HARBOR
PICNIC AREA
TO RIO GRANDE CITY
BORROW
BORROW
STATE PARK BOAT LANDING
MILITARY ROAD
BENTSEN RIO GRANDE VALLEY STATE PARK
RIO GRANDE
STUDY PLAN
RECREATIONAL USE DEVELOPMENT
MISSION RESERVOIR
RIO GRANDE VALLEY GRAVITY PROJECT
RS-LRG-7001
CODE NO. [illegible]/101-A
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SCALE IN FEET
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PROJECT REPORT

RECREATIONAL USE AND DEVELOPMENT

LOWER RIO GRANDE

VALLEY GRAVITY PROJECT

Introduction

By letter of April 26, 1946, Acting Regional Director Thompson, Region 5, Bureau of Reclamation, Amarillo, Texas, and by subsequent personal contact, requested a further report on the recreational use and development of the Mission Reservoir and the Valley Gravity Canal, to be incorporated in the project report being prepared by the Bureau of Reclamation.

A conference was had with Mr. Thompson and other officials of the regional office, in Amarillo May 7, for the purpose of learning just what information and material was wanted for the requested project report, as a preliminary report had been made of the Mission Reservoir by this office, August 1944. It was learned that this report should include all information, data and estimates necessary to presentation of a definite project. Particular emphasis was placed on the requirement of estimates of all costs of development, operation, maintenance and administration including cost of surveys, plans and supervision and construction with such costs balanced against both direct and indirect benefits.

On the morning of May 28, Mr. John Thompson, Assistant Project Engineer, met me at Brownsville, Texas. The afternoon was spent on field study of the reservoir site and the canal system through the city of McAllen. The morning of May 29 was spent in conference, with Project Engineer Charles P. Seger, Mr. Thompson and others of the project office, discussing various details and problems involved in the project.

MISSION RESERVOIR

General

At the time the preliminary survey and report of the Mission Reservoir Area was made, August 1944, it was understood that the Mission Reservoir would not be needed if the Water Treaty between the United

States and Mexico was ratified and the river storage reservoirs were authorized. Subsequent studies have indicated the need for the Mission Reservoir, in addition to the reservoirs on the river, for control purposes on the canal system.

The deficiency of public park and recreational areas, and in particular the lack of public fresh water swimming pools or places, is still as apparent as reported in the August 1944 report, and the need for such areas is greater now than then as even within only two years new industry and business has come into the valley resulting in a noticeable increase in population. This increase is not of a temporary nature due only to war activities.

The construction of the Mission Reservoir and its development for recreational use will help to accommodate some of the need, but will fall far short of abating the deficiency. Being located about a mile southwest of Mission, its greatest alleviating effect upon public need will be felt in the upper part of the valley. From the angle of recreational needs, three or four of such reservoirs could be justified in the valley from Mission to Brownsville.

It is not intended that such a statement is meant to advocate the building of more reservoirs by the Federal Government in the valley for recreational purposes. Although greatly needed but because of only local benefits the responsibility of providing public park and recreational areas in the valley rightfully is that of the cities and counties.

The Bentsen-Rio Grande Valley State Park is immediately adjacent to the south shore of the proposed reservoir. In fact a small portion of the reservoir will inundate park land. The reservoir should have a beneficial effect upon the park, as each will be an attraction to the other. At present the park has no development and but few visitors. The park is very much of a reservation of the natural plant growth of that region.

Annual Use

Until more similar recreational areas are provided in the valley, the Mission Reservoir when developed for such a use should draw visitors from all of Hidalgo County. That county had, in 1940, a population of 106,059, most of which was concentrated in the southeast two-thirds of the county, with the greatest concentration along and immediately adjacent to U. S. Highway 83, the main highway between Laredo and Brownsville.

It is estimated that from this population and in consideration of other factors, there should be at least 53,000 man days of recreational use made of the Mission Reservoir particularly if quality fishing is maintained and swimming is a permissible activity.

Recreational Development

The character and the method of construction of the reservoir is unique and greatly limits the selection of feasible sites for recreational development.

The reservoir is proposed to have a total capacity of 65,000 acre-feet. It will be approximately 3 miles long and average about 2 miles wide with an average depth of approximately 10 feet. It will be constructed by the Building of a dike for almost its entire shore line. The borrow for the building of the dike will be taken from the outside. From the recreational use and development point of view it would be better to take the borrow from within the reservoir basin. To do so would, however, disturb the clay deposit upon which the engineers are depending for success of the reservoir for water storage.

At about the middle of the north shore line there is a section of high ground which will extend into the reservoir about one-fourth of a mile. The dike will not be needed across this section which will result in a peninsula into the reservoir. This peninsula offers what appears to be the only feasible site for the concentration of facilities necessary to the kind of recreational use anticipated. This site is within a half mile of U. S. Highway 83, and about three miles west of the city of Mission. With but little fill this peninsula site can be made large enough to accommodate an adequate development for day use recreational activities. (See attached drawing.)

Indications are that fishing, boating, picnicking and swimming will be the major activities. Dancing and dining out may also be a popular pastime at this area.

Due to the limited area for development, it appears desirable to give consideration to a very formal plan as such is more economical in the use of space. Formality of plan should not be understood to mean elaborate and costly development and facilities but instead orderly, economic and convenient relation between various units and facilities.

Cost of Development

The recommended development, facilities and costs thereof are estimated as follows with costs based on 1946 prices:

1.	Surveys and Plans	$ 7,800	
2.	Water Supply System	12,000	
3.	Sewer and Sewage Disposal System	13,600	
4.	Electric Power Distribution System	10,000	
5.	Roads	8,500	
6.	Walks and Trails	3,400	
7.	Grading and Fills	15,000	
8.	Rock Riprap	16,000	
9.	Boat Harbor	7,500	
10.	Swimming Beach and Facilities	10,200	
11.	Tree Planting	6,500	
12.	General Landscaping	13,000	
13.	Parking Areas (3)	10,200	
14.	Picnic Areas (40 Units)	6,800	
15.	Boat Landing	4,000	
16.	Boat Launching Facilities	3,400	
17.	Administration Building	10,000	
18.	Utility Building and Yard	10,200	
19.	Employee's Residences (2)	20,000	
20.	Supervision of Construction	10,400	
		$198,500	
	Contingency 10%	19,850	
		$218,350	
	Annual Cost - 40 years no interest (Government provides and operates for public use without revenue)		$5,458.75
21.	Bathhouse	$ 12,000	
22.	Boat Docks (20 Boats)	8,000	
23.	Concession Building	12,000	
24.	Restaurant with Dining Room	12,000	
25.	Dance Pavilion	8,000	
		$ 52,000	
	Contingency 10%	5,200	
		$ 57,200	
	Interest 3% - 1 year construction period	1,716	
		$ 58,916	
	Annual Cost - Amortized over 40 years at 3%		$2,548.70
	TOTAL ANNUAL COST OF DEVELOPMENT		$8,007.45

Operation and Maintenance

1.	Manager	$ 4,149.60
2.	Chief Ranger	3,397.20
3.	Rangers 3 @ $2895.60	8,686.80
4.	Clerk-Stenographer (1)	2,168.28
5.	Life Guards (3) @ ½ $2020	3,030.00
6.	Laborers	5,200.00
7.	Materials	4,080.00
8.	Supplies	1,260.00
9.	Trucks	1,300.00
10.	Other Equipment	780.00
11.	Utilities	2,340.00
		$36,391.88

Direct Annual Revenues

Rent

1.	Boat Concession	$1,800
2.	Boat Docks	450
3.	Bathhouse	1,800
4.	Restaurant	1,800
5.	Dance Pavilion	1,800
6.	Concession	1,800
	Total Rent	$9,450

Possible and Recommended Additional Revenues:

Profit on Utilities	$2,640
Boat and Fishing Permits	6,890
Entrance Fee Adults @ 25¢	8,750
Swimming Fee - Adults 25¢ (Children 10¢ per day seasonal fee.)	8,080
Commission on gross earnings of concessions est. $160,000 Per Annum, 5%	8,000
Total	$43,810

Total Annual Cost	$44,399.33
Possible Direct Revenue Repayment	43,810.00
Excess of Cost Over Revenue	$ 589.33

Benefits -- 30% increase over those estimated in August 1944 Report $39,982.00

The gross earnings of the concessioners are based upon an average of approximately $3.00 per visitor day. Since the estimated potential attendance figure of 53,000 is based to a great extent on the 1940 population within the service radius of the reservoir, and is about equal to the average 1940 attendance at the Texas State Parks, it seems logical to consider the estimate of $160,000 gross annual earnings of

the concessioners as low. Likewise the estimated direct revenues may be low. The purpose of the direct revenues is to effect as much of the costs as is reasonably possible. It is not intended that the various charges and rates be established and maintained for the purpose of making a profit over costs. It is recommended that when the direct annual revenues do exceed the annual costs for a period long enough to indicate a continuation of such excess that charges direct to the visitors, such as entrance, swimming, fishing and boating fees be reduced or eliminated in proportion to the excess direct revenues.

CANAL DEVELOPMENT

Consideration is being given to park and recreational development along the irrigation canal, particularly that portion of the canal which will run through the city of McAllen. Such a consideration is commendable but since the city would be the greatest or sole benefactor of such development it seems questionable whether much expenditure of government funds can be justified for the development.

It would be a great asset to McAllen if the canal were treated as a parkway and boulevard through the city. Unfortunately, portions of the canal will be through a section of the city which is being encroached upon by industrial development. The maintenance of a development of this nature would be costly and certainly should be the responsibility of the city. Much of the construction such as streets and paving probably could not be financed by government funds.

The acquisition of right-of-way for a park like boulevard development would no doubt be of sufficient cost to preclude an attempt to justify the expenditure, without consideration of development cost. Land values are generally very high along the proposed route of the canal.

A more economically justifiable plan of improvement seems to be, to select one or more areas where the topography will permit a widened section of the canal and where the land costs are comparatively low. The area or areas so selected should allow for the main channel or deep section of the canal to be carried at one side, preferably the south side opposite the more developed section of the city. From this channel of deep section the bottom should gradually slope up to no depth.

This area need not be large and its development should be limited to picnic areas, boat landings and if approved by health authorities a swimming beach. In conjunction to this area, if possible the canal should be planned and constructed so as to have as little drop as permissible for as great a distance each side of the areas as is feasible.

The flow of the canal should be reduced sufficiently within that section to make it safe to navigate canoes, row boats and small motor boats preferably powered by small quiet electric motors. Such a recreational activity and swimming should be extremely popular, not only in the McAllen section of the canal but at other places adjacent to the other cities along or near the canal.

The annual costs for development, maintenance and operation of such areas should not be great; yet the annual use should bring in sufficient revenue direct and indirect to more than pay such costs.

Cost of Development (McAllen Area)

1.	Lands for Development Area	$ 10,000	
2.	Roads, Walk and Parking Area	13,600	
3.	Picnic Area	3,400	
4.	Landscaping	6,500	
5.	Miscellaneous Development	7,000	
		$ 40,500	
	Contingency 10%	4,050	
		$ 44,550	
	Annual Cost - 40 years		$1,113.75
6.	Concession Building	$ 8,500	
7.	Boat Landing	3,400	
8.	Bathhouse and Beach	13,600	
9.	Utilities, Power, Water and Sewer	17,000	
		$ 42,500	
	Contingency 10%	4,250	
		$ 46,750	
	Annual Cost - Amortized @ 3% - 40 years		$2,022.40
	Total Annual Cost		$3,136.15

The above development is estimated for an area adjacent to the city of McAllen. For other cities along the canal, such as Pharr, San Juan, Alamo and Dana it is believed that an adequate development can be provided for half of the above cost for each area.

Since all of these developments would be of definite local city use, it is recommended that if developed, the areas and facilities be leased to the respective cities for administration, operation and maintenance. It seems reasonable that a yearly rent equal to the annual development cost be charged to the cities, for a period long enough to amortize the costs, after which they could be transferred or deeded to the respective cities.

The cities can pay most or all of that rent from rent received from concessioners for use of facilities. Additional fees may or may not be levied by the cities upon the concessioners and the recreational users which may help to pay the annual administration, maintenance and operation costs.

Due to the definite local use and benefit aspect of these areas, it is specifically recommended that they not be developed by federal funds unless the cities are able and willing to accept the responsibility of administration maintenance and operation as recommended above.

CONCLUSION

The Lower Rio Grande Valley is noticeably deficient in public recreational areas. The proposed Mission Reservoir and the distribution canal offer possibilities for development of a kind which will help alleviate that deficiency.

It is estimated that the annual costs for the recreational development, maintenance, operation and use of the Mission Reservoir can be repaid by revenues collected from the concessioners and the using public based on reasonable rents, fees, permits and other charges. With all costs repayable or nearly so, and many obvious benefits to the service area there should be no question as to the justification of the recommended recreational development of the proposed Mission Reservoir.

The development recommended at a site or sites along the canal as previously recommended is justified only if the cities benefited assume the administration, maintenance and operation for a period of years sufficient to repay development costs.

Milton J. McColm,
Chief, Recreation Study Division,
July 2, 1946.