1949

Development of the Potential Weber Basin Project, Utah: Bonneville Basin

United States Department of the Interior

81ST CONGRESS
2d Session

SENATE

DOCUMENT
No. 147

WEBER BASIN PROJECT, UTAH

DEVELOPMENT

OF THE

POTENTIAL WEBER BASIN PROJECT, UTAH

BONNEVILLE BASIN

JULY 15, 1949

PRESENTED BY MR. WATKINS

SEPTEMBER 23 (legislative day, SEPTEMBER 3), 1949.—Referred to the Committee on Rules and Administration

UNITED STATES
GOVERNMENT PRINTING OFFICE
63961 WASHINGTON : 1950

SENATE RESOLUTION NO. 238

[Reported by Mr. Hayden]

IN THE SENATE OF THE UNITED STATES,
March 9 (legislative day, March 8), 1950.

Resolved, That there be printed as a Senate document with illustrations the Bureau of Reclamation Project Planning Report Numbered 4–7.10–2 entitled "Weber Basin Project, Utah," dated July 15, 1949.

Attest:

LESLIE L. BIFFLE,
Secretary.
By EMERY L. FRAZIER,
Chief Clerk.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WEBER BASIN PROJECT

HRS 1948

REPORT OF THE REGIONAL DIRECTOR

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UNITED STATES DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
Region 4, Salt Lake City 8, Utah, July 15, 1949.

To: Commissioner.
From: Regional director.
Subject: Development of the potential Weber Basin project, Utah—Bonneville Basin.

1. This is my report on the potential Weber Basin project, a multiple-purpose development designed for maximum utilization of the water and related resources of a rapidly growing section of north central Utah. The report is submitted for your approval and appropriate departmental action with a view to securing congressional authorization of the project for immediate start of development. Substantiating materials, including reports of the Bureau of Reclamation, National Park Service, Fish and Wildlife Service, and Public Health Service, are appended.

2. Authority to make this report and supporting investigations is provided in the Federal reclamation laws (act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto).

DESCRIPTION OF THE AREA

3. The Weber Basin area, a part of the Bonneville Basin, covers approximately 2,500 square miles, 3 percent of the State of Utah. Great Salt Lake forms the western boundary of the area and the north, east, and south boundaries are the divides between the basin and the Bear, Provo, and Jordan River drainages, respectively. Elevations range from 11,900 feet (the highest mountain peak) to 4,200 feet on the shores of Great Salt Lake. From its headwaters on the northwest slope of the Uinta Mountains, the Weber River flows some 40 miles northwesterly between the Uinta and Wasatch Mountains and then turns west, cutting a channel through the Wasatch Mountains in their most rugged part to discharge into Great Salt Lake. Ogden River, the Weber's principal tributary, heads in the southern end of the Bear River Mountains and flows westerly, also cutting through the Wasatch Range, to its confluence with Weber River immediately west of Ogden, Utah. In addition to streams in the Weber River system, the area includes many small, deeply engorged streams draining the steep west slope of the Wasatch Mountains and discharging directly into Great Salt Lake.

4. The narrow strip of land between the mountains and Great Salt Lake slopes gently from the foothills to the lake and consists generally of terraced benches and deltalike areas that were formed during the various cycles of inundation and recession of prehistoric Lake Bonneville, the ancestral lake to the present Great Salt Lake. Here is

concentrated the major part of the agricultural and industrial development of the Weber Basin area and about 90 percent of its population. To the east is a mountainous area (utilized primarily for grazing) containing some narrow tracts of cultivated lands situated in the mountain stream valleys and on adjacent benches. Irrigated and irrigable lands range in elevation from 4,200 to 5,000 feet bordering Great Salt Lake and up to 7,000 feet in the mountain valleys.

5. The climate is temperate and semiarid with a low relative humidity. Precipitation is erratic, averaging 17 to 20 inches annually on the agricultural lands throughout the area. Less than one-third of the precipitation occurs during the growing season. Thus irrigation is necessary for sustained and successful crop production. Lands in the mountain areas above an elevation of 8,000 feet have a rigorous, alpine climate. Here the precipitation averages more than 20 inches annually and snow accumulates to considerable depth during the winter season.

6. Near the turn of the century all stream flow in the area, except spring flood flows, was appropriated. Much of the irrigated farm land suffered water shortages in the summer season and total crop failures were experienced in drought years. To reduce the irrigation shortages East Canyon Reservoir was developed in 1896 (subsequently enlarged in 1916), Echo Reservoir in 1929, and Pineview Reservoir in 1936. The three reservoirs, together with several small additional reservoirs, have a combined storage capacity of about 150,000 acre-feet and were developed primarily for the purpose of supplementing water supplies for lands inadequately irrigated from direct flows. Very little new land was brought under irrigation. Echo Reservoir and Pineview Reservoir are principal features of Federal reclamation projects.

7. The Weber Basin area is a highly developed agricultural and industrial section. Agriculture, manufacturing, transportation, oil refining, and mining are the most important industries. Agriculture consists of irrigation farming, dairying, and livestock raising. Manufacturing establishments are engaged largely in the processing of agricultural products of the immediate and surrounding area. Three large, permanent military installations—Hill Field, the Ogden Arsenal, and the naval supply depot at Clearfield—were established during World War II. Largely as a result of these establishments and increased industrialization, the population in the Weber area increased from 90,000 in 1940 to 127,000 in 1947, an increase of 37,000 or 41 percent. The 1947 population of the area represented 20 percent of the population of the State of Utah.

NEED FOR FURTHER DEVELOPMENT OF WATER AND LAND RESOURCES

8. Construction of facilities to regulate and distribute surplus stream flows for irrigation and municipal use is the greatest need of the Weber Basin area. Natural stream flows are erratic and fluctuate widely from season to season and from year to year. The flows are high in the spring when accumulated snow in the mountains is melting but are at low stage the remainder of the year. Present water-resource developments utilize an average of 60 percent of the total stream flow. The remaining 40 percent is unregulated and causes flood damage in the spring season along the lower reaches of Weber

and Ogden Rivers. Only with additional storage regulation and distribution works can the maximum practicable development of this wasting resource be realized. State and local officials have long recognized the need of such development, but the works required are too large and costly for private financing.

9. Urgent need now exists for irrigation expansion. The rapidly growing population of the Weber Basin area, as well as much of the western United States, has greatly increased the demands for locally produced foods and other agricultural products and for settlement opportunities on farms. At the same time more than one-fourth of the total area presently irrigated requires supplemental water. Large acreages of land suitable for irrigation farming have not been developed for lack of water and irrigation facilities. Thousands of ares in need of a full or supplemental water supply require drainage for full productivity.

10. Even greater need exists for increasing dependable supplies of municipal water. Population increases far beyond the growth anticipated a decade ago have overtaxed present municipal supplies. Only the above normal precipitation during the past few years has prevented serious shortages. With recurrence of extended periods of below normal precipitation and particularly of extreme drought years, the situation would be critical.

11. Additional electric power is needed to supply growing requirements. Electric generating capacity installed by electric utilities and industrial plants serving the area and surrounding region is sufficient only to meet the immediate needs. Continued rapid load growth is expected in the future. To keep pace with this growth utilities are currently planning extensive installation of new fuel-electric generating plants.

PLAN OF DEVELOPMENT

12. The Weber Basin project is designed to develop the basin's remaining water resources for agriculture and municipalities, both dependent on the available water supply. By further storage regulation of the fluctuating flows of Weber River, more effective utilization of natural flows from Wasatch slope streams, and development of usable return flows and ground water, the project would increase the useful water supply of the area at canal heads by an average total of 285,000 acre-feet annually. Of this total supply, 245,000 acre-feet would be utilized for irrigation and 40,000 acre-feet would be used for municipal purposes in communities in Davis and Weber Counties. The irrigation water would provide a full-season supply for 100,400 acres, including 70,400 acres of potentially productive lands now unirrigated and approximately 30,000 acres now only partially productive because of irrigation shortages. Through drainage, the project would make suitable for irrigation farming 31,700 acres of the 70,400 acres of new land and would increase the productivity of 7,000 acres of the 30,000 acres now inadequately irrigated. Flood damage along the Weber and Ogden Rivers would be materially reduced by the storage regulation and canal diversions of flood flows. The amount of hydroelectric energy that would be generated annually by the project would only slightly exceed the project's electric-energy requirements for pumping during the irrigation season. The project would

increase recreational values in the area. Results of a reconnaissance study of fish and wildlife aspects of the project indicate that the project may result in a benefit to fish and wildlife. Operation of the project would not further aggravate stream pollution in the area. Silt problems would be minor and navigation and Indian lands would not be involved.

13. The basic plan for the development includes the further regulation of the flows of the Weber River by means of a system of upstream reservoirs and an offstream reservoir at the Willard site on the east shore of Great Salt Lake. As regulated by the upstream reservoirs, the stream flow would meet the irrigation and municipal requirements of the high-level lands (those lands lying above the service area of the Willard Reservoir) and a portion of the requirements of the low-level lands (those lands within the service area of the Willard Reservoir). Flows not regulated upstream, consisting of a relatively large portion of the total stream flow, would be diverted from Weber River at a point common with the lowest existing diversion and stored at the Willard Reservoir. Water would be pumped from the reservoir as needed to meet the remaining irrigation requirements of the low-level lands.

14. The required stream-flow regulation would be provided by five new reservoirs and enlargement of an existing reservoir. In all, 418,000 acre-feet of new storage capacity, as shown in the following table, would be provided:

Reservoir	Location	Capacity (acre-feet)
Perdue	Weber River	50,000
Lost Creek	Lost Creek	20,000
Jeremy	East Canyon Creek	35,000
Magpie	South Fork of Ogden River	60,000
Pineview (enlargement)	Ogden River	48,000
Willard	Shore of Great Salt Lake	205,000
Total reservoir storage capacity		418,000

15. The delivery of water to the high-level lands would require three new conveyance systems: namely, the Eden canal and the Weber and Davis aqueducts. The Eden canal would divert from the South Fork of Ogden River below the Magpie Reservoir and extend 5 miles to the northwest to serve lands in Ogden Valley with new and supplemental water. The Weber aqueduct, 19 miles in length, would divert from Weber River at the Stoddard diversion dam about 4 miles below Morgan, Utah, and would extend along the south side of Weber Canyon to its mouth. Here the aqueduct would siphon across the canyon and extend northward a short distance onto benchlands south of Ogden. This aqueduct would convey irrigation water to the benchlands north of the river and municipal water for use in Ogden and vicinity. The Davis aqueduct would divert from the Weber aqueduct at the mouth of Weber Canyon and extend 23 miles along the foothills of the Wasatch Mountains to the south end of the area. In addition to supplying a portion of the lands south of Weber River with irrigation water, the Davis aqueduct would also convey water for the municipalities along its course. Where practicable it would also intercept and divert a portion of the surplus

spring-season flows of several of the Wasatch slope streams. Arable benchlands lying adjacent to and above the Weber and Davis aqueducts would be served with water as required by pumping from these aqueducts.

16. Furnishing water to the low-level lands would require three new main canals—the Willard gravity, the Willard pump, and the Layton canals—the Slaterville and Ogden diversion dams, and the Willard and Layton pumping plants. With the exception of occasional peak discharges, all flows of Weber River not used upstream would be diverted by the Slaterville diversion dam a short distance below the mouth of Ogden River and conveyed 11.5 miles northward through the Willard gravity canal to Willard Reservoir. Water from the reservoir would be pumped to the Willard pump canal. This canal, extending 11.5 miles south from Willard Reservoir to Weber River, would serve the low-level lands. The Layton canal would divert from Weber River at the Ogden diversion dam and extend 20 miles south to a point near Kaysville, Utah. The water supply for this canal would be obtained from available flow of the Weber River supplemented by Willard Reservoir water. The reservoir water would be lifted 20 feet to the canal from the Willard pump canal at the Layton pumping plant.

17. Distribution of irrigation water from the main canals and aqueducts would be made through existing irrigation systems where practicable. Enlargements and extension of the existing systems would be undertaken where necessary and new main lateral systems constructed where needed. Facilities for treatment of the municipal water and for its distribution beyond the turn-out points along the Weber and Davis aqueducts would be provided by the water users' organization and municipalities through local financing.

18. Hydroelectric energy would be generated at the Magpie and Perdue power plants that would be located at the Magpie and Perdue Dams.[1] These plants would have a total installed generating capacity of 6,000 kilowatts, 3,000 kilowatts each, and would operate under average heads of 210 and 190 feet. Average annual energy production would amount to 28,400,000 kilowatt-hours. These plants would be interconnected with the power system of the Utah Power & Light Co. by constructing 25 miles of transmission lines. Energy produced by the plants would be utilized at the project pumping plants. Additional pumping energy required during the irrigation season would be obtained from the power company through exchange of energy produced by the project in the nonirrigation season. The small amount of power that would be produced by the project in excess of pumping and exchange requirements would be available for sale on a nonfirm basis. The Bureau of Reclamation would retain ownership and operate the hydroelectric plants constructed as part of the project.

19. Project operation would affect the flows available to three existing hydroelectric power plants of the Utah Power & Light Co. The net effect on the company's Pioneer plant on Ogden River would be an average increase in production of about 3,000,000 kilowatt-hours annually. Changes in production at the company's Weber plant on Weber River would be negligible and production at the Riverdale Plant on the same stream would be decreased approxi-

[1] The potential Gateway power plant on Weber River shown on the general map is not included in the present project plan.

mately 5,000,000 kilowatt-hours annually. Under the present tentative plan the power company would be charged on an annual basis for the increase in production at its Pioneer plant and would be reimbursed by a lump-sum settlement for the loss in power at its Riverdale plant.

20. A system of approximately 115 miles of open drainage channels and wasteways would be provided to reclaim and make suitable for productive irrigation farming those waterlogged lands susceptible of drainage. This system would also drain some presently irrigated land having impaired productivity because of a high water table and would protect other farm lands against seepage resulting from the increased water application on the high-level lands.

21. As recommended by the National Park Service in its report, recreation facilities would be built at most of the reservoirs as part of the project development. These facilities would include access roads, camping and parking areas, boating and picnicking facilities, beach development, landscaping, and sanitary and other service utilities. Additional related recreational facilities such as lodges and appurtenances, bathhouses, and group camps would be constructed, operated, and maintained by private interests under the general administration of a public agency.

22. Operation of the project to maintain certain stream flows and provision of facilities for the conservation and enhancement of fish and wildlife, in accordance with the future findings and recommendations of the Fish and Wildlife Service, would be undertaken where justified.

23. An 11-year period is expected to be required for project construction following 1 year required for detailed preconstruction investigations. Construction of project features would follow a schedule designed to make separate blocks of irrigation and municipal water available for use in about the fifth, ninth, and twelfth years after the start of construction. The first block of water would meet the urgent municipal needs and would provide a portion of the required supplemental irrigation water. Initial construction would include the Perdue Reservoir and enlargement of Pineview Reservoir, the Weber and Davis aqueducts, the Stoddard and Slaterville diversion dams, and some laterals. Construction of the other project features would be initiated and completed as required to make available the remaining blocks of project water and to provide the project pumping energy and land drainage as needed.

24. The basic plan of comprehensive development discussed herein is sound and was selected as a means for maximum development of the water and land resources of the area after consideration of several possible alternatives. Some modifications in details of the plan may yet evolve during the course of detailed preconstruction investigations leading to the preparation of a final plan report. Any such modification, however, would be expected to enhance the economy of the project.

WATER SUPPLY

25. Simulated operations of the project, based on stream-flow records over the 20-year period 1928 to 1947, show that with hold-over of storable water an adequate water supply would be physically

available for the project as planned. In the simulated project operation municipal water requirements were considered a preferential use and were fully met throughout the 20-year period of study. Only minor irrigation shortages of less than 10 percent would have occurred in the dry years of 1931, 1934, and 1935 included in the study period.

26. An appraisal of the water-right situation in the Weber Basin area indicates that adequate water rights could be obtained in accordance with the Utah State water law for the project as planned. To protect the public interest in the potential development, the Governor of the State of Utah has formally withdrawn the surface and ground waters of the Weber Basin area from further appropriation pending authorization and construction of the project. Many water exchanges with owners of existing rights to the use of waters of the Weber Basin area, particularly between low-level and high-level lands, would be necessary to permit the successful operation of the project. Such exchanges are expressly authorized by Utah law.

PROJECT WORKS AND COSTS

27. The capital cost of the project features and appurtenant structures expected to be financed through Federal funds is estimated at $69,534,000 on the basis of January 1949 prices. This estimate includes costs for construction, engineering, overhead, rights-of-way, contingencies, and investigations and surveys. Annual operation and maintenance costs of project features, including costs of producing electric energy for pumping, are estimated to average $275,000. They are expected to provide for proper operation and maintenance and sufficient replacement to assure the project works a useful life of 100 years or more. The annual costs, except those of power and pumping features, are based on average 1939–44 prices believed to be indicative of average prices over an extended period in the future. Annual costs for power and pumping features are based on January 1949 prices. Project features and their estimated costs are summarized in the following tabulation:

Summary of project costs

Project feature	January 1949 construction cost	Annual operation, maintenance, and replacement reserve cost
Dams and reservoirs:		
Perdue	$9,400,000	$6,000
Enlarged Pineview	2,425,000	4,000
Jeremy	3,410,000	5,000
Lost Creek	3,550,000	5,000
Magpie	9,350,000	6,000
Willard	10,940,000	4,000
Subtotal	39,075,000	30,000
Diversion dams:		
Stoddard	300,000	900
Ogden	290,000	700
Slaterville	350,000	900
Huntsville	70,000	300
Subtotal	1,010,000	2,800

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Summary of project costs—Continued

Project feature	January 1949 construction cost	Annual operation, maintenance, and replacement reserve cost
Aqueducts and canals:		
Weber aqueduct	$7,000,000	$4,800
Davis aqueduct	9,800,000	5,300
Layton canal	700,000	4,700
Willard gravity canal	700,000	8,300
Willard pump canal	900,000	6,000
Eden canal	160,000	1,200
Subtotal	19,260,000	30,300
Power plants:		
Perdue	684,000	41,100
Magpie	692,000	41,800
Subtotal	1,376,000	82,900
Pumping plants:		
Davis	490,000	13,200
Weber	180,000	6,900
Willard	1,460,000	35,600
Layton	190,000	7,000
Subtotal	2,320,000	62,700
Miscellaneous:		
Drainage system	3,000,000	17,000
Lateral system	1,400,000	5,000
Ground-water pumping	300,000	3,000
Davis County storage charge [1]	181,000	----------
Compensation to Utah Power & Light Co. for reduction in power output at Riverdale plant	290,000	----------
Operation and maintenance during construction	360,000	----------
Investigations and surveys [2]	330,000	----------
Recreational facilities [3]	632,000	41,300
Subtotal	6,493,000	66,300
Total	69,534,000	275,000

[1] For acquisition of rights to 5,000 acre-feet of water in Echo Reservoir now contracted for by Davis County.
[2] Includes only reimbursable costs of investigations and surveys to June 30, 1949. Costs of preconstruction surveys are prorated among the costs of project facilities.
[3] Includes only Federal costs of recreational development. An additional amount of about $550,000 would be expended for recreational developments by private interests.

COST ALLOCATIONS

28. The project costs are tentatively allocated to the various purposes as shown in the following tabulation. The allocation to flood control represents the present value of estimated benefits from this purpose over a 100-year period with an interest rate of 2.5 percent. The total allocation to recreation is the sum of the costs of the specific recreational facilities plus an equivalent amount of the joint costs of the project reservoirs (including capital and annual costs) less the non-Federal costs. No allocation was made to power since the sole purpose of the proposed power features of the project is to provide irrigation pumping energy and any incidental energy sales would be surplus to these requirements. Costs of project facilities used for one purpose only were allocated to that purpose. Costs of joint use facilities were allotted to irrigation and municipal water in accordance with the proportionate use of those facilities. The allocation to flood control and any costs found properly allocable to fish and wildlife would be nonreimbursable in accordance with present law. Because recreational benefits resulting from construction of the project are national

in scope the allocation to recreation would be expected to be made nonreimbursable by authorization of the project. Allocations to irrigation and municipal water would be reimbursable.

Allocation of costs

	Construction costs	Annual operation and maintenance costs [1]
Reimbursable:		
Irrigation	$40,234,000	$212,300
Municipal water	18,744,000	21,400
Subtotal	58,978,000	233,700
Nonreimbursable:		
Flood control	5,900,000	
Recreation	4,656,000	41,300
Subtotal	10,556,000	41,300
Total	69,534,000	275,000

[1] Includes replacement costs.

REIMBURSEMENTS

29. Estimated project revenues from irrigation, municipal water, and power would be sufficient to pay the reimbursable capital costs in 60 years after water users in the last irrigation block began payments on capital costs. Payments would begin at different times in the various areas under the project since lands and communities would be served water in three blocks on completion of the various project works. After starting payments, however, water users would pay continuously for 60 years on each block of water. A development period averaging 5 years after the delivery of project water and before the assessment of capital costs would be desirable for each irrigation block in order that the irrigators could improve their lands and realize benefits from project water at the time assessments were started.

30. Construction charges are expected to be distributed equitably among the project lands consonant with the variable quantities of water and benefits they would receive from the project and their ability to pay. The actual distribution of irrigation charges would be resolved in preconstruction investigations and negotiations with the water users and the contracting organization. The estimated annual installments that could be made by irrigators after payment of operation and maintenance costs are shown below. The estimates are made for various land categories and kinds of farms.

Area and type of farming	Acres	Total acre-feet	Annual operation and maintenance cost per acre-foot	Annual installment	
				Per acre-foot	Area total
Foothill: Fruit-truck crop	26,600	58,800	$0.91	$3.15	$185,200
Benchlands: Dairy cash crop	29,000	67,800	.91	1.94	131,500
Delta: Dairy cash crop	31,700	95,100	.91	1.72	163,600
Mountain valleys: Dairy field crop	13,100	23,300	.47	.92	21,400
Project total	100,400	245,000			501,700

31. On the basis of the estimated payments, irrigators each year could pay their allocation of the operation, maintenance, and replacement costs, estimated at $212,300, and could pay $501,700 toward their allocation of capital costs. Thus in a 60-year period they could pay a total of $30,102,000 toward the construction cost allocation of $40,234,000. The balance of $10,132,000 could be paid from power revenues and revenues paid by the municipal water users after retirement of the municipal allocation.

32. Municipalities would be required to pay for water at a rate sufficient to pay in 40 years without interest that part of the project cost properly allocable to municipal use. Although no interest is charged, annual payments by the municipal users would be continued after retirement of the allocation so that they would pay for the same length of time as any irrigation block. In the estimated 60-year repayment period, they would thus return to the Government $9,372,000 over and above the allocation to municipal water for use in paying a portion of the irrigation allocation. The annual rate for the 40,000 acre-feet of municipal water would amount to $490,000 of $12.26 an acre-foot. Of this amount, $21,400 or $0.54 an acre-foot would be required for operation, maintenance, and replacements and $468,600 or $11.72 an acre-foot would be available to apply on the allocation of capital cost. Additional costs of treatment plants and extensive pipe lines to convey water from the project aqueducts to the regulation or distribution systems of the municipalities would be financed by the water users' organization. The temporary organization of the municipalities in a report by its consulting engineer has estimated these additional costs to be from $15 to $20 an acre-foot.

33. Revenues from sale of the small block of nonfirm electric energy that would be produced by the project in excess of the project pumping and exchange needs would amount to approximately $15,000 annually. Revenues from the increased water supply that would be made available at the Pioneer power plant of the Utah Power & Light Co. would amount to approximately $9,000 annually. Total power revenues, with allowances made for variable returns during the construction period, would amount to $1,626,000 during the entire period of repayment.

34. Revenues available during the repayment period toward payment of the reimbursable capital costs are summarized below.

Irrigation water	$30, 102, 000
Municipal water	28, 116, 000
Power	1, 626, 000
Total	59, 844, 000

BENEFITS AND COSTS

35. Measurable benefits from the project attributable to Federal costs would compare with the costs in a ratio of 3.35 to 1, indicating that an economic value of approximately $3.35 would result from each Federal dollar expended for the development. The ratio of benefits to costs was determined by considering both the benefits and costs on the basis of average annual equivalents over the same 100-year

period (beginning the year the first block of project water would be available). Annual benefits and costs were computed at a 2.5 interest rate and were adjusted to allow for the construction and development periods. The annual value was thus determined as $6,995,500 and the annual cost of $2,088,400.

36. The $6,995,500 annual benefit value represents a value of $5,979,000 from increased irrigation that would be brought about by project development, $636,000 from municipal water, $161,000 from flood control, $168,500 from recreation, and $51,000 from power. The equivalent average annual cost of $2,088,400 includes annual operation and maintenance costs and the annual amount required to amortize the capital cost over a 100-year period.

37. Construction costs used in the analysis are estimated at current high prices, while benefits are based on average 1939–44 prices. Future variations in these price levels may result in a substantially different benefit-cost ratio than is indicated by the analysis as the actual ratio would depend largely on the relationship between actual costs at the time of construction and the average prices prevailing throughout the long useful life of the project.

PARTICIPATION BY OTHER AGENCIES

38. The National Park Service has reviewed the project plan. In its report it has appraised the potential recreational values of project reservoirs and has recommended that certain recreational developments be undertaken as part of the project. The Bureau of Reclamation is in general accord with the recommendations of the Service.

39. The Fish and Wildlife Service has briefly reviewed the project plan and made a reconnaissance survey of the fish and wildlife aspects of the area. The Service concluded that further investigations would be necessary to obtain the detailed information required for full consideration of the fish and wildlife aspects of the project and for the formulation of specific recommendations. The necessary investigations by the Service are now in progress and can be completed during the course of other detailed preconstruction investigations of the project.

40. The United States Public Health Service conducted a sanitary survey of the Weber Basin area to evaluate public-health problems that would be encountered in connection with the development of the project. The Service recommends that sanitary facilities at all recreational and construction camp areas be installed in accordance with accepted sanitary standards, that wastes from existing and proposed sewerage systems in the Weber Basin be adequately treated prior to their discharge into the Weber River and its tributaries, and that the purification plants for treating project municipal water be provided. The Bureau of Reclamation is in general accord with these recommendations.

41. Data on flood damages and magnitude and frequency of floods in the Weber and Ogden Rivers were compiled by the Corps of Engineers, United States Army, and were used as the basis for evaluating the effects the Weber Basin project would have on prevention of flood damages.

ACKNOWLEDGMENTS

42. Work of the investigation has been carried on by the Bureau of Reclamation with funds appropriated by Congress and funds contributed by the State of Utah. Several Federal, State, and local governmental agencies and local interests, aside from the agencies participating directly in the investigation, have supplied helpful information and data. Free use has been made of applicable information in previous reports on investigations and studies related to development and resources of the area.

CONCLUSIONS

43. The multiple-purpose Weber Basin project outlined in this report is a practicable means for maximum utilization of the area's water and land resources. Its early development is highly desirable to meet the pressing needs of the area. The basic plan of comprehensive development discussed in this report is sound. Some modifications in details of the plan may yet evolve during the course of detailed preconstruction investigations required for a final plan report. Any such modifications, however, would be expected to enhance the economy of the project. No unusual construction or design problems would be involved. An adequate water right for the project could be obtained in accordance with Utah water law.

44. The preliminary estimates show the project to be economically justified on the basis of national benefits and costs, its benefits comparing with its costs in the ratio of 3.35 to 1. The reimbursable capital cost of the project allocable to irrigation and municipal water could be repaid in approximately 60 years following appropriate development periods for project lands. A water-conservancy district organized in accordance with Utah law would be the most suitable organization to represent the water users and to contract with the United States for repayment of reimbursable costs. Satisfactory repayment contracts with water users' organizations and a suitable contract with the power company should be consummated prior to commencement of construction of the project.

RECOMMENDATIONS

45. It is recommended:

(1) That the basic plan of development of the potential Weber Basin project as described in this report be approved;

(2) That the project features listed in paragraph 27 hereof and such related works as may be incidental thereto, constituting the Weber Basin project in the Bonneville Basin in Utah, be authorized to be constructed, operated, and maintained by the Bureau of Reclamation in accordance with Federal reclamation law (act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto), and substantially in accordance with the plans set forth in the report, with such modifications, omissions, or additions to the works as the Commissioner of Reclamation,

with approval of the Secretary of the Interior (hereinafter called the Secretary), may find proper and necessary for carrying out the purposes of the project:

Provided,

(*a*) That the Secretary, upon consideration of all appropriate factors, shall determine the parts of the project's construction and annual operation and maintenance costs which can properly be allocated to flood control, recreation, and preservation and propagation of fish and wildlife and be nonreimbursable and also the parts of the project's capital costs which can properly be allocated to irrigation and municipal water and be reimbursable;

(*b*) That the repayment of reimbursable capital costs of the project be made substantially in accordance with the plan described in paragraphs 29 to 34 hereof:

Provided further,

That the Secretary be authorized to establish a mutually satisfactory repayment plan with water users which would provide for variable annual payments.

E. O. LARSON,
Regional Director, Region 4.

SUBSTANTIATING MATERIALS

BUREAU OF RECLAMATION REPORT

CHAPTER I

GENERAL DESCRIPTION

The Weber Basin project area, a part of the Bonneville Basin, is situated in the north-central portion of the State of Utah in the middle of the intermountain empire. It includes the drainage areas of the Weber River and of several smaller independent streams, all of which drain into Great Salt Lake.

PHYSICAL GEOGRAPHY

Great Salt Lake forms the western boundary of the project area. The north, east, and south boundaries are the divides separating the basin from the Bear, Provo, and Jordan River watersheds. The Wasatch Mountain Range, a branch of the Rocky Mountain system, extends in a north-south direction through the area. The western slope of this range is generally steep and rugged and joins gently sloping valley lands at its base in an abrupt transition. This western slope is commonly known as the Wasatch front.

The section at the foot of the Wasatch front, while comprising only about 20 percent of the total project area, contains most of the area's agricultural and industrial development and about 90 percent of its population. This area includes Ogden, the second largest city in the State, as well as the communities of Bountiful, Brigham City, Kaysville, Layton, Clearfield, Farmington, Roy, and a number of other smaller towns. The area east of the Wasatch front is rough and mountainous and contains several small agricultural valleys. Principal communities in this area are Morgan, Huntsville, Coalville, and Park City. Within the project area are all of Davis, Weber, and Morgan Counties, most of Summit County, and a small part of Box Elder County. Salt Lake City, the capital and largest city of Utah, is situated just south of the project area, about 40 miles from Ogden.

The Weber River originates near the west end of the Uinta Mountain Range (elevation 11,900 feet) and flows in a northwesterly direction for a distance of 130 miles to Great Salt Lake (elevation 4,200 feet). In its course it is joined by numerous tributaries, including Ogden River, East Canyon, Chalk, and Lost Creeks. Ogden River, the most important tributary, meets the Weber just west of Ogden, about 15 miles upstream from the lake. Twenty-four small perennial streams discharge directly into Great Salt Lake from small canyons along the Wasatch front.

Climate

The Weber Basin project area has a temperate semiarid climate. In the section west of the Wasatch front the mean annual temperature is 51° with extremes of 24° below zero and 106°. The frost-free period averages 163 days. In the mountain valleys east of the Wasatch front the mean annual temperature is 45° with extremes of 40° below

zero and 104°. The average period between killing frosts is 87 days. Precipitation in the project area averages 18 inches annually, less than one-third of which occurs during the growing season. Irrigation is necessary for successful crop production.

Winds in northern Utah are seldom violent. Normally their direction is southerly during the morning hours and northwesterly at increased velocities during the evening hours. In or near the canyons, air drainage causes variations from this routine in the evening and early morning hours. This air drainage helps to prevent late spring frosts and makes possible the production of a wide variety of fruits.

POPULATION

The population in the Weber Basin project area was about 127,000 in 1947. Most of the residents are white. Before the turn of the century most of the population growth in the area was attributable to farming. Since that time, however, gains have been almost entirely due to manufacturing, mining, and related industries. From 1900 to 1940 the population increased by an average of about 17 percent each decade. From 1940 to 1947, however, the population increased more than 40 percent, principally as a result of military bases and defense industries established within and near the project area during World War II. The population increases have been maintained since the war as many industries have been converted to peacetime production and new industries have been established in the area. The following tabulation shows population trends:

Population trends

Year	Population			
	Ogden	Project area	Salt Lake City	Utah
1900	16,313	48,000	53,531	276,749
1910	25,580	61,000	92,777	373,351
1920	32,804	72,000	118,110	449,326
1930	40,272	84,000	140,267	507,847
1940	43,688	90,000	149,934	550,310
1947	51,927	127,000	181,419	636,821

PRESENT DEVELOPMENT

Farming, manufacturing, mining, smelting, and refining are all important industries within the general vicinity of the project. Abundant yields of fruit, truck, and other cash crops are produced in areas with sufficient irrigation water. Agricultural products, including fruits, dairy products, meats, sugar beets, and grains, are processed in the area. The smelting and refining of minerals, while carried on outside of the project boundaries, have an important influence on the area's economy. The most important nonferrous smelting center in the world is located south and west of Salt Lake City. The largest integrated steel plant west of the Mississippi is located near Provo, south of Salt Lake. Three large oil refineries, receiving oil from Utah, Wyoming, and Colorado, are located in a 5-mile stretch between Bountiful and Salt Lake City. A large port-

land cement plant is operated at Devils Slide in Weber Canyon. Many other smaller industries are within and adjacent to the project area.

Transportation and other facilities

The project area is provided with good transportation and communication service. Ogden and Salt Lake City are connected by excellent highway, railroad, and air-transportation facilities and are focal points for major transcontinental railroads, highways, and air lines. Good farm-to-market roads extend throughout the project area.

Natural gas, piped from several fields in the vicinity of the common corner of Wyoming, Utah, and Colorado, supplies fuel for heating, cooking, and refrigeration to Ogden and towns in the area south of Ogden.

Electric energy is furnished the area mainly from the Utah Power & Light Co.'s system. This company generates power at hydroelectric plants in northern Utah and southern Idaho and at steam plants in Salt Lake City and Orem, Utah. In addition, it purchases large quantities of power from the Geneva Steel Co. and the Kennecott Copper Corp. when these companies are producing energy beyond their own requirements. Three hydroelectric plants are owned and operated by the Utah Power & Light Co. in the project area. Brigham City and Bountiful have municipal electric plants.

Grammar and high schools are located in the larger communities of the area, and consolidated school systems serve the smaller communities. Higher educational institutions are the Weber College at Ogden, the University of Utah at Salt Lake City, and the Utah State Agricultural College at Logan, some 46 miles northeast of Ogden.

Churches of various denominations are established in each of the principal towns and cities. Banks in Salt Lake City, Ogden, and the smaller communities serve the area.

Land use

Approximately 83 percent of the land in the project area is privately owned. About 16 percent of the land is federally owned and 1 percent State owned. The agricultural lands are located along the gently sloping foothills and lower benches west of the Wasatch front and in the mountain stream valleys east of the front. About 202,800 acres are suitable for irrigation farming. Of these about 125,200 acres are presently irrigated. Extensive mining operations are carried on in the Park City and Devils Slide mining districts in the Weber River drainage area of the project. Famous ski and recreational resorts are located in the mountainous area within and adjacent to the project area.

Water use

On July 23, 1847, an advance guard of pioneers turned the waters of City Creek onto land now occupied by the business district of Salt Lake City. The following year irrigation started in the project area. About 1900 the natural flows of project streams, except spring flood flows, were fully appropriated and the development of storage reservoirs was undertaken to counteract the effects of drought periods and late summer shortages.

East Canyon Reservoir on East Canyon Creek, a tributary of Weber River, was developed by private irrigation interests in 1896.

This reservoir was originally built to a capacity of 3,850 acre-feet to supplement the water supply for 30,000 acres of land. In 1916 it was enlarged to its present capacity of 28,000 acre-feet.

Echo Reservoir on Weber River, with a capacity of 74,000 acre-feet was completed by the Bureau of Reclamation in 1931 as part of the Weber River project and furnishes supplemental irrigation water to 71,250 acres in the area, including the land served by the East Canyon Reservoir. Also included as part of the Weber River project was the Weber-Provo diversion canal which conveys water from Weber River to the Provo River Basin as a supplemental irrigation supply for that basin. The Weber-Provo diversion canal was recently enlarged as part of the Provo River project, currently being developed by the Bureau of Reclamation, to convey additional water from Weber River to the Provo River for use in Utah and Salt Lake Valleys.

The Ogden River project was undertaken by the Bureau of Reclamation in 1934 to irrigate 4,500 acres of undeveloped land and supplement the irrigation supply for 17,250 acres. This project includes as principal features the Pineview Reservoir of 44,000 acre-foot capacity on Ogden River, the Ogden Canyon conduit, the Ogden-Brigham canal, the South Ogden canal and a high-pressure distribution system for a suburban area southeast of Ogden.

Water for irrigation is first used to generate much-needed electric energy at four hydroelectric plants located on the project streams. The municipal water supply for cities and towns within the project is obtained from mountain streams and artesian basins. Water resources of the area provide numerous recreational opportunities, including fishing in the clear mountain streams, boating and swimming on the reservoirs, and duck and goose hunting on the fresh-water marshes along the shore of Great Salt Lake. Surplus and return flows supply water for the Farmington Bay, Ogden Bay, and Bear River Migratory Bird Refuges on the east shore of the lake.

Water problems

In years of high run-off floods from rapidly melting snow cause considerable crop and property damage in the canyons and in the highly developed area west of the Wasatch front. Extensive property damage has been caused by summer cloudbursts in the Willard and Farmington-Centerville areas during the past 30 years. Damage from storms, however, has been reduced in recent years as a result of curtailments in grazing and a revegetation program along the Wasatch front.

Seepage water from higher irrigated lands has caused a waterlogged condition in approximately 32,000 acres of potential farm lands and in about 7,000 acres with impaired productivity. This condition could be corrected with proper drainage facilities.

Undeveloped resources

Important undeveloped resources within and near the Weber Basin are water, agricultural lands, minerals, and timber Surface stream flows totaling approximately 300,000 acre-feet annually waste into Great Salt Lake, and some ground water, approximately 12,000 acre-feet, awaits development With irrigation and drainage facilities most of the potentially productive land could be developed. Large reserves of copper, zinc, gold, lead, and silver await development in

the Park City mining district within the project boundary, the Cottonwood mining area southeast of Salt Lake City, and the Brigham and Tintic mining districts to the south of the project. Approximately 800,000,000,000 tons of coal, representing about 10 percent of the known reserves in the world, are found in the eastern part of the State. Utah also contains important deposits of iron ore, phosphate, gilsonite, salt, limestone, gypsum, sulfur, asphalt, and many other minerals. The Cache, Wasatch, Uinta, and Ashley National Forests, parts of which lie within and adjacent to the project, contain timber reserves of 3¼ billion board feet with an annual yield of about 38 million board feet.

Possibilities exist in Utah for the production of a vast amount of hydroelectric power, useful in the development of the area's natural resources. More than a million kilowatts of capacity could be installed on Utah streams, the greatest power potentialities existing on the Colorado River and its tributary, the Green River, in eastern Utah.

ECONOMIC CONDITIONS

Economic conditions within the project area have changed materially since 1940. Some agricultural land has been taken over for industrial and residential developments. Off-farm employment opportunities have increased. Markets for agricultural products have improved because of increased population in the area and throughout the West. Higher farm-product prices have permitted farmers to retire a large part of the farm-mortgage debt which existed in 1940.

Despite the improved conditions of recent years, the Weber Basin is faced with numerous problems. Many farms are too small for profitable full-time operation. Because of the inadequate irrigation supply more than one-fourth of the irrigated land is only partially productive and more than one-third of the total area potentially suitable for irrigation farming is practically unproductive, yet more than sufficient water to meet the needs of all these lands flows uncontrolled into Great Salt Lake. Agriculture is no longer expanding and until 1941 unemployment was increasing.

The need for additional dependable supplies of municipal water is urgent. Population increases far beyond the growth anticipated a decade ago have overtaxed present municipal water supplies. Only the above-normal precipitation during the past few years has averted serious shortages. With extended periods of below-normal precipitation, the situation will be critical.

CHAPTER II

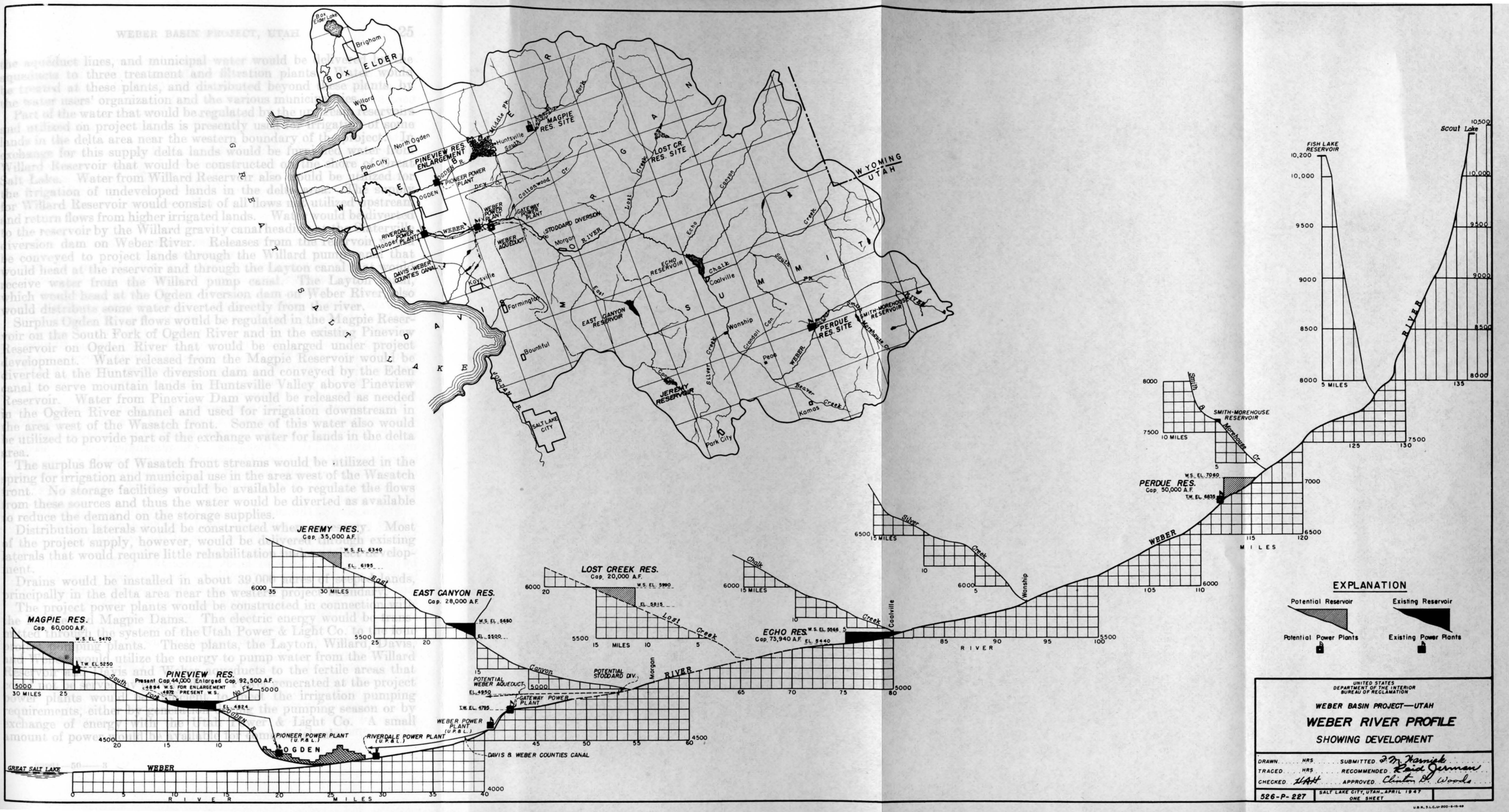
PLAN OF DEVELOPMENT

The Weber Basin project, a coordinated multiple-purpose development, would regulate the limited quantities of unused water in the Weber Basin to meet the immediate and future needs of agriculture and municipalities, both dependent on the area's water resources. In addition to providing the water needed for irrigation and municipal use, the project would provide drainage of seeped areas to permit full productivity of agricultural lands. The project would control damaging floods in the area and would provide increased recreational facilities. It would increase the output of electric energy in the area, the additional energy to be used primarily for pumping irrigation water. Fish and wildlife values would likely be maintained. Stream pollution abatement, silt and debris control, navigation, and Indian lands would not be involved in the development.

By storage and effective utilization of surplus surface flows and increased use of ground-water supplies, 285,000 acre-feet of water would be provided annually to meet project needs. Approximately 245,000 acre-feet of this supply would be used for irrigation and would provide a full water supply for 70,400 acres of new lands and a supplemental supply for 30,000 acres of land only partially irrigated. The remaining water developed, 40,000 acre-feet, would be provided to communities in Weber and Davis Counties for municipal use.

The water supply of the Weber River system would be regulated by six storage reservoirs. Five of these would be constructed as project features and the other, an existing reservoir, would be enlarged under project development. Storage releases would be augmented by direct diversions of surplus flows from the Wasatch front streams and from the wells that would be developed by the project. Conveyance and operation facilities would consist of 2 aqueducts, 4 diversion dams, 4 canals, 4 irrigation water pumping plants, 20 pump wells, a drainage system, and 2 hydroelectric plants. Major features are indicated on the frontispiece map and on the profile on the following page.

Three reservoirs east of the Wasatch Front—Perdue on Weber River, Jeremy on East Canyon Creek, and Lost Creek on Lost Creek—would regulate flows of the Weber River system for use by lands in the mountain valleys and on foothills and bench lands west of the Wasatch front. Water would be stored in the reservoirs in the high spring run-off season and released as needed to the stream channels. The regulated flow would be diverted for municipal and irrigation use at the Stoddard diversion dam on the Weber River. Diversions would be conveyed in the Weber aqueduct to the mouth of the canyon, then across the canyon, and north to a point near Ogden. Part of the water from the Weber aqueduct would be diverted at the mouth of Weber Canyon to the Davis aqueduct and conveyed to lands south of Weber River. Irrigation diversions would be made along



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WEBER BASIN PROJECT—UTAH

WEBER RIVER PROFILE

SHOWING DEVELOPMENT

DRAWN	HRS	SUBMITTED	F.M. Hamick
TRACED	HRS	RECOMMENDED	Reid Jerman
CHECKED	HAH	APPROVED	Clinton D. Woods

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U.S.B.R. S.L.C.U. 200-6-15-48

the aqueduct lines, and municipal water would be delivered by the aqueducts to three treatment and filtration plants. Water would be treated at these plants, and distributed beyond these plants, by the water users' organization and the various municipalities.

Part of the water that would be regulated by the upstream reservoirs and utilized on project lands is presently used for irrigation of some lands in the delta area near the western boundary of the project. In exchange for this supply delta lands would be furnished water from Willard Reservoir that would be constructed on the shore of Great Salt Lake. Water from Willard Reservoir also would be utilized for the irrigation of undeveloped lands in the delta area. The supply for Willard Reservoir would consist of all flows not utilized upstream and return flows from higher irrigated lands. Water would be diverted to the reservoir by the Willard gravity canal heading at the Slaterville diversion dam on Weber River. Releases from the reservoir would be conveyed to project lands through the Willard pump canal that would head at the reservoir and through the Layton canal that would receive water from the Willard pump canal. The Layton canal, which would head at the Ogden diversion dam on Weber River, also would distribute some water diverted directly from the river.

Surplus Ogden River flows would be regulated in the Magpie Reservoir on the South Fork of Ogden River and in the existing Pineview Reservoir on Ogden River that would be enlarged under project development. Water released from the Magpie Reservoir would be diverted at the Huntsville diversion dam and conveyed by the Eden canal to serve mountain lands in Huntsville Valley above Pineview Reservoir. Water from Pineview Dam would be released as needed in the Ogden River channel and used for irrigation downstream in the area west of the Wasatch front. Some of this water also would be utilized to provide part of the exchange water for lands in the delta area.

The surplus flow of Wasatch front streams would be utilized in the spring for irrigation and municipal use in the area west of the Wasatch front. No storage facilities would be available to regulate the flows from these sources and thus the water would be diverted as available to reduce the demand on the storage supplies.

Distribution laterals would be constructed where necessary. Most of the project supply, however, would be delivered through existing laterals that would require little rehabilitation under project development.

Drains would be installed in about 39,000 acres of seeped lands, principally in the delta area near the western project boundary.

The project power plants would be constructed in connection with the Perdue and Magpie Dams. The electric energy would be transmitted through the system of the Utah Power & Light Co. to the four project pumping plants. These plants, the Layton, Willard, Davis, and Weber, would utilize the energy to pump water from the Willard Reservoir and Davis and Weber aqueducts to the fertile areas that could not be served by gravity flow. Power generated at the project power plants would be sufficient to meet the irrigation pumping requirements, either by generation during the pumping season or by exchange of energy with the Utah Power & Light Co. A small amount of power would be available for commercial sale.

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The reservoirs provided for storage regulation would permit control of the large snow melt floods which frequently occur in the spring. An effective stream flow forecasting system would be installed and used and sufficient releases made from the reservoirs to provide storage for anticipated flood flows. Water released could be recaptured in the Willard Reservoir and conserved for later irrigation use in the delta area.

Recreational facilities would be provided as recommended in the report of the National Park Service, which is appended. As only a reconnaissance report of the Fish and Wildlife Service is available, definite plans have not been made for conservation of fish and wildlife. Measures for conservation, however, would be taken wherever practicable.

CONSTRUCTION AND DEVELOPMENT PROGRAM

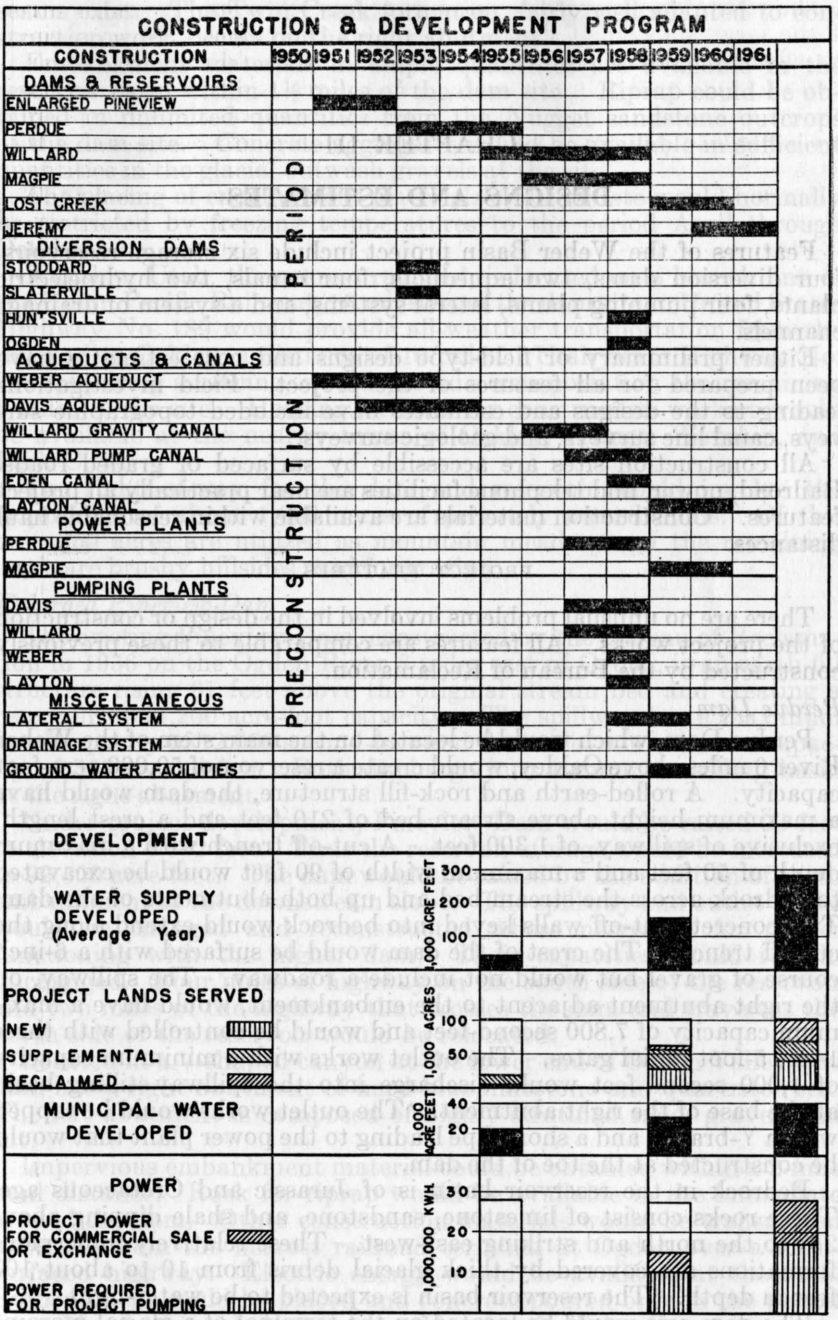
The project would be constructed over a 12-year period which is considered a reasonable period in which to complete all features and place them in operation. The chart on the following page shows the program of constructing the project to make water available in three blocks at the end of the fifth, ninth, and twelfth year of construction.

During the first period facilities would be constructed to meet the most urgent needs of the project area. The first year of this period would be devoted to negotiating contracts with water users and other preconstruction activities such as final location surveys, final-type designs, and the formulation of detailed construction schedules for the individual project features.

Upon completion of the first period (fifth year) of construction a water supply of 40,000 acre-feet a year would be available. Approximately 20,000 acre-feet of this water would be provided for municipal use in Davis and Weber Counties. The remainder would be used for irrigation and would provide a supplemental supply to all inadequately irrigated lands under the Davis aqueduct (13,400 acres) and a full supply for 2,200 acres of new land under either the Davis or Weber aqueduct.

At the end of the second period (ninth year) project features to deliver a total water supply of about 120,000 acre-feet a year would be completed. This supply would meet the irrigation requirements of an additional 55,300 acres of lands, including all lands serviceable by the aqueduct system, lands serviceable by Eden canal, some lands in the delta area serviceable by Willard pump canal, and some lands in the mountain valleys east of the Wasatch Front serviceable by existing canals. Some lands also would be drained. An additional 12,000 acre-feet of municipal water would be provided. To meet energy requirements for pumping from Willard Reservoir an annual average of 15,200,000 kilowatt-hours would be produced at the Perdue power plant.

At the end of the twelfth year all project features would be completed and 285,000 acre-feet of water, including 245,000 acre-feet for irrigation and 40,000 acre-feet for municipal use, would be available. A full water supply would be available to the arable project lands and municipal water would be available for immediate demands and for future population growth and industrial expansion.


CONSTRUCTION & DEVELOPMENT PROGRAM
CONSTRUCTION
1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961
PERIOD OF CONSTRUCTION
DAMS & RESERVOIRS
ENLARGED PINEVIEW
PERDUE
WILLARD
MAGPIE
LOST CREEK
JEREMY
DIVERSION DAMS
STODDARD
SLATERVILLE
HUNTSVILLE
OGDEN
AQUEDUCTS & CANALS
WEBER AQUEDUCT
DAVIS AQUEDUCT
WILLARD GRAVITY CANAL
WILLARD PUMP CANAL
EDEN CANAL
LAYTON CANAL
POWER PLANTS
PERDUE
MAGPIE
PUMPING PLANTS
DAVIS
WILLARD
WEBER
LAYTON
MISCELLANEOUS
LATERAL SYSTEM
DRAINAGE SYSTEM
GROUND WATER FACILITIES
DEVELOPMENT
WATER SUPPLY DEVELOPED (Average Year)
1,000 ACRE FEET
300
200
100
PROJECT LANDS SERVED
NEW
SUPPLEMENTAL
RECLAIMED
1,000 ACRES
100
50
MUNICIPAL WATER DEVELOPED
1,000 ACRE FEET
40
20
POWER
PROJECT POWER FOR COMMERCIAL SALE OR EXCHANGE
POWER REQUIRED FOR PROJECT PUMPING
1,000,000 KWH
30
20
10

CHAPTER III

DESIGNS AND ESTIMATES

Features of the Weber Basin project include six storage reservoirs, four diversion dams, two aqueducts, four canals, two hydroelectric plants, four pumping plants, lateral systems, and a system of drainage channels.

Either preliminary or field-type designs and cost estimates have been prepared for all features of the project. Field investigations leading to the designs and estimates have included topographic surveys, canal line surveys, and geologic surveys.

All construction sites are accessible by surfaced or graded roads. Railroad, power, and telephone facilities are near practically all project features. Construction materials are available within reasonable haul distances.

PROJECT FEATURES

There are no unusual problems involved in the design or construction of the project works. All features are comparable to those previously constructed by the Bureau of Reclamation.

Perdue Dam

Perdue Dam, which would be located on the main stem of the Weber River 6 miles above Oakley, would create a reservoir of 50,000 acre-foot capacity. A rolled-earth and rock-fill structure, the dam would have a maximum height above stream bed of 210 feet and a crest length, exclusive of spillway, of 1,300 feet. A cut-off trench with a maximum depth of 50 feet and a maximum width of 90 feet would be excavated to bedrock across the stream bed and up both abutments of the dam. Two concrete cut-off walls keyed into bedrock would extend along the cut-off trench. The crest of the dam would be surfaced with a 6-inch course of gravel but would not include a roadway. The spillway, on the right abutment adjacent to the embankment, would have a maximum capacity of 7,800 second-feet and would be controlled with three 14 x 15-foot radial gates. The outlet works with a minimum capacity of 1,000 second-feet would discharge into the spillway stilling basin at the base of the right abutment. The outlet works would be tapped with a Y-branch and a short pipe leading to the power plant that would be constructed at the toe of the dam.

Bedrock in the reservoir basin is of Jurassic and Cretaceous age. These rocks consist of limestone, sandstone, and shale dipping about 25° to the north and striking east-west. These relatively impervious formations are covered by thick glacial debris from 10 to about 100 feet in depth. The reservoir basin is expected to be water-tight.

The dam axis would be located on the terminal of a glacial moraine that existed during the Pleistocene period. Nugget sandstone occurs along the floor and left abutment of the dam site. This is of good quality except on the left abutment where fractures and open vertical

seams exist. The Twin Creek formation, fairly well adapted to construction work, occurs on the right abutment.

Embankment materials in ample quantities are available in the reservoir basin within 1½ miles of the dam site. Riprap could be obtained in unlimited quantities from the Nugget sandstone outcrops at the dam site. Concrete aggregates would be available in sufficient quantities in the glacial outwash gravels at the site.

The placing of embankment materials and concrete would normally be restricted by freezing temperatures to the period April through October.

Wanship, Utah, the nearest railhead, is located on a branch line of the Union Pacific Railroad, 16 miles from the dam site. United States Highway No. 189 would provide all-weather transportation from the railhead to Oakley, a distance of 10 miles. Utah State Highway No. 213, requiring surfacing, would provide transportation the remaining 6 miles to the site. Housing facilities for construction workers would be available at the nearby towns of Oakley, Kamas, Wanship, and Park City.

The rights-of-way for the dam and reservoir would involve the acquisition of about 1,000 acres of privately owned lands. Of this area 250 acres are utilized as mountain meadow and the remaining lands are brushy hillsides used for grazing.

Enlarged Pineview Dam

The existing Pineview Dam, constructed by the Bureau of Reclamation in 1936 on the Ogden River 8 miles east of Ogden, is an earth-fill structure rising 61 feet above the original stream bed and creating a reservoir of 44,200 acre-foot capacity. The spillway has a maximum flood capacity of 12,000 second-feet and the outlet works have a capacity of 300 second-feet. Both discharge into a common stilling basin at the right abutment.

Under project development, Pineview Dam would be raised 23 feet to elevation 4,902 feet. Thus the reservoir storage would be increased to 92,500 acre-feet. The dam would be raised by the addition of earth embankment to the downstream slope. The spillway and outlet works would be changed and reconstructed where necessary for proper functioning with the higher dam. Their capacities would remain unchanged. Four miles of highway on the south side of the reservoir and two miles of the highway that crosses the dam and traverses the north side of the reservoir would be relocated.

Located in a V-shaped canyon at the lower end of Ogden Valley, the dam has a right abutment of hard blue limestone and quartzite rock. The left abutment is composed of highly stratified sand, gravel, and silt.

Impervious embankment material could be obtained within a 2-mile haul distance. Rock for riprap would be available in the immediate area of the dam. Other construction materials would be transported by truck from the nearest railroad terminal at Ogden over a hard-surfaced highway. Electric energy would be available at the dam. Embankment could be placed and concrete poured only in the period from March through November. Housing facilities for construction workers would be available at Ogden.

Jeremy Dam

Jeremy Dam, which would be located on East Canyon Creek in Summit County, would be a rolled-earth and rock-fill structure with a height of 150 feet above the stream bed and a crest length of 730 feet. A cut-off trench located 180 feet upstream from the dam axis would extend across the floor of the canyon and up the two abutments. A concrete cut-off wall would be keyed into bedrock in the trench. The spillway, a straight line channel type with uncontrolled crest, would be located on the left abutment adjacent to the embankment. It would have a maximum capacity of 2,500 second-feet. The outlet works, with a capacity of 600 second-feet, would discharge into the spillway stilling basin at the base of the left abutment, the reservoir at its normal storage capacity of 35,000 acre-feet would inundate about 740 acres of privately owned land, most of which is dry land pasture.

Rock in the dam site area belongs to the Kelvin formation of Cretaceous age. This formation includes about 3,000 feet of variegated shales and sandstones with some conglomerate near the base. Two very resistant beds of sandstone and conglomerate form the narrow part of the abutments. The rock formation at the dam site has a dip of 75–80° to the north or downstream and a strike of N 80° E which is nearly parallel to the dam axis. This steep slope is conducive to water tightness since the direction of seepage flow would be nearly perpendicular to the strata.

The bedrock underlying the reservoir basin is composed of shale and sandstone. This rock would prevent appreciable seepage losses.

The dam site is accessible and is well located with respect to construction materials, public utilities, and availability of construction workers. Impervious embankment materials are available within the immediate vicinity of the dam site. Riprap of excellent quality could be obtained 1 mile from the site. Salt Lake City, 22 miles from the site, would normally furnish adequate housing facilities for the construction workers. Two miles of United States Highway No. 40, which passes within a mile of the site, would require relocation.

Embankment and concrete could be placed only from April through November.

Lost Creek Dam

The Lost Creek Dam, which would be located on Lost Creek 12 miles above the creek's confluence with the Weber River, would create a reservoir with a maximum capacity of 20,000 acre-feet. It would be a rolled-earth and rock-fill structure with a height of 180 feet above stream bed and a crest length, exclusive of the spillway, of 1,020 feet. A cut-off trench 200 feet upstream from the dam axis would extend to bedrock across the canyon floor and up the abutments to the crest of the dam. A concrete cut-off wall keyed into the bedrock would extend along the bottom of the trench. The spillway would be a free-flowing side-channel type set into the rock on the right abutment. It would have a maximum capacity of 6,000 second-feet. The outlet works, with a capacity of 600 second-feet, would discharge into the spillway stilling pool at the base of the right abutment.

The Twin Creek limestone of Jurassic age outcrops on both abutments at the dam site and forms the bedrock material at the floor of the site. This formation is composed chiefly of a hard gray limestone with a few layers of shale and is well adapted to construction work.

Rocks in the reservoir area consist of highly folded limestone and sandstone of Jurassic age overlain by sandstone and conglomerate of the Almy formation. Although these rocks could contain fractures which might serve as channels for percolating waters, it is unlikely that they could lead out of the drainage basin. The reservoir is expected to be tight.

The nearest railhead is located on the main line of the Union Pacific Railroad at Devils Slide, Utah. Haulage from either the railhead or from United States Highway No. 30–S would be over 12 miles of graded earth road. Electric energy and telephone service are available at the dam site. Housing facilities for construction workers would be available at the nearby towns of Croyden, Henefer, and Morgan.

Ample embankment material is available in the reservoir basin, within 1½ miles of the dam site. Riprap would be available at the site.

Relocation of a short section of a small diameter oil pipe line, a rural telephone line, a small power transmission line, and an unimproved roadway through the reservoir basin would be required.

The reservoir would inundate only sage-covered, undeveloped range lands.

Magpie Dam

Magpie Dam, on the South Fork of the Ogden River 18 miles east of Ogden, would be a rolled-earth and rock-fill structure. It would rise 260 feet above stream bed and extend 895 feet in length at the crest. A cut-off trench with a maximum depth of 40 feet and a maximum width of 300 feet would be excavated to bedrock across the canyon 200 feet upstream from the dam axis. Two concrete cut-off walls keyed into bedrock would extend along the trench. The spillway, with a maximum capacity of 4,150 second-feet, would be a side channel type with an uncontrolled crest. It would be located on the left abutment and would discharge into a stilling pool at the base of the dam. The outlet works, with a capacity of 800 second-feet, would extend through the left abutment and discharge into the spillway stilling pool. A Y-branch near the lower end of the outlet works would permit diversion of water to the Magpie power plant at the toe of the dam.

The reservoir, with a total storage capacity of 60,000 acre-feet, would inundate 750 acres. About one-third of this area is presently utilized as a picnic and recreation area. The remainder is primarily rough brushy undeveloped grazing land.

At the dam site the Ogden River flows in a narrow steep-walled canyon, cut in the highly resistant quartzites of Cambrian Age. The Cambrian beds strike approximately at right angles to the stream channel and dip steeply upstream into the reservoir area. Overlying the quartzites, and conformable with them, are the shales and limestones of the normal Cambrian section. The basin itself is an erosional valley, most of which has been cut out of Wasatch conglomerate. The Cambrian beds underlying the conglomerate have a dip upstream, thus forming a structural basin beneath the erosional basin. This composition should provide a watertight reservoir. The valley floor is mantled with an alluvial deposit composed mainly of wash derived from the weathering of the conglomerate. This material is quite water-tight.

Several borrow areas within the reservoir basin and one a short distance below the dam site are available for embankment material. Riprap materials are available at the dam site.

Utah State Highway No. 39, an all-weather surfaced roadway, connects the site with Ogden, Utah, the nearest railhead. Housing facilities are available in Ogden and Huntsville. Power and telephone lines extend through the reservoir basin.

Willard Reservoir

Willard Reservoir would be constructed about 1 mile west of Willard, Utah, in a large mud flat and marshy area known as Willard Bay. The reservoir would have a maximum storage capacity of 205,000 acre-feet and would be created by diking a portion of the Willard Bay. The reservoir would inundate approximately 11,000 acres of the old clay lake bed.

The dike would be divided into two sections, a short eastern section to provide protection for the Union Pacific Railroad which passes through the eastern portion of the reservoir site, and the main section separating the reservoir from Great Salt Lake. The entire dike would be 12.8 miles long and would have a maximum height of 30 feet. The outlet works and spillway would be incorporated into a single structure and would be controlled by a 12-by-20 foot radial gate. The spillway would pass 3,000 second-feet of water at maximum discharge. The outlet would consist of a 500 second-foot sump canal excavated in the floor of the reservoir. This canal would convey the water of the reservoir to the intake of the Willard pumping plant.

The clay materials comprising the reservoir floor of the Willard Bay area were laid down in water and are well compacted. Several shallow test pits within the reservoir basin indicated that the reservoir floor would be suitable as a foundation for the low dikes contemplated and would be watertight.

Clay for construction is available in the lake bed in abundant quantities. Other dike materials are available about 8 miles northeast of the reservoir site. The reservoir site would be readily accessible from Ogden for transportation of labor and material. The Union Pacific Railroad and a four-lane highway are adjacent to the site on the east.

Stoddard Diversion Dam

The Stoddard diversion dam, on the Weber River about 4 miles northwest of Morgan, would be a reinforced concrete structure. It would consist of an ogee overflow weir section capable of passing the design flood of 8,800 second-feet, a radial gate controlled sluiceway, and a canal heading capable of diverting 435 second-feet into the Weber aqueduct.

The foundation for the dam consists of stratified deposits of clay, sand, and gravel that were laid down in ancient Lake Bonneville. The cross slopes on either side of the river at the diversion site are comparatively flat, necessitating the construction of short dikes on either side of the structure.

Transportation facilities are provided by a double-track line of the Union Pacific Railroad and United States Highway 30–S adjacent to the site. A 44-kilovolt power transmission line and a telephone line are also adjacent to the site. Morgan and Ogden at distances of 5

and 19 miles, respectively, would provide housing facilities for construction workers. Concrete aggregate and cement are available at distances of 5 and 15 miles, respectively.

Ogden diversion dam

The Ogden diversion dam, on the main channel of the Weber River near the main railroad switchyard in Ogden, would be a reinforced concrete structure. It would provide for a diversion of 165 second-feet through the left side of the dam to the Layton canal.

The dam would have an ogee weir section capable of passing a design flood of 8,300 second-feet. The foundation for this dam consists of stratified deposits of clay, sand, and gravel that were laid down in ancient Lake Bonneville.

Construction materials, transportation, power, and telephone facilities are available at the dam site. Housing for construction workers would be available in Ogden.

Slaterville diversion dam

The Slaterville diversion dam would be constructed on the lower Weber River about 1,000 feet downstream from the river's confluence with the Ogden River. It would divert a maximum of 800 second-feet to the Willard gravity canal to the north of the river and a maximum of 325 second-feet to the existing Hooper canal south of the river.

The diversion dam would be a reinforced concrete structure with an ogee weir section capable of passing a design flood of 8,900 second-feet. The foundation for this dam consists of stratified deposits of clay, sand, and gravel that were laid in ancient Lake Bonneville. The surrounding terrain is quite level except for remnants of old river channels.

Power, transportation facilities, and construction materials are available near the dam site. Housing for construction workers would be available at Ogden, a mile to the east.

Huntsville diversion dam

Huntsville diversion dam would be constructed on the South Fork of the Ogden River, about 3 miles east of Huntsville, to permit the diversion of 60 second-feet into the Eden canal. The dam would have a reinforced concrete ogee overflow weir section capable of passing a design flood of 5,000 second-feet. A sluiceway and the headworks of the Eden canal would be constructed in the right side of the dam.

The foundation materials at the site are composed of silts, sand, and gravel of the Lake Bonneville period.

The site would be readily accessible from Utah State Highway 39, a surfaced all-weather roadway. Power and telephone facilities are available near the site. Construction materials and housing facilities for workers would be available at Ogden, 13 miles distant.

Weber aqueduct

The Weber aqueduct, which would divert from the Weber River at the Stoddard diversion dam, would be 17.1 miles in length. For the first 12.1 miles of its course, consisting of 8.9 miles of lined canal and 3.2 miles of tunnel, the aqueduct would have a capacity of 435 second-feet. At the end of this section a bifurcation works would permit the release of 350 second-feet into the Davis aqueduct, and the remaining

85 second-feet would be carried north through a 1-mile-long steel inverted siphon across Weber Canyon to Burch Creek bench. The water carried to the Burch Creek bench would be conveyed 4 miles farther north in a precast concrete pipe. This pipe, decreasing in capacity from 85 to 60 second-feet as irrigation releases were made, would convey 10 second-feet to the South Ogden high-line canal and 50 second-feet to Ogden.

The Weber aqueduct, with a maximum capacity of 435 second-feet, would convey a total of 26,800 acre-feet during the peak month to the project area. The average annual delivery would be 110,000 acre-feet.

The first 6-mile section of the aqueduct would extend through lake deposit soils of clay, sand, and gravel with relatively flat transverse slopes. The next 2.9-mile section would traverse an area of moderately steep transverse slopes with increased amounts of rock. The 3.2 miles of tunnel would be entirely through rock. The steel inverted siphon across Weber Canyon would be embedded in the overburden of the canyon floor and would pass under the Union Pacific Railroad tracks in tunnel. The remaining 4 miles of the aqueduct would pass through lake shore deposits with scattered rock outcrops and flat to moderately steep transverse slopes.

Excellent transportation facilities for construction materials and equipment would be provided by the Union Pacific Railroad and United States Highway 30–S, which parallel the entire aqueduct line. Electric power would be available from a nearby transmission line. Housing facilities for construction workers are available at Morgan and Ogden.

Davis aqueduct

The Davis aqueduct, extending south from the bifurcation of the Weber aqueduct at the mouth of Weber Canyon to the Davis-Salt Lake County line, would be a precast concrete structure nearly 23 miles long. It would have an initial capacity of 350 second-feet. The capacity would gradually be reduced as diversions were made from the aqueduct until a terminal capacity of 30 second-feet was reached. The 350 second-foot capacity of the aqueduct would permit the delivery of 21,500 acre-feet during the peak month to the Davis County area. The average annual demand on the aqueduct would be 80,000 acre-feet.

Except for occasional rock outcrops at stream crossings, excavation for the aqueduct would be in lake shore deposits laid down during the Provo stage of Lake Bonnveille. Transverse slopes, moderately steep at the upper end of the aqueduct, would decrease somewhat along the central portion where the old lake terraces are encountered. At the lower end the aqueduct would run through farm and residential areas with moderate to flat slopes.

Highways, railroads, and other public utilities parallel the aqueduct line. Construction materials are available within a reasonable haul distance of the entire aqueduct line. Housing facilities are available in the many communities in the Davis County area. Except for a short distance in the farm and residential area at the lower end of the aqueduct, rights-of-way would be required through brushy, undeveloped pasture land.

Layton canal

The Layton canal, an enlargement and extension of the present Wilson canal, would be an unlined earth section 20 miles in length. It would follow the alinement of the Wilson canal for the first 3.8 miles and then would continue in a southerly direction for 16.2 miles. The canal, with an initial capacity of 165 second-feet at its heading at Ogden diversion dam, would deliver a maximum of 10,000 acre-feet a month to project lands. An average of 37,500 acre-feet would be delivered through the canal each year. The capacity of the canal would be reduced throughout its length as irrigation diversions are made. The terminal capacity would be 30 second-feet.

The canal would be located on lake terraces of ancient Lake Bonneville. The soils in the area consist primarily of lake bottom clay with some sand and gravel. The terrain is relatively flat except in the area adjacent to the Weber River. No rock is likely to be encountered in excavation.

Surfaced roads parallel and cross the canal along its entire length, facilitating transportation of construction materials and equipment.

Willard gravity canal

The Willard gravity canal would convey water from the Slaterville diversion dam on the Weber River to the Willard Reservoir. It would be an unlined earth section and would extend for 11 miles along the terraces of old Lake Bonneville. It would have a capacity of 800 second-feet and could convey a maximum of 49,000 acre-feet a month to the Willard Reservoir. During the irrigation season this canal would also supply water to the existing Warren, Slaterville, and Plain City canals and a few small laterals.

All excavation for the canal would be in clay and silt. The canal line would traverse generally flat terrain.

Primary and secondary roads would provide access to the canal throughout its entire length. Nearby railroads and highways would facilitate the transportation of construction materials and equipment. Ample housing for construction workers would be available at Ogden.

Willard pump canal

The Willard pump canal would extend from a pumping plant on the eastern end of Willard Reservoir south to the Ogden River, a distance of 11.3 miles. It would convey water stored in Willard Reservoir to the Ogden River for rediversion at Slaterville diversion dam and also would supply water to project lands above the Willard gravity canal. The canal would be an unlined earth section with a capacity of 500 second-feet and could deliver a maximum of 30,800 acre-feet a month at the Slaterville diversion dam. An average of 82,000 acre-feet would pass through this canal annually.

The canal would traverse the moderate cross slopes of the old Lake Bonneville terraces. Excavation would be made primarily in clay, loam, and gravelly soils. Rights-of-way would be required through farm lands.

The canal could be easily reached from the numerous hard-surfaced roads in the vicinity. Power and telephone facilities are available in the area. Construction materials and equipment could be obtained in Ogden.

Eden canal

The Eden canal, an unlined earth section, would extend northwest 7.9 miles from the Huntsville diversion dam on the South Fork of Ogden River to the vicinity of Eden, Utah. It would replace an existing inadequate canal. The Eden canal, with an initial capacity of 60 second-feet, could provide a maximum of 3,700 acre-feet a month to project lands. An average of 14,000 acre-feet annually would be delivered through the canal. The initial capacity of 60 second-feet would be reduced as irrigation diversions were made. The minimum capacity at the canal terminus would be 13 second-feet.

The canal would cross sagebrush-covered slopes of the upper Ogden Valley. The soils through which it would pass consist primarily of clay, loam, and gravel.

Construction materials and equipment would be available at Ogden, about 18 miles to the west. The canal could be reached from county roads. Power and telephone facilities are available in the area.

Magpie power plant

The Magpie power plant would be constructed at the left downstream toe of the Magpie Dam on the South Fork of Ogden River. Two 1,500-kilowatt generating units would provide the plant with an installed capacity of 3,000 kilowatts. The plant would operate under an average head of 210 feet and would produce an average of 13,200,000 kilowatt-hours of electric energy annually.

A concrete control house constructed at the outlet portal of the reservoir outlet works would contain a concrete anchor enclosing a Y with an 84-inch ring follower gate. This gate would discharge into a short penstock leading to the power plant. Tailrace from the power plant would be made into the stilling pool below the plant.

Electric energy generated at the Magpie plant would be stepped up to 44 kilovolts and transmitted for about 15 miles to a 44-kilovolt transmission line of the Utah Power & Light Co.

The power plant would be constructed concurrently with Magpie Dam. Concrete aggregate for construction work could be obtained from stream deposits below the dam. Other construction materials would be trucked to the site from Ogden, the nearest railhead.

Perdue power plant

The Perdue power plant would be constructed at the right downstream toe of Perdue Dam. The plant with a total installed capacity of 3,000 kilowatts would contain two 1,500-kilowatt units. The plant would operate under an average head of 190 feet and would generate an average of 15,200,000 kilowatt-hours of electric energy annually.

The substructure of the control house for the reservoir outlet works would contain a concrete anchor enclosing a wye and a ring follower gate for release of water to the powerhouse. A short penstock from the wye would connect the reservoir outlet works with the powerhouse. The plant would discharge into the outlet works channel.

Electric energy generated at the Perdue plant would be stepped up to 44 kilovolts and transmitted 10 miles to a 44-kilovolt transmission line of the Utah Power & Light Co.

The power plant would be constructed following the completion of Perdue Dam. Concrete aggregate would be available from pits developed during construction of the dam. Other materials would be trucked from Wanship, the nearest railhead.

Davis pumping plant

The Davis pumping plant would be located adjacent to the Davis aqueduct east of Bountiful, Utah. The plant would consist of two units. One would be a 400-horsepower, 370-kilowatt unit capable of pumping a maximum of 14 second-feet against a static head of 190 feet. The other unit would be an 800-horsepower, 740-kilowatt unit capable of pumping a maximum of 14 second-feet against a static head of 380 feet.

The Davis pumping plant would deliver an average of 7,660 acre-feet annually to an area of 2,470 acres above the Davis aqueduct in the southern portion of Davis County.

Hard-surfaced roads would provide access to the site during all seasons of the year. A main transmission line of the Utah Power & Light Co. passes within 2 miles of the site.

Weber pumping plant

The Weber pumping plant would be located adjacent to the Weber aqueduct on the southern end of the Burch Creek bench. The plant would consist of two units. One would be a 145-horsepower, 135-kilowatt unit capable of pumping a maximum of 6½ second-feet against a static head of 150 feet. The other unit would be a 290 horsepower, 270-kilowatt unit capable of pumping 6½ second-feet against a static head of 300 feet.

The Weber pumping plant would serve an area of 1,150 acres above the Weber aqueduct. The plant would pump an average of 3,565 acre-feet annually.

Hard-surfaced all-weather roads pass within a mile of the site. Telephone lines and a main power transmission line are in the immediate vicinity.

Willard pumping plant

The Willard pumping plant would be located on the eastern edge of the Willard Reservoir near Willard, Utah. The plant would consist of two 2,400-horsepower, 2,200-kilowatt units each capable of pumping 200 second-feet and one 1,200-horsepower, 1,100-kilowatt unit capable of pumping 100 second-feet. The plant would operate against a static head of 80 feet. It would pump a maximum of 30,800 second-feet a month and would deliver an average of 82,250 acre-feet annually to the Willard pump canal. The water would be conveyed through the Willard pump canal to the Slaterville diversion dam for rediversion to various project areas.

The pumping plant site is adjacent to the Union Pacific Railroad and United States Highway 91. A high voltage interstate power transmission line passes through the Willard Reservoir area. After relocation the line would be in the immediate vicinity of the pumping plant.

Layton pumping plant

The Layton pumping plant would be located at the foot of a bench to the south of the Slaterville diversion dam. A 4,000-foot inlet canal, a part of the Hooper canal, would extend from the diversion dam to the pumping plant. The plant would consist of two 235-horsepower, 215-kilowatt units, each designed to pump a maximum of 82½ second-feet against a static head of 20 feet. This plant would operate only during the late summer season when stream flow at the

Ogden diversion dam could not meet the requirements of the Layton canal. An average of 18,770 acre-feet would be pumped through the plant annually.

Surfaced roads and other public facilities are available in the immediate vicinity of the site. Construction materials and housing, are available in Ogden, 2 miles from the site.

Drainage channels

A system of open drainage channels, with a total length of about 115 miles, would be constructed to collect drainage water from farm lateral drains and to intercept ground water seeping from higher irrigated lands. About 40 miles of the system would be formed by cleaning and enlarging natural drainage channels. About 15 miles of constructed shallow drains would also be enlarged. Right-of-way costs on these drains would be negligible. The remaining 60 miles of the system would consist of new drains. These would require purchase of right-of-way through lands of low agricultural value.

The drainage channels would have a maximum depth of 10 feet and side slopes of 1½ to 1. The drains located beyond the reclaimable lands would be only deep enough to convey the drainage water into Great Salt Lake or, where possible, into bird refuges adjacent to the lake. The drains would be constructed through stratified layers of loams, clay loams, and sands.

Lateral systems

Main lateral systems would be required for lands located above the project conveyance facilities and for lands on the Weber delta that would be reclaimed. The remaining lands would be served by existing laterals that are expected to require little rehabilitation under the project.

Ground-water pumping

Twenty pumps would be required for development of ground water resources. These pumps would be located near project conveyance facilities principally in the area served by the Layton canal. Each pump would supply a maximum of 2 second-feet. Based on a 30-foot lift, a 9-horsepower, 8-kilowatt unit would be required for each pump.

Recreation facilities

Certain recreational facilities, as recommended by the National Park Service, would be constructed by the Government as a part of the project development. These would include roads, access and parking areas, boating facilities, camping areas, water and sewerage systems, and camp ground and picnic facilities. Lodges, bath houses, group camps and other appurtenant structures would be constructed by private interests.

SUMMARY

The construction cost of the project features and appurtenant structures as estimated on a preliminary basis at January 1949 prices would be $69,534,000. This estimate includes cost of construction, engineering, overhead, contingencies, rights-of-way and investigations and surveys. Annual operation, maintenance, replacements and administrative costs including costs of electric energy for pumping, are estimated to average $275,000. Except for costs of power features,

these estimates are based on average 1939-44 prices which are believed to be indicative of average prices over an extended period in the future. Annual power costs are based on prices prevailing on January 1, 1949. Project features and their estimated costs are summarized in the tabulation below:

Summary of project costs

Project feature	January 1949 construction cost	Annual operation, maintenance, and replacement reserve cost
Dams and reservoirs:		
Perdue	$9,400,000	$6,000
Enlarged Pineview	2,425,000	4,000
Jeremy	3,410,000	5,000
Lost Creek	3,550,000	5,000
Magpie	9,350,000	6,000
Willard	10,940,000	4,000
Subtotal	39,075,000	30,000
Diversion dams:		
Stoddard	300,000	900
Ogden	290,000	700
Slaterville	350,000	900
Huntsville	70,000	300
Subtotal	1,010,000	2,800
Aqueducts and canals:		
Weber aqueduct	7,000,000	4,800
Davis aqueduct	9,800,000	5,300
Layton canal	700,000	4,700
Willard gravity canal	700,000	8,300
Willard pump canal	900,000	6,000
Eden canal	160,000	1,200
Subtotal	19,260,000	30,300
Power plants:		
Perdue	684,000	41,100
Magpie	692,000	41,800
Subtotal	1,376,000	82,900
Pumping plants:		
Davis	$490,000	$13,200
Weber	180,000	6,900
Willard	1,460,000	35,600
Layton	190,000	7,000
Subtotal	2,320,000	62,700
Miscellaneous:		
Drainage system	3,000,000	17,000
Lateral system	1,400,000	5,000
Ground-water pumping	300,000	3,000
Davis County storage charge [1]	181,000	----
Compensation to Utah Power & Light Co. for reduction in power output at Riverdale plant [2]	290,000	----
Operation and maintenance during construction [3]	360,000	----
Investigations and surveys [4]	330,000	----
Recreation facilities [5]	632,000	41,300
Subtotal	6,493,000	66,300
Total	69,534,000	275,000

[1] For acquisition of rights to 5,000 acre-feet of water in Echo Reservoir now contracted for by Davis County.
[2] Amount of payment derived in ch. VII.
[3] Estimated to be ½ of 1 percent of the total construction cost.
[4] Includes only reimbursable costs of investigations and surveys to June 30, 1949. Costs of preconstruction surveys are prorated among the costs of project facilities.
[5] Includes only Federal costs of recreational development.

Slightly mature and moderately mature soils of the deltas.—Soils of this group, being farther from the mountains, have a heavier texture than soils of the benchlands. A typical profile consists of 12 inches of pale brown silt loam or clay loam with a somewhat flaky structure and rather low permeability. The subsoil consists of layers of very pale brown clay loam or clay alternating with layers of sandy loams, loamy sands, or sands. Permeability of the subsoil depends on the number and location of the sandy layers in the profile. Many of these soils have a high water table because of their low elevation. With proper drainage, however, the higher delta lands could produce all locally grown farm crops and the lower areas could be reclaimed into permanent pasture land.

Topography

The foothills have rolling topography with some relatively steep slopes. This topography would be suitable for orchards, and only a small amount of land leveling would be required. The steeper slopes would necessitate the use of sprinkler systems for irrigation in some areas. Sufficient pressure would be available for such systems under the project because of the high elevation of the Davis and Weber aqueduct lines.

The benchlands are situated on long, smooth slopes with a few abrupt drops. They would require little preparation for irrigation as many of the lands are already improved for cultivation.

The delta lands are characterized by low gradient and hummocky topography. They would require some heavy grading and leveling for economical irrigation farming. Heavy equipment, such as a carry-all, would be necessary to level part of the area. A land plane or float, however, could be used for leveling operations on most of the lands.

Drainage, salinity, and alkalinity

Drainage and alkali problems are confined almost entirely to the delta lands where the heavier textured soils occur. Because of a high water table and excessive accumulations of soluble salts, agricultural crops cannot be produced at the present time on most of these lands. With proper drainage and with irrigation, however, these lands could be reclaimed into productive farm areas.

MOUNTAIN VALLEY AREA

Soils

Soils in the mountain valleys along the Weber and Ogden Rivers were developed largely from recent alluvial material from adjacent mountains. Within only a few feet the texture often ranges from clay loams and gravelly clay loams to sandy loams and gravelly sandy loams. There are occasional deposits of coarse gravel and cobble. Permeability is generally good throughout the area. The soils have a good water-holding capacity except in areas with a preponderance of gravel and cobble in the profile. The heavy soils usually occur along the valley bottoms and are used mostly for the production of pasture grasses. If tilled, however, the heavy soils produce good crop yields.

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Topography

The area is characterized by flat-topped benches broken at intervals by stream channels. The general slope of the lands is from 2 to 3 percent in the center of the valleys and from 5 to 10 percent at the base of the mountains. The land surface is relatively smooth and would require little land leveling for irrigation farming.

Drainage, salinity, and alkalinity

Drainage and alkali problems are almost nonexistent in the mountain valleys. Small areas in valley bottoms adjacent to the stream channels have excessive accumulations of soluble salts because of impeded drainage conditions. These conditions could easily be corrected, however, with short inexpensive drains that could be constructed by the individual farmers.

LAND CLASSIFICATION

All lands in the Weber area, except lands along the upper Weber River, have been classified in a semidetailed survey. The survey was started in 1943 and completed in 1947. The 1943 specifications, shown in the following table, were used in the first investigations and, in order that uniform standards might be maintained, were followed in the 1947 investigations. Information on the acreage not covered by the classification was obtained from the office of the Utah State engineer. Before project construction the acreage not covered should be classified and certain classified areas should be covered by a detailed survey. This work could be undertaken as a part of preconstruction investigations.

Semidetailed land-classification specifications of soils: Weber Basin project, Utah

Land characteristics	Class 1, arable	Class 2, arable	Class 4, orchard	Class 4, pasture	Class 5, potentially arable
Texture	Sandy loam to friable clay loam.	Loamy sand to friable clay	Loamy sand to friable clay loam.	Loamy sand to clay	Loamy sand to permeable clay.
Depth:					
To sand, gravel, or cobble.	18 to 24 inches plus—good free working soil.	12 to 18 inches plus—good free working soil.	Loamy sand 24 inches plus—sandy loam 14 inches plus loam or heavier 12 inches plus. Gravel or sand occurring in lenses overlying finer soil material or gravel that is well mixed with soil is allowable.	6 inches plus—good free working soil. 12 to 18 inches loamy sand.	18 inches plus—good free working soil of fine sandy loam or heavier; or 24 to 30 inches of light sandy or loamy sand.
To relatively impervious subsoil material.	48 inches plus	36 inches plus	48 inches plus	36 inches plus; or 30 inches with minimum of 6 inches of gravel overlying impervious material or loamy sand throughout.	42 inches plus; or 36 inches with minimum of 6 inches of gravel overlying impervious material or loamy sand throughout.
To penetrable lime zone	18 inches with 48 inches penetrable.	14 inches with 36 inches penetrable.	12 inches plus with 48 inches penetrable.	8 inches with 24 inches penetrable.	12 inches with 36 inches penetrable.
Alkalinity	pH less than 8.8 unless soil is calcareous, total salts are low and evidence of black alkali is absent.	pH 9.0 or less, unless soil is calcareous, total salts are low and evidence of black alkali is absent.	pH less than 9.0	pH less than 9.0	pH less than 9.0.
Salinity	Total salts not to exceed 0.2 percent. May be slightly higher in open permeable soils exhibiting good drainage qualities.	Total salts not to exceed 0.5 percent. May be slightly higher in open permeable soils exhibiting good drainage qualities.	Total salts not more than 0.4 percent.	Total salts may slightly exceed 0.5 percent to an extent not limiting to good growth of tolerant grasses useful for pasture.	Total salts may be high, in excess of 0.5 percent if soil is permeable to feasible and adequate leaching.
Rock and rocky soil	No solid rock or loose that will interfere with ordinary cultivation.	No rock in place. Easily removable large loose rock limited to that generally cleared in similar communities where irrigation is practiced.	No rock in place. Easily removable large loose rock limited to that generally cleared in orchards in the area. Numerous rocks having diameters generally less than 6 inches and being well mixed with soil throughout the profile is allowable.	No rock in place. Rocks or boulders not present in amounts sufficient to prevent good pasture production.	No rock in place. Easily removable loose rock limited to that generally cleared in similar communities where irrigation is practiced.

Semidetailed land-classification specifications of soils: Weber Basin project, Utah—Continued

TOPOGRAPHY

Land characteristics	Class 1, arable	Class 2, arable	Class 4, orchard	Class 4, pasture	Class 5, potentially arable
Slopes	Smooth slopes up to 5 percent in general gradient; reasonably large-sized bodies sloping in the same plane.	Smooth general slopes of 5 to 10 percent or rougher slopes which may be less than 5 percent in general gradient.	Smooth slopes up to 20 percent in general gradient or rougher slopes may be less than 15 percent. Where sprinkler irrigation is anticipated slopes up to 45 percent may be mapped if soils are favorable.	Flat or depressional to 20 percent on smooth slopes.	Smooth slopes up to 10 percent.
Surface	Even enough to require only small amount of leveling and no heavy grading.	May require considerable leveling and moderate grading but in amounts generally found feasible in like areas where irrigation is practiced.	Moderate grading may be required, but in amounts found feasible in orchard lands of the area.	Even enough to permit irrigation.	May require heavy grading, but feasible as in comparable irrigated areas.

DRAINAGE

Soil and topography	Soil and topographic conditions such that no specific drainage requirement is anticipated.	Soil and topographic conditions such that some drainage will probably be required, but artificial drainage practicable at reasonable cost.	Soil and topographic conditions such that profile is well drained to a 5-foot depth.	Soil and topographic conditions such that drainage is excessive to imperfect. Inexpensive drainage necessary for growth of adapted grasses and some tolerant legumes.	Soil and topographic conditions resulting in good to imperfect drainage. If poorly drained, soil must be permeable and susceptible to feasible and adequate drainage.

NOTE.—Class 6, nonarable lands, includes lands which do not meet the minimum requirements of higher classes.

Several classes of land were established, namely, class 1, the best land of the project, suitable for the production of all climatically adapted crops; class 2, lands suitable for irrigation farming but less desirable than class 1 lands; class 4–F, orchard lands with soil or topographic deficiencies, limited to orchards, vineyards, or similar uses; class 4–P, lands limited to pasture use; class 5, lands temporarily nonproductive because of excessive salt accumulations or inadequate drainage, but considered reclaimable; and class 6, permanently nonarable lands.

RESULTS OF CLASSIFICATION

The classification showed a total of 202,800 acres of arable land in the Weber Basin area. Of these lands about 80,400 acres presently receive a full water supply and do not require additional development and 22,000 acres could not practicably be included in the project because of their location in scattered areas or at high elevations. The remaining lands, 100,400 acres, were found to be in need of development and to be so located that their development could be practicably undertaken. Thus these 100,400 acres were included in the project area. The acreages given are irrigable acreages, allowances having been made for existing and potential rights-of-way for railroads, highways, ditches, and drains.

Of the lands included in the project 70,400 acres are not irrigated while 30,000 acres receive an inadequate irrigation supply. For full productivity drainage would be required on 31,700 acres of the 70,400 acres of nonirrigated lands and on 7,000 acres of the 30,000 acres of inadequately irrigated lands.

The acreage included in the project is shown by land class in the following table. The 31,700 acres of nonirrigated lands that would be drained are presently class 5 lands but are shown in classes 1, 2, and 4–P as they would meet the qualifications for these classes after project development. The 7,000 acres now inadequately irrigated that would be drained are shown by their present class with the other inadequately irrigated lands as their classification would not be changed with project development.

Land classification summary

[Irrigable acreage]

Area	Arable									Class 5—Temporarily nonarable, nonirrigated				Total project area
	Inadequately irrigated				Nonirrigated									
	Class 1	Class 2	Class 4–F	Total	Class 1	Class 2	Class 4–F	Class 4–P	Total	Class 1	Class 2	Class 4–P	Total	
Lower Weber:														
Foothills	2,980	5,290	2,230	10,500	640	1,610	13,850	0	16,100	0	0	0	0	26,600
Benchlands	5,700	3,800	0	9,500	0	13,200	0	6,300	19,500	0	0	0	0	29,000
Delta	0	0	0	0	0	0	0	0	0	2,370	21,790	7,500	31,700	31,700
Subtotal	8,680	9,090	2,230	20,000	640	14,810	13,850	6,300	35,600	2,370	21,790	7,500	31,700	87,300
Mountain valleys:														
Morgan-Huntsville	1,820	1,690	0	3,510	10	1,260	0	1,030	2,300	0	430	90	520	
Upper Weber [1]				6,490					280					
Subtotal				10,000	10	1,260		1,030	2,580		430	90	520	13,100
Total				30,000					38,180				32,220	100,400

[1] Utah State engineer data, not classified by Bureau of Reclamation.

CHAPTER V

WATER SUPPLY

All usable surface and ground water now undeveloped in the Weber area would be utilized under the Weber Basin project. The principal supply would be surplus spring run-off from the Weber River system and the small streams along the Wasatch Front. The spring run-off, resulting from rapidly melting snows, is now only partially controlled by existing facilities and large quantities of water waste into Great Salt Lake each year.

WATER RESOURCES

Available supply

Weber River.—Estimates of stream flow for the Weber River and tributaries were based on records obtained at key-gaging stations by the Geological Survey. The estimates were made for the period 1928 to 1947 which includes the critically low run-off years 1931, 1934, and 1940.

On the basis of the recorded flow the average annual virgin flow of the Weber River was estimated at 620,000 acre-feet. During the period of study, when numerous upstream diversions were made, the recorded flow averaged 360,000 acre-feet annually at the Plain City gaging station near the mouth of the river. The average annual flows recorded at other key stations during the period of study are shown below. During this period flows ranged from 40 to 210 percent of normal.

Recorded flow: Weber River

Stream	Point of measurement	Drainage area (square miles)	Mean annual run-off 1928–47 (acre-feet)
Weber River	Near Plain City	2,060	[1] 360,100
Do	Gateway	1,610	[1] 359,200
Do	Echo	732	[1] 186,500
Do	Oakley	163	138,400
Lost Creek	Near Croyden	133	17,000
East Canyon Creek	Near Morgan	145	[2] 33,900
Ogden River	Below Pineview Dam	321	[2] 151,900
South Fork of Ogden River	Near Huntsville	148	71,300

[1] Run-off influenced by upstream regulation, depletions, and transbasin diversions.
[2] Run-off influenced by upstream regulation and depletion.

Adjustments were made in the recorded flow of the Weber River to allow for diversions under the Ogden, Weber, and Provo River projects which were in operation during only part of the study period. Allowance was made for an average annual diversion of 73,000 acre-feet expected to be made ultimately from the Weber to the Provo River, although only part of that amount is presently exported. The quantity of water remaining after the adjustments, as shown in the following tabulation, was considered the amount available for project

development. The annual available supply near Plain City was estimated at 260,000 acre-feet.

Estimated flow available for development: Weber River

Stream	Point of measurement	Adjusted annual run-off, 1928–47 (acre-feet)
Weber River	Near Plain City	[1] 260,000
Do	Gateway	52,000
Do	Echo	18,000
Do	Oakley	12,000
Lost Creek	Near Croyden	10,600
East Canyon Creek	Near Morgan	9,700
Ogden River	Below Pineview Dam	48,500
South Fork of Ogden River	Near Huntsville	19,700

[1] Includes 100,000 acre-feet of water which is required during the winter for upstream power developments and so is not available for use at other points of measurement.

Wasatch Front streams.—Because of the small size of the Wasatch Front streams and the difficulty of maintaining channel control, permanent gaging stations have been established on only four of the streams in the last 20 years. From the recorded Forest Service data available and miscellaneous data obtained by the State engineer and the Bureau of Reclamation, the flow of each stream has been estimated for a normal year and an extremely dry year. Total run-off of the streams, as summarized in the following table, was estimated from the individual stream data. Nearly all of the run-off consists of high flows from rapidly melting snows in the spring.

Estimated run-off: Wasatch Front streams

Area	Number of streams	Drainage area (square miles)	Estimated normal run-off (acre-feet)	Estimated dry year run-off (acre-feet)
Weber River to Farmington Creek	7	15.7	23,600	9,400
Farmington Creek	1	9.9	9,700	3,900
Farmington Creek to Davis-Salt Lake County line	10	33.1	12,900	5,200
Ogden River to Box Elder Creek	5	14.3	8,000	3,600
Box Elder Creek	1	30.6	19,000	7,600
Total	24	103.6	73,200	29,700

During a 10-year period a dry year could be expected to occur once, with normal run-off occurring the other 9 years. Thus the average annual run-off of the streams was estimated at about 70,000 acre-feet. A study of present municipal and industrial use and of available stream flow records obtained below all diversions indicates that approximately 40,000 acre-feet of the run-off is surplus. The high percentage of surplus water is attributable to the erratic run-off characteristics of the streams and the lack of suitable sites for regulatory storage. At the present time only three reservoirs, regulating the supply of four streams, are in operation. Only a few other sites are available and these could not be economically developed.

The erratic stream flow characteristics and lack of suitable regulatory sites would permit only about 17,000 acre-feet of the surplus

water to be used annually under the Weber Basin project. This supply would be available only during the high spring run-off and would have to be applied immediately to project lands.

Ground water.—Two artesian basins—one in the lower Weber area west of the Wasatch Mountains and the other, now inundated by Pineview Reservoir in the Huntsville area in Ogden River Valley—are the principal sources of ground water in the area. Estimated present and potential yields of these basins are summarized in the following tabulation. The estimates are based on detailed data on the Bountiful district on the lower Weber area, obtained by the Geological Survey, and from records of measured yields in the Ogden River Valley, obtained by the city of Ogden.

Ground water yields

[Acre-feet]

Area	Estimated potential yield	Estimated present use	Estimated increased potential use
Lower Weber area	35,000	23,000	12,000
Huntsville area (Odgen River Valley)	15,000	15,000	0
Total	50,000	38,000	12,000

The estimates of potential ground-water yields are considered conservative as the basins are expected to be recharged by seepage and unavoidable wastes from project water applied to bench lands west of the Wasatch Front. The major recharge zones are located below several thousand acres of project lands.

Quality of water

An analysis of water samples taken at various points in the basin indicates that the surface waters contain no harmful concentrations of salts or foreign materials to render them unsuitable for irrigation or municipal use. Because of its high salt content and low temperature, most of the ground water developed would have to be commingled with surface water in project canals before it would be suitable for irrigation use. All the water is subject to bacteriological contamination and would require filtration and chlorination if used for municipal purposes. In certain areas water intercepted by drains and other return flows would be too alkaline for irrigation use but would probably be acceptable for use in the three lakeside bird refuges within or adjacent to the project boundaries.

WATER RIGHTS

Water laws of the State of Utah, which govern the use of water in the project area, are based upon the doctrine of appropriation and beneficial use. A complex water right situation has developed in the area, particularly in recent years, because of the heavy demand on the available water resources.

Existing rights

Rights to the flow of the Weber River and its tributaries, except Ogden River, were adjudicated in a final decree issued June 2, 1937. Rights to the flow of Ogden River were adjudicated in a final decree

issued February 2, 1948. The decrees list all rights that are senior to Weber Basin project rights, as summarized below, but do not set forth provisions of contractual agreements between the holders of these rights. The courts have not made a final determination of rights to ground-water resources or to the waters of the Wasatch Front streams.

Decreed rights

WEBER RIVER

Nature of right	Amount	Period of use
Irrigation: Below gateway	911 cubic feet per second	Irrigation season.
Power:		
Weber plant	365 cubic feet per second	Jan. 1–Dec. 31.
Riverdale plant	300 cubic feet per second	Do.
Storage:		
Echo Reservoir	74,000 acre-feet	Do.
East Canyon Reservoir	28,000 acre-feet	Do.
Transbasin diversion	140,000 acre-feet	Do.
Other	7.0 cubic feet per second	Do.

OGDEN RIVER

Irrigation: Below Pineview Dam	247 cubic feet per second	Irrigation season.
Power (Pioneer plant)	200 cubic feet per second	Jan. 1–Dec. 31.
Storage (Pineview)	44,000 acre-feet	Do.
Other	6.0 cubic feet per second	Do.

The rights and contractual agreements involved with existing Bureau of Reclamation projects—the largest and most complex developments in the area—are discussed in the following paragraphs.

Weber River project.—An application was filed with the State engineer in 1924 to store 74,000 acre-feet of surplus Weber River water in Echo Reservoir under the Weber River project. An application was also filed in 1924 to divert 300 second-feet from the Weber to the Provo River through the Weber-Provo diversion canal, constructed as a project feature.

Use of Echo Reservoir storage water has been modified several times since the project was completed in 1931. At the present time the Weber River waters users control 63,600 acre-feet of storage water; the Provo River water users, 5,400 acre-feet; and Davis County, 5,000 acre-feet. The water to which Davis County has a right is not used at the present time as there are no distribution facilities to the lands on which the water was intended to be used.

Ogden River project.—An application was filed with the State engineer in 1930 to store 45,000 acre-feet of Ogden River water in Pineview Reservoir. As the reservoir inundates the artesian wells from which Ogden obtains its municipal supply, it was stipulated in a contract between the United States and the city of Ogden, dated August 20, 1934, that the Bureau of Reclamation or the Ogden River Water Users' Association would drain the reservoir on Ogden's demand at the end of the irrigation season in order that the wells could be inspected. Originally an annual inspection was thought to be necessary. After 13 years of operation, however, it has been found an inspection once every 3 years probably would be sufficient as the well mechanism is not complicated nor subject to wear. In cases of emergency special arrangements for draining the reservoir could readily be made.

Provo River project.—Inasmuch as waters of the Provo River were overappropriated when large quantities of Weber River water continued to waste into Great Salt Lake, several rights have been obtained to divert Weber River flow to the Provo Basin. In addition to the application filed for the diversion of 300 second-feet in connection with the Weber River project, an application was filed in 1924 for the diversion of 140,000 acre-feet. A power contract to divert additional water from the Weber to the Provo River was made in 1938 between the United States, the Provo and Weber River Water Users' Associations, the Utah Power & Light Co., and the Utah Light & Traction Co. This contract provided that water utilized at plants of the Utah Power & Light Co. on the Weber River could be withheld upstream during the nonirrigation season, with 50 percent of the water storable in Echo Reservoir and 50 percent divertible to the Provo River. Compensation for the resulting power losses on the Weber River would be provided by the Provo River project. Since the Provo River project is only partially completed at this time, the power contract has not been fully operative to date. On the basis of all the rights obtained and on the basis of stream flow available for the period 1928–47, an average of 73,000 acre-feet annually could be diverted from the Weber to the Provo Basin.

Project rights

Sufficient surplus water not appropriated under existing rights is available for project development. Rights to some of the water would require exchange agreements between the irrigators and the United States. It is believed these agreements could be obtained without difficulty as they would not curtail the supply of any users and in most cases would provide the irrigators with more effective control of their supply.

The waters of the Weber Basin have been withdrawn from further appropriation by a proclamation issued February 2, 1949, by the Governor of the State of Utah. This action was taken to protect the public interest in the project water supply pending completion of project investigations.

WATER REQUIREMENTS

In estimating the project water requirements and the net demand on sources of supply and reservoir storage, consideration was given to the following factors: irrigation diversion requirements, return flow, reservoir evaporation losses, sedimentation, municipal water requirements, and requirements of bird refuges on the east shore of Great Salt Lake.

Irrigation requirements

The per acre irrigation diversion requirements at the head of canals were estimated by two methods—a study of historical diversions and a study of consumptive use—the results of which were in close agreement.

The study of historical diversions was based on records obtained by the Ogden and Weber River water commissioners. Records were utilized of canals serving areas with representative soil conditions and irrigation practices. To determine the unit diversion requirement adjustments were made for conditions of delivery and farm irrigation

practices anticipated under project operation. Years of evident short supply were not included in the studies.

The study of consumptive use was made by the Lowry-Johnson method.[1] The estimates were based on temperature and precipitation data collected at Ogden, Morgan, and Coalville for the lower Weber, Morgan-Huntsville and upper Weber areas, respectively. Annual consumptive use requirements were estimated as 1.83 acre-feet per acre for the lower Weber area, 1.71 acre-feet per acre for the Morgan-Huntsville area, and 1.52 acre-feet per acre for the upper Weber area. In arriving at diversion requirements allowances were made for canal distribution losses and for farm application losses.

The diversion requirements estimated by the studies are summarized below.

Unit diversion requirement

Area:	*Acre-feet per acre*
Lower Weber	3.0
Morgan-Huntsville	4.3
Upper Weber	4.3

On the basis of per acre irrigation requirements, the total amount of additional water required for project lands was estimated at 245,000 acre-feet annually. Allowances were made in the estimate for the partial irrigation supply already furnished some of the lands, the additional per-acre requirement of presently irrigated lands being estimated at about 1 acre-foot. The gross requirements of the project lands are shown by service areas in the following table:

Area	Presently nonirrigated		Inadequately irrigated		Total acre-feet
	Acres	Irrigation diversion requirement (acre-feet)	Acres	Irrigation diversion requirement (acre-feet)	
Lower Weber:	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*
Served from Ogden River	7.9	23.7	1.6	1.6	25.3
Served from Weber River	31.1	93.3	13.4	13.4	106.7
Served from Ogden and Weber Rivers and Willard Reservoir	28.3	84.9	5.0	5.0	89.9
Subtotal	67.3	201.9	20.0	20.0	221.9
Mountain Valleys:					
Upper Weber	0	0	6.5	6.5	6.5
Morgan-Huntsville:					
Served from Weber River	2.3	9.9	1.0	1.0	10.9
Served from Ogden River	.8	3.4	2.5	2.5	5.9
Subtotal	3.1	13.3	10.0	10.0	23.3
Total	70.4	215.2	30.0	30.0	245.2
Rounded		215	30	30	245

Return flows

An annual average of approximately 69,000 acre-feet of return flows suitable for irrigation would be intercepted by drainageways and natural stream channels for reuse under the project. The return flows could be used on lands served from the lower reach of the Ogden River, the benchlands served from the aqueduct system, and lands in the Weber delta area adjacent to the east shore of Great Salt Lake.

[1] Transactions of American Society of Civil Engineers, vol. 107, 1942, p. 1243, Consumptive Use of Water for Agriculture by Lowry and Johnson.

The usable return flow would be about 14 percent of the total annual diversion to new and presently irrigated lands.

Reservoir evaporation

Net evaporation losses from Willard Reservoir would average 35,000 acre-feet annually. Net annual evaporation losses from the upstream reservoirs would be less than 1,000 acre-feet at each site.

Sedimentation

No special provision for sediment storage would be necessary in project reservoirs. Reconnaissance surveys have shown that the streams of the project area carry an exceptionally low sediment load.

Special uses

Communities in Davis and Weber Counties ultimately will require an additional 40,000 acre-feet of municipal water annually. The need for this water is discussed in detail in chapter VI.

Migratory bird refuges on the east shore of Great Salt Lake are in need of additional late-season water.

WATER UTILIZATION

Simulated project operations, based on periods of critical supply, have shown that with effective operation of project facilities, irrigation farming would be expanded, increasing municipal demands would be met without shortage, and power production would be increased—all without detriment to present water users.

Water exchanges

Through a series of water exchanges the source of supply of about 29,000 acres in the Weber delta area would be changed without any adverse effect on present irrigation operations. These lands derive most of their existing water supply from the Weber River (excluding the Ogden River) and Echo Reservoir. Under the project they would derive their water from Willard Reservoir on the lake shore and from the enlarged Pineview Reservoir and Magpie Reservoir on Ogden River. Thus Weber River flows and Echo Reservoir storage water would be available for diversion to the Weber and Davis aqueducts for distribution to the foothills and benchlands. The exchanges, which would be required for successful operation of the project, would involve the transfer of a mean annual amount of 76,300 acre-feet of water including 22,100 acre-feet of storage water in Echo Reservoir.

Weber River storage

Project storage reservoirs at the Perdue, Lost Creek, and Jeremy sites on the upper Weber River would be utilized to regulate surplus Weber River flows and, in conjunction with Echo Reservoir, to regulate water derived from the exchange. The regulation would permit complete development of lands in the area above Echo Reservoir, the lands bordering Lost Creek, the lands in Morgan Valley, and all lands west of the Wasatch Mountains serviceable from the Davis and Weber aqueducts. Regulation provided by these reservoirs would also permit the project to satisfy municipal requirements of Davis and Weber County communities. With construction of the Weber and Davis aqueducts, the 5,000 acre-feet of Echo storage water belonging to Davis County, which is now unused, could be delivered

to lands in the county. Thus this water is considered as part of the new project supply.

Perdue Reservoir would be operated so that power for irrigation pumping could be produced at the Perdue power plant at the downstream toe of the dam. Production at the existing Riverdale plant of the Utah Power & Light Co. would be reduced by project operation as the Weber-delta exchange would eliminate the need for releases through this plant during most of the irrigation season. Project operation would not materially affect the water releases through the Weber plant of the Utah Power & Light Co.

A run-off forecasting system would be initiated and, when dangers of floods occurred, storage water would be released from the reservoirs to provide space for flood flows. Reservoir water thus released would be rediverted downstream for storage at the Willard Reservoir.

Ogden River storage

The Magpie and the enlarged Pineview Reservoirs on the Ogden River would meet irrigation requirements of lands in Ogden Valley (Huntsville area) and of lands extending west of the Wasatch Front from the Ogden River north to Brigham City. Part of the storage facilities would be used to regulate surplus Ogden River water for exchange purposes in the Weber-delta area. By partially meeting the exchange requirements, these facilities would reduce the requirements for pumping from Willard Reservoir.

Project operation would increase, by 10,000 acre-feet annually, flows through the Pioneer plant of the Utah Power & Light Co. Releases from Magpie Reservoir would be used for the production of energy at the Magpie power plant, located at the toe of the dam.

The large amount of storage capacity on Ogden River would provide effective control of floods in the river reaches below the dams. Coordination of the reservoirs on the river with those on Weber River also would provide flood protection in the area below the confluence of the two streams.

Lakeside storage

Willard Reservoir would store and regulate winter power releases from upstream reservoirs, surplus high flow not regulated by upstream reservoirs, and return flow from upstream diversions. The flow of the Weber River remaining after all upstream uses would be diverted at the Slaterville diversion dam and conveyed to the reservoir by the Willard gravity canal. Water would be pumped from the reservoir through a mean head of 80 feet to irrigate a maximum of 28,300 acres of project lands. In addition it would be utilized with Ogden River storage to effect an exchange in the source of supply for 29,000 acres of delta lands.

Willard Reservoir could enhance the operation of upstream reservoirs for both flood control and power. When necessary to reduce upstream reservoir storage to provide adequate flood control, the released water could be captured in Willard Reservoir and then pumped from the reservoir for subsequent irrigation use. The releases to the reservoir, which would be made in the winter and early spring, could be routed through the existing Weber, Riverdale, and Pioneer plants. The net effective power head on either the Ogden or Weber River exceeds 400 feet. As the pump lift out of Willard Reservoir is only 80 feet, project operation would result in a net energy

increase as well as in a saving of the water released to provide upstream flood protection. Willard gravity canal, with a capacity of 800 second-feet, would also help alleviate flood damages on the lower Weber River below Slaterville diversion dam.

Wasatch Front stream and ground-water development

Surplus Wasatch Front stream flow would be utilized for both irrigation and municipal purposes during the months of April, May, and June, thereby reducing the demand on project storage during that period. Part of the run-off, approximately 11,100 acre-feet, would be diverted from streams south of Ogden River by the Davis aqueduct and conveyed to heads of various municipal and irrigation systems. The remainder of the water, approximately 5,900 acre-feet, would be obtained from streams north of Ogden River and would be diverted directly from the streams to adjacent nonirrigated lands. Lands and municipalities furnished run-off from the Wasatch Front streams in the spring would receive their fall and summer requirements from project storage.

Ground water developed by the project would be used for irrigation in the delta area, thereby reducing the demand on storage. Most of the water would be commingled with storage water in the distribution canals and thus it would be so diluted that it would be suitable for irrigation use.

Regulation for special uses

The project would be operated so far as practicable to conserve fish and wildlife values and to provide opportunities for recreational developments. Although a detailed plan of integrating these special water uses in the project has not been completed, the addition of four new upstream reservoirs, the enlargement of another, and the creation of a large 10,000-acre fresh-water lake would undoubtedly provide excellent opportunity for the development of recreational facilities. It may also be practicable to incorporate into the reservoir-operation plan operation procedures that would be beneficial to fish and wildlife.

Large quantities of return flow, made available by the installation of an extensive drainage system and the irrigation of a large acreage of benchlands previously nonirrigated, could be diverted into the Farmington and Ogden Bird Refuges, increasing their value. The simulated reservoir operation study of Willard Reservoir indicates large spills would occur in 3 out of every 4 years. Undoubtedly the water lost through these spills could be regulated to provide additional late-season fresh water for the Bear River Migratory Bird Refuge north of the reservoir.

Project operation study

Operation studies for the project, simulated over the study period 1928–47, are given in the tables on the following pages. The studies are based on the estimated yields of the reservoirs which would store flows of the Weber River system and estimate yields of the Wasatch Front streams and of ground-water sources. Only water surplus to prior rights is considered in the studies. The studies indicated that with project operation irrigation shortages of less than 10 percent would have occurred in each of the years 1931, 1934, and 1935 with an average shortage for the study period of less than 2 percent. The municipal water would be delivered on demand with no shortages permitted in the operation studies.

Weber Basin project: Weber River Reservoir operation study (excluding Ogden River)

Water year	Perdue Reservoir: Total capacity, 50,000 acre-feet; active capacity, 45,000 acre-feet			Echo Reservoir:[1] Total capacity, 74,000 acre-feet; project capacity, 27,100 acre-feet				Lost Creek Reservoir: Total capacity, 20,000 acre-feet; active capacity 20,000 acre-feet			Jeremy Reservoir: Total capacity, 35,000 acre-feet; active capacity, 30,000 acre-feet			Wasatch Front streams: Interceptible flows for project use	Ground water: Estimated yield for project use	Exchange water: Project diversions satisfied by exchange
	Storable inflow	Releases for project	Project storage hold-over	Storable inflow	Spills and releases from Perdue Reservoir	Releases for project	Project storage hold-over	Storable inflow	Releases for project	Project storage hold-over	Storable inflow	Releases for project	Project storage hold-over			
1928	24.7	5.0	47.1	41.2	0	31.3	0	15.4	12.8	7.7	6.5	2.2	33.1	14.0	6.0	53.0
1929	22.1	12.6	44.9	38.2	19.3	38.9	0	14.5	5.2	15.3	3.5	2.2	32.1	14.0	6.0	53.0
1930	1.6	19.8	26.7	27.1	14.8	41.9	0	3.8	5.2	13.9	.5	2.2	31.4	8.0	6.0	56.0
1931	0	26.7	5.0	8.1	21.7	30.8	0	0	15.4	0	0	7.8	24.1	3.0	6.0	56.3
1932	13.0	13.0	5.0	27.1	8.0	35.1	0	17.1	9.0	8.1	2.7	2.2	24.6	14.0	6.0	53.0
1933	29.9	16.8	18.1	27.1	11.8	38.9	0	3.3	5.2	6.2	0	2.2	22.4	14.0	6.0	53.0
1934	0	18.1	5.0	7.5	13.1	24.8	0	0	10.9	0	0	18.3	6.0	3.0	6.0	56.3
1935	.3	8.3	[2] 2.0	26.7	3.3	35.0	0	.6	5.8	0	0	8.5	[2] 2.0	8.0	6.0	56.0
1936	31.9	5.0	28.9	46.6	0	31.3	0	18.7	10.2	8.5	22.7	4.8	19.9	14.0	6.0	53.0
1937	23.6	12.6	39.9	42.5	7.6	38.9	0	12.3	5.2	15.3	16.2	2.2	33.1	14.0	6.0	53.0
1938	15.7	7.6	45.7	53.3	4.9	33.9	0	13.7	7.2	13.3	5.5	5.2	30.1	14.0	6.0	53.0
1939	1.9	19.8	27.8	27.1	14.8	41.9	0	6.2	5.2	14.3	5.1	2.2	33.0	8.0	6.0	56.0
1940	.3	21.4	6.7	15.2	16.4	31.6	0	1.0	5.2	10.1	0	12.5	20.5	8.0	6.0	56.0
1941	3.3	5.0	5.0	25.0	0	25.0	0	0	5.8	4.3	0	15.5	5.0	14.0	6.0	53.0
1942	14.7	12.6	7.1	36.8	7.6	38.9	0	4.5	5.2	3.6	8.5	2.2	11.3	14.0	6.0	53.0
1943	25.6	19.8	12.9	27.1	14.8	41.9	0	11.1	5.2	9.5	10.4	2.2	19.5	8.0	6.0	56.0
1944	32.7	10.3	35.3	39.1	5.3	38.9	0	4.8	5.2	9.1	0	2.2	17.3	14.0	6.0	53.0
1945	16.2	13.0	38.5	27.1	8.0	35.1	0	9.0	12.0	6.1	5.7	2.2	20.8	8.0	6.0	56.0
1946	12.2	12.6	37.4	36.6	8.3	38.9	0	14.9	5.2	15.3	15.0	2.2	33.1	14.0	6.0	53.0
1947	15.0	16.8	35.6	27.1	11.8	38.9	0	5.2	5.2	15.3	.9	2.2	31.8	14.0	6.0	53.0
Total	284.7	276.8	474.6	606.5	191.5	711.9	0	156.1	146.3	175.9	103.2	101.2	452.1	222.0	120.0	1,084.6
Mean	14.2	13.8	23.7	30.3	9.6	35.6	0	7.8	7.3	8.8	5.2	5.1	22.6	11.1	6.0	54.2

[1] Use of Echo Reservoir predicated upon exchange of water and Davis County right.
[2] Reservoir drawn below inactive capacity due to successive years of low run-off and need to supply municipal demands.

Weber Basin project: Ogden River Reservoir and Willard Reservoir operation studies

Water year	Magpie Reservoir: Total capacity, 60,000 acre-feet; active capacity 55,000 acre-feet			Pineview Reservoir: Total capacity, 48,000 acre-feet; active capacity, 48,000 acre-feet					Willard Reservoir: Total capacity, 205,000 acre-feet; active capacity, 185,000 acre-feet								
	Storable inflow	Releases for project	Project storage hold-over	Storable flow	Spills and releases from Magpie Reservoir	Releases for exchange	Releases for project	Project storage hold-over	Storable inflow	Upstream spills	Releases for exchange	Releases for new and reclaimable land	Evaporation	Project storage hold-over	Wasatch Front streams: Interceptible flows for project use	Ground water: Estimated yield for project use	Total project spills	Total project shortages
1928	34.5	5.9	54.6	43.1	0	37.0	7.4	3.8	181.2	-------	41.4	65.0	37.1	130.2	5.9	6.0	112.5	-------
1929	48.0	5.9	54.6	42.8	42.1	37.0	7.4	10.7	235.1	55.2	41.4	65.0	37.1	161.7	5.9	6.0	115.3	-------
1930	10.0	20.5	40.0	0	18.7	22.0	7.4	0	115.7	-------	56.4	65.0	37.1	109.4	5.9	6.0	9.5	-------
1931	10.0	25.3	24.7	0	19.4	12.0	7.4	0	98.0	-------	50.9	65.0	33.1	58.4	5.9	6.0	-------	8.0
1932	65.7	5.9	54.6	66.6	29.9	37.0	7.4	12.4	195.5	39.7	41.4	65.0	33.0	127.2	5.9	6.0	27.0	-------
1933	22.4	5.9	54.6	40.2	16.5	37.0	7.4	19.0	195.4	5.7	41.4	65.0	37.1	130.7	5.9	6.0	54.1	-------
1934	10.0	25.3	35.2	0	23.5	35.1	7.4	0	30.3	-------	27.3	65.0	30.0	38.7	5.9	6.0	-------	15.8
1935	10.0	40.2	5.0	15.0	34.3	41.9	7.4	0	108.4	-------	36.2	65.0	17.3	28.6	5.9	6.0	-------	19.7
1936	86.8	5.9	54.6	76.7	31.3	37.0	7.4	8.9	200.0	70.0	41.4	65.0	30.8	152.9	5.9	6.0	8.5	-------
1937	44.1	5.9	54.6	42.2	38.2	37.0	7.4	9.8	215.2	47.4	41.4	65.0	37.1	140.5	5.9	6.0	131.5	-------
1938	41.4	5.9	54.6	20.6	35.5	37.0	7.4	5.0	215.9	52.6	41.4	65.0	37.1	126.7	5.9	6.0	138.8	-------
1939	10.0	14.5	46.0	21.7	12.7	32.0	7.4	0	166.8	-------	36.7	65.0	37.1	124.7	5.9	6.0	30.0	-------
1940	10.0	35.3	20.7	0	29.4	22.0	7.4	0	125.3	-------	54.7	65.0	35.6	94.7	5.9	6.0	-------	-------
1941	10.0	15.9	14.8	9.4	10.0	12.0	7.4	0	190.3	-------	66.4	65.0	36.1	117.5	5.9	6.0	-------	-------
1942	11.1	5.9	20.0	43.1	0	22.0	7.4	13.7	229.7	5.5	56.4	65.0	37.1	118.3	5.9	6.0	75.9	-------
1943	18.6	5.9	32.7	50.5	0	37.0	7.4	11.6	272.4	8.2	41.4	65.0	37.1	160.2	5.9	6.0	95.2	-------
1944	10.0	18.1	24.6	10.6	12.2	27.0	7.4	0	220.7	5.5	51.4	65.0	37.1	161.7	5.9	6.0	71.2	-------
1945	34.9	5.9	53.6	57.0	0	37.0	7.4	12.6	227.0	-------	41.4	65.0	37.1	184.2	5.9	6.0	61.0	-------
1946	66.3	5.9	54.6	23.9	59.4	37.0	7.4	5.2	258.8	53.3	41.4	65.0	37.1	142.2	5.9	6.0	210.6	-------
1947	10.0	28.0	32.5	13.0	26.2	37.0	7.4	0	219.5	-------	41.4	65.0	37.1	158.8	5.9	6.0	59.4	-------
Total	563.8	288.0	786.6	576.4	439.3	633.0	148.0	112.7	3,701.2	343.1	891.8	1,300.0	698.2	2,467.3	118.0	120.0	1,200.5	43.5
Mean	28.2	14.4	39.3	28.8	22.0	31.7	7.4	5.6	185.1	17.2	44.6	65.0	34.9	123.4	5.9	6.0	60.0	2.2

63961—59——5

The water-supply studies have been conservatively made, particularly with respect to existing rights. Although senior rights would be satisfied under the plan herein presented, there are definite indications that some holders have rights to more water than is required for beneficial irrigation. Upon the initiation of a basin-wide plan to conserve the remaining water resources, the present irrigators will be urged to be more conservative in their water use. More efficient irrigation practices would not only permit more efficient and economical development of the basin but would also conserve the plant nutrients of the soils and reduce the rapidly increasing drainage problems. Since these studies were intended to formulate a completely sound project plan, they were not based on the assumption that improved farm practices would be adopted. Adoption of such practices, however, would greatly enhance the project.

Use of facilities

Willard Reservoir would be operated only for irrigation purposes. The other reservoirs, including Perdue, the enlarged Pineview, Magpie, Jeremy, and Lost Creek Reservoirs, would be operated for joint use. Wasatch Front stream flow would be developed for joint municipal and irrigation use. Ground water, however, would be developed only for irrigation purposes.

As shown by the simulated project operation studies, the anticipated average yield from joint-use reservoirs and surplus Wasatch Front stream flow would be 89,000 acre-feet annually. The yield would be less, however, in extended periods of low run-off years. Therefore, in order that the ultimate municipal demands of 40,000 acre-feet could be met without shortage, as provided in the project plan, approximately 50 percent of upstream storage capacity would have to be reserved exclusively for municipal use.

Davis and Weber aqueducts, the only conveyance facilities that would be used jointly, would be utilized for distribution of irrigation and municipal water during the irrigation season and exclusively for use of municipal water during the nonirrigation season.

CHAPTER VI

MUNICIPAL AND DOMESTIC WATER

The increases in population in the area west of the Wasatch Front since 1940 have taxed municipal and domestic water supplies to the limit. Demands on present supplies are particularly heavy in the late summer months. In many areas lawn and garden irrigation has been restricted to a rotation schedule, park and cemetery irrigation has been sharply curtailed, and emergency supplies for fire protection are dangerously low because of the constant load on distribution systems. A serious shortage has not occurred in the last few years only because precipitation and run-off have been abnormally high. If a drought period occurred comparable to that of 1934, its effects would be serious. More water is required to supplement existing supplies to provide for the needs of the increased population. A reserve supply also is necessary to permit future expansion.

Because of the severity of the water-supply conditions, communities of Davis and Weber Counties west of the Wasatch Mountains, formed the Davis-Weber Counties Municipal Water Development Association. The association employed a consulting engineer to investigate water-development possibilities. The findings of these investigations, essentially the same as the findings of the Bureau investigations, are discussed in a report issued by the association entitled Davis-Weber Counties Water Development, dated February 1949.

PRESENT DEVELOPMENT

Sources of supply

All water resources of the area, including supplies from surface streams, artesian wells, pump wells, and springs, have been almost fully developed. As pointed out in chapter V, only surplus surface run-off in the spring and a limited amount of ground water are available for further development. Present sources of supply for communities in Davis and Weber Counties west of the Wasatch Front are discussed in the following paragraphs.

Surface.—The municipalities of Bountiful, Centerville, Clearfield, East Layton, Farmington, Fruit Heights, Kaysville, Layton, Laytona, North Ogden, and Woods Cross obtain all or a portion of their supply from the streams which drain directly into Great Salt Lake from the Wasatch Front. The late-summer flows of these streams have been fully appropriated under irrigation and municipal rights. Even if irrigation rights were condemned, the late-season flows would not be sufficient to meet municipal requirements. Surplus spring flows could not be stored for late-season use as no suitable reservoir sites exist on these streams.

Ogden derives a minor portion of its municipal supply from Wheeler, Coldwater, and Warmwater Creeks—tributaries of the Odgen River.

Artesian.—Artesian wells are the major source of water for Ogden.

Many residences west of Odgen in Weber County obtain their supply from privately operated wells. The supply for Ogden is obtained from an artesian basin beneath Pineview Reservoir which is tapped by a system of 47 wells yielding an average of 15,000 acre-feet annually. The output of the wells is conveyed to a steel collection tank beneath the reservoir. From the tank the water is conveyed through Pineview Dam to the main which extends down Odgen Canyon to the city. Much of the artesian water obtained west of Ogden contains excessive concentrations of chlorides, iron, and hydrogen sulfide, and is of poor quality for municipal use.

Pump wells.—Pump wells serve Ogden, Woods Cross, Bountiful, Centerville, Clearfield, Sunset, Syracuse, West Point, Riverdale, and Roy. Ogden pumps from three wells—two at the municipal airport and one within the city limits. Although demands on the Ogden City system have markedly increased since 1940, drafts from these wells are restricted as there is danger of salt contamination from adjacent areas. Water from the well that supplies the town of Woods Cross has a total hardness of 500 parts per million, a high degree of hardness for domestic use. There is danger of bacteriological contamination in this well as it is being recharged by waste water from the Bonneville Canal which diverts water from the Jordan River.

Springs.—Water is obtained from springs for Kaysville, Layton, South Weber, Ogden, Roy, Uintah, and Farmington. To recharge their springs Kaysville, Farmington, and Layton divert water from Wasatch Front streams onto spreading areas. The total yield from spring sources does not exceed 6 cubic feet per second.

Facilities

Water-storage facilities of the various communities in the area are listed in the following tabulation:

Town	Estimated 1948 population	Storage capacity (gallons)	Town	Estimated 1948 population	Storage capacity (gallons)
Bountiful	5,500	4,732,000	South Weber	360	48,000
Centerville	1,100	240,000	Sunset	800	100,000
Clearfield	5,000	1,600,000	West Point	700	3,000
East Layton	210	50,000	Woods Cross	300	150,000
Farmington	1,600	587,000	North Ogden	1,500	120,000
Fruit Heights	150	75,000	Ogden City	60,000	60,000,000
Kaysville	1,800	650,000	Riverdale	800	250,000
Layton	3,600	750,000	Roy	4,400	1,250,000
Laytona	360	30,000	South Ogden	3,600	1,100,000

Several communities in Weber County west of Ogden do not have centralized distribution systems. These communities are Warren, Marriott, Harrisville, Far West, Slaterville, Hooper, Plain City, West Weber, Wilson, Taylor, and Kanesville.

ANTICIPATED NEEDS

Communities outside of Davis and Weber Counties in the project area are stable rural towns not appreciably affected by population increases or industrialization. Therefore, they are not expected to experience shortages in municipal water supply. Population and industrialization, however, are expected to continue to increase in

Davis and Weber Counties and to result in continuously heavier demands on the municipal supply.

The anticipated annual water requirements in the Davis-Weber area are summarized in the following table. They are based on an estimated average per capita requirement of 250 gallons a day, the average amount of water presently used per capita in Ogden. They are also based on population trends that were estimated from data compiled by the Bureau of the Census and from other studies of population trends in the western United States.

Year	Population	Water requirement (acre-feet)	Year	Population	Water requirement (acre-feet)
1940	[1] 72,498	20,300	1990	175,000	49,000
1948	[2] 111,000	31,100	2000	180,500	50,520
1950	116,000	32,480	2010	184,000	51,520
1960	139,000	38,920	2020	187,000	52,360
1970	154,000	43,120	2030	189,500	53,060
1980	166,000	46,480			

[1] Reported by Bureau of Census, U. S. Department of Commerce.
[2] Estimated by Bureau of Census, U. S. Department of Commerce.

The demand for 1940 was met by the available supply. Therefore, since no significant amount of water has been developed since that time, the supply for 1940, or 20,300 acre-feet, is considered the amount of water now available. With that entire supply available throughout the projected period, the additional quantities of water shown in the following tabulation would be required for municipal use:

Year	*New requirement (acre-feet)*	*Year*	*New requirement (acre-feet)*
1940	0	1990	28,700
1948	11,100	2000	30,240
1950	12,180	2010	31,220
1960	18,620	2020	32,060
1970	22,820	2030	33,760
1980	26,180		

The actual requirements for additional municipal water are expected to be higher than those shown in the preceding tabulation as reductions probably will be made in the present available supply. The supply probably will be reduced by several thousand acre-feet by the year 2030 and thus the ultimate requirement from project sources is estimated at 40,000 acre-feet annually. Reductions in the present supply are likely as some sources are in danger of contamination by bacteria and high salt concentrations. Under project development municipalities whose water could not be treated would tend to reject their present supply for the high-quality project water. Some communities may find it more economical to utilize the project water and thus reduce the pumping from wells. The municipal requirements are not expected to be increased beyond 40,000 acre-feet unless some agricultural lands are converted into residential areas. In the event of such a conversion, the irrigation water appurtenant to the land would be sufficient for the domestic needs. At a per capita requirement of 250 gallons per day, the annual supply of 3.0 acre-feet of water allowed each acre of irrigated land in Weber and Davis Counties would support 10.7 people.

POTENTIAL DEVELOPMENT

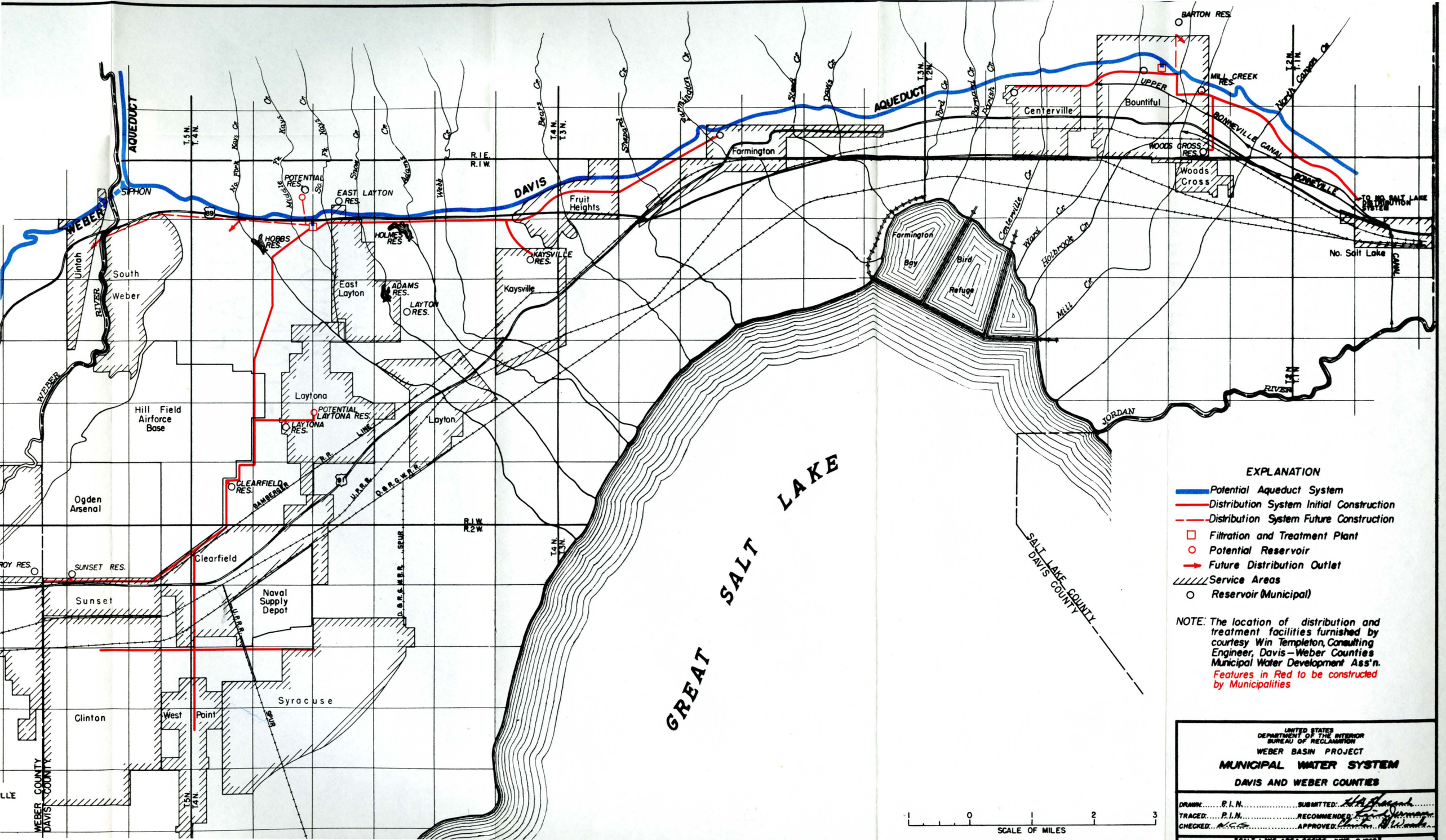
The additional municipal water required in communities in Davis and Weber Counties west of the Wasatch Front, up to the estimated ultimate requirement of 40,000 acre-feet, would be provided as needed by the Weber Basin project. The water would be developed by the Bureau of Reclamation from surplus spring run-off of the Weber River System and Wasatch Front streams and would be delivered by the Bureau to turn-out points along the Davis and Weber aqueducts. (In the present tentative plan the treatment plants would be located at the aqueduct turn-out points.) Development of the water by the Bureau and delivery to the aqueduct turn-out points would be accomplished through joint use of all project storage and aqueduct facilities, except Willard Reservoir and its appurtenant works.

Treatment of the water and distribution beyond the aqueduct turn-outs to points of use would be the responsibility of a water users' organization and the municipalities. The Davis-Weber Counties Municipal Water Development Association has outlined a plan for these operations. Chief features that would be constructed and the various areas that would be served are shown on the map on the following page. The cost of treating the water and conveying the supplies from the turn-out points to the municipalities is estimated at $15 per acre-foot or 4.6 cents per 1,000 gallons. This estimate is made by the association and is based on local financing with 40-year bonds and a small district tax levy. Additional costs of distributing water within the municipalities and replacing and extending existing lines would average around $16 per acre-foot, or 5 cents per 1,000 gallons, as indicated by records of the water departments of Ogden, Bountiful, and Layton. Thus on the basis of the above estimates, the total cost of treating the water and distributing it beyond the aqueducts to points of use would amount to around $31 per acre-foot or 9.5 cents per 1,000 gallons. The cost of supplying water through Bureau facilities to the aqueduct turn-out points is duscussed in chapter XI.

In its report, which is appended, the United States Public Health Service recommended that all water destined for municipal use be treated by coagulation, sedimentation, rapid sand filtration, and post-chlorination. Such treatment would be given by the facilities contemplated by the water development association.

Alternative source of supply

As an alternative to the municipal water development included as part of the Weber Basin project, an independent single-purpose system could be constructed to furnish water to the treatment plants of the municipalities. To provide an annual yield of 40,000 acre-feet of water, such a system would require 133,000 acre-feet of storage capacity at the Pineview, Perdue, and Jeremy sites on the upper reaches of the Weber River and tributaries. Two separate aqueducts would be required to deliver water from the reservoirs to the treatment plants, which would be located at the same sites as planned for the Weber Basin project. One aqueduct would head at the enlarged Pineview Dam and convey water to a treatment plant and an interconnecting system that would serve Ogden and other small communities in Weber County north of the Weber River. The other aqueduct, which would parallel the potential Weber and Davis aque-



EXPLANATION

- Potential Aqueduct System
- Distribution System Initial Construction
- Distribution System Future Construction
- Filtration and Treatment Plant
- Potential Reservoir
- Future Distribution Outlet
- Service Areas
- Reservoir (Municipal)

NOTE: The location of distribution and treatment facilities furnished by courtesy Win Templeton, Consulting Engineer, Davis–Weber Counties Municipal Water Development Ass'n.

Features in Red to be constructed by Municipalities

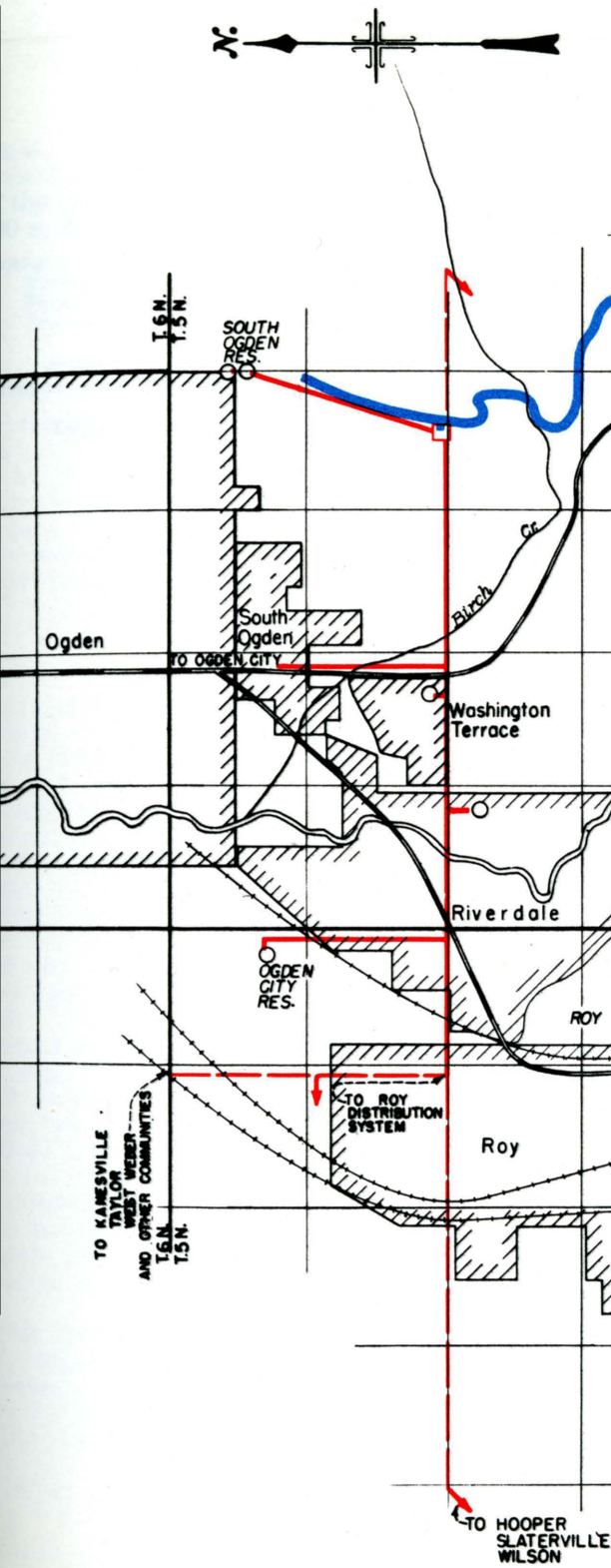
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WEBER BASIN PROJECT

MUNICIPAL WATER SYSTEM

DAVIS AND WEBER COUNTIES

DRAWN:	P.I.N.	SUBMITTED:	
TRACED:	P.I.N.	RECOMMENDED:	
CHECKED: A.C.G.		APPROVED:	


T.6N.
T.5N.
SOUTH OGDEN RES.
Ogden
South Ogden
TO OGDEN CITY
Birch Cr.
Washington Terrace
Riverdale
OGDEN CITY RES.
ROY
TO ROY DISTRIBUTION SYSTEM
Roy
TO KAMESVILLE TAYLOR WEST WEBER AND OTHER COMMUNITIES
T.6N.
T.5N.
TO HOOPER SLATERVILLE WILSON

ducts, would serve two treatment plants and an interconnecting system to Davis and southern Weber County communities. Costs of the independent development would total approximately $23,300,000 as shown below.

Storage:	
Perdue Dam	$9, 400, 000
Enlarged Pineview Dam	2, 350, 000
Jeremy Dam	2, 560, 000
Subtotal	17, 310, 000
Diversion and conveyance works	8, 990, 000
Total	23, 300, 000

CHAPTER VII

POWER

The power market area considered in the report, as shown in the map on the following page, includes 11 counties in the northwestern portion of Utah, 3 counties in southeastern Idaho, and 1 county in southwestern Wyoming. This area corresponds to subarea III–A–2 of the Federal Power Commission's Power Market Survey covering the Bureau of Reclamation's region 4. The power market and supply data in this chapter have been based on the Power Commission's survey although certain modifications have been made to incorporate more recent information.

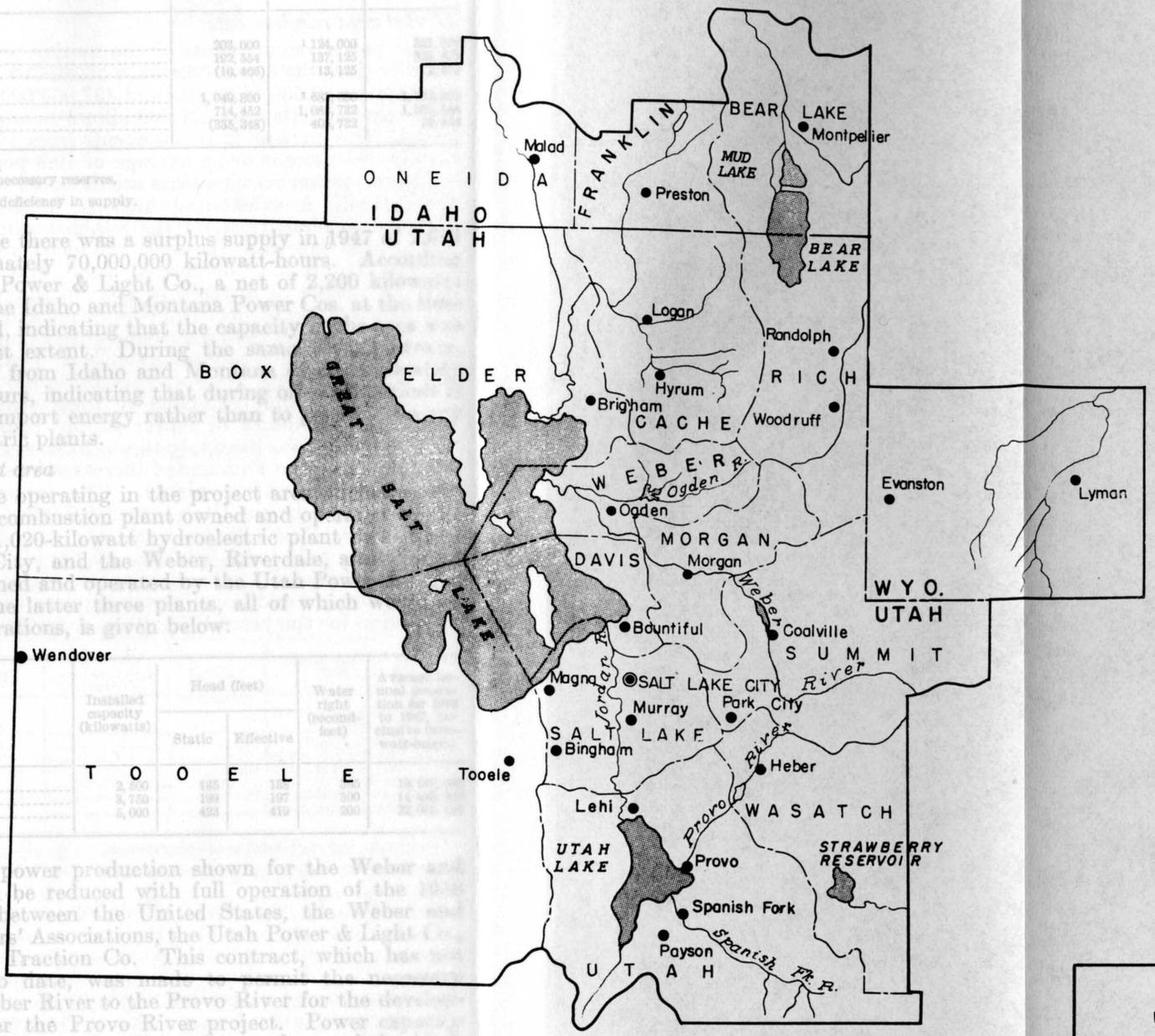
PRESENT DEVELOPMENT

As of December 31, 1947, the area had a total installed generating capacity of 419,538 kilowatts, including 177,281 kilowatts of hydroelectric capacity, 231,012 kilowatts steam-electric, and 11,245 kilowatts internal combusion. The Utah Power & Light Co. had an installed hydroelectric capacity of 169,780 kilowatts or 96 percent of the total hydroelectric capacity. Most of the company's hydroelectric capacity is installed on the Bear River in southern Idaho and northern Utah. The main steam-electric plants in the area are those of the Utah Power & Light Co. at Salt Lake City and Orem and those of the Kennecott Copper Corp. and the Geneva Steel Co. at Magna and Geneva, respectively. The plants of the latter two industrial firms operate in parallel with the Utah Power & Light Co. and make surplus energy available for the use of the utility. Internal-combustion plants are operated by the municipalities of Logan, Murray, and Bountiful, the largest plant being located at Logan.

The Utah Power & Light Co. system is interconnected with the system of Telluride Power Co. to the south of the market area and with the systems of the Idaho and Montana Power Cos. to the north. Considerable energy has been imported in the past from the Idaho and Montana Power Cos. In recent years, however, importations have been steadily decreasing until they are now limited almost entirely to the spring and summer months. During the fall and winter months, especially during the peak hours of the day, energy is now exported from the area to Idaho and Montana.

The market area is traversed by numerous transmission lines, most of which are owned and operated by the Utah Power & Light Co. The lines interconnecting the company's system with the Montana and Idaho Power Cos. are operated at 161,000 volts and 132,000 volts, and the main trunk lines of the company are operated at 132,000 volts. Subtransmission lines are operated at 44,000 volts.

The following tabulation indicates the power and energy requirements and supply in the market area for the year 1947.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WEBER BASIN PROJECT—UTAH

POWER MARKET SUPPLY AREA

DRAWN R.S.H.	SUBMITTED P.H. Harris
TRACED R.S.H.	RECOMMENDED Paul Jerman
CHECKED HAH	APPROVED C.D. Webb
526-P21	SALT LAKE CITY, UT. JAN. 1949 ONE SHEET

	Utilities	Industrials	Total
Power (kilowatts):			
Requirements	203,000	[1] 124,000	327,000
Net assured capacity [2]	192,554	137,125	329,679
Surplus in supply	(10,466)	13,125	2,679
Energy (1,000 kilowatt-hours):			
Requirements	1,049,800	[1] 683,000	1,732,800
Net assured capability	714,452	1,088,732	1,803,184
Surplus in supply	(335,348)	405,732	70,384

[1] Industrial generation for own use.
[2] Dependable capacity minus the necessary reserves.

NOTE.—Parentheses () indicate a deficiency in supply.

As shown by the table there was a surplus supply in 1947 of 2,679 kilowatts and approximately 70,000,000 kilowatt-hours. According to reports of the Utah Power & Light Co., a net of 2,200 kilowatts was being exported to the Idaho and Montana Power Cos. at the time of its 1947 peak demand, indicating that the capacity in the area was being used to its fullest extent. During the same year, however, there was a net import from Idaho and Montana of approximately 299,000,000 kilowatt-hours, indicating that during off-peak periods it was more desirable to import energy rather than to generate energy in the area's steam-electric plants.

Existing plants in project area

Five power plants are operating in the project area, including the 1,700-kilowatt internal combustion plant owned and operated by the city of Bountiful, the 1,020-kilowatt hydroelectric plant owned and operated by Brigham City, and the Weber, Riverdale, and Pioneer hydroelectric plants owned and operated by the Utah Power & Light Co. Information on the latter three plants, all of which would be affected by project operations, is given below:

Plant	Installed capacity (kilowatts)	Head (feet)		Water right (second-feet)	Average annual generation for 1938 to 1947, inclusive (kilowatt-hours)
		Static	Effective		
Weber	2,500	185	138	365	19,680,000
Riverdale	3,750	199	197	300	14,820,000
Pioneer	5,000	423	419	200	22,960,000

The average annual power production shown for the Weber and Riverdale plants would be reduced with full operation of the 1938 power contract made between the United States, the Weber and Provo River Water Users' Associations, the Utah Power & Light Co., and the Utah Light & Traction Co. This contract, which has not been fully operative to date, was made to permit the necessary diversions from the Weber River to the Provo River for the development of irrigation under the Provo River project. Power capacity and energy losses occurring at the Weber River plants of the Utah Power & Light Co. as a result of operations under the contract are to be compensated by increased production at the Provo River plants of the company or by replacement from other sources.

POWER REQUIREMENTS

Market area requirements

The power requirements of the market area have been increasing steadily since the depression years of 1932 to 1934. The 1933 requirements were 82,500 kilowatts and 437,000,000 kilowatt-hours, and the 1947 requirements were 327,000 kilowatts and 1,733,000,000 kilowatt-hours. The increase in requirements from 1933 to 1947 was approximately 300 percent or an average of 10.3 percent a year.

Electric power requirements are expected to continue to increase in the future. A substantial increase in industrial consumption is expected as plans exist for the establishment of numerous plants in the area to fabricate the steel produced and to process the area's mineral resources. Commercial, rural, and residential consumption also is expected to increase because of the increased population and the increased use of electrical equipment and appliances.

Based partly on past trends and partly on anticipated conditions in the market area, estimates have been made of the area's electric power requirements for the years 1950, 1960, and 1970. Estimates of the power supply available for these years have also been made. In making estimates of power supply consideration was given to possible reductions in supply through the aging of existing generating equipment and to anticipated increases in supply through additions to existing generating plants. The largest addition anticipated would be made by the Utah Power & Light Co. which has announced plans to install 240,000 kilowatts of steam-electric capacity, 200,000 kilowatts in Salt Lake City and 40,000 kilowatts at Orem.

The estimated power requirements, estimated net assured capacity, and amounts of additional power required are shown in the following tabulation for the years 1950, 1960, and 1970:

	1950	1960	1970
Power (kilowatts):			
Requirements	385,000	635,000	915,000
Net assured capacity [1]	378,000	531,000	502,000
Additional supply needed	7,000	104,000	413,000
Energy (millions of kilowatt-hours):			
Requirements	1,925	3,113	4,450
Net assured capability	2,111	3,261	2,597
Additional supply needed	(186)	(147)	1,854

[1] Dependable capacity minus the necessary reserves.

NOTE.—Parentheses () indicate surplus in supply.

As shown by the above tabulation, power and energy produced from facilities contemplated in the area in 1970 would fall short of demands for that year by 413,000 kilowatts and 1,854,000,000 kilowatt-hours. The deficiencies would have to be met either by the construction of additional generating plants by utilities and industries in the area, by importation from outside of the area, or by the construction of hydroelectric plants on Government projects.

Project pumping requirements

The four pumping plants and numerous well pumps included in the project development would require approximately 17,127,000 kilowatt-hours annually. The power would be required from June

to October, inclusive, as the plants would operate only during the irrigation season. Requirements of the individual plants are shown in the tabulation below:

Plant	Quantity of water to be pumped annually (acre-feet)	Capacity (kilowatts)	Annual electric energy requirements (kilowatt-hours)
Willard	82,250	5,500	11,025,000
Layton	18,770	430	592,000
Weber	3,565	400	1,320,000
Davis	7,660	1,110	3,620,000
Well pumps [1]	12,000	160	570,000
Total	124,245	7,600	17,127,000

[1] 20 pumps each requiring approximately 8 kilowatts for pumping ground water.

In accordance with the act of April 16, 1906, any power developed by the project would have to be used first to supply the requirements of the pumping plants. Any surplus power not required by the plants could be sold commercially.

PROJECT POWER DEVELOPMENT

Project power facilities

As outlined in chapter II, hydroelectric power plants would be constructed in connection with the Magpie and Perdue Dams under the Weber Basin project to provide energy for irrigation pumping.

Estimated operating data for the Magpie and Perdue plants are given below:

Plant	Mean operating head (feet)	Installed capacity (kilowatts)	Energy generation (1,000 kilowatt-hours)	
			Average year	Adverse year
Magpie	210	3,000	13,200	8,900
Perdue	190	3,000	15,200	12,800
Total		6,000	28,400	21,700

Consideration was also given to construction of hydroelectric plants at other points on the Weber River, including a plant at Gateway about 10 miles southeast of Ogden. The plans for developing hydroelectric power at other sites were abandoned, as studies indicated that the plants would be financially infeasible at present day costs. These potentialities may prove desirable when they can be integrated with hydroelectric plants of the potential central Utah and Colorado storage projects which are planned to serve the same general power-market areas. Future conditions will determine the advisability of including other hydroelectric power plants in the comprehensive river development plan.

The Bureau of Reclamation would retain ownership and operate the hydroelectric plants on the project.

Since the project area is traversed by numerous interconnected transmission lines of the Utah Power & Light Co., a Bureau trans-

mission system to interconnect the project power plants and serve the pumping plants would necessarily parallel the power company's existing lines. In view of this situation and in view of the fact that the project power plant capacity which can be economically justified is less than the peak load of the pumping plants, it has been assumed that the plants would be connected with the company's 44 kilovolt lines and that suitable arrangements could be made with the company for transmitting energy over its lines and for supplying the balance of the energy needed by the pumping plants. The map on the following page shows the contemplated project power plants and transmission lines as well as the existing power facilities in and near the project area.

Project power operation

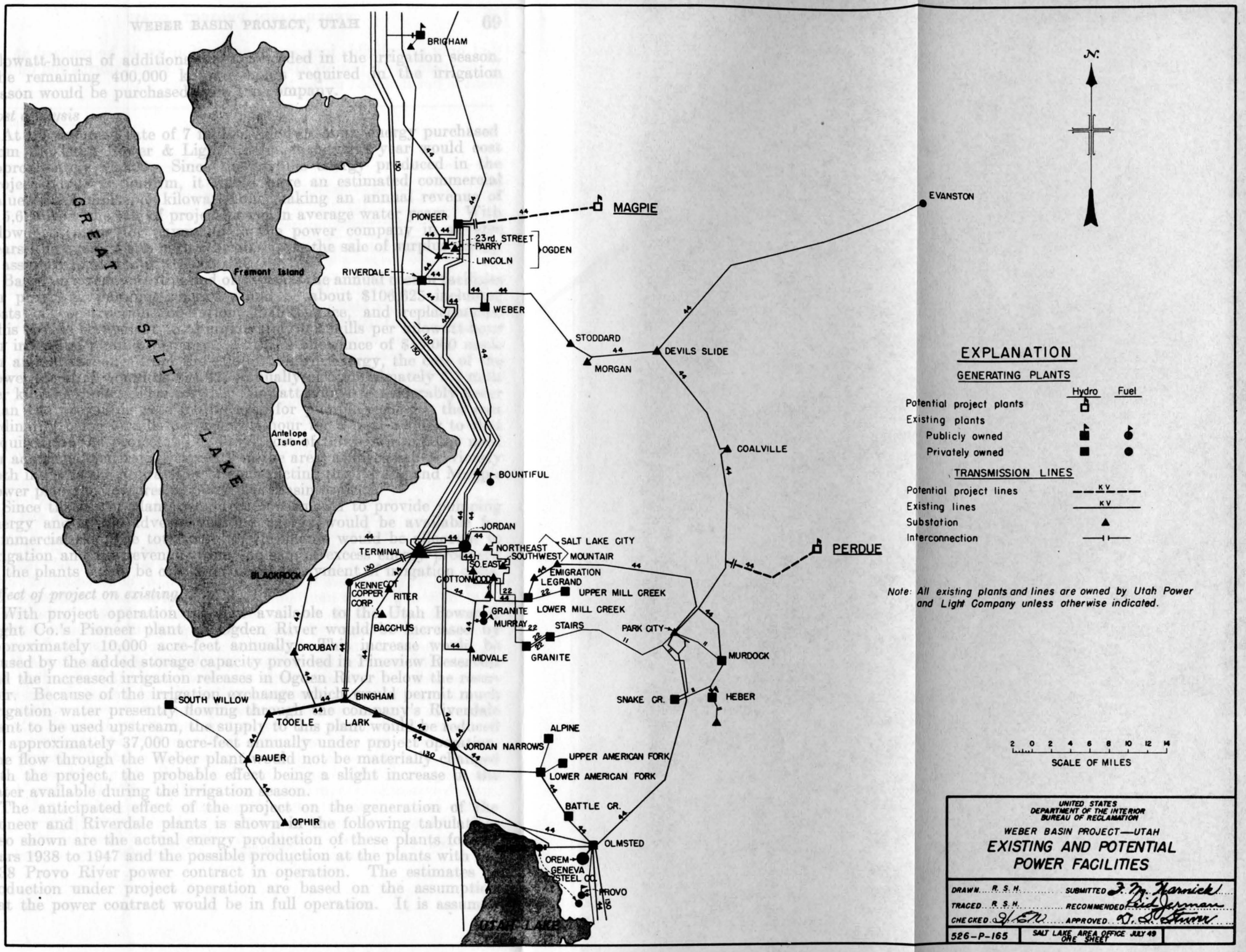
About 16,700,000 kilowatt-hours would be produced by the project power plants during the irrigation season in an adverse year. With allowances made for transmission and operational losses, about 15,000,000 kilowatt-hours of this energy would be available for use by the pumping plants. In an average year about 17,200,000 kilowatt-hours would be produced during the irrigation season and, with allowances made for losses, about 15,500,000 kilowatt-hours would be available for use at the pumping plants. Thus in an adverse year about 2,000,000 kilowatt-hours would be needed from the power company to meet the pumping requirements and in an average year about 1,500,000 kilowatt-hours would be needed.

To compensate the power company for the capacity and energy required from its system and for the use of its transmission facilities, energy from the project plants would be furnished the company during the nonirrigation season. In an adverse year the amount of energy available for the company from the project plants, with allowances made for transmission and operational losses, would be approximately 4,800,000 kilowatt-hours and in an average year the amount available would be approximately 10,750,000 kilowatt-hours.

The terms of an exchange agreement with the power company would be subject to negotiation. It has been assumed for purposes of this report, however, that to compensate the power company the project would supply the company 3 kilowatt-hours of nonirrigation season energy for 1 kilowatt-hour of irrigation pumping energy. Thus in an average year 4,500,000 kilowatt-hours would be provided the company, leaving 6,250,000 kilowatt-hours available for commercial sale. The following tabulation shows the estimated distribution of the energy that would be produced by the project power plants in an average year:

	Kilowatt-hours
Supplied to project pumping plants	15, 500, 000
Off-pumping season energy supplied to power company in exchange for pumping season energy	4, 500, 000
Transmission and operational losses	2, 150, 000
Surplus energy available for commercial sale	6, 250, 000
Total	28, 400, 000

During the nonirrigation season in an adverse year sufficient project power would not be produced to compensate the company at the assumed rate for all the power required in the irrigation season. Thus the 4,800,000 kilowatt-hours of surplus energy in the nonirrigation season would be provided the company as compensation for 1,600,000



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

WEBER BASIN PROJECT—UTAH

EXISTING AND POTENTIAL POWER FACILITIES

DRAWN R. S. H.	SUBMITTED	J. M. Harnick
TRACED R. S. H.	RECOMMENDED	Reid Jarman
CHECKED	APPROVED	W. L. Stoner
526-P-165	SALT LAKE AREA OFFICE JULY 49 ONE SHEET	

kilowatt-hours of additional energy needed in the irrigation season. The remaining 400,000 kilowatt-hours required in the irrigation season would be purchased from the company.

Cost analysis

At the assumed rate of 7 mills a kilowatt-hour, energy purchased from the Utah Power & Light Co. in an adverse year would cost approximately $2,800. Since the surplus energy produced in the project plants is nonfirm, it would have an estimated commercial value of 2.5 mills per kilowatt-hour making an annual revenue of $15,625 from the sale of project power in average water years. With allowances made for payments to the power company in adverse years, the average annual net income from the sale of surplus energy is assumed to be about $15,000.

Based on a repayment period of 58 years the annual cost of facilities for providing pumping energy would be about $106,625 including costs of construction, operation, maintenance, and replacements. This cost is equivalent to approximately 6.2 mills per kilowatt-hour for irrigation pumping energy. With an allowance of $15,000 made for annual revenues from the sale of nonfirm energy, the cost of the power facilities would be $91,625 annually or approximately 5.3 mills per kilowatt-hour. This cost per kilowatt-hour is considerably lower than the prevailing rate in the area for pumping energy, the cost ordinarily being 7 mills per kilowatt-hour for a load similar to that required for the project. The lower cost of the power and the need for additional generating capacity in the area, as discussed previously both indicate the desirability of constructing the Perdue and Magpie power plants as features of the Weber Basin project.

Since the power plants would be constructed to provide pumping energy and in an adverse year no energy would be available for commercial sale, the total costs of the plants would be allocated to irrigation and the revenues from the sale of excess energy produced at the plants would be credited toward repayment of irrigation costs.

Effect of project on existing plants

With project operation the flow available to the Utah Power & Light Co.'s Pioneer plant on Ogden River would be increased by approximately 10,000 acre-feet annually. This increase would be caused by the added storage capacity provided in Pineview Reservoir and the increased irrigation releases in Ogden River below the reservoir. Because of the irrigation exchange which would permit much irrigation water presently flowing through the company's Riverdale plant to be used upstream, the supply to this plant would be reduced by approximately 37,000 acre-feet annually under project operation. The flow through the Weber plant would not be materially changed with the project, the probable effect being a slight increase in the water available during the irrigation season.

The anticipated effect of the project on the generation of the Pioneer and Riverdale plants is shown in the following tabulation. Also shown are the actual energy production of these plants for the years 1938 to 1947 and the possible production at the plants with the 1938 Provo River power contract in operation. The estimates of production under project operation are based on the assumption that the power contract would be in full operation. It is assumed

that only a negligible increase in generation would be realized at the Weber plant with project operation and therefore information on this plant is not included in the tabulation below:

	Thousands of kilowatt-hours	
	Pioneer	Riverdale
Actual energy production	[1] 20,665	14,820
Possible production with Provo River contract in force	[1] 20,665	11,560
Estimated production with project in operation	23,830	6,400
Increase due to project operation	3,165	
Decrease due to project operation		5,160

[1] Represents actual energy production less energy produced from irrigation water purchased in transit. It has been assumed that such water will be unavailable in future years.

To compensate for the decrease in generation at the Riverdale plant, the project plan provides for the payment of a lump sum to the Utah Power & Light Co., the payment to be made at the time of the first depletions in the water supply available to the plant. The amount of a fair payment, which should be sufficient to return the revenue that would be lost by the company, is tentatively estimated at $290,000. This amount represents the annual value of the power that would be lost through project operation amortized over a 25-year period at 2.5 percent interest. The energy value, estimated at the rate of 3 mills a kilowatt-hour, was amortized over a 25-year period as the plant could be expected to have a useful life of about 25 years after the time project operation is expected to be started. The estimated payment to the power company is a tentative figure and may change as a result of negotiations with the company. It is included in this report as a part of the project construction cost and is allocated for payment by the irrigators.

The increase in net revenues from the Pioneer plant as a result of project operation is expected to amount to approximately $9,000 annually. The increase is estimated on the basis of an assumed value of 3 mills a kilowatt-hour for the energy produced. Although the actual rate at which the energy could be sold would have to be determined in negotiations with the power company, the assumed cost per kilowatt-hour is considered justified as it is approximately the same as the fuel costs per kilowatt-hour at steam-electric plants operating in the area. Agreements with the power company regarding the increase would be on a short-term basis, subject to renegotiation with changes in irrigation and power developments.

CHAPTER VIII

FLOOD CONTROL

The Bureau of Reclamation's studies of flood control, particularly with respect to magnitude-frequency relationships, were based on information contained in a memorandum on flood damage and protection issued in October 1948 by the Corps of Engineers, United States Army, Sacramento district. Information of the Corps of Engineers was utilized as it was derived from techniques and standards comparable to those used by the Bureau of Reclamation. It is quite probable that in the near future, before the flood-control program outlined in this report could be accomplished, the Corps of Engineers might undertake such measures as straightening, deepening, or clearing the present river channel or building levees and wasteways. Such measures would not conflict with, nor duplicate, the flood-control plan contemplated in connection with the Weber Basin project.

PRESENT FLOOD DANGER

In years of high winter precipitation and abnormally high spring temperatures, snow melt from the high mountain ranges results in damaging floods, particularly along the middle and lower reaches of the river system. The project area is rarely deluged with concentrated rainfall, and at no time of record has any serious flood due to rainfall been experienced along the main channel of either the Weber or the Ogden Rivers. Occasional summer cloudbursts cause short, high-intensity floods in the smaller steep tributaries, but these floods have only minor effect on the flow of the major tributaries. Only rainfall which occurs at the same time as the spring snow melt need be considered in the flood-control studies. Protection against a snow melt flood would provide ample protection against a rainfall flood with a similar frequency.

The portions of the project area subject to the severest flood damage are those adjacent to the Weber River downstream from Morgan and adjacent to the Ogden River downstream from Pineview Dam. In Weber Canyon snow-melt floods threaten the main line of the Union Pacific Railroad which lies only a few feet above the normal river flow, United States Highway 30-S, oil and gas lines, a power plant, and transmission facilities, and communication lines serving the industrialized area west of the Wasatch Front. The highly developed delta lands west of the Wasatch Front also are in danger of extensive damage. The Corps of Engineers estimates the potential annual flood damage in the project area under present conditions at $188,900. This estimate is based on potential damages in various reaches of the Weber system as shown in the following tabulation:

Flood damages and change of land use [1]

Description	Direct damages [2]	Improved land use [2]	Total
Weber River:			
Reach 1. Head of river to Weber-Provo diversion canal	$700		$700
Reach 2. Weber-Provo diversion canal to Echo Reservoir	500		500
Reach 3. Echo Reservoir to Lost Creek	200		200
Reach 4. Lost Creek to Morgan	400	$2,300	2,700
Reach 5. Morgan to Gateway	25,200	5,300	30,500
Reach 6. Gateway to junction with Ogden River	24,400	5,200	29,600
Reach 7. Junction with Ogden River to Ogden Bay Bird Refuge	86,400	12,100	98,500
Ogden River: Reach 8. Ogden River below Pineview Reservoir	13,300		13,300
South Fork Ogden River: Reach 9. Potential Magpie Reservoir to Pineview Reservoir	4,900		4,900
East Canyon Creek: Reach 10. East Canyon Dam to Weber River	4,700		4,700
Lost Creek: Reach 11. Lost Creek Site to Weber River	3,300		3,300
	164,000	24,900	188,900

[1] Adjusted to represent prospective future economic conditions (average annual values).
[2] Adjusted to 1939–44 price level.

HISTORICAL FLOODS

Peaks, volumes, and frequencies

No permanent stream gaging stations were established in the area until 1903. Some stream measurements, however, were recorded as early as 1889 and from that time until the stations were established intermittent records were obtained on both the Ogden and Weber Rivers. Data obtained from stream flow records in years of flood conditions are shown in the following table. Although no recorded data are available for 1876, 1884, and 1893, newspapers and other local sources indicate that severe floods occurred in those years, with the heaviest damage being experienced in 1893 in the area below the confluence of the Weber and Ogden Rivers.

Magnitude of historical flood flows

Station	Years	Maximum mean daily peak (second-feet)	Frequency of maximum mean daily peak (years)	Maximum volume during flood stage (1,000 acre-feet)	Frequency of maximum volume (years)
Gateway	1896	7,980	61	[1] 394.0	29
Ogden	1907	2,862	9	61.5	6
Ogden	1909	2,252	4	180.4	9
Plain City		7,580	9	693.0	52
Gateway	1922	6,570	10	402.3	31
Plain City		7,270	8	442.0	14
Ogden	1936	3,430	22	180.8	83
Gateway		4,180	2	190.3	28
Plain City		6,050	4	368.0	10

[1] Total run-off May and June.

POTENTIAL FLOODS

Flood peaks and frequencies

Expected flood peaks and frequencies based on historical flood flow records are summarized in the following table:

Peak discharge magnitude-frequency relationships

Number of times in 100 years discharge may be equaled or exceeded	Weber River at—		South Fork of Ogden River	Ogden River below Pineview	Weber River at Coalville	Lost Creek at Devils Slide
	Plain City	Gateway				
1	10,200	6,300	1,800	4,300	3,250	1,550
2	9,500	5,800	1,690	3,900	3,000	1,430
5	8,300	5,000	1,490	3,350	2,650	1,270
10	7,300	4,400	1,320	2,900	2,370	1,140
20	6,200	3,700	1,140	2,450	2,050	970
25	5,800	3,500	1,050	2,300	1,930	910
50	4,100	2,350	740	1,700	1,520	630

Flood volumes

On the basis of Geological Survey stream-flow records, probable flood volumes and frequencies were estimated to determine the storage capacity that would be required for control of major floods in the area. The estimates made are shown below:

Volumetric magnitude-frequency relationships

[Unit=1,000 acre-feet]

Number of times in 100 years discharge may be equaled or exceeded	Total discharge in excess of channel capacity					
	Weber River at—			Ogden River below Pineview	South Fork Ogden River	Lost Creek at Devils Slide
	Coalville	Gateway [1]	Plain City [1]			
1	69.6	194.6	270.0	84.0	26.9	24.2
2	51.0	152.0	200.0	65.5	19.8	20.5
5	26.5	79.6	120.0	41.0	10.9	16.0
25	6	0	0	0	0	6.0
50	0	0	0	0	0	.1
100	0	0	0	0	0	0

[1] Flows in excess of safe channel capacities in these reaches often occur for prolonged periods, sometimes in excess of 60 days.

FLOOD STORAGE PLAN

The plan for controlling potential floods is based on the supposition that a reliable run-off forecasting system would be instituted. When danger of floods occur, storage waters would be released from the Weber and Ogden River Reservoirs to provide space for flood flows. The released water would be recaptured in the downstream Willard Reservoir. The following table shows the project storage that would be available for flood control and the quantities of floodwater that would have to be withheld to protect the various river reaches from maximum floods that might be expected to occur as often as once in 50 years.

Flood storage plan

[Unit=1,000 acre-feet]

	Total excess discharge at lower end of reach [1]	Cumulative storage capacity above lower end of each reach	Reservoir furnishing storage capacity	Flood frequency in 100 years	Uncontrollable water	Excess storage capacity available
Reach 1			Not controllable			
Reach 2	51.0	50	Perdue	2	1.0	
Reach 3	53.7	124	Perdue, Echo	2		70.3
Reach 4	45.0	144	Perdue, Echo, Lost Creek	2		99.0
Reach 5	152.0	179	Perdue, Echo, Lost Creek, Jeremy	2		27.0
Reach 6	1.0	179	do	2		27.0
Reach 7	200.0	331	Perdue, Echo, Lost Creek, Jeremy, Pineview, Magpie.	2		131.0
Reach 8	65.5	152	Pineview, Magpie	2		86.5
Reach 9	19.8	60	Magpie	2		40.2
Reach 10	5.5	35	Jeremy	2		29.5
Reach 11	18.7	20	Lost Creek	2	.7	

[1] Total volume which could not be safely carried by present channels during flood season.

Project operation would reduce the flood damages in the area by an estimated $161,351 annually. Probable reductions in damages in the various river reaches are shown in the following table:

Total annual flood damages preventable by project

	Direct damage	Improved land use		Direct damage	Improved land use
Reach 1	0		Reach 8	$10,640	
Reach 2	$251		Reach 9	3,670	
Reach 3	110		Reach 10	2,590	
Reach 4	290	$2,300	Reach 11	3,100	
Reach 5	20,200	5,300			
Reach 6	20,200	5,200	Subtotal	136,451	$24,900
Reach 7	75,400	12,100	Total	161,351	

CHAPTER IX

DRAINAGE

As shown by the semidetailed land classification discussed in chapter IV, drainage would be essential to the reclamation of 31,700 acres of nonirrigated land and 7,000 acres inadequately irrigated. These lands, nearly all of which are delta lands near the western boundary of the project, have a high-water table because of seepage from higher irrigated areas and can now be used only for pasture. These lands, among the first to be developed by settlers in the area, once yielded excellent crops and were abandoned only because of the rising water table.

Drainage systems in the project area have usually been limited to small tracts of land. The small systems have been successful in areas where there are natural drains or breaks in the topography of sufficient depth to dispose of the drainage water. Many individual farm-drainage attempts have failed on the larger and flatter areas because of the difficulty and expense of constructing long channels to provide outlets for the farm drains.

Only two small drainage districts have been formed within the project area. Known as Davis County drainage districts Nos. 1 and 2, these were organized to serve 2,000 and 190 acres, respectively. District No. 1 served the delta lands west of Bountiful. Although the drains apparently were successful, the district failed financially several years after it was organized, principally because a supply of irrigation water was not provided for the drained lands. District No. 2 serves land west of Farmington and is still functioning after 30 years of operation.

GENERAL DRAINAGE CONDITIONS

The bench and foothill lands near the Wasatch Mountains, having relatively steep slopes and being composed of the coarser lake deposits, have excellent natural drainage characteristics. Irrigation water applied to these lands seeps freely into the subsoil and then flows west toward Great Salt Lake. Some of this water finds its way into artesian aquifers, particularly in areas near the mountains. The remainder of the water is restricted in its downward movement by impervious layers and is forced to flow to the west, generally parallel to the land surface. The velocity of the flow is reduced as the water reaches the flatter and more impervious delta lands near the lake. As a result a seeped condition exists in these delta lands and in many places during the fall and winter months the water level reaches the land surface. The fact that the ground water is highest during November and December indicates that several months elapse before seepage from water applied on the bench and foothill lands reaches the delta area.

Numerous artesian wells from which a partial irrigation supply is obtained exist in the delta area. Many of these wells are not closed during the nonirrigation season and the water is wasted on the land surface, thus aggravating the seeped condition.

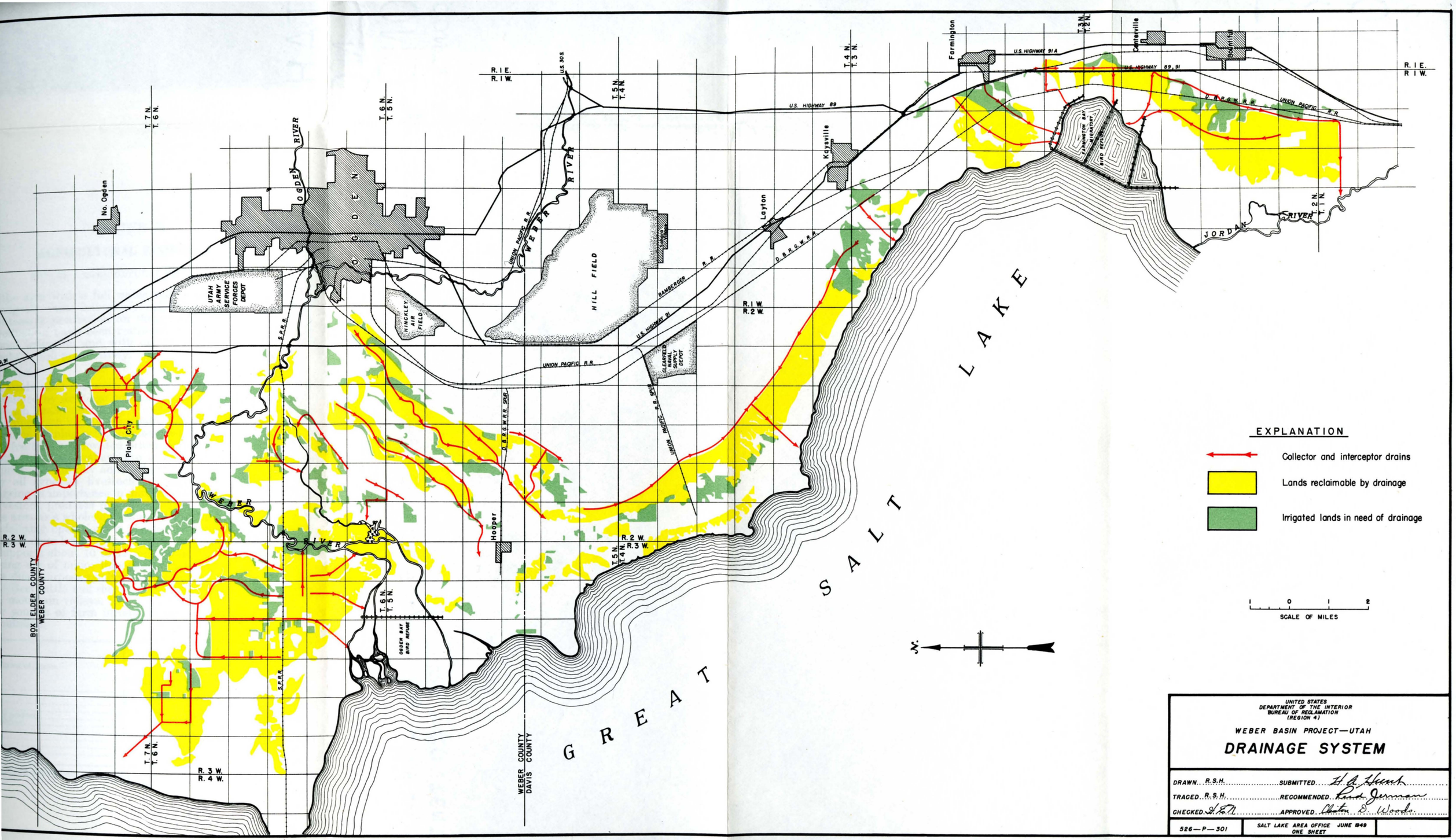
DRAINAGE INVESTIGATIONS

Ground-water observation wells were established throughout the area in need of drainage. These wells were placed at or near section corners and above and below breaks in the topography along section lines. A study of ground-water profiles, prepared from periodic water surface-elevation readings in the observation wells, was made to determine the required position and depths of drains to intercept ground water seeping from higher lands. The direction of ground-water flow was determined from ground-water contour maps superimposed on topographic maps. Depth-to-ground-water maps for maximum and minimum fluctuations of the water table were prepared in order to determine the relative drainage requirements throughout the area.

PLAN FOR DRAINAGE

Under the Weber Basin project a system of main drainage channels would be constructed approximately as shown in the map on the following page. These channels would serve as collectors for farm-drainage systems and would intercept seepage water coming from higher lands. The farm drains are not included in the project plan but would be constructed on an individual or cooperative basis by the landowners. The cost of the farm drains has been considered in the economic studies as part of the land-development costs.

Channels provided as part of the project would have a total length of about 115 miles. About 40 miles of these channels would be formed by cleaning and enlarging existing natural drainage channels and 15 miles would be formed by enlarging constructed drains that are too shallow for efficient use and that have not been properly maintained. The remaining 60 miles would be new drainage channels. For the new drains rights-of-way would be purchased through land that is presently of low agricultural value.



EXPLANATION

- Collector and interceptor drains
- Lands reclaimable by drainage
- Irrigated lands in need of drainage

SCALE OF MILES

1 0 1 2

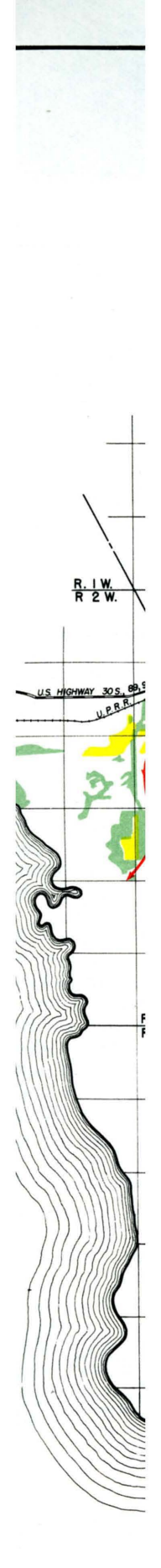
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
(REGION 4)

WEBER BASIN PROJECT—UTAH

DRAINAGE SYSTEM

DRAWN R.S.H.	SUBMITTED H. A. Hewlett
TRACED R.S.H.	RECOMMENDED Rud. Jorman
CHECKED A.S.N.	APPROVED Clinton S. Woods
526—P—301	SALT LAKE AREA OFFICE JUNE 1949 ONE SHEET

U.S.H., SLEM. 3926-4-8-48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R 2 W.
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U.P.R.R.

CHAPTER X

AGRICULTURAL ECONOMY

PRESENT AGRICULTURAL ECONOMY

Lands in the area with a full water supply are highly productive and are among the most intensively cultivated areas in the State. To permit intensive production on these lands, however, irrigation and crop production have been restricted to a limited area. Only with additional irrigation and with drainage can the entire arable area be brought to full productivity.

Crops and livestock

The delta lands near the western boundary of the project which would be reclaimed by drainage now have only a limited use for pasture. The bench lands west of the Wasatch Front produce a variety of crops, including fresh vegetables, alfalfa, cereal crops, and intensive row crops such as canning peas, tomatoes, sugar beets, potatoes, and onions. The foothills are devoted primarily to fruit and truck crops while the high mountain valleys are utilized for irrigated pastures and for the production of hay and feed grains.

Practically all types of livestock are kept in the project area. Although varying in importance in different sections of the area, livestock and livestock products provide a significant part of the farm income in the area as a whole. Because of crop limitations, extensive commercial dairying operations in the higher mountain valleys and on the bench and delta lands to the west are carried on. The average dairy farm supports about 10 to 12 milk cows. Commercial poultry and hog raising are of minor importance in the area. Most of the farmers keep dual purpose poultry and maintain small flocks of 50 to 100 hens. Beef cattle and sheep are generally found only on farms in the higher mountain valleys.

The major sources of farm income in the area are shown in the following tabulation:

Source of income	Percent of income				
	Box Elder [1]	Davis	Morgan	Summit	Weber
Livestock	12.4	4.4	26.0	25.7	5.0
Dairy products	9.0	8.0	27.7	39.1	17.1
Poultry and poultry products	4.4	2.4	5.4	8.5	4.7
Other livestock products	.5	.3	3.7	3.7	.6
Field crops	59.4	47.9	25.6	7.9	45.3
Vegetables	3.9	16.7	5.4	----	6.0
Fruits and berries	5.8	10.7	----	----	9.1
Self-sufficing	4.6	9.6	6.2	15.1	12.2

[1] Includes figures for the entire county although only part of the county is included in the project area.

Markets

Farmers of the Weber Basin area are favorably located with respect to markets. Perishable products, such as whole milk, fresh eggs, fruits, and vegetables, are consumed almost entirely in the local area or in immediately adjacent areas. Fourteen canneries in the Weber area process most of the tomato, pea, and sweet cherry crops. Other plants in the area, including sugar beet factories, flour mills, meat packing plants, creameries, and cold storage plants, process farm products and distribute them through national markets. Practically all truck and berry crops are marketed through the public market in nearby Salt Lake City or through roadside stands adjacent to the individual farms. Dairymen find ready markets for their products, principally in Salt Lake City and Ogden.

Livestock is shipped both east and west, with most of the sheep and feeder cattle going to such markets as Denver, Kansas City, and Omaha. Milk cows and some beef cattle, particularly fat cattle, go to California. The Ogden Union Stockyards rank first, west of Denver, in total livestock receipts. They are second in the Nation in sheep receipts.

Farms and farmers

Of the total 1940 population (90,000) in the project area, 61 percent was classed as urban and 39 percent as rural. Of the rural population 52 percent was classed as rural farm and 48 percent as rural nonfarm. This indicates that only 21 percent of the population is actually engaged in farming. Since the 1940 census the population of the area has increased significantly. Practically all of the additional population is engaged in nonagricultural activities although many are living in rural areas.

Project farms generally contain a farmstead in town and several noncontiguous parcels of land located at various distances from the farmstead. The farmer, therefore, usually operates more than one class of land.

Most farmers own and operate their own farms, the percentage of tenant operators being relatively small. The agricultural census shows 10 percent of the operators in the area were tenants in 1945, as compared to 14 percent in 1940, 17 percent in 1935, and 14 percent in 1930.

Size of farms

Within the project area there is a material difference in the intensity of land use; consequently, there is considerable difference in the size of full-time farms. Some intensively cultivated full-time truck crop farms in the vicinity of Bountiful include 10 or 12 acres, while in part of the project area some farms, cultivated much less intensively, approach 160 acres in size. Because of the difference in intensity of land use, acreage per farm is not necessarily the best measure of size of farm. It is, however, the only measure available that can be readily applied to all farms. Nearly 90 per cent of the farms are less

than 100 acres in size. At least 70 percent of the farms are less than 50 acres in size, while about 20 percent contain less than 10 acres. The average size of farm, as shown in the 1945 Census of Agriculture, is 30 acres in Davis County, 65 acres in Summit County, 64 acres in Morgan County, and 25 acres in Weber County.

Within the project area only about 12 ownerships contain more than 160 acres, the amount of land in single ownership that could be furnished project water under reclamation law. These ownerships involve about 7,000 acres. Nearly half the land, however, is held by a corporation which has expressed its willingness to dispose of excess holdings.

Off-farm employment

Off-farm employment, especially in recent years, has had a tremendous effect on the economy of farmers in the project area. Industrial expansion in this area has resulted in many farmers obtaining a few days to nearly full-time employment away from the farm.

The 1940 Agricultural Census shows that for the year 1939 approximately 40 percent of farm operators in the project area were employed off their farms. The average time worked off the farm for those reporting was 143 days. Roughly 17 percent of the work consisted of work on other farms, while 83 percent consisted of nonfarm work. Based on a 1939–1944 average farm wage rate of $3.50 a day, an average of $600 was earned annually by farmers who reported off-farm work in 1939.

Finance

Land values vary considerably in the project area and depend principally on such factors as water supply, type of soil, and location with respect to towns, industrial areas, and transportation facilities. Some of the better irrigated agricultural lands in the Davis-Weber area sell for as much as $400 an acre, while the presently undeveloped arable lands in the project area usually sell for not more than $5 to $10 an acre unless sold for building lots.

The per-acre assessed valuations of various classes and types of agricultural land are shown below. Past assessed valuations have generally ranged from 35 to 50 percent of the real value.

Assessed valuation of farm lands

County	Irrigated land				Dry-farmed land	Grazing land
	Class A	Class B	Class C	Class D		
Davis	$120–$180	$80–$120	$70	$35–$40	$20–$40	$5–$50
Box Elder [1]	120	80	40	20	20–40	3
Morgan	81	57	24	8	12–20	1–3
Summit	60	50	40	15	7–10	3
Weber	120	80	40	20	20–40	3

[1] Estimated; includes only that part of Box Elder County within project.

The 1945 assessed valuations of all agricultural land in the various counties of the project area are shown below:

1945 assessed valuation of agricultural land

County:	
Davis	$12, 583, 501
Box Elder [1]	1, 800, 000
Morgan	2, 214, 320
Summit	4, 544, 934
Weber	18, 078, 732

[1] Estimated; includes only that part of Box Elder County within project.

Most farmers are paying their taxes when due. In 1945 no farms were sold for taxes, and in the past several years only occasional small tracts of farm land, usually less than 1 acre in size, have been sold for taxes. All counties are free of any bonded indebtedness.

Banks in the various communities of the project make operating loans to farmers when needed. Additional credit is obtained from the Federal Land Bank, Production Credit Administration, Farm and Home Administration, insurance companies, and private individuals. The general credit of farmers is considered good.

In 1940, the last year for which published records are available, approximately 54 percent of farms in the project area were mortgaged. The average farm mortgage debt was $2,860 for farmers operating their own units. The farm mortgage debt, however, has been reduced nearly one-half since 1940.

A field survey shows that most of the irrigation companies along the Wasatch Front are debt-free. The few having indebtedness are up to date on payments. All irrigation companies on the Weber and Ogden River system are free of indebtedness except for indebtedness to the Government for the construction of the Weber and Ogden River projects. Payments on these projects are based on 40-year repayment contracts and all payments are substantially on schedule.

Relief problems

Approximately 7 percent of the population in the project area received some sort of welfare assistance in 1940. Four percent of the 1940 population received assistance in 1944 and 4.5 percent in 1946. A recent report of the State public welfare service states that the high rate of industrial employment has virtually wiped out the unemployment relief phases of the welfare program. The report further shows that employable persons, representing 27 percent of the State's public assistance caseloads in 1939 represented only one-half of 1 percent of the case loads in the periods 1942–44 and 1944–46.

ANTICIPATED AGRICULTURAL ECONOMY

With adequate irrigation and proper drainage, arable lands, now idle or only partially productive would provide the additional farm produce needed in the area. The demand for farm-produced foods

has increased markedly in recent years because of the increased population. At the same time some farm land has been taken out of production and used for housing developments or military establishments, thus reducing the amount of farm produce available.

Type of farming

The cropping pattern on new lands developed under the project is expected to follow in a general way the pattern on adjacent areas with a full water supply. Yields and cropping patterns probably would not be stabilized until from 2 to 8 years after the project water was made available.

More than 75 percent of the foothill area along the Wasatch Front is expected to be devoted to fruit and truck crops. Although this area is ideally situated with respect to Utah's largest fresh milk market, its adaptability to fruits and vegetables, and the demand for such produce in the vicinity encourage farmers to specialize in the cash crops. Probably 1 cow and about 50 hen flock would be maintained for family use on the average foothills farm.

Feed and cash crops are expected to be produced on nearly 80 percent of the bench lands. About 10 to 12 dairy cows would be supported on each farm on these lands because of the farms' proximity to the fresh milk market and the adaptability of the lands to the production of feed. Because of the availability of feeds, farm chicken flocks with about 100 hens could be economically raised.

Practically the same pattern of farming anticipated for the bench lands is expected to be followed on the delta lands that would be reclaimed by drainage. With project development dairying and feed crop production would continue to predominate in the high mountain valleys.

The availability of additional feed crops in the project area would not markedly affect the numbers of beef cattle, hogs, and sheep normally raised. Because of the increased feed supply, however, more sheep and beef cattle could be fattened for maket. The additional feeds would assist in stabilizing the livestock industry, especially in periods of drought.

Improvements required

The extent of improvements required as a result of project development would differ in various sections of the area. Many farm units which would be served are already established. Little more than cleaning or rehabilitating of existing farm laterals and control structures would be required on lands which are irrigated or which have previously been irrigated. The dry-farmed land and undeveloped lands would be divided into economic irrigation farm units and each unit would require an entire lay-out of farm buildings, farm laterals, control structures, and a domestic water system. Undeveloped lands are generally covered with sage brush, oak brush, or salt grass and would require clearing and leveling prior to delivery of water. Much of this undeveloped land is owned by farmers with small developed farms and

would be incorporated in existing farm units, resulting in farms of more economic size. Individual farm drains would be installed by the farm operators in the delta lands reclaimable by drainage.

Lands brought into production as a result of the project would increase in value thus broadening the tax base. It is possible that with this increased valuation increased tax levies would not be necessary to meet the public service needs of the area.

Settlement

The 70,400 acres of new land that would be developed by the project are practically all in private ownership. Development of this acreage would permit the formation of about 1,500 new farm units and the expansion of many existing units. In the fruit-truck crop area on the foothills, where about 16,100 acres of the undeveloped land are located, about 500 of the new farm units could be established and many existing units could be expanded. In the dairy-cash crop area on the bench and delta lands where about 51,300 acres of the undevloped lands are located 1,000 new farm units could be established and other units could be expanded. The 3,100 acres of new lands in the mountain valleys are expected to be incorporated into existing farm units with project development.

REPAYMENT

Studies of water users' ability to pay irrigation costs have been based on the established and accepted farm budget method of analysis. Through this method payment capacity was estimated by the development and analysis of budgets for representative farms and the projection of the results to the area under study. Payment capacities were determined both for conditions expected "without" project development and "with" project development. The difference in the two payment capacities, less irrigation operation and maintenance costs, was taken as the amortization capacity or the amount that the irrigation water users could pay toward capital costs of the project.

Repayment studies were made for four representative types of farm organizations in the area, namely, a 20-acre fruit-truck crop farm on class 1 and 4–F land on the foothills area, a 43.5-acre dairy-cash crop farm on class 2 and 4–P lands on the benches, a 40-acre dairy-cash crop farm on class 2 and 4–P lands in the delta area, and a 60-acre dairy-field crop farm on class 1, 2, and 4–P land in the mountain valleys. Budgets for these representative farms included in detail the anticipated income and expenditures for a year of farm operations. In the analysis both farm budget income and expense items were based on 1939–44 prices, which is believed to be indicative of average price over an extended period in the future. Summaries of the budgets made are given on the following pages. These farm budget summaries show in detail the anticipated cropping system, crop yields, livestock and livestock production, and farm product sales. Also shown are the itemized farm operating expenses, including operation and maintenance costs and the value of farm-furnished living, and a financial summary.

The land in the "Delta area" will require a full supply of irrigation water and has been analyzed on the basis of new land and new farms. The rest of the new land is expected to be largely absorbed into existing farm units since this land is widely scattered throughout the project area. If a farm were to be composed entirely of new land, the estimated repayment per acre-foot would be less than the average of all lands which included lands requiring only a partial supply. For this reason, an additional farm budget summary has been prepared on the basis that the land in each area required a full irrigation supply. This analysis demonstrates that land requiring a full supply cannot pay as much per acre-foot as land requiring only a supplemental supply.

Farm budget: Summary of income and expenses

[Land, class 1 and orchard; acres, 20; type, fruit and truck; condition, "without"; area, foothills]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	5.5	1.1	Ton	3.0	3.3	$12.00	$40	$40		
Pasture	5.5	1.1	Animal unit per month	6.0	6.6	2.00	13	13		
Apricots	5.0	1.0	Bushel	150	150	1.30	195			$195
Cherries	7.5	1.5	Ton	2.2	3.3	112.00	370			370
Peaches	6.0	1.2	Bushel	150	180	1.30	234			234
Small fruit	2.5	.5	Value	$220	$110	220.00	110			110
Snap beans	4.0	.8	Ton	3.1	2.5	60.00	150			150
Peas	3.5	.7	do	1.5	1.1	65.00	72			72
Cantaloup	8.0	1.6	do	2.5	4.0	76.00	304			304
Tomatoes	3.5	.7	do	10.5	7.4	15.00	111			111
Sweet corn	3.5	.7	do	3.1	2.2	56.00	123			123
Pea ensilage [1]	(3.5)	(.7)	do	4.0	(2.8)	4.28	12	12		
Garden [1]	(1.0)	(.2)	Value	$275	$55	275.00	55		$55	
Undeveloped	40.5	8.1	Animal unit per month	1	8.1	2.00	16	16		
Farmstead and waste	5.0	1.0								
Subtotal	100.0	20.0					1,805	81	55	1,669
Livestock	**Number**	**Product**								
Dairy cows	1	Butterfat	Pound	243	243	.56	136		98	38
Cull cows		Cull cows	do	168	168	.052	9			9
Veal		Veal	do	70	70	.1081	8			8
Chickens	50	Chickens	do	7.2	360	.167	60		35	25
Eggs		Eggs	Dozen	9.0	450	.28	126		38	88
Subtotal							339		171	168
Total							2,144	81	226	1,837

[1] Duplicated acreage.

CURRENT FARM EXPENSES

Interest cost, at 3 percent	$160
Taxes (35 mills)	112
Hired labor, 65 days, at $3.50	227
Irrigation, operation, and maintenance	20
Crop expense:	
Seed	63
Fertilizer	27
Baskets, liners, lugs	63
Dusting and spraying	37
Livestock expense:	
Purchased feed	151
Veterinarian and supplies	15
Chicks	12
Car (farm share)	85
Depreciation and repairs on buildings and improvements	210
Depreciation and repairs on machinery	45
Insurance on buildings and improvements	13
Electricity	16
Depreciation on orchard	31
Other farm expenses, 2 percent of above	26
Total	1,312

INVESTMENTS

Land	2,323
Dwelling	1,440
Other improvements	1,083
Machinery and equipment	318
Livestock	172
Feed and supplies	10
Total	5,346

COST OF LIVING

Cash, family	$525
Home used products	226
Use of dwelling	187
Total	938

FINANCIAL SUMMARY

Receipts:	*Farm budget*
Crop sales	$1,669
Livestock	168
Farm privileges	413
Total	2,250
Farm expenses	1,312
Net income	938
Family living allowance	938
Payment capacity per farm	0
Payment capacity per acre	0

FARM WORK

	Days
Crops	256
Livestock	46
Miscellaneous	6
Total	308
Work by:	
Operator	185
Family	58
Hired	65
Total	308

Farm budget: Summary of income and expenses

[Land, class 1 and orchard; acres, 20; type, fruit and truck; condition, "with"; area, foothills]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	10.0	2.0	Ton	3.3	66.0	$12.00	$79	$79		
Pasture	10.0	2.0	Animal unit per month	8.0	16.0	2.00	32	32		
Cherries	15.0	3.0	Ton	2.2	6.6	112.00	739			$739
Peaches	15.0	3.0	Bushel	150	450	1.30	585			585
Apricots	10.0	2.0	do	150	300	1.30	390			390
Miscellaneous fruit	5.0	1.0	Value	$220	$220	220.00	220			220
Snap beans	5.0	1.0	Ton	3.1	3.1	60.00	186			186
Peas	5.0	1.0	do	1.5	1.5	65.00	98			98
Cantaloup	10.0	2.0	do	2.5	5.0	76.00	380			380
Tomatoes	5.0	1.0	do	10.5	10.5	15.00	158			158
Sweet corn	5.0	1.0	do	3.1	3.1	56.00	174			174
Pea ensilage [1]	(5.0)	(1.0)	do	4.0	4.0	4.28	17	17		
Garden [1]	(1.0)	(.2)	Value	$275	$55	275.00	55		$55	
Farmstead	5.0	1.0								
Subtotal	100.0	20.0					3,113	128	55	2,930
Livestock	**Number**	**Product**								
Dairy cows	1	Butterfat	Pound	243	243	.56	136		98	38
Cull cows		Cull cows	do	168	168	.052	9			9
Veal		Veal	do	70	70	.1081	8			8
Chickens	50	Chickens	do	7.2	360	.167	60		35	25
Eggs		Eggs	Dozen	9	450	.28	126		38	88
Subtotal							339		171	168
Total							3,572	128	226	3,098

[1] Duplicated acreage.

CURRENT FARM EXPENSES	
Interest cost at 3 percent	$222
Taxes (35 mills)	170
Hired labor, 144 days, at $3.50	504
Irrigation, operation and maintenance	60
Crop expense:	
Seed	86
Fertilizer	50
Baskets, liners, lugs	135
Dusting and spraying	80
Livestock expense:	
Purchased feed	140
Veterinarian and supplies	15
Chicks	12
Car (farm share)	125
Depreciation and repairs on buildings and improvements	210
Depreciation and repairs on machinery	84
Insurance on buildings and improvements	13
Electricity	24
Depreciation on orchard	67
Other farm expenses 2 percent of above	40
Total	2,037

INVESTMENT	
Land	4,060
Dwelling	1,440
Other improvements	1,083
Machinery and equipment	589
Livestock	237
Feed and supplies	20
Total	7,429

COST OF LIVING	
Cash family	$872
Home used products	226
Use of dwelling	187
Total	1,285

FINANCIAL SUMMARY	*Farm budget*
Receipts:	
Crop sales	$2,930.00
Livestock	168.00
Farm privileges	413.00
Total	3,511.00
Farm expenses	2,037.00
Net income	1,474.00
Family living allowance	1,285.00
Payment capacity per farm	189.00
Payment capacity per acre	9.45

FARM WORK	*Days*
Crops	356
Livestock	46
Miscellaneous	6
Total	408
Work by:	
Operator	200
Family	64
Hired	144
Total	408

Farm budget: Summary of income and expenses

[Land, class 1 and orchard; acres, 20; type, fruit and truck; condition "with"; area, foothills; new land]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	10.0	2.0	Ton	3.3	66.0	$12.00	$79	$79		
Pasture	10.0	2.0	Animal unit per month	8.0	16.0	2.00	32	32		
Cherries	15.0	3.0	Ton	2.2	6.6	112.00	739			$739
Peaches	15.0	3.0	Bushel	150	450	1.30	585			585
Apricots	10.0	2.0	do	150	300	1.30	390			390
Miscellaneous fruit	5.0	1.0	Value	220	220	220.00	220			220
Snap beans	5.0	1.0	Ton	3.1	3.1	60.00	186			186
Peas	5.0	1.0	do	1.5	1.5	65.00	98			98
Cantaloup	10.0	2.0	do	2.5	5.0	76.00	380			380
Tomatoes	5.0	1.0	do	10.5	10.5	15.00	158			158
Sweet corn	5.0	1.0	do	3.1	3.1	56.00	174			174
Pea ensilage [1]	(5.0)	(1.0)	do	4.0	4.0	4.28	17	17		
Garden [1]	(1.0)	(.2)	Value	$275	$55	275.00	55		$55	
Farmstead	5.0	1.0								
Subtotal	100.0	20.0					3,113	128	55	2,930
Livestock	**Number**	**Product**								
Dairy cows	1	Butterfat	Pound	243	243	.56	136		98	38
Cull cows		Cull cows	do	168	168	.052	9			9
Veal		Veal	do	70	70	.1081	8			8
Chickens	50	Chickens	do	7.2	360	.167	60		35	25
Eggs		Eggs	Dozen	9	450	.28	126		38	88
Subtotal							339		171	168
Total							3,572	128	226	3,098

[1] Duplicated acreage.

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CURRENT FARM EXPENSES	
Interest cost at 3 percent	$206
Taxes (35 mills)	170
Hired labor, 144 days at $3.50	504
Irrigation, operation and maintenance	55
Crop expenses:	
Seed	86
Fertilizer	50
Baskets, liners, lugs	135
Dusting and spraying	80
Livestock expenses:	
Purchased feed	140
Veterinarian and supplies	15
Chicks	12
Car (farm share)	125
Depreciation and repairs on buildings and improvements	210
Depreciation and repairs on machinery	84
Insurance on buildings and improvements	13
Electricity	24
Depreciation on orchard	67
Other farm expenses 2 percent of above	40
Total	2,016

INVESTMENT	
Land	3,500
Dwelling	1,440
Other improvements	1,083
Machinery and equipment	589
Livestock	237
Feed and supplies	20
Total	6,869

COST OF LIVING	
Cash family	$872
Home used products	226
Use of dwelling	187
Total	1,285

FINANCIAL SUMMARY	*Farm budget*
Receipts:	
Crop sales	$2,930.00
Livestock	168.00
Farm privileges	413.00
Total	3,511.00
Farm expenses	2,016.00
Net income	1,495.00
Family living allowance	1,285.00
Payment capacity per farm	210.00
Payment capacity per acre	10.50

FARM WORK	*Days*
Crops	356
Livestock	46
Miscellaneous	6
Total	408
Work by:	
Operator	200
Family	64
Hired	144
Total	408

Farm budget: Summary of income and expenses

[Land, classes 2 and 4P; acres, 43.5; type, dairy farm; condition, "without"; area, bench]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	37.0	16.0	Ton	3.0	48.0	$12.00	$576	$576		
Wheat:										
Irrigated	5.0	2.2	Bushel	30.0	66	.94	62	62		
Dry	10.0	4.4	do	19.0	84	.94	79	79		
Fallow	5.0	2.2	Animal unit per month	1.0	2.0	2.00	4	4		
Barley	5.0	2.2	Bushel	42	92	.73	67	55		$12
Corn silage	4.5	2.0	Ton	12	24	6.00	144	144		
Pasture:										
Rotated	13.0	5.6	Animal unit per month	6	34	2.00	68	68		
Permanent	16.0	7.0	do	2	14	2.00	28	28		
Garden	.5	.2	Value	$275	$55	275.00	55		$55	
Farmstead and waste	4.0	1.7								
Subtotal	100.0	43.5					1,083	1,016	55	12
Livestock	**Number**	**Product**								
Dairy cows	9	Butterfat	Pound	243	2,187	.56	1,225		98	1,127
Cull cows		Cull cows	do	168	1,512	.052	79			79
Veal		Veal	do	70	630	.1081	68			68
Milk cows, heifers		Milk cows and heifers.	do	80	720	.093	67			67
Laying hens	100	Chickens	do	7.2	720	.167	120		35	85
Eggs		Eggs	Dozen	10	1,000	.28	280		38	242
Subtotal							1,839		171	1,668
Total							2,922	1,016	226	1,680

CURRENT FARM EXPENSES

Interest cost at 3 percent	$249
Taxes (35 mills)	194
Hired labor, 0 days at $3.50	0
Custom work: Combine grain	39
Irrigation operation and maintenance	44
Crop expense: Seed	40
Livestock expense:	
Purchased feed	68
Veterinarian and supplies	54
Chicks	24
Car (farm share)	110
Depreciation and repairs on building and improvements	229
Depreciation and repairs on equipment	51
Insurance on building and improvements	13
Electricity	16
Other farm expenses 2 percent of above	22
Total	1,153

INVESTMENT

Land	4,334
Dwelling	1,440
Other improvements	1,278
Machinery and equipment	368
Livestock	870
Feed and supplies	232
Total	8,522

COST OF LIVING

Cash, family	527
Home used products	226
Use of dwelling	187
Total	940

FINANCIAL SUMMARY

	Farm budget
Receipts:	
Crop sales	$12
Livestock	1,668
Farm privileges	413
Total	2,093
Farm expenses	1,153
Net income	940
Family living allowance	940
Payment capacity per farm	0
Payment capacity per acre	0

FARM WORK

	Days
Crops	76
Livestock	188
Miscellaneous	12
Total	276
Worked by:	
Operator	216
Family	60
Hired	0
Total	276

Farm budget: Summary of income and expenses

[Land, classes 2 and 4P; acres, 43.5; type, dairy and cash crop; condition "with"; area, bench]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	31.0	13.5	Ton	3.3	44.6	$12.00	$535	$537		
Wheat	5.5	2.4	Bushel	34	82	.94	77	77		
Barley	6.9	3.0	do	50	150	.73	110	110		
Ensilage:										
Corn	4.8	2.1	Ton	14	29.4	6.00	176	176		
Pea [1]	(8.0)	(3.5)	do	4	14.0	4.28	60	60		
Pasture:										
Rotated	16.1	7.0	Animal unit per month	8	56	2.00	112	112		
Permanent	15.0	6.5	do	4	26	2.00	52	52		
Tomatoes	8.0	3.5	Ton	10.5	36.8	15.00	552			$552
Canning peas	8.0	3.5	do	1.5	5.3	50.00	265			265
Garden	.5	.2	Value	$275	$55	275.00	55		$55	
Farmstead and waste	4.1	1.8								
Subtotal	100.0	43.5					1,994	1,122	55	817
Livestock	**Number**	**Product**								
Dairy cows	11	Butterfat	Pound	243	2,673	.56	1,497		98	1,399
Cull cows		Cull cows	do	168	1,848	.052	96			96
Veal		Veal	do	70	770	.1081	83			83
Milk cows, heifers		Milk cows	do	80	880	.093	82			82
Chickens	100	Chickens	do	7.2	720	.167	120		35	85
Eggs		Eggs	Dozen	10.0	1,000	.28	280		38	242
Subtotal							2,158		171	1,987
Total							4,152	1,122	226	2,804

[1] Duplicated acreage.

CURRENT FARM EXPENSES

Interest cost at 3 percent	$291
Taxes (35 mills)	258
Hired labor, 26 days at $3.50	91
Custom work: combine grain	34
Irrigation, operation and maintenance	137
Crop expense: seed	173
Livestock expense:	
Purchased feed	60
Veterinarian and supplies	63
Chicks	24
Car (farm share)	125
Depreciation and repairs on buildings and improvements	235
Depreciation and repairs on equipment	99
Insurance on buildings and improvements	14
Electricity	24
Other farm expenses 2 percent of above	32
Total	1,660

INVESTMENT

Land	5,197
Dwelling	1,440
Other improvements	1,344
Machinery and equipment	704
Livestock	1,020
Feed and supplies	224
Total	9,929

COST OF LIVING

Cash, family	917
Home used products	226
Use of dwelling	187
Total	1,330

FINANCIAL SUMMARY

Receipts:	*Farm budget*
Crop sales	$817.00
Livestock	1,987.00
Farm privileges	413.00
Total	3,217.00
Farm expenses	1,660.00
Net income	1,557.00
Family living allowance	1,330.00
Payment capacity per farm	227.00
Payment capacity per acre	5.21

FARM WORK

	Days
Crops	159
Livestock	220
Miscellaneous	14
Total	393
Work by:	
Operator	261
Family	106
Hired	26
Total	393

Farm budget: Summary of income and expenses

[Land classes, 2 and 4P; acres, 43.5; type, dairy and cash crop; condition, "with"; area, bench; new land]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	31.0	13.5	Ton	3.3	44.6	$12.00	$535	$537		
Wheat	5.5	2.4	Bushel	34	82	.94	77	77		
Barley	6.9	3.0	do	50	150	.73	110	110		
Ensilage:										
Corn	4.8	2.1	Ton	14	29.4	6.00	176	176		
Pea [1]	(8.0)	(3.5)	do	4	14.0	4.28	60	60		
Pasture:										
Rotated	16.1	7.0	Animal unit per month	8	56	2.00	112	112		
Permanent	15.0	6.5	do	4	26	2.00	52	52		
Tomatoes	8.0	3.5	Ton	10.5	36.8	15.00	552			$552
Canning peas	8.0	3.5	do	1.5	5.3	50.00	265			265
Garden	.5	.2	Value	$275	$55	275.00	55		$55	
Farmstead and waste	4.1	1.8								
Subtotal	100.0	43.5					1,994	1,122	55	817
Livestock	**Number**	**Product**								
Dairy cows	11	Butterfat	Pound	243	2,673	.56	1,497		98	1,399
Cull cows		Cull cows	do	168	1,848	.052	96			96
Veal		Veal	do	70	770	.1081	83			83
Milk cows, heifers		Milk cows	do	80	880	.093	82			82
Chickens	100	Chickens	do	7.2	720	.167	120		35	85
Eggs		Eggs	Dozen	10.0	1,000	.28	280		38	242
Subtotal							2,158		171	1,987
Total							4,152	1,122	226	2,804

[1] Duplicated acreage.

CURRENT FARM EXPENSES

Interest cost at 3 percent	$256
Taxes (35 mills)	258
Hired labor, 26 days at $3.50	91
Custom work: combine grain	34
Irrigation, operation and maintenance	118
Crop expense: seed	173
Livestock expense:	
Purchased feed	60
Veterinarian and supplies	63
Chicks	24
Car (farm share)	125
Depreciation and repairs on building and improvements	235
Depreciation and repairs on equipment	99
Insurance on building and improvements	14
Electricity	24
Other farm expenses 2 percent of above	32
Total	1,606

INVESTMENT

Land	3,808
Dwelling	1,440
Other improvements	1,344
machinery and equipment	704
Livestock	1,020
Feed and supplies	224
Total	8,540

COST OF LIVING

Cash, family	917
Home used products	226
Use of dwelling	187
Total	1,330

FINANCIAL SUMMARY

	Farm budget
Receipts:	
Crop sales	$817.00
Livestock	1,987.00
Farm privileges	413.00
Total	3,217.00
Farm expenses	1,606.00
Net income	1,611.00
Family living allowance	1,330.00
Payment capacity per farm	281.00
Payment capacity per acre	6.46

FARM WORK

	Days
Crops	159
Livestock	220
Miscellaneous	14
Total	393
Work by:	
Operator	261
Family	106
Hired	26
Total	393

Farm budget: Summary of income and expenses

[Land, classes 1, 2, and 4P; acres, 40; type, dairy and cash crop; condition, "with"; area, Delta]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	29.5	11.8	Ton	3.3	39	$12.00	$468	$468		
Wheat	6.8	2.7	Bushel	33	89	.94	84	84		
Barley	8.5	3.4	do	48	163	.73	119	119		
Pasture:										
Rotated	6.7	2.7	Animal unit per month	8.0	22	2.00	44	44		
Permanent	19.0	7.6	do	5.0	38	2.00	76	76		
Sugar beet tops [1]	(6.7)	2.7	Ton	2.5	7	1.00	7	7		
Pea ensilage [1]	(5.8)	2.3	do	4.0	9	4.28	39	39		
Sugar beets	6.7	2.7	do	14	38	9.90	376			$376
Potatoes	9.5	3.8	Bushel	205	779	.62	483			483
Peas	5.8	2.3	Ton	1.5	3.5	50.00	175			175
Garden	.5	.2	Value	$275	$55	275.00	55		$55	
Farmstead and waste	7.0	2.8								
Subtotal	100.0	40.0					1,926	837	55	1,034
Livestock	**Number**	**Product**								
Dairy cows	9	Butterfat	Pound	243	2,187	.56	1,225		98	1,127
Cull cows		Cull cows	do	168	1,512	.052	79			79
Veal		Veal	do	70	630	.1081	68			68
Milk cows, heifers		Cull cows	do	80	720	.093	67			67
Chickens	100	Poultry	do	7.2	720	.167	120		35	85
Eggs		Eggs	Dozen	10.0	1,000	.28	280		38	242
Brood sow	1	Pork	Pound	104	104	.1001	10			10
Hogs		do	do	1,750	1,750	.1001	175		37	138
Subtotal							2,024		208	1,816
Total							3,950	837	263	2,850

[1] Duplicated acreage.

CURRENT FARM EXPENSES

Interest cost at 3 percent	$282
Taxes (35 mills)	232
Hired labor, 12 days at $3.50	42
Custom work: combine grain	24
Irrigation, operation and maintenance	109
Crop expense: seed	118
Livestock expense:	
Purchased feed	335
Veterinarian and supplies	60
Chicks	24
Car (farm share)	125
Depreciation and repairs on building and improvements	229
Depreciation and repairs on machinery and equipment	89
Insurance on building and improvements	14
Electricity	24
Other farm expenses 2 percent of above	34
Total	1,741

INVESTMENT

Land	4,884
Dwelling	1,440
Other improvements	1,311
Machinery and equipment	634
Livestock	963
Feed and supplies	168
Total	9,400

COST OF LIVING

Cash, family	880
Home used products	263
Use of dwelling	187
Total	1,330

FINANCIAL SUMMARY

	Farm budget
Receipts:	
Crop sales	$1,034.00
Livestock	1,816.00
Farm privileges	450.00
Total	3,300.00
Farm expenses	1,741.00
Net income	1,559.00
Family living allowances	1,330.00
Payment capacity per farm	229.00
Payment capacity per acre	5.72

FARM WORK

	Days
Crop	138
Livestock	197
Miscellaneous	14
Total	349
Work by:	
Operator	240
Family	97
Hired	12
Total	349

Farm budget: Summary of income and expenses

[Land, class 1, 2 and 4P; acres, 60; type, dairy and field crop; condition "without"; area, Mountain Valley]

Crops	Percent of area	Acres	Production				Disposition			
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	41.8	25.1	Ton	2.1	52.7	$12.00	$632	$632		
Meadow hay	6.7	4.0	do	1.4	5.6	9.75	55	55		
Pasture aftermath [1]	(48.5)	(29.1)	Animal unit per month	1.0	29	2.00	58	58		
Wheat	9.2	5.5	Bushel	24	132	.94	124	124		
Barley	12.3	7.4	do	42	311	.73	227	174		$42
Oats	4.7	2.8	do	40	112	.60	67	12		58
Peas	2.2	1.3	Ton	1.4	1.8	50.00	90			90
Pea ensilage [1]	(2.2)	(1.3)	do	4.0	5.2	4.28	22	22		
Potatoes	2.3	1.4	Bushel	155	217	.62	135			135
Pasture	13.0	7.8	Animal unit per month	5.3	41	2.00	82	82		
Garden	.3	.2	Value	$275	$55	275.00	55		$55	
Farmstead and waste	7.5	4.5								
Subtotal	100.0	60.0					1,547	1,159	55	325
Livestock	**Number**	**Product**								
Dairy cows	9	Butterfat	Pound	243	2,187	.56	1,225		98	1,127
Cull cows		Cull cows	do	168	1,512	.052	79			79
Veal		Veal	do	70	630	.1081	68			68
Milk cows, heifers		Cull cows	do	80	720	.093	67			67
Chickens	100	Poultry	do	7.2	720	.167	120		35	85
Eggs		Eggs	Dozen	10.0	1,000	.28	280		38	242
Brood sow	1	Pork	Pound	104	104	.1001	10			10
Hogs		do	do	1,750	1,750	.1001	175		37	138
Subtotal									208	1,816
Total									263	2,141

[1] Duplicated acreage.

CURRENT FARM EXPENSES

Interest cost at 3 percent	$285
Taxes (35 mills)	208
Hired labor, 0 days at $3.50	0
Custom work:	
Combine grain	63
Irrigation operation and maintenance	60
Crop expense: seed	94
Livestock expense:	
Purchased feed	62
Veterinarian and supplies	60
Chicks	24
Car (farm share)	125
Depreciation and repairs on building and improvements	229
Depreciation and repairs on machinery and equipment	71
Insurance on building and improvements	14
Electricity	16
Other farm expenses, 2 percent of above	26
Total	1,337

INVESTMENT

Land	5,014
Dwelling	1,440
Other improvements	1,311
Machinery and equipment	502
Livestock	963
Feed and supplies	287
Total	9,517

COST OF LIVING

Cash, family	710
Home used products	263
Use of dwelling	187
Total	1,160

FINANCIAL SUMMARY

	Farm budget
Receipts:	
Crop sales	$325.00
Livestock	1,816.00
Farm privileges	450.00
Total	2,591.00
Farm expenses	1,337.00
Net income	1,254.00
Family living allowance	1,160.00
Payment capacity per farm	94.00
Payment capacity per acre	1.56

FARM WORK

	Days
Crops	118
Livestock	197
Miscellaneous	14
Total	329
Work by:	
Operator	232
Family	97
Hired	--
Total	329

Farm budget: Summary of income and expenses

[Land, class 1, 2 and 4P; acres, 60; type, dairy and field crop; condition, "with"; area, Mountain Valley]

Crops	Percent of area	Acres	Production					Disposition		
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	43.0	25.8	Ton	2.4	62.0	$12.00	$744	$744		
Meadow hay	7.0	4.2	do	1.6	6.7	9.75	65	65		
Pasture aftermath [1]	(50.0)	30.0	Animal unit per month	1.0	30.0	2.00	60	60		
Wheat	6.5	3.9	Bushel	33	129	.94	121	121		
Barley	14.0	8.4	do	50	420	.73	307	187		$120
Oats	5.0	3.0	do	55	165	.60	99	12		87
Peas	2.3	1.4	Ton	1.5	2.1	50.00	105			105
Pea ensilage [1]	(2.3)	1.4	do	4.0	5.6	4.28	24	24		
Potatoes	3.1	1.9	Bushel	170	323	.62	200			200
Pasture	13.0	7.8	Animal unit per month	6.4	50	2.00	100	100		
Garden	.3	.2	Value	$275	$55	275.00	55		$55	
Farmstead and waste	5.8	3.5								
Subtotal	100.0	60.0					1,880	1,313	55	512
Livestock	**Number**	**Product**								
Dairy cows	11	Butterfat	Pound	243	2,673	.56	1,497		98	1,399
Cull cows		Cull cows	do	168	1,848	.052	96			96
Veal		Veal	do	70	770	.1081	83			83
Milk cows, heifers		Milk cows	do	80	880	.093	82			82
Chickens	100	Poultry	do	7.2	720	.167	120		35	85
Eggs		Eggs	Dozen	10.0	1,000	.28	280		38	242
Brood sow	1	Pork	Pound	104	104	.1001	10			10
Hogs		do	do	1,750	1,750	.1001	175		37	138
Subtotal							2,343		208	2,135
Total							4,223	1,313	263	2,647

[1] Duplicated acreage.

CURRENT FARM EXPENSES

Interest cost at 3 percent	$299
Taxes (35 mills)	255
Hired labor, 14 days at $3.50	49
Custom work: combine grain	61
Irrigation operation and maintenance	110
Crop expense: seed	106
Livestock expense:	
Purchased feed	65
Veterinarian and supplies	70
Chicks	24
Car (farm share)	125
Depreciation and repairs on building and improvements	235
Depreciation and repairs on equipment	92
Insurance on building and improvements	14
Electricity	16
Other farm expenses 2 percent of above	31
Total	1,552

INVESTMENT

Land	5,069
Dwelling	1,440
Other improvements	1,377
Machinery and equipment	652
Livestock	1,113
Feed and supplies	334
Total	9,985

COST OF LIVING

Cash, family	875
Home used products	263
Use of dwelling	187
Total	1,325

FINANCIAL SUMMARY

	Farm budget
Receipts:	
Crop sales	$512.00
Livestock	2,155.00
Farm privileges	450.00
Total	3,097.00
Farm expenses	1,552.00
Net income	1,545.00
Family living allowance	1,325.00
Payment capacity per farm	220.00
Payment capacity per acre	3.67

FARM WORK

	Days
Crops	124
Livestock	228
Miscellaneous	17
Total	369
Work by:	
Operator	258
Family	97
Hired	14
Total	369

Farm budget: Summary of income and expenses

[Land, class 1, 2 and 4P; acres, 60; type, dairy and field crop; condition, "with"; area, Mountain Valley; new land]

Crops	Percent of area	Acres	Production					Disposition		
			Unit	Yield	Total	1939–44 price	Total value	Feed	Family use	Sales value
Alfalfa	43.0	25.8	Ton	2.4	62.0	$12.00	$744	$744		
Meadow hay	7.0	4.2	do	1.6	6.7	9.75	65	65		
Pasture aftermath [1]	(50.0)	30.0	Animal unit per month	1.0	30.0	2.00	60	60		
Wheat	6.5	3.9	Bushel	33	129	.94	121	121		
Barley	14.0	8.4	do	50	420	.73	307	187		$120
Oats	5.0	3.0	do	55	165	.60	99	12		87
Peas	2.3	1.4	Ton	1.5	21	50.00	105			105
Pea ensilage [1]	(2.3)	1.4	do	4.0	5.6	4.28	24	24		
Potatoes	3.1	1.9	Bushel	170	323	.62	200			200
Pasture	13.0	7.8	Animal unit per month	6.4	50	2.00	100	100		
Garden	.3	.2	Value	$275	$55	275.00	55		$55	
Farmstead and waste	5.8	3.5								
Subtotal	100.0	60.0					1,880	1,313	55	512
Livestock	**Number**	**Product**								
Dairy cows	11	Butterfat	Pound	243	2,673	.56	1,497		98	1,399
Cull cows		Cull cows	do	168	1,848	.052	96			96
Veal		Veal	do	70	770	.1081	83			83
Milk cows, heifers		Milk cows	do	80	880	.093	82			82
Chickens	100	Poultry	do	7.2	720	.167	120		35	85
Eggs		Eggs	Dozen	10.0	1,000	.28	280		38	242
Brood sow	1	Pork	Pound	104	104	.1001	10			10
Hogs		do	do	1,750	1,750	.1001	175		37	138
Subtotal							2,343		208	2,135
Total							4,223	1,313	263	2,647

[1] Duplicated acreage.

CURRENT FARM EXPENSES

Interest cost at 3 percent	$245
Taxes (35 mills)	255
Hired labor, 14 days at $3.50	49
Custom work: combine grain	61
Irrigation operation and maintenance	121
Crop expense: seed	106
Livestock expense:	
Purchased feed	65
Veterinarian and supplies	70
Chicks	24
Car (farm share)	125
Depreciation and repairs on buildings and improvements	235
Depreciation and repairs on equipment	92
Insurance on buildings and improvements	14
Electricity	16
Other farm expenses 2 percent of above	31
Total	1,509

INVESTMENT

Land	3,250
Dwelling	1,440
Other improvements	1,377
Machinery and equipment	652
Livestock	1,113
Feed and supplies	334
Total	8,166

COST OF LIVING

Cash, family	875
Home used products	263
Use of dwelling	187
Total	1,325

FINANCIAL SUMMARY

	Farm budget
Receipts:	
Crop sales	$512.00
Livestock	2,135.00
Farm privileges	450.00
Total	3,097.00
Farm expenses	1,509.00
Net income	1,588.00
Family living allowance	1,325.00
Payment capacity per farm	263.00
Payment capacity per acre	4.38

FARM WORK

	Days
Crops	124
Livestock	228
Miscellaneous	17
Total	369
Work by:	
Operator	258
Family	97
Hired	14
Total	369

The estimated payment capacity, estimated amortization capacity, and the recommended annual installment toward debt retirement are summarized in the following table for each representative farming area. The recommended annual installments by irrigation blocks are also shown in an accompanying table. The recommended annual installment is based on the repayment ability of the lands requiring a full irrigation water supply and represents 90 percent of the amortization capacity, a contingency factor of 10 percent having been allowed because of limitations in estimating income and expenses over an extended period in the future. On the basis of estimates made for the representative farms, water users could pay a total of approximately $501,700 annually toward debt retirement.

Summary of payment and amortization capacity and recommended annual installment

Area and type of farming	Acres	Water requirements (acre-feet)			Average payment capacity per acre less O and M		Amortization capacity				Recommended annual installment	
							Weighted average all lands		New lands			
		Average per acre	New land per acre	Total	"With"	"Without"	Per acre	Per acre-foot	Per acre	Per acre-foot	Per acre-foot	Total
Lower Weber area:												
Foothills, fruit-truck crop	26,600	2.21	3.00	58,800	$9.45	0	$9.45	$4.28	$10.50	$3.50	$3.15	$185,200
Bench lands, dairy-cash crop	29,000	2.34	3.00	67,800	5.21	0	5.21	2.23	6.46	2.15	1.94	131,500
Delta, dairy-cash crop	31,700	3.00	3.00	95,100	5.72	0	5.72	1.91	5.72	1.91	1.72	163,600
Morgan, Huntsville and upper Weber areas: Mountain valleys, dairy-field crop	13,100	1.78	4.30	23,300	3.67	$1.56	2.11	1.19	4.38	1.02	.92	21,400
Project total	100,400	2.44	----	245,000	-----	-----	-----	-----	-----	-----	2.05	501,700

Development period

A variable period averaging 5 years after the first delivery of project water would be desirable before irrigation water users were assessed construction charges. This development period would be necessary before construction costs were assessed to give farmers time to make necessary improvements in irrigation distribution systems, to reorganize some farms, to establish crop rotation practices, and to attain full crop production.

Attitude of local land owners toward project

Numerous personal interviews and group meetings with local landowners have been made throughout the project area. All landowners contacted have reacted favorably toward the project and most have expressed deep concern over the shortage of water in the area. The possibilities of obtaining an adequate supply of irrigation water have given many landowners in the area the hope of some day having a profitable, full-time irrigated farm.

Recommended annual installments by irrigation blocks

	Block 1			Block 2			Block 3		
	Requirement (acre-feet)	Repayment (per acre-foot)	Total repayment	Requirement acre-feet)	Repayment (per acre-foot)	Total repayment	Requirement (acre-feet)	Repayment (per acre-foot)	Total repayment
Foothills:									
Full	6,600	$3.15	$20,800	34,200	$3.15	$107,700	7,500	$3.15	$23,600
Supplemental	10,500	3.15	33,100	0	-------	----------	0	-------	--------
Bench lands:									
Full	0	-------	----------	49,600	1.94	96,200	8,700	1.94	16,900
Supplemental	2,900	1.94	5,600	6,600	1.94	12,800	0	-------	--------
Delta:									
Full	0	-------	----------	0	-------	----------	95,100	1.72	163,600
Supplemental	0	-------	----------	0	-------	----------	0	-------	--------
Mountain valleys:									
Full	0	-------	----------	11,600	.92	10,700	1,700	.92	1,500
Supplemental	0	-------	----------	8,000	.92	7,400	2,000	.92	1,800
Total	20,000	-------	59,500	110,000	-------	234,800	115,000	-------	207,400
Project total	-------	-------	----------	----------	-------	----------	----------	-------	501,700

CHAPTER XI

FINANCIAL ANALYSIS

BENEFITS AND COSTS

To determine the economic justification of the project, the national benefits anticipated from the development were compared with the project costs. For the comparison both benefits and costs were expressed in terms of annual monetary equivalents and were computed over a 100-year period, the estimated useful life of the major project works. All computations were based on an interest rate of 2.5 percent.

Project benefits and operation, maintenance, and replacement costs (except power costs) were based on 1939–44 prices which are believed representative of prices that would prevail during project operation. Construction cost estimates were based on current prices. Future variations in these price levels may result in a different benefit-cost ratio than is indicated in the analysis, as the actual ratio would depend largely on the relationship between costs at the time of construction and the average prices prevailing throughout project operation.

Annual benefits

With project development tangible benefits would accrue from irrigation, municipal water development, flood control, power, fish and wildlife conservation, and recreation. Sufficient information was not available for a detailed appraisal of the benefits from fish and wildlife conservation. All other tangible benefits, however, have been measured and evaluated as described in the following paragraphs. In addition to the tangible benefits that have been evaluated, numerous benefits of an intangible nature would result from project development. Although not measurable in monetary terms, these benefits would make a definite contribution to public welfare and national security.

Irrigation.—Irrigation benefits, adjusted for a 5-year development period, are expected to have a total annual value of $5,979,000. This value includes a direct annual benefit of $2,686,000 that would be realized from the project as a result of its effect in increasing earnings of the land (and water), labor, invested capital, and management involved in production. The total value also includes an indirect annual benefit of $3,293,000 that would result from the project's effect in stimulating merchandising, industrial processing, and wholesale and retail trade.

The direct benefits would be realized from the various irrigation blocks in the following amounts: $344,000, block 1; $991,000, block 2; and $1,351,000, block 3. The indirect benefits would be realized from the blocks in the following amounts: $399,000, block 1; $1,197,000, block 2; and $1,697,000, block 3.

Municipal water supply.—Annual benefits from supplying municipal water to the municipalities' filtration plants are estimated at $636,000. These benefits were based on the justifiable cost of an alternative supply, estimated at $23,300,000, as discussed in chapter VI. The annual benefit value was determined by amortizing the alternative cost over a 100-year period at 2.5 percent interest. A justification for the cost of the alternative supply was not developed, as a water supply is indispensable to the communities that would be served.

Flood control.—Annual benefits from flood control are estimated at approximately $161,000. These benefits, based on data obtained from the Corps of Engineers, adjusted to reflect the 1939–44 price level, represent the value that would be realized from reductions in flood damage as a result of project development.

Power.—Power benefits with a measurable annual value of $51,000 are expected from project development. These would include a direct benefit of $24,000 and an indirect benefit of $27,000.

The direct power benefits, summarized below, were measured by revenues that would be realized from the sale of surplus energy generated at project plants and by the value of the additional energy that would be produced as a result of project development at the Pioneer plant of the Utah Power & Light Co.

Direct power benefits

Sale of surplus project energy (6,000,000 kilowatt-hours at 2.5 mills)	$15,000
Revenues from increased water supply at Pioneer plant of Utah Power & Light Co. (3,000,000 kilowatt-hours at 3 mills)	9,000
Total	24,000

The indirect benefits, summarized below, have been determined through consideration of the following items: (1) the savings in production cost to the utility purchasing surplus project energy for resale, (2) a proportionate share in the retailing utility's benefits accruing from resale of the power at a higher rate, (3) a proportionate share of the increased value of goods and services arising from the final utilization of the project power, and (4) the savings to the irrigators from the use of project power in place of commercial power.

Indirect power benefits

Savings in production cost	$4,000
Proportionate share of retailing	7,800
Proportionate share of value to ultimate consumer	1,200
Savings in cost of irrigation pumping energy	14,000
Total	27,000

Fish and wildlife conservation.—A preliminary report by the Fish and Wildlife Service indicates that benefits to fish and wildlife from project development would at least offset damages. The final report is not available, however, and the benefits cannot be considered in this analysis. The benefits will be considered in detail when more information is available.

Recreation.—Annual recreational benefits from the development are estimated at $168,500. The total value was determined as twice the cost of constructing, operating, and maintaining the recreational facilities, less the non-Federal costs of recreational development. The annual value was determined by consideration of the total benefit value over the 100-year period at 2.5 percent interest.

Summary.—The annual values of tangible benefits that would result from project development are summarized below.

	Annual benefit
Irrigation	$5, 979, 000
Municipal use	636, 000
Flood control	161, 000
Power	51, 000
Recreation	168, 500
Total	6, 995, 500

Annual equivalent costs

The annual equivalent costs of project development are estimated at $2,084,000, including $1,809,000 as the annual construction cost and $275,000 as the annual cost for operation, maintenance, and replacements. The annual construction cost is based on amortization of the total project cost ($69,534,000) over a 100-year period at 2.5 percent interest. Allowance was made in the estimate for interest during construction and salvage values of structures having a useful life of more than 100 years.

Ratio of project benefits to costs

The estimated annual benefits would compare with the annual costs in a ratio of 3.35 to 1.00. Thus each dollar spent for project development would bring $3.35 in National benefits.

COST ALLOCATIONS

The project costs have been tentatively allocated to the various purposes of the development. The portion of the construction cost allocated to flood control represents the present value of estimated annual flood-control benefits capitalized over a 100-year period with an interest rate of 2.5 percent. The total allocation to recreation is the sum of the costs of the specific recreational facilities plus an equivalent amount of the joint costs of the project reservoirs (including capital and annual costs) less the non-Federal costs. No allocation was made to power since the sole purpose of the proposed power features of the project is to provide irrigation pumping energy and any incidental energy sales would be surplus to these requirements. The remaining project costs were allocated to irrigation and municipal use by the use-of-facilities method. The allocation to municipal use was based on the assumption that municipal use would have a prior right to a firm water supply and thus would require greater proportionate use of storage and conveyance facilities than irrigation. By the use-of-facilities method both irrigation and municipal use would share in the economy of the multiple-purpose development, each purpose realizing a saving over the cost of its cheapest alternative development.

Each purpose would pay in accordance with its proportionate use of project facilities and no one purpose would be allocated more than the capitalized value of its tangible benefits.

The operation, maintenance, and replacement costs of recreational facilities have been allocated to recreation. The remaining operation, maintenance, and replacement costs have been allocated to irrigation and municipal use by the use-of-facilities method.

Sufficient information was not available to permit an allocation to fish and wildlife conservation. Such an allocation, however, may be found justified when detailed investigations on the development are completed by the Fish and Wildlife Service.

The allocations made to the various purposes are summarized in the following tabulation:

Allocation of costs

Purpose	Construction costs	Annual costs [1]
Irrigation water	$40,234,000	$212,300
Municipal water	18,744,000	21,400
Flood control	5,900,000	
Fish and wildlife conservation, recreation	4,656,000	41,300
Total	69,534,000	275,000

[1] Includes operation, maintenance, and replacement costs.

Cost allocations, Weber Basin project, Utah

Item	Direct costs			Joint costs [1]			
	Reimbursable		Nonreimbursable	Reimbursable		Nonreimbursable	
	Irrigation	Municipal	Recreation	Irrigation	Municipal	Flood control	Recreation
Storage facilities: Dams and reservoirs:							
Perdue							
Enlarged Pineview							
Jeremy				$9,997,000	$10,000,000	$5,200,000	$2,938,000
Lost Creek							
Magpie							
Willard	$9,854,000						1,086,000
Diversion dams:							
Stoddard				165,000	135,000		
Ogden				160,000	130,000		
Slaterville				192,000	158,000		
Huntsville				40,000	30,000		
Aqueducts and canals:							
Weber aqueduct				3,850,000	3,150,000		
Davis aqueduct				5,390,000	4,410,000		
Layton canal				385,000	315,000		
Willard gravity canal						700,000	
Willard pump canal	900,000						
Eden canal				88,000	72,000		
Power plants:							
Perdue	684,000						
Magpie	692,000						
Pumping plants:							
Davis	490,000						
Weber	180,000						
Willard	1,460,000						
Layton	190,000						
Miscellaneous:							
Drainage system	3,000,000						
Lateral system	1,400,000						
Ground-water pumping	300,000						
Davis County storage charges	181,000						
Recreational facilities			$632,000				
Operation and maintenance during construction				180,000	180,000		
Investigation and surveys				166,000	164,000		
Cost of reduction in power to Riverdale power plant	290,000						
Total	19,621,000		632,000	20,613,000	18,744,000	5,900,000	4,024,000

Item	Total direct and joint costs					Annual operation, maintenance, and replacement costs			
	Reimbursable		Nonreimbursable		Grand total costs	Reimbursable		Nonreimbursable	Total
	Irrigation	Municipal	Flood control	Recreation		Irrigation	Municipal	Recreation	
Storage facilities: Dams and reservoirs:									
Perdue						$3,000	$3,000		$6,000
Enlarged Pineview						2,000	2,000		4,000
Jeremy	$9,997,000	$10,000,000	$5,200,000	$2,938,000	$28,135,000	2,500	2,500		5,000
Lost Creek						2,500	2,500		5,000
Magpie						3,000	3,000		6,000
Willard	9,854,000			1,086,000	10,940,000	4,000			4,000
Diversion dams:									
Stoddard	165,000	135,000			300,000	500	400		900
Ogden	160,000	130,000			290,000	400	300		700
Slaterville	192,000	158,000			350,000	500	400		900
Huntsville	40,000	30,000			70,000	200	100		300
Aqueducts and canals:									
Weber aqueduct	3,850,000	3,150,000			7,000,000	2,600	2,200		4,800
Davis aqueduct	5,390,000	4,410,000			9,800,000	2,900	2,400		5,300
Layton canal	385,000	315,000			700,000	2,600	2,100		4,700
Willard gravity canal			700,000		700,000	8,300			8,300
Willard pump canal	900,000				900,000	6,000			6,000
Eden canal	88,000	72,000			160,000	700	500		1,200
Power plants:									
Perdue	684,000				684,000	41,100			41,100
Magpie	692,000				692,000	41,800			41.800
Pumping plants:									
Davis	490,000				490.000	13,200			13,200
Weber	180,000				180,000	6,900			6,900
Willard	1,460,000				1,460,000	35,600			35,600
Layton	190,000				190,000	7,000			7,000
Miscellaneous:									
Drainage system	3,000,000				3,000,000	17,000			17,000
Lateral system	1,400,000				1,400,000	5,000			5,000
Ground-water pumping	300,000				300,000	3,000			3,000
Davis County storage charges	181,000				181,000				
Recreational facilities				632,000	632,000			$41,300	41,300
Operation and maintenance during construction	180,000	180,000			360,000				
Investigation and surveys	166,000	164,000			330,000				
Cost of reduction in power to Riverdale power plant	290,000				290,000				
Total	40,234,000	18,744,000	5,900,000	4,656,000	69,534,000	212,300	21,400	41,300	275,000

[1] Irrigation and municipal joint costs were allocated by the use-of-facilities method. After flood-control and recreational allocations were deducted, use of reservoirs for irrigation and municipal use on a proportionate-share basis was determined to be 50 percent for each purpose. Use of conveyance features for irrigation and municipal use was determined to be 55 and 45 percent, respectively.

PROJECT REPAYMENT

The allocation to flood control would be nonreimbursable in accordance with present law and the allocations to recreation would be expected to be made nonreimbursable by authorization of the project. Any costs found allocable to fish and wildlife on completion of more detailed studies would also be nonreimbursable. The allocations to irrigation and municipal use would be reimbursable and could be repaid in 60 years after irrigators in the last irrigation block began payments on capital costs.

Municipal water repayment

In order that the municipal allocation of $18,744,000 might be retired without interest in 40 years, the municipal users would be charged at an average annual rate of $468,600 or at the average rate of $11.72 per acre-foot of water. These payments would be continued for 20 years after debt retirement, thus returning to the Government a balance of $9,372,000 for use in paying a portion of the irrigation allocation. Municipal water users also would be required to pay the operation, maintenance, and replacement costs allocated to municipal use, estimated at $21,400 annually or at 54 cents per acre-foot of water. Thus the total cost for Bureau facilities would average $490,000 annually or $12.26 per acre-foot of water. In addition to these costs, the municipal users would be required to pay to the municipalities the costs of distribution and filtration plants as discussed in chapter VI.

Irrigation repayment

In addition to irrigation operation and maintenance costs, estimated to amount to $212,300 annually, irrigation water users are expected to be able to pay $501,700 annually toward retirement of construction costs allocated to irrigation. Irrigation payments would begin at different times since irrigation development would be undertaken in three blocks upon completion of the various project works. After starting payments, however, irrigators in each block would pay continuously for 60 years. Thus, within 60 years after payments were started in the last block, irrigation water users would pay a total of $30,102,000 toward the total irrigation allocation of $40,234,000. The balance of $10,132,000 could be paid from power revenues and from revenue paid by the municipal users after retirement of the municipal allocation. Power revenues that could apply on irrigation costs would amount to $1,626,000, including revenues from the sale of surplus nonfirm energy produced by the project and revenues from additional energy that could be produced at the Utah Power & Light Co.'s Pioneer plant as a result of project operation. The municipal revenues would amount to $28,116,000 and would include 20 annual payments that would be made after retirement of the construction costs allocated to municipal use.

A development period averaging 5 years would be desirable before irrigators were charged construction costs. The irrigators, however, would be expected to pay annual operation, maintenance, and replacement costs immediately after the delivery of project water.

FINANCIAL STUDY
WEBER BASIN PROJECT, UTAH

Year of study (fiscal)	IRRIGATION: Net Revenues From Irrigation Water Users — Block 1	Block 2	Block 3	Total	Net revenue from increased water supply to existing power plants	Net revenue from sale of surplus energy above project pumping needs	Total irrigation revenue	Municipal water payment applied to irrigation	Total irrigation revenue and municipal water payment applied to irrigation	Investment Repayment: Irrigation plant in service at end of year	Interest free balance to be repaid	MUNICIPAL WATER SUPPLY: Net Revenue From Sale of Water — Block 1	Block 2	Block 3	Total	Investment plant in service at end of year	Repayment interest free balance to be repaid	RECAPITULATION: Net project revenues	Unpaid balance of project investment	Earned surplus cumulative
0	0			0						$15,850,000	$15,850,000	0			0	$ 9,372,000	$ 9,372,000		$25,222,000	
1					$ 9,000		$ 9,000		$ 9,000	15,850,000	15,841,000	$234,300			$234,300	9,372,000	9,137,700	$243,300	24,978,700	
2							9,000		9,000	15,832,000	15,832,000				234,300	9,372,000	8,903,400	243,300	24,735,400	
3							9,000		9,000	15,850,000	15,823,000				234,300	9,372,000	8,669,100	243,300	24,492,100	
4		0					9,000		9,000	33,500,000	33,464,000				234,300	14,995,200	14,058,000	243,300	47,522,000	
5	0			0		$ 1,000	10,000		10,000	33,500,000	33,454,000		0		374,900	14,995,200	13,683,100	384,900	47,137,100	
6	$59,500			$59,500		1,000	69,500		69,500	33,500,000	33,384,500				374,900	14,995,200	13,308,200	444,400	46,692,700	
7			0	59,500		1,000	69,500		69,500	40,234,000	40,049,000			0	374,900	18,744,000	16,682,100	444,400	56,731,100	
8				59,500		15,000	83,500		83,500		39,965,500			$93,700	468,600		16,213,500	552,100	56,179,000	
9		0		59,500			83,500		83,500		39,882,000						15,744,900	552,100	55,626,900	
10		$234,800		294,300			318,300		318,300		39,563,700						15,276,300	786,900	54,840,000	
11				294,300			318,300		318,300		39,245,400						14,807,700	786,900	54,053,100	
12			0	294,300			318,300		318,300		38,927,100						14,339,100	786,900	53,266,200	
13			$207,400	501,700			525,700		525,700		38,401,400						13,870,500	994,300	52,271,900	
14											37,875,700						13,401,900		51,277,600	
15											37,350,000						12,933,300		50,283,300	
16											36,824,300						12,464,700		49,289,000	
17											36,298,600						11,996,100		48,294,700	
18											35,772,900						11,527,500		47,300,400	
19											35,247,200						11,058,900		46,306,100	
20											34,721,500						10,590,300		45,311,800	
21											34,195,800						10,121,700		44,317,500	
22											33,670,100						9,653,100		43,323,200	
23											33,144,400						9,184,500		42,328,900	
24											32,618,700						8,715,900		41,334,600	
25											32,093,000						8,247,300		40,340,300	
26											31,567,300						7,778,700		39,346,000	
27											31,041,600						7,310,100		38,351,700	
28											30,515,900						6,841,500		37,357,400	
29											29,990,200						6,372,900		36,363,100	
30											29,464,500						5,904,300		35,368,800	
31											28,938,800						5,435,700		34,374,500	
32											28,413,100						4,967,100		33,380,200	
33											27,887,400						4,498,500		32,385,900	
34											27,361,700						4,029,900		31,391,600	
35											26,836,000						3,561,300		30,397,300	
36											26,310,300						3,092,700		29,403,000	
37											25,784,600						2,624,100		28,408,700	
38											25,258,900						2,155,500		27,414,400	
39											24,733,200						1,686,900		26,420,100	
40								0	525,700		24,207,500	234,300			468,600		1,218,300		25,425,800	
41								$234,300	760,000		23,447,500						984,000		24,431,500	
42								234,300	760,000		22,687,500						749,700		23,437,200	
43								234,300	760,000		21,927,500						515,400		22,442,900	
44								234,300	760,000		21,167,500		140,600				281,100		21,448,600	
45								374,900	900,600		20,266,900						187,400		20,454,300	
46								374,900	900,600		19,366,300						93,700		19,460,000	
47								374,900	900,600		18,465,700			93,700	0		0		18,465,700	
48								468,600	994,300		17,471,400								17,471,400	
49											16,477,100								16,477,100	
50											15,482,800								15,482,800	
51											14,488,500								14,488,500	
52											13,494,200								13,494,200	
53											12,499,900								12,499,900	
54											11,505,600								11,505,600	
55											10,511,300								10,511,300	
56											9,517,000								9,517,000	
57											8,522,700								8,522,700	
58											7,528,400								7,528,400	
59											6,534,100								6,534,100	
60								468,600	994,300		5,539,800	234,300			468,600			994,300	5,539,800	
61								234,300	760,000		4,779,800	0			234,300			760,000	4,779,800	
62								234,300	760,000		4,019,800				234,300			760,000	4,019,800	
63								234,300	760,000		3,259,800				234,300			760,000	3,259,800	
64								234,300	760,000		2,499,800		140,600		234,300			760,000	2,499,800	
65	59,500			501,700			525,700	93,700	619,400		1,880,400		0		93,700			619,400	1,880,400	
66	0			442,200			466,200	93,700	559,900		1,320,500				93,700			559,900	1,320,500	
67				442,200			466,200	93,700	559,900		760,600			93,700	93,700			559,900	760,600	
68				442,200			466,200	0	466,200		294,400			0	0			466,200	294,400	
69		234,800		442,200			466,200		466,200		0							466,200	0	$171,800
70		0		207,400			231,400		231,400									231,400		403,200
71				207,400			231,400		231,400									231,400		634,600
72			207,400	207,400	9,000	15,000	231,400		231,400	40,234,000						18,744,000		231,400		866,000

Cost and Repayment Allocations

Total estimated project cost	$69,534,000
Allocation of costs:	
Reimbursable costs	
Irrigation	40,234,000
Municipal Water Supply	18,744,000
Subtotal	58,978,000
Non-Reimbursable costs	
Flood control	5,900,000
Recreation	4,656,000
Subtotal	10,556,000
Total	69,534,000
Repayment of reimbursable costs	
From irrigation water users	31,728,000
From municipal water users	28,116,000
Subtotal	58,978,000
Less earned surplus	866,000
Subtotal	58,978,000

Payout schedule

The repayment schedule, based on analysis of the annual project revenues over a 60-year period, is given on the preceding page. In this analysis payment capacity determinations have been based on the 1939–44 period when prices received by farmers for produce and prices paid by farmers for goods and services were more nearly in balance than in any other given period. While such a balance may exist most of the time over a long period in the future, there will be times when the balance will not exist. Thus a variable repayment plan as provided for in the Reclamation Act of 1939, as amended, is desirable in order that annual payments on construction costs may be varied from year to year in accordance with the farmers' net income.

Repayment organization

A water conservancy district would be desirable to act as a contracting entity between the United States and the water users under the Weber Basin project. Such a district is authorized by Utah statutes and may include not only lands to be irrigated by the project development, but municipalities, utilities, industries, and lands directly or indirectly benefited by the project. The district would have power to enter into contract with the Government of the United States or any agency thereof. It would have certain taxing powers and authority to contract for the development and sale of water resources for irrigation, municipal, and industrial use.

CHAPTER XII

ALTERNATIVE PLANS

Several alternatives for project features, outlined in the following paragraphs, were considered in the course of the investigations. Only two possibilities—the enlargement of East Canyon Reservoir and the construction of Gateway power plant—appear worthy of further investigations during preconstruction surveys. Other potentialities were rejected as they would not provide as much water as developments included in the project plan, would be more costly, or would utilize sites shown to be undesirable from a geologic standpoint.

STORAGE FACILITIES

Enlarged East Canyon Reservoir

As an alternative to construction of Jeremy and Perdue Reservoirs, the East Canyon Reservoir could be enlarged from its present capacity of 28,700 acre-feet to a capacity of about 110,000 acre-feet. The reservoir, the property of the Davis-Weber Counties Canal Co., would continue to store water from East Canyon Creek for the canal company and would store new project supplies diverted from Weber River, Sheep Creek, and Hardscrabble Creek. Water from Weber River would be diverted at a point 3 miles below the confluence of Beaver Creek and Weber River and conveyed to the reservoir through a conduit 13.8 miles long, consisting of 5 miles of canal and 8.8 miles of tunnel. Water from Sheep and Hardscrabble Creeks would be conveyed to the reservoir through a canal 13.5 miles long.

To provide for the enlarged reservoir a new dam would have to be constructed at the East Canyon site since the existing dam, a thin-arch concrete structure, could not be safely raised to the height required for the reservoir. Two power plants also could be installed—one at the base of the dam and one at the outlet of the diversion tunnel from the Weber River.

Although only a reconnaissance study has been made, development of East Canyon Reservoir would apparently have the following advantages over construction of Perdue and Jeremy Reservoirs: (1) Cheaper dam construction, (2) cheaper operation and maintenance, (3) higher power output, and (4) improved regulation of releases to the aqueduct system since the East Canyon Reservoir would be closer to the Weber aqueduct diversion than would the Perdue and Jeremy Reservoirs.

Development of East Canyon Reservoir would have the following disadvantages: (1) The necessity for costly diversion works; (2) the possibility of financial obligations and concessions to the canal company since the company presently owns the existing dam and reservoir, and (3) the interference in present irrigation while the dam was being replaced.

Further investigations of the enlarged East Canyon Reservoir were requested by the Davis-Weber Counties Canal Co. The Bureau of Reclamation has adopted the plan to construct Perdue and Jeremy Reservoirs until complete comparative cost estimates of both possibilities are available and the desires of the canal company are known.

Other storage possibilities

Several reservoir sites on Weber River were considered and rejected as alternatives to the Perdue site for development under the adopted plan. The Larabee site was rejected because of an extensive glacial fill of porous material on the left abutment and the Peoa site was rejected because of excessive right-of-way costs. A plan to enlarge Echo Reservoir was not adopted as the enlarged reservoir would inundate the town of Coalville. A plan to develop a series of sites in Weber Canyon between Morgan and the canyon mouth was also found undesirable as it would require relocating sections of the Union Pacific mainline tracks at a prohibitive cost. The Chalk Creek site on Chalk Creek also was considered as an alternative to the Perdue but was rejected, as an adequate water supply could not be developed at the site.

The Croydon site at the mouth of Lost Creek was considered as an alternative to the Lost Creek site but was rejected, as a reservoir at this site would flood the plant and quarry of the Ideal Portland Cement Co., an installation valued at more than $4,000,000.

CONVEYANCE FACILITIES

The Davis and Burch Creek bench canals were considered as an alternative to the Davis-Weber aqueduct system. The aqueduct system, however, was found to be more desirable than the canal system for the following reasons: (1) It would involve lower operation and maintenance costs, (2) it would be more adaptable for conversion from irrigation to municipal use, and (3) it would consist of closed conduits that would reduce evaporation and seepage losses, hazards to human life, contamination from surface wastes, and likelihood of winter freezing.

Dry Creek Reservoir, at an offstream site about 11 miles downstream from Morgan, Utah, was contemplated to provide regulatory storage for releases to the Davis and Burch Creek bench canals. With the canal system power could be produced at a hydroelectric plant operating in connection with the reservoir. With the adopted aqueduct system, however, the head available to the plant would be so reduced that the power development could not be justified and, therefore, development of the reservoir would not be feasible.

POWER PLANTS

Gateway power plant

Consideration was given to the possibility of constructing Gateway power plant on the Weber River for generation of hydroelectric power. Water would be diverted to the plant from Weber aqueduct and tailwater from the plant would be released to Weber River and subsequently used for downstream power and irrigation uses. The plant would operate under a constant head of 155 feet and would have an installed capacity of 4,000 kilowatts.

The plant was not included in the adopted plan of development since, on the basis of present prices, the original cost of the development and annual operating costs could not be paid from the plant revenues. If a lower price level exists at the time of project construction, however, this plant may be found feasible.

Other power possibilities

Consideration was given to plans for constructing the Perdue and Magpie power plants downstream from the plant sites adopted in the project plan in order that increased head might be developed. The plans were rejected, however, as the additional power generation would not compensate for the increased costs of the penstock.

CHAPTER XIII

INVESTIGATIONS

Investigations leading to the present report were started in 1942 but, except for studies of a small potential drainage development, were discontinued during the war years. Investigations of the entire basin project were resumed in 1946 and have been continued to date.

Previous investigations in the area, which led to construction of the Weber and Ogden River projects, were started as early as 1904. Reports of the more important early investigations are listed below.

A reconnaissance report of the Weber River.—This report was prepared by the Bureau of Reclamation in 1904–5 and discussed findings of a reconnaissance survey.

Weber River division of the Salt Lake Basin investigations.—This report, dated December 1922 and prepared by William M. Green, engineer, Bureau of Reclamation, led to construction of the Weber River project. It outlined plans for providing new and supplemental water for lands serviceable by the Ogden and Weber Rivers in Weber, Davis, and Morgan Counties.

Weber River irrigation project.—This report, dated December 4, 1907, was prepared by Willard Young and Frank C. Kelsey, civil engineers. It outlined a plan to provide storage on the Weber River for use on benchlands between Ogden and Salt Lake City.

Report on the Ogden River project of the Salt Lake Basin investigations.—Prepared in April 1924 by William Green, this report modified the plan of Ogden River development presented earlier in the report on the Weber River division. It presented a plan for furnishing a full and supplemental water supply to lands in Weber and Box Elder Counties.

Report on Ogden River division—Salt Lake division of Salt Lake Basin Investigations.—This report, dated August 1932, was prepared by E. O. Larson, engineer, Bureau of Reclamation. It presented the plan for the Ogden River project and led to construction of that project.

The Bonneville Basin.—This report, dated January 1949, was a presentation of the Department of the Interior, sponsored and coordinated by the Bureau of Reclamation. The report outlined potential projects, including the Weber Basin project, that may be coordinated into a comprehensive plan for irrigation, municipal use, power production, and other beneficial uses in the Bonneville Basin.

Acknowledgments

The State of Utah has cooperated with the Bureau of Reclamation in its present investigations by making large financial contributions and by supplying helpful data. Financial contributions were made by the Davis County Water Users Association during the 1948 fiscal year.

The Fish and Wildlife Service, National Park Service, and Public Health Service participated directly in the investigations, preparing reports which are included as part of these substantiating materials. Other Federal agencies which cooperated in the investigations by supplying helpful information are the Corps of Engineers, Bureau of Agricultural Economics, Geological Survey, Forest Service, Federal Power Commission, Bureau of Mines, and Production and Marketing Administration.

Local organizations and institutions that were especially helpful are the Davis-Weber Counties Municipal Water Development Association, Weber River Water Users Association, Ogden River Water Users Association, Utah Power & Light Co., University of Utah, and Utah State Agricultural College.

Helpful information and data were given by DeLore Nichols, Davis County extension agent; A. L. Christensen, Weber County extension agent; P. H. Sorensen, water commissioner of Weber River, and many other individuals.

RECONNAISSANCE REPORT
RECREATIONAL USE AND DEVELOPMENT
WEBER BASIN PROJECT

WILLARD BAY, PINEVIEW, MAGPIE, LOST CREEK, DRY CREEK, JEREMY, PERDUE, AND CHALK CREEK RESERVOIRS, UTAH

PREPARED BY

REGION 3 OFFICE, NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

FOR

REGION 4, BUREAU OF RECLAMATION
DEPARTMENT OF THE INTERIOR

FEBRUARY 1949

MILTON J. MCCOLM, Regional Chief of Land and Recreational Planning

Report by: RICHARD W. BARNETT, Park Planner

NATIONAL PARK SERVICE REPORT

Reconnaissance Report on Recreational Use and Development of Weber Basin Project

INTRODUCTION

Authority

In accordance with departmental policies regarding interagency cooperation in the river basin study program, and as covered by a memorandum of agreement between region 3, National Park Service, and region 4, Bureau of Reclamation, for the 1948 fiscal year, the National Park Service was requested by letter of September 29, 1947, to prepare a report on the recreational use and development of the Weber Basin project for the Bureau of Reclamation. Field reconnaissance of the existing Pineview Reservoir and proposed Willard and Magpie Reservoirs, was made November 12, 1947, by Mr. R. C. Johnson, engineer in charge, and Mr. F. M. Warnick, office engineer, both of the Salt Lake City field office, region 4, Bureau of Reclamation, and Mr. R. W. Barnett, park planner of the region 3 office of the National Park Service. Reconnaissance of the Lost Creek, Jeremy, and Perdue Reservoir sites was made November 13 and 14, by Mr. Robert W. Reitz, engineer of the Salt Lake City field office, and Mr. Barnett.

Further field studies were made August 2, 1948, in connection with the proposal to include a reservoir on Chalk Creek, as well as to further review the recreational possibilities at the Jeremy and Perdue Reservoir sites.

Contact was also made with the intermountain region (region 4) office of the United States Forest Service at Ogden where interesting information was found concerning the use and attendance at recreational areas administered in the area by that Service.

Purpose of report

The purpose of this report is to appraise and analyze, in a general way, the recreational opportunities currently available in the Weber Basin and to consider them in relation to recreational potentialities that may be created as a result of the construction of certain reservoirs; namely, the Willard, Pineview (existing), Magpie, Lost Creek, Jeremy, and Perdue. While it is possible to make general estimates regarding the present recreational evaluation of these reservoir sites, it can be a general appraisal at best. To make a definite and specific statement of the current recreational value of each site would require a statistical survey beyond the scope of this type of report, requiring time and personnel at present unavailable to this office. Thus, this report will attempt to give a general analysis of the "present recreational evaluation of reservoir sites" as compared to similar values con-

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sidered potentially possible at such time as the impoundments become a reality under the plan of operation currently proposed by the Bureau of Reclamation. In making such comparative appraisals for the Pineview Reservoir, however, it will be necessary to estimate the recreational value of the existing reservoir rather than before the original impoundment, as this Service does not have the basic information available to make the original appraisal.

A summary of recreational projects and estimated benefits of potential reservoirs published in "The Bonneville Basin", Project Planning Report of the Bureau of Reclamation, December 31, 1946, stated estimated costs of construction for recreational facilities and estimated the annual benefits for the Willard Bay, Magpie, and Pineview Reservoirs. These appraisals were predicated upon preliminary studies made by representatives of the National Park Service. While it is probable that current appraisals will be relative, it will be necessary to make adjustments that are more in keeping with the current pattern of increased costs and revised plans of operation for certain reservoirs, as proposed by the sponsor.

SUMMARY

Findings, conclusions, and recommendations

1. As a result of field reconnaissance of the Weber Basin, review of earlier appraisals made by representatives of the National Park Service, and consideration of operational data currently supplied by the sponsor, the National Park Service finds that the development of the Weber Basin project will result in an increase in the over-all recreational value of the basin.

2. Of the six sites reviewed at this time, the proposed Willard and Pineview sites are considered to offer the greatest potential recreational benefit, for reasons described in the report.

3. Jeremy, Magpie, Perdue, and Lost Creek are found to be of potential recreational value in the order listed, as influenced primarily by comparison of existing recreational values with those considered possible.

4. It is recommended that Willard, Pineview, Jeremy, Perdue, and Magpie receive consideration for recreational developments commensurate with their significance, location, and availability to the public. While the Magpie site is recognized as desirable and convenient, the comparison of recreational development now existing in the valley to the post project possibilities may indicate that recreational aspects will not be greatly increased.

5. It is recommended that Lost Creek receive encouragement for camping, fishing, and more specialized recreational use rather than for over-all general development purposes.

6. The interests of the United States Forest Service, particularly as affected by Pineview, Magpie, and Perdue are recognized and appreciated to the extent that further cooperation is recommended at the time additional recreational development is planned on these reservoirs. The Forest Service is also invited to offer recommendations relative to any of the proposed recreational developments herein described.

7. According to the University of Utah, Department of Anthropology, no sites of archeological interest exist in the vicinity of projects proposed for impoundment in the Weber Basin.

8. The Weber Basin project and its development for recreational use will have no effect upon any National or State park.

General description of the Weber Basin

The Weber River originates in the Uinta Mountains, flows west and northwest cutting its way through the Wasatch Mountains to flow eventually into Great Salt Lake approximately 15 miles due west of the city of Ogden. By some standards only a moderate-sized creek, the Weber River is, nevertheless, one of Utah's major streams and of inestimable importance to irrigators. The river passes through canyons of eroded sandstone, with rock formations of nearly every geologic age. The first transcontinental railroad followed the beaten path through Echo and Weber Canyons. Farmers settled in the canyon valleys to till the soil and build substantial villages, and today farming remains one of the chief sources of income.

Climate.—There is considerable range of climate in Utah, the differences being largely due to variation in altitude and the position of mountain ranges. Being far from the ocean, there are also marked differences in temperature between night and day and between winter and summer months. Bright sunny days are frequent, while clouds and fogs are rare. In summer the days are warm and the nights cool, the difference between maximum and minimum temperatures for a day (24 hours) averaging about 35 degrees. In winter the daily variation is only about 15 degrees. In the Great Basin, monthly average temperatures vary from about 20 to 76 degrees, averaging about 48 degrees for the year.

The yearly average rainfall varies in different parts of the State from less than 5 inches to more than 30 inches, but these extremes apply only to small areas. In general, the Weber River Basin falls in the 15- to 20-inch range of average annual precipitation.

Historical and archeological investigations.—According to information from the University of Utah Department of Anthropology, the sites proposed for reservoir impoundment in the Weber Basin contain nothing of archeological interest. It would, nevertheless, be advisable to arrange further clearance with the Smithsonian Institution before project construction is started.

THE WILLARD RESERVOIR

Location

The Willard Reservoir site is located in sections 3 to 10, and 16 to 18 inclusive of T. 7 N., R. 2 W., and sections 20 to 22 and 27 to 34, inclusive, of T. 8 N., R. 2 W., Salt Lake Base and Meridian. It is situated in the edge of Great Salt Lake, in Box Elder County, about 10 miles northwest of Ogden, in the north central section of Utah.

U S 30–S and 91, between Ogden and Brigham, passes by the edge of the site. This is the principal access to the area as these combined highways join at Ogden, with U S 30–S approaching Ogden from the east, giving access from southwestern Wyoming, and U S 91 providing the principal north-south routing through the State. At Brigham,

Utah, some 10 miles north of the Willard Reservoir site, U S 30–S and 91 again branch with the former taking a northwesterly direction toward Twin Falls, Idaho, and the latter continuing north toward Pocatello, Idah. U S 89 is a second north-south artery, joining U S 91 south of Provo and separating again at Brigham, where U S 89 proceeds north before taking an east and northeast routing along the edge of Bear Lake and thus into Idaho. Although United States Highway 30 (S)–91 is the only one traversing the edge of the reservoir site, it receives traffic not only from U S 89 and lesser roads, but from U S 40 and 50 passing east and west through Salt Lake City.

Purpose and operation of the Willard Reservoir

A dike surrounding a portion of Willard Bay will be constructed to form this reservoir having a capacity of about 205,000 acre-feet. It would be used to store all surplus water originating below upstream reservoirs. Surplus flows of the Weber River would be conveyed to the reservoir through a canal having a capacity of about 800 second-feet. The water would be used primarily for irrigation by pumping but any surplus not required for irrigation would be available for use by the Bear River Bird Refuge which is now short of water during certain periods of the year. According to data furnished by the sponsor (November 17, 1947), the maximum water surface area at Willard would be some 10,700 acres at maximum surface elevation of 4,225 feet. Capacity at this elevation would be about 205,000 acre-feet. Maximum storage would occur about July 1 of each year. Maximum fluctuation in water surface elevation would be 20 feet, but the maximum annual fluctuation would probably not exceed 10 feet. Water surface area at maximum draw-down to elevation 4,205 would be 6,800 acres with a capacity of 20,000 acre-feet.

For recreational use, this plan of operation represents a favorable situation. With maximum surface acreage occurring early in July, it should appear that the maximum period of recreational use, from late June to early October, would coincide with the period of maximum water content. This is desirable not only as it concerns the use of the reservoir for recreation but as it affects the general scenic quality of the reservoir margins. Although some draw-down is likely to begin in mid or late July, it is improbable that it would diminish the recreational use to a great extent.

Physical characteristics

At the east end of the Willard Bay arm of Great Salt Lake but separated by a dike to impound fresh waters and keep out saline waters, the Willard Reservoir site is generally flat and treeless. However, the location is by no means uninteresting as the Wasatch Mountains slope almost to the very margins of the site. With the water of Willard Bay to the west and the towering peaks of the Wasatch Range penetrating the eastern horizon, the site could be considered of spectacular interest. The treeless aspect of the probable recreation development sites does not present an insurmountable obstacle. Since the area is otherwise scenic and interesting, the landscaping, including tree planting, can become a part of the recreational development program. At such time as a project phase of development should require specific designation of recreational development sites, it should be possible to make a selection which will include the advan-

tage of the mountain view as well as that across the bay itself. Although the reservoir is to be impounded in the edge of Great Salt Lake, the fact should be emphasized that the dikes impounding the reservoir will not only contain the fresh water from the Weber River but will exclude the saline waters from Great Salt Lake. Thus, the content of the Willard Reservoir should be fresh water at probable average depths of 10 to 12 feet with 25 feet the probable maximum. This depth is sufficient for recreational use.

Present recreational evaluation of reservoir site

One of the stated purposes of this report is to estimate the present recreational evaluation of reservoir sites before impoundment takes place. This estimate is based upon broad appraisals plus what meager information is available from existing sources, such as use counts at nearby Forest Service areas or private resorts. In the case of the Willard Reservoir, however, there is no statistical information currently available to this Service which would lend credence to there being any current recreational value or appeal to this particular site. It is adjacent to the Bear River Migratory Bird Refuge on the north but the present shore-line fluctuation, and treeless margins of Willard Bay do not appear to offer much in the way of recreational appeal, whereas development of a fresh-water reservoir with vegetation and public accommodations adjacent to the large bird refuge could invite considerable public use. Description of the Bear River Bird Refuge will be given in connection with related areas.

Type of recreation for which area is suitable

As indicated by the size, accessible location, and proximity to the urban populations of Ogden and Salt Lake City areas, the Willard Reservoir should be considered for general recreational development. Summer use could include swimming, boating, fishing, picnicking, and camping. The wide expanse of the reservoir open to unobstructed breezes could also offer excellent opportunity for sailing without the risks inherent in Great Salt Lake itself. It does not seem probable that winter activities could include skating or ice boating, as winter temperatures are not usually low enough to freeze a surface of this extent. Even in the event of unseasonable freezes providing a safe ice surface, it is probable that accompanying snows would obstruct the surface for such use.

Nor does it seem likely that group camps or related activities could be accommodated in an area of this description and size. While it would seem practical to landscape and provide trees for shade in the vicinity of a general development area, it would not seem logical to extend such artificial development to the degree required to provide pleasant surroundings for group camp sites. For similar reasons, it does not seem likely that any private cabin sites would prove popular because of limitation of space as well as barren aspect from lack of shade trees. It seems much more probable that sites for group camping and private homes will develop in connection with other reservoirs proposed in the Weber River Basin.

Factors influencing recreational development

Region served and population.—It is probable that the Willard Reservoir can provide means for recreational outlets for many people in the Ogden-Salt Lake City area. While it is improbable that the

reservoir will ever assume more than local importance, there is increasing need for recreational release in this area, which is growing rapidly in population and is likely to continue so, because of the greater economic opportunities. Utah's population has grown from 11,380 in 1850 to 550,310 in 1940. As of July 1, 1945, the population was estimated to be about 647,000 and by 1970 the State's population is estimated at 1,100,000. Much of this increase in population has occurred through the Provo-Salt Lake City-Ogden area of which particularly the Salt Lake City and Ogden areas will be served recreationally by the reservoirs proposed for the Weber Basin project. The largest concentration of urban populations is in Salt Lake City which in 1940 had a population of approximately 150,000 or 49.1 percent of the total urban population of the State. It is therefore apparent that the generally increasing population and particularly the increase in urban population for Ogden and Salt Lake City will require recreational outlets which can be at least partially accommodated by recreational developments adjacent to reservoirs proposed for the Weber Basin.

It is conservatively estimated that some 321,720 (322,000 in round figures) people reside within the recreational sphere of influence of the Willard Reservoir site. This sphere is approximately 50 miles in radius, but the population was estimated upon the following county and city break-down:

Morgan County	2, 611
Davis County	15, 784
Weber County	56, 714
Cache County	29, 797
Box Elder County (with the exception of the following precincts: Park Valley, Standrod, Clear Creek, Yost, Rosette, Junction, Grouse Creek, Lucin, and Lakeside)	17, 820
Salt Lake City metropolitan district in Salt Lake County	198, 994
Total	321, 720

Cities included in county populations include: Ogden (1940 population, 43,688); Brigham (1940 population, 5,641); and Logan (1940 population, 11,868) as well as several small municipalities of slightly more than 1,000. With Salt Lake City included, this is an urban population in excess of 210,000 (round figures) which is further indication of an urban populace requiring recreational outlets.

Related areas, existing and proposed.—Related areas are sometimes involved in the competition and use estimated for a proposed recreational development area. Experience has shown that a healthy competition between areas is usually of benefit to all. While it is possible for an area to become overly endowed with recreational opportunity, it is not probable that such could be the case in the area concerned, at least not in the foreseeable future. Some of the existing recreational areas within use distance of the proposed Willard Reservoir site include:

The Bear River Migratory Bird Refuge: This is a region of flats and salt marshes rimming the north shores of Bear River Bay, Great Salt Lake. The refuge will probably join the Willard Reservoir on the north, but road access is some 22 miles via Brigham including 15 miles of dirt road approaching the entrance to the refuge. The 64,200 acres of land and water at the mouth of the Bear River is an avian crossroads of two of the continent's major migratory waterfowl

flyways. The refuge was placed under the jurisdiction of the United States Biological Survey in 1928. The area has been improved and developed including dikes, canals, an administration building, research laboratory, power and filtration plant, service building, garage, duck hospital, and two residences. A 100-foot trussed-steel observation tower affords a view, through field glasses, of the entire area. Much of the construction was done by the CCC. Hunting in season is permitted in designated areas on 40 percent of the refuge.

A private club, the "Million Dollar" Bear River Gun Club, was organized in the early 1900's by wealthy sportsmen. Situated immediately north of the refuge and owning a fenced 18,000-acre tract which includes a 6,000-acre lake, the club has a $75,000 club house, roads, canals, and a 3.5-mile dike.

Pineview Reservoir is an existing reservoir constructed in 1935–36 by the Bureau of Reclamation. It is situated in Ogden Valley, 7 miles east of Ogden. Consisting of some 1,787 surface acres at maximum capacity, this impoundment was an attraction for thousands of visitors before the war. Fishing, swimming, boating, and picnicking are all popular. A yachting club and Boy Scout camp constitute minor development at the present time.

Approximately 17 miles from the Willard Reservoir site, the Pineview Reservoir has current recreational value and considerable future potential, especially if enlarged according to current plans and properly developed for recreational use.

The Meadows and the Willows campgrounds near the Pineview Reservoir are popular areas for picnicking with some fishing in the Ogden River.

Snow Basin, some 17 miles from Ogden and therefore some 27 to 30 miles from the Willard Reservoir site is advertised as Utah's winter sport wonderland. Skiing is the primary attraction, but other attractions include a comfortable shelter. Hot lunches and refreshments are available. The 1946–47 estimate of attendance included some 45,600 skiers and 24,100 spectators. There are no present accommodations for lodging, although several applications have been made. A new route from Ogden reducing the distance to 14 miles is partially completed.

Great Salt Lake, the largest lake in the United States west of the Mississippi, is noted more for its salt content than for its size. The average salinity is six to eight times that of the ocean. In 1925 the water came within a few feet of Highway U. S. 40, but 5 years later it dropped to its lowest recorded level, receding nearly a mile from the road and leaving the Saltair Beach pavilion high and dry. At present, a miniature railroad carries bathers from the harbor to the beach. Other recreational sites along the margin of Great Salt Lake include: Black Rock, Salt Lake Yacht Club, and Sunset Beach. For reasons primarily of distance and salinity of the water, it is not believed that any of these developments will compete unfavorably with any recreational development at Willard Reservoir.

Reservoir impoundments in the vicinity of the Willard Reservoir include, besides Pineview:

Deer Creek Reservoir, located some 40 to 50 miles by road south of Salt Lake City and therefore 90 to 100 miles from Willard Reservoir site, is on the Provo River. When full, the reservoir is approximately 7 miles long and three-fourths of a mile wide. The area is scenic

and the reservoir could be developed for pleasant recreational enjoyment barring limitations imposed by domestic use of the water.

Echo Reservoir, on the Weber River near Coalville, Utah, has been described as attractive and desirable. It is some 50 miles from Willard Reservoir and should not interfere appreciably with patronage there regardless of developments at Echo.

East Canyon, on East Canyon Creek south of Porterville, Utah, is another existing reservoir some 45 to 50 miles from the Willard site. It is small but attractive and desirable although without appreciable development.

Bear Lake is a natural lake of considerable recreational attraction. The lake, 30 miles long and 7 miles wide, lies half in Utah and half in Idaho. It has white sand beaches, and because of its great depth has a wide range of marine colors. Facilities are available for fishing, boating, and swimming. Located some seventy-odd miles northeast of the Willard site, it is improbable that the great appeal of this fresh-water lake would compete with Willard.

Box Elder Lake, some 10 miles north of Willard is assumed to have some recreational appeal as well as Hyrum Reservoir about twenty-odd miles northeast of Willard. Neither, however, is expected to reduce the patronage at the Willard Reservoir.

The above related areas appear to constitute those most likely to influence or to be influenced to some extent by recreational opportunities which could be developed at the Willard Bay project. On the whole, however, it is believed that the effect of these various reservoirs, and possibly others, will tend to be more supplementary and complementary than unduly competitive. This has frequently been observed to be the case in similar multiple reservoir areas elsewhere where it has been possible to avoid the often serious disadvantages of overdevelopment and overuse of an area because of desirable and often similar, related recreational opportunities.

Estimate of recreational need and use

The increasing industrialization and resultant increase in urban population are obvious factors pointing toward a greater need for general outdoor recreational opportunities for the people in the Weber Basin. Principal income for people of Utah is derived from mineral production, farming, and manufacturing of which mineral production provides almost as much income as both farming and manufacturing. This is current indication of industrialization. The future trend is definitely toward further industrialization which will utilize the hydroelectric power from the reservoir impoundments. An industrial population means an urban population for which recreational outlet is required. While there are existing attractions of scenic and recreational value within use distance of this population, the opportunity is limited and will become more so in ratio as the industrial population increases. There is a need not only for day-use and week-end development, but for vacation accommodations where tourists may come to spend several days or more. It is significant that the reservoirs which will provide hydroelectric power and thus the opportunity for further industrialization should likewise offer the means to provide recreational opportunity for the population engaged in industry.

Recommended recreational development

Considering the convenient access from Ogden and Salt Lake City and the scenic quality and location adjacent to the Bear River Bird Refuge, the Willard Reservoir should be developed for general recreational use. It is probable that Willard Bay can become an all-season development except during exceptional years of very cold winter or very dry summer when the water may be required for irrigation.

Availability of areas on the land side of the reservoir only will necessarily limit the extent of development, but there should be ample opportunity for at least one major development area and possibly one secondary area in addition to incidental facilities for boat docking, picnicking, and camping.

Major area.—Several sites for general development appear available along the east side of the proposed reservoir. The south side could also be considered to a limited extent, although access roads from U S 91 could extend to a site along the eastern shore with less difficulty and shorter extension than would be required for the south side. Project study and survey of the reservoir site should provide further details required to select a specific site.

The planning for general development should include consideration of the following facilities:

(*a*) Boating (small boats) to include piers and boathouses (probably floating type), repair and launching facilities. This site will require careful selection in order to screen the unsightliness often connected with repair and service operations. Boat rentals and possibly excursions, as well as boat and fishing supplies, are other supplementary activities.

(*b*) Swimming to include beach development, bathhouse, diving, and other facilities, and nearby arrangements for refreshments and picnicking. Swimming should become one of the major activities at the Willard Reservoir.

(*c*) Picnic areas to include tables, fireplaces, potable water, garbage disposal, and toilet facilities. Because of the lack of natural shade surrounding Willard Reservoir, it may be more practical, at first, to include picnicking in conjunction with bathing, boat docking, camping, or other facilities where shade trees will be planted, at least until public use and demand should press the development of additional picnicking facilities on their own merit. Picknicking should eventually become another of the major activities for this reservoir.

(*d*) Campgrounds with usual facilities.

(*e*) Play area, often associated with or related to picnic and camp areas.

(*f*) Administrative group to include utility area, offices, and essential quarters.

(*g*) Concession: Lodge with dining and refreshment arrangements, public lounge and terrace, probably some guest rooms and quarters for concessioner and employees. Overnight accommodations for week end and vacation use, including housekeeping facilities, are often operated in connection with a complete lodge establishment.

(*h*) Equestrian facilities (if justified).

(*i*) Private cabin sites: As previously mentioned, private cabin sites may prove impractical in an area of this limited size, lacking in natural shade and landscaping. In any event, should plans ever include such development, sites should be chosen to avoid interference with general public use of the area as well as future expansion of public facilities.

Secondary development.—Secondary development could include facilities for camping in the vicinity of the Bear River Bird Refuge and incidental boat docking where demand seems to indicate.

Facilities mentioned for inclusion in the major development area and those of secondary and incidental significance are subject to revision at such time as project study or planning phases of study should enlarge upon possible recreational use of the area, resulting from more detailed survey of the site. However, the suggestions presently offered are considered practical and feasible in view of the current plan of operation for the Willard Reservoir and its relation to other reservoirs proposed as part of the Weber Basin project.

Recommended land acquisition

Present information available to this Service does not indicate that tentative severance lines have been set for the reservoir itself. Nevertheless, it is reasonable to assume that much of the land required for recreational use and development will be acquired in connection with other project phases of the reservoir. However, emphasis should be placed upon the desirability of including sufficient property for recreation in the over-all acquisitional program not only for purposes of recreational development but, so far as possible within existing limitations, sufficient additional lands to guarantee protection against encroachment from undesirable elements, which tend to mushroom on the periphery of recreational use areas. Much difficulty can be avoided if recreational use is planned in conjunction with other functional developments of the reservoir and sufficient lands are provided for this purpose at the time other lands are acquired.

Estimated cost of development

On the basis of broad reconnaissance without actual selection of development sites or detailed planning schedules, the estimate of development cost must be accepted as general and subject to revision as later study provides additional information. It is believed that the costs indicated, predicated upon 1948 indexes, are sufficient to permit development of facilities commensurate with estimated needs as indicated in the report.

Under this premise, it is estimated that it would cost some $319,000 to provide recreational facilities as described in the appendix with $157,500 for nonrepayment items and $161,500 for repayment items. Operation and maintenance are broadly estimated at $6,000. At such times as actual developments are under operation, it could become possible to economize on operation by combining certain functions with other reservoirs. This will become especially desirable when administration of more than one reservoir is assumed by a single agency.

Agency for administration

Agencies recommended for administration could include either the city of Ogden, Weber County, or the Utah Department of Publicity

and Industrial Development. The latter, however, is primarily interested in developments of State significance which could preclude immediate interest of that agency.

The city of Ogden would seem to offer the most logical administration in view of its representing the population most interested and most likely to benefit from the area.

PINEVIEW RESERVOIR

Location

The Pineview Reservoir, constructed by the Bureau of Reclamation in 1935–36, is located in sections 1–3, 10–16, inclusive, T. 6 N., R. 1 E., Salt Lake Base and Meridian. This is in the Ogden River Valley, in Weber County east of Ogden, Utah. The Ogden River is one of the principal tributaries of the Weber River.

State Road 39 is the most direct route, 7 miles from Ogden to the Pineview Reservoir. It is a paved road through scenic Ogden Canyon. Another State road, 162, with gravel surface, approaches the reservoir from North Ogden which is approximately 11 miles from the reservoir. State Route 85 is an unimproved road connecting U S 30–S near Mount Green and joining State 39 at Huntsville, which is at the edge of the reservoir.

The most probable route for travel from Salt Lake City or vicinity to Pineview is via U S 89 to Ogden and State 39 to the reservoir. Attendance from the north can enter Ogden over U S 89–91 or other main roads approaching from that area and follow State 39 to Pineview or leave the main road at North Ogden and take the unpaved State 162. Readily accessible over scenic and improved roads, the Pineview Reservoir is approximately 17 to 20 miles from the proposed Willard Bay Reservoir.

Purpose and operation of the Pineview Reservoir

The Pineview Reservoir was constructed primarily for the storage of irrigation waters. The plan of development includes enlarging this reservoir.

Maximum capacity is 92,000 acre-feet at elevation 4,894, giving a surface area of 2,700 acres. The reservoir can be drawn down to zero capacity at elevation 4,818 feet. Under normal operating conditions, the reservoir fills in late May or early June and remains near maximum water-surface elevation until July 15. By October 1, the reservoir is drawn down almost to elevation 4,853 feet. At this stage, the reservoir contains 10,000 acre-feet and has a water-surface area of 780 acres. During drought years, the reservoir will not fill to maximum capacity and will be emptied by the end of the irrigation season. This will be exceptional, however. The more normal operation will probably not exceed 30 to 40 feet of vertical fluctuation during the recreational use season. The shores of this reservoir are fairly steep, so that a vertical fluctuation of even as much as 30 feet does not greatly disturb the margins so far as appearance is concerned, horizontal fluctuations being nominal.

Physical characteristics

This existing reservoir is located in scenic surroundings. The approach through Ogden Canyon is just wide enough for the highway and the Ogden River. The towering cliffs in the canyon, several

thousand feet high, seem to block the way, but a passageway continually opens through vertical masses of pink quartzite. In the more eroded deposits of blue-gray limestone and sandstone, the canyon broadens into fertile glades.

The stream beds are forested mainly with alder, willow, and cottonwood; in the lower levels grow chokecherry, scrub oak, maple, and pine while in the upper areas are aspen, juniper, and spruce.

The reservoir area is picturesquely surrounded by high mountains. When completed in 1937, the reservoir was partly within the Cache National Forest. On May 12, 1941, the boundary of the forest was extended to include all the shore line. As an existing reservoir, Pineview is attractive and highly recommended for further recreational use and development.

Present recreational evaluation of reservoir

The appraisal of existing recreational values connected with the Pineview Reservoir must be general in scope, based upon figures of attendance at nearby Forest Service picnic and camp areas, attendance counts at boating regettas, and a general statement concerning existing bathing beaches, yacht club, and Boy Scout camp. The beauty of Ogden Canyon below the reservoir has attracted considerable development including lodges and private homes which undoubtedly have a high value. Although more or less private in nature, the developments are generally attractive and indicate the desire of the people to find cool and pleasurable retreat from the nearby urban centers.

Area	Camping	Picknicking	Swimming	Fishing	Boating	Sightseeing	General	Total
Idlewild		51,000		2,500		3,000		56,500
The Bluffs	200	4,000		650				4,850
The Point	100	5,600	1,500	650	6,700	7,500		22,050
North Fork		16,500		1,500				18,000
Eden Beach		1,430	1,120	730	2,230			5,510
Huntsville		1,950	1,730	475	4,500		29,560	[1] 38,215
Total	300	80,480	4,350	6,505	13,430	10,500	29,560	145,125

[1] Includes boating regatta, national speed boat races.

This total of 145,125 is exclusive of attendance at Snow Basin, a winter resort primarily for skiing, some 15 miles from Pineview. An estimate of attendance there, from November to April of 1936–47, was 45,600 for skiing and some 24,100 spectators. While Snow Basin is not a reservoir area, attendance there is significant as an indication of the use made of popular recreational areas in the vicinity.

The Pineview Yacht Club has a clubhouse on the peninsula extending into the reservoir from the east. While the club is obviously not an elaborate development, it is at least an indication of interest that future development could encourage.

The Boy Scouts development on the north shore is very minor, but expansion is possible, and it is understood that the Ogden area council for the Boy Scouts is interested in further development.

While it is not practical to place a monetary value upon the developments mentioned without making a complete statistical appraisal of each one, it is evident that considerable use is made of the area with

only limited facilities. With further development to facilitate use and enjoyment, it is apparent that the Pineview Reservoir and area would be extensively used even more than at present.

Types of recreation for which area is suitable

With the general use already made of the area for swimming, boating, picnicking, camping, and fishing as well as for more specialized events such as the boating regatta, it is evident that at least these activities should be further encouraged and possibly others included. Of course, all boating, whether motor or sail, should be restricted to small craft. While the maximum acreage of 1,787 could accommodate some larger craft, the 630 acres at normal draw-down could seem even dangerous for such boats. Although the lake has a shoreline of more than 20 miles, it is not recommended that private cabin sites be considered. It could be desirable, on the other hand, to include at least one group camp, particularly in connection with the Boy Scouts development.

Emphasis for the recreational use on a reservoir of this size should be for the general public use. By planning this use around one major development area with some secondary development where needed, it should be possible to attract and accommodate even larger numbers of people than at present.

Factors influencing recreational development

Region served and population.—Because of the proximity to the proposed Willard Reservoir, it is contemplated that the Pineview Reservoir will serve approximately the same area, recreationally. This should be of benefit to both reservoirs as overdevelopment will be less probable. Urban population is already fairly dense and is increasing, which would provide ample patronage for both reservoirs as well as for the proposed Magpie Reservoir farther up the Ogden River.

The same general statements concerning the economy and probable growth of urban population described for the Willard Reservoir area apply generally to the Pineview area. Estimating the population within 50 miles of the Pineview Reservoir gives a figure of some 21,000 more than that for Willard. Based upon populations of counties within an approximate 50-mile area, the following break-down is given:

Salt Lake County	211,623
Davis County	15,784
Morgan County	2,611
Weber County	56,714
Cache County	29,797
Box Elder County (excepting following precincts: Centerdale, Curlew, Kelton, Park Valley, Clear Creek, Rosette, Yost, Standrod, Junction, Grouse Creek, Lucin, and Lakeside)	17,478
Summit County	8,698
Total (round figures 343,000)	342,705

The difference of some 21,000 estimate in population between Willard and Pineview service areas is principally accounted for by including the entire population of Salt Lake County in the Pineview estimate, whereas only the population of the Salt Lake City metropolitan district was included for Willard. While the 50-mile radius from Willard seems to barely include Salt Lake City, the 50-mile

radius from Pineview takes in all but a small portion of the entire county. Actually, people attending either area from this section would probably drive to Ogden and then either 10 miles to Willard or 7 miles to Pineview, giving a difference of only 3 miles. However, considering that there is more than one approach to Pineview, even though only one is paved, and that the main approach is through the scenic Ogden Canyon, it seems logical to believe that more people could be attracted to that area particularly from the south which, though mountainous and scenic, is less so than Ogden Canyon. Other attractions which may give precedence to Pineview are the several opportunities for accommodations at nearby private lodges and public campgrounds, in addition to the prospect of further development at the existing Pineview. There also could be, in the future, the prospect of a second reservoir, Magpie, in the vicinity to draw people to this area. It therefore seems practical to consider prospective attendance at Pineview from the more extensive area than for Willard.

Related areas, existing and proposed.—The recreational areas, existing and proposed, described as within the recreational use sphere of the proposed Willard Reservoir are all worthy of similar consideration relative to the existing Pineview Reservoir. In addition, there are other reservoirs proposed for the Weber Basin which could be considered in connection with Pineview.

Magpie Reservoir is proposed for impoundment on the South Fork of the Ogden River 6 to 8 miles above the existing Pineview Reservoir. Water surface area at maximum elevation 5,471 would be 720 acres. At maximum draw-down to elevation 5,325, the surface area would be 130 acres. In general, the plan of operation, described further in the specific section for this reservoir, will allow for recreational use. However, based upon the limited size of the reservoir and the size of the urban population available, it is evident that this area would be of supplementary value, recreationally, to Pineview, rather than competitive.

Lost Creek: Another small reservoir, about 40 miles by road from Ogden and slightly more than 40 miles from Pineview, as currently proposed, would comprise some 350 surface acres at maximum elevation but would remain at this elevation for only 2 or 3 weeks after June 1 when water would be drawn for municipal and irrigation use. It will be emptied by November 1. Only in years of above normal run-off will this reservoir be partially full at the end of the irrigation season. This plan precludes any but limited seasonal use which should discourage all but the most simple type of facilities, if any.

Jeremy Reservoir is proposed on East Canyon Creek some 40 miles by road from Ogden and a similar distance from Pineview. Maximum surface acreage of 730 acres could have recreational appeal, but the indefinite plan of operation whereby the filling and emptying will be variable from year to year leaves also an indefinite factor for planning recreational use, until later study of the operational plan establishes a definite basis for considering potential recreational values.

Perdue Reservoir, proposed on the Weber River, will be some 60 to 70 miles by road from Pineview. While this reservoir will consist of 650 surface acres at maximum elevation and about 150 surface acres at maximum draw-down, the distance from Pineview should alone preclude the possibility of recreational competition.

This tabulation of reservoir recreational areas does not indicate any present competition for the Pineview Reservoir nor any for the immediate future as current proposals are for reservoirs considerably smaller than Pineview, and, while of local value, it is not considered probable that any of these will draw appreciably from the attendance believed possible for Pineview.

Estimate of recreational need and use

The recreational need for the area as stated in connection with the proposed Willard Reservoir is also applicable to Pineview. The probable population to be served recreationally by Pineview is slightly larger than for Willard, which should indicate proportionate increase for the need to provide recreational opportunity for day use as well as week-end and vacation use.

Recommended recreational development

Although the Pineview Reservoir is smaller than is proposed for the Willard site, there are several reasons for recommending more extensive developments for Pineview. Primarily, the shore line available for development at Pineview is considerably greater than at Willard, where space for recreational use will be practically limited to the east side. In addition, the Pineview Reservoir is located in more scenic surroundings and has the current appeal of being already existing. Patronage of recreational development presently available in Ogden Canyon clearly indicates that further development is desirable. Although existing beaches and camp grounds have drawn close to 50,000 people to the reservoir in 1 year, it is possible that further general development could increase this use. Under the present plan of operation, Pineview should have at least one general development area, one or two secondary areas, possibly a group camp development in connection with the Boy Scout location, and incidental facilities for additional boat docking, picnicking, and camping wherever such needs can be properly coordinated with other developments by adequate planning.

Major area.—The long peninsula extending into the reservoir from the east between the South Fork and Middle Fork of the Ogden River is clearly defined as the most desirable site for general recreational development. The Huntsville Cemetery on this peninsula need not conflict unduly with recreational use and development, nor does use of this sort need necessarily to conflict with the cemetery. If any future plans for the reservoir should involve raising the water elevation, it is probable that they would also include arrangements for moving the cemetery. However, plans for recreational use of the peninsula could indicate access road alinement around the cemetery. Topography is such that the road could be at a lower elevation so that neither use need interfere with the other.

One area on the south side of this peninsula is already in use for swimming. If further developed and additional facilities added, the entire tip of this peninsula could become the most desirable development on the reservoir. Additional facilities should include provision for the following:

(*a*) Boating for small craft, sail, motor, or rowboat, including facilities for their launching, storage, service, and repair. A possible location for this development could be on the north side

of the peninsula associated with the Pineview Yacht Club which already has a floating dock. This location would remove the boating from other general-use areas, particularly the swimming beach which would probably be on the south shore of the peninsula. The usual supplementary facilities could include boat rentals, excursions, fishing supplies, etc.

(*b*) Swimming: The beach site mentioned on the south side of the peninsula could be improved and possibly enlarged. Construction of a bathhouse, diving facilities, and nearby arrangements for refreshments and picnicking should be considered in planning development of this area.

(*c*) Picnic areas to include tables, fireplaces, potable water, garbage disposal, and toilet facilities. Picnicking at Pineview could be in conjunction with other activities as well as on its own merit at roadside areas and desirable spots, large or small, around the edge of the reservoir.

(*d*) Camp grounds with usual facilities, either by enlarging present camp sites or by developing other appropriate sites.

(*e*) Play areas in conjunction with other appropriate developments.

(*f*) Administrative group to include utility area, offices, and essential quarters. It is unlikely that appropriate space could be found on the peninsula for this development. It seems more practical to consider enlarging the dam administrative area below the dam to include additional facilities required or, if considered more desirable to keep the two separated, other space could be found for recreational administration and maintenance equipment.

(*g*) Concession: A delightful site is available on the end of the peninsula for a lodge with dining and refreshment arrangements, public lounge, terraces, and guest rooms. Views would be open in all directions and the rooms would be open to breezes from the reservoir. Care must be exercised to locate the lodge where later, possible enlarging of the reservoir would still leave the building well above high water.

(*h*) Equestrian facilities if warranted.

(*i*) Group camp could be developed on the north shore of the reservoir by expanding the existing Boy Scout camp. Space is limited which would otherwise limit the size of the camp; however, a development of this sort for cooperative use by Boy and Girl scouts, 4–H Clubs, and so forth, would undoubtedly prove popular.

(*j*) Private cabin sites: It is doubtful if sufficient space would be available to encourage private development.

Secondary development.—In addition to the group camp enlargement of the Boy Scout site, secondary development could include enlarging and improving Eden Beach, additional camping sites around the reservoir, and incidental picnicking and boat landings where justified by need in relation to other well-considered developments.

Recommended land acquisition.—Definite information is not currently available to the National Park Service concerning the exact status of privately held lands, but it is understood that much of the usable area surrounding the reclamation lands is yet in private ownership. While it is further understood that local agencies are negotiating for certain tracts for the purpose of long-range planning and recrea-

tional development, it is definitely recommended that further plans include acquisition of all lands usable for recreational purposes.

Estimated cost of development.—Developments at the existing Pineview Reservoir clearly indicate the value of providing facilities for public recreational use. With only a minimum of recreational development, attendance has been great. On this basis, it is believed practical to estimate increased attendance and resulting monetary benefits in proportion to further recreational development. It would be possible to overdevelop any reservoir beyond the point of reasonable use expectation. However, further developments recommended for Pineview are considered commensurate with the scope of the reservoir and proportionate to the estimated population from which attendance can be drawn.

It is estimated that enlarged recreational facilities at this area would cost some $377,500 in round figures. A break-down of the cost estimate is included in the appendix of this report. Of this figure, approximately $179,500 would be for nonrepayment items and $198,000 for repayment items. The $6,000 for operation and maintenance could possibly be reduced if a combined administration could be effected with smaller development at Magpie or even Willard Reservoir.

Recommended agency for administration

In view of recent agreements between the Commissioner of Reclamation and the Acting Chief of the Forest Service, under which the Forest Service agrees to administer national forest lands in reclamation withdrawals which are not used in connection with reclamation works, including recreational developments, it is assumed that the Forest Service will therefore accept administration of recreational developments at Pineview. Since 1941, the Pineview Reservoir has been entirely within the boundary of Cache National Forest.

Other interested agencies include the State department of publicity and industrial development and the city of Ogden. The former is already interested and has made considerable contribution to the existing area. The city of Ogden could become interested as the agency representing the population most likely to patronize the area.

MAGPIE RESERVOIR

Location

This site is in secs. 4 to 7, inclusive, of T. 6 N., R. 3 E., and secs. 31–34, inclusive, of T. 7 N., R. 3 E., Salt Lake base and meridian. It is on the South Fork of the Ogden River about 6 miles east of Huntsville, Weber County, Utah. While the reservoir site is within the boundaries of the Cache National Forest, the land to be inundated is privately owned.

The Magpie Reservoir would be accessible over approximately the same roads as Pineview except that it will be some 6 to 8 miles farther up State 39 than Pineview; thus, both sites are readily available over scenic and improved highways.

Purpose and operation of Magpie Reservoir

The reservoir will be operated for stream flow regulation, irrigation, power production, and flood control. The maximum capacity will be 60,000 acre-feet at elevation 5,471 feet. Water surface area at this

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capacity will be 720 acres. Water surface area at maximum draw-down, elevation 5,325, will be 130 acres. Inactive storage at maximum draw-down (dead storage) will be 5,000 acre-feet. The reservoir will, in general, be full about June 1 and will be drawn down to about elevation 5,450 (600 acres) October 1. In dry years, the reservoir will not fill and will be drawn down to about elevation 5,410 (area 400 acres) by October 1. Maximum draw-down will occur in March.

This plan of operation should, in general, permit use of the reservoir for recreational use. The possibility of wide range in surface acreage of 130 to 720 acres necessarily limits the type of recreational development. However, since the reservoir margins are steep, keeping the horizontal fluctuation within fairly narrow limits, and since the general range of surface acreage will probably be 600 to 720 acres, there should be opportunity for limited recreational use.

Physical characteristics

Approaches to the Magpie Reservoir site, as to Pineview Reservoir, are through scenic canyons with alder, willow, and cottonwood in the bottoms. Above Pineview, the valley broadens but becomes more canyonlike again near the proposed Magpie Dam site. The steep slopes with occasional benches favor recreational development, the slopes reducing the amount of horizontal fluctuation and the benches suggesting possible recreational development sites.

While the Magpie site does not appear to have the recreational appeal existing and partially in use at Pineview, the area is scenic, accessible, and could become a very pleasant supplement to recreational development recommended at Pineview.

Present recreational evaluation of reservoir site

The general appraisal of existing recreational values at Magpie is based primarily upon estimated values of private homes and camps existing in the reservoir site, itself. Conservatively estimated, there are some 30 private summer homes that would be inundated by the reservoir. These seem to vary in value from $200 to $12,000 with a possible average of $2,000. Very broadly estimated, this could place a value of $60,000 on existing private recreational development that would be eliminated by impounding the reservoir. It is considered desirable to place primary emphasis upon the general public use and enjoyment at proposed reservoir recreational areas, although not necessarily excluding private use entirely. Nevertheless, it could seem practicable to consider the economic value of existing private holdings as compared to the prospective general recreational values potentially deriving from the impoundment.

According to use counts compiled by the United States Forest Service in 1947, there were some 44,000 people who made use of facilities in the Mapgie area for picnicking and fishing. This is an indication of general public use in addition to private use previously described:

Area	Picnicking	Fishing	Total
Magpie	9,500	600	10,100
Meadows (picnic)	12,300	350	12,650
Cottonwood	7,000	250	7,250
South Fork	13,850	600	14,450
Total	42,650	1,800	44,450

While it is entirely possible that private and general public use of the reservoir could equal and even surpass current recreational use of the site, it will require further specific appraisal to determine if more recreational value would be destroyed by the impoundment than could result from post project recreational developments. At such time as plans for this reservoir reach a project phase of study, an appraisal should be made of private and public developments in order to determine the current recreational value of the site. However, information based upon general estimates only would indicate that the present Magpie area could provide a pleasant recreational adjunct to the Pineview area without further change and that, recreationally, the impoundment would not be recommended.

In reviewing the recreational situation, consideration should also be given to the proximity of the Magpie site to both the Pineview Reservoir (6 to 8 miles) and the proposed Willard site (23 to 25 miles). Since it is recommended to develop these two areas for general public use, it is possible to consider the justification of preserving the private homes existing in the Magpie area in lieu of extensive additional public facilities in connection with another reservoir.

Types of recreation for which area is suitable

On the basis of current recreational use, the Magpie site is suitable for picnicking, camping, fishing, and private summer-home use. Providing impoundment takes place and the reservoir is developed for recreational use, additional recreation for which the reservoir would be suitable could include: Swimming, boating, group camping, hiking, and possibly horseback riding.

While emphasis at Willard and Pineview has been for the general public use, it could appear feasible to allow private cabin development at Magpie. This site is further removed from centers of population and is fairly limited in size for extensive developments for general public use. It could, therefore, seem possible to consider limited development for general public use and open other areas for private home sites.

Factors influencing recreational development

Region served and population.—The Magpie Reservoir site is close enough to the Pineview Reservoir to be considered in the same sphere of influence. While factors other than available population will undoubtedly affect probable attendance at Magpie, it is apparent that the influence due to population both urban and rural and the economy of the region will be similar on both areas.

Existing and proposed related areas.—Areas of probable competitive influence on the proposed Magpie Reservoir have been described in connection with the Willard and Pineview Reservoirs. While the degree of influence these areas could assert upon Magpie may vary from that described as probable for the other two areas, it is believed, generally, that none of the described areas would detract appreciably from anticipated attendance at Magpie.

Estimate of recreational need and use.—Again, because of proximity to the Pineview Reservoir, it is reasonable to assume that the need for recreational outlet is similar to that described for Pineview. While the probable function that Magpie is likely to perform in satisfying this need is quite different from that of Pineview, the possible

developments at Magpie can, nevertheless, fill a need for private home sites and supplement general use of the Pineview area.

Recommended recreational development

In the event that existing summer-home sites and camp grounds at Magpie are cleared to provide a basin for the impoundment, there will be recreational sites on the reservoir shore areas. A reservoir of this size and plan of operation within easy distance of another reservoir (Pineview) developed for general recreational use could be considered for limited general recreational development and also for private home sites.

Public use area.—The area surrounding the principal lateral arm on the north side of the reservoir in sec. 6, T. 6 N., R. 3 E., is the most probable site for public use. The west side of this arm, toward the dam, is more gently sloping and could provide limited accommodations for:

(*a*) Swimming, including a small beach and simple bath shelter.

(*b*) Picnicking, near the beach and associated with a small refreshment stand which could be a temporary seasonal structure.

(*c*) Boating, which should be removed from the beach (possibly on the opposite side of the bay or on one of the other inlets). Associated concessions could include fishing equipment and boat rentals.

Incidental areas for picnicking, camping, and necessary boat landings should be provided wherever the need coincides with good planning.

Private cabin sites should be available, particularly on the north side of the reservoir if the present road through the basin is relocated on that side. Other sites for summer homes would be available on the south side at such time as an access road is provided presumably by local agencies. Margins are rather steep on this side, but private developments would not find access to the water impossible where such access would not infringe on larger public interests.

Group camp sites would also be available on the north side of the proposed reservoir. These sites should be as remote as possible, where group activities would not conflict with either private homes or general public use.

While these suggestions for recreational development are advanced for such time as the Magpie Reservoir may become a reality, it is not necessarily implied that impoundment of the reservoir will greatly improve the recreational value of this area. The comparative situations have been discussed in connection with the "Present recreational evaluation of the reservoir site." However, these recreational developments are suggested, providing the reservoir is impounded under justification of the primary purposes of stream flow regulation, irrigation, power production, and flood control.

Recommended land acquisition

Specific information is not yet available to the National Park Service concerning even tentative withdrawal boundaries for this project. It is assumed that project withdrawals will include at least part of the lands required for recreational developments. Additional lands for recreational use should include at least sufficient land to develop recreational projects proposed in sec. 6, T. 6 N., R. 3 E., as

well as additional property to protect this development from undesirable infringement.

It is quite possible that private summer home lease site needs can be satisfactorily accommodated on private land adjacent to the public reservoir area. In such cases, land acquisition for primary project purposes should be adequate to assure public control of all shore lines, across which access to the reservoir can be in accordance with well considered over-all land utilization planning and administration of the area. The latter, especially, can be greatly complicated by the inclusion of private lease sites, and acquisition of land for this purpose is not advocated in this case.

Estimated cost of development

Based upon very broad estimates and as in other instances, considering costs which could be justified by the project, it is believed that recreational developments for the proposed Magpie Reservoir would be some $142,000 in round figures. This includes approximately $108,000 for nonrepayment items, with repayment items totaling some $34,000. Annual operation and maintenance is estimated at $5,200, although it could be possible to reduce this amount if administration here were combined with other similar areas.

Recommended agency for administration

In view of its location within the boundary of the Cache National Forest, the proposed Magpie Reservoir, like Pineview, could be considered for administration by the United States Forest Service. Administration of both areas by the same agency would, of course, have its advantages and should be seriously considered. However, it is understood that Weber County is also very much interested in the Magpie area and that the county government would welcome the opportunity to assist in the recreational development and subsequent administration.

While there could be certain advantages to having both Pineview and Magpie administered by the same agency, there could also be very good reasons for dividing the responsibility. In either case, the United States Forest Service or the Weber County government appear to be the two most logical agencies to consider.

LOST CREEK RESERVOIR

Location

The Lost Creek Reservoir site is located on Lost Creek, in sections 4, 5, 8, and 9 of T. 5 N., R. 5 E., Salt Lake base and meridian. This location is also in Morgan County and 12 miles east of Devils Slide, Utah.

The site is generally accessible via US 30–S which passes through Devils Slide. State road 158 from Devils Slide to Croyden (2 miles) is an improved road, but the remaining 8 to 10 miles to the Lost Creek Dam site are unimproved, affording the only immediate access to the site. However, this access is likely to be sufficient as very little recreational use is anticipated for this reservoir.

Purpose and operation of reservoir

This reservoir will store the surplus waters of Lost Creek for municipal and irrigation use. The reservoir will also control floods originating in the Lost Creek drainage area. Actual capacity will be

determined by flood reserve requirements. The tentative volume has been set at 20,000 acre-feet. At this capacity, the water surface would be 350 acres. The depth of water at the dam will be 160 feet, which will be the maximum possible draw-down.

Under the plan of operation for this reservoir, it will be full in early June and remain full for a 2- or 3-week period. The reservoir will then be emptied by November 1. Only in years of above normal run-off will the reservoir be partially full at the end of the irrigation season, retaining only a small reserve necessary for fish and water fowl protection.

This plan of operation will not allow appreciable use of the reservoir for general recreation. Such use would be limited to a very brief period early in the summer, which, combined with the small surface acreage planned, indicates that general recreational development should not be recommended. Under the current plan of operation, the recommendation for recreational use would be to reserve certain areas between the reservoir and State road 158 which may be relocated along one edge of the reservoir. This land could be used for camping during the 2- to the 3-week use period—sometimes longer, depending upon the rate of draw-down.

Physical characteristics and type of recreation for which area is suitable

Scenically, the Lost Creek area is average for this part of the country. The mountainous country is unspectacular. The area is rather removed and there is no great attraction to draw people interested in recreation. Both Francis and Lost Creek are reportedly good fishing streams but the Fish and Wildlife Service will make specific comment on that subject.

Providing that good fishing is established and maintained, it would be logical to expect visitors on that basis alone, regardless of the limited size and rapid draw-down of the reservoir. However, under this operational plan, it is not anticipated that the reservoir would have attraction for any other recreational use.

Factors influencing recreational development

Region served and population.—The Lost Creek Reservoir is not likely to be of recreational interest beyond a 25-mile radius and probably less than that unless good fishing is maintained. However, assuming that fishing would be good enough to attract visitors from within the 25-mile radius, it is estimated that there would be approximately 5,636 people to draw upon. These are from the following counties:

Weber (Huntsville precinct only)	773
Morgan	2, 611
Summit (including only Castle Rock, Upton, Coalville, Hoytsville, Echo, and Henefer precincts)	2, 252
Total	5, 636

This population is not only small, but it is in some instances closer to other more desirable, existing and proposed reservoir impoundments. It would appear, therefore, that very few people would be likely to come to the Lost Creek Reservoir for recreational reasons. In fact, attendance at this reservoir will depend almost entirely upon the quality of fishing.

Related areas.—Existing: Within the 25-mile radius of the proposed Lost Creek Reservoir, there are at least three existing reservoirs all

of which are more desirable for recreational use than Lost Creek promises to become. These sites are Pineview, some 40 miles (by road) from Lost Creek; East Canyon, some 20 to 25 miles (by road); and Echo Reservoir, approximately 20 miles by road from the Lost Creek site. All of these reservoirs are described elsewhere in the report.

Proposed: In addition to the existing reservoirs, there are at least three others proposed and possibly four if Willard, which is well beyond the 25-mile radius is included. These are:

Approximate distance by road from Lost Creek site

	Miles
Jeremy Reservoir	35
Perdue Reservoir	50
Magpie Reservoir	45
Willard Reservoir	55

These proposed reservoirs, within a possible recreational sphere of influence of Lost Creek, all show a greater recreational potential than that indicated for Lost Creek.

Recommended recreational development

The only apparent recreational value of Lost Creek, under the current plan of operation, could be for fishing. Provided the Fish and Wildlife Service attribute sufficient value to the project for that purpose, it could be desirable to retain limited areas for camping between the reservoir and the road, if it is relocated along the edge of the reservoir. It would not, at present, seem desirable to provide any camp development as such; however, roadside space where camping parties could bring their own equipment and camp without the advantage of provided facilities may be in order.

In the event that later study should for any reason produce a different plan of operation for the reservoir, whereby a larger minimum pool could be retained, it could then become desirable to consider some kind of recreational development for the Lost Creek Reservoir area.

Recommended land acquisition

It is entirely possible that land acquisition for project purposes could include procuring property between the reservoir and the relocated State Road 158. Since space for camping between the road and the reservoir is all that is currently recommended for recreational use, provision should be made for acquiring a few select areas on benches suitable for such use, providing the property is not acquired for primary project purposes.

Estimated cost of development

While there is no actual development recommended, there could be a cost for land acquisition for camping use. This would depend primarily upon the acreage acquired for the camping recommended and whether or not this land was acquired for primary project purposes. In either event, the cost should be nominal.

At such time as the project is approved, a project recreational study should determine exactly what sites should be chosen for camping.

Recommended agency for administration

In this instance, where no actual recreational development is recommended, there is no necessity for an administrative organization. However, in the event camping and incidental picnicking are

allowed, such areas could be serviced as a part of the State highway roadside program. In the event this were not feasible, an alternate plan could be for the dam administration to supervise clean-up and policing of the area with part time labor. This would undoubtedly be a very minor and incidental responsibility.

JEREMY RESERVOIR

Location

It is proposed to locate the dam for the Jeremy Reservoir on East Canyon Creek in sections 1, 2, 11, 12, and 13 of T. 1 S., R. 3 E., and section 18 of T. 1 N., R 4 E., Salt Lake base and meridian. This is in Summit County about 16 miles east of Salt Lake City, Utah.

The dam site is a mile to a mile and a half north of U S 40, and the reservoir will extend some 3 to 4 miles up the creek, perhaps requiring the relocation of approximately 1 or 2 miles of U S 40.

The most direct access to the site is via U S 40 with United States Highway 189 feeding into U S 40 at Heber south of the site, and State 530 coming into U S 40 from the east of Kimball Junction.

Access from Highway 40 to possible recreational development sites along the reservoir is over an unimproved county road which follows the East Canyon Creek Valley. This road will probably be relocated, possibly on the western side of the reservoir, extending access to possible recreational sites on that side of the reservoir.

In general, the reservoir appears suitable for recreational development and access will be convenient providing the county road is relocated along either edge of the reservoir.

Purpose of reservoir

This reservoir will be constructed to a capacity of about 35,000 acre-feet. It will be used primarily for hold-over storage. At maximum capacity, elevation 6,340, it will have a surface area of 730 acres. The reservoir will fill in years of high run-off and be drawn down in dry years. Maximum draw-down in any single year may be to elevation 6,266 feet or 5,000 acre-feet capacity. According to statements from the sponsor, exact operational conditions cannot be fully explained at this time, but the sponsor further states that filling and emptying will be variable from year to year and that in many years, the reservoir may remain almost full. While this statement leaves considerable latitude in the proposed method of operation, the National Park Service will assume that the plan of operation indicated by the sponsor will at least retain sufficient conservation pool, during most years, to permit use of the reservoir for general recreational purposes.

During the years that the reservoir remains near the maximum capacity elevation, it should be especially desirable for recreational use and during the years of draw-down there should be some recreational value, providing the draw-down is not too great. Definite data on actual frequency and amount of draw-down are not available to the National Park Service at this time.

Physical characteristics

The area surrounding the proposed Jeremy Reservoir site is scenic, particularly the vista toward the south which is of mountain peaks and forest land. The immediate aspect in the East Canyon Creek Valley is pleasant and should provide attractive location for one or more recreational development areas.

There are willow, haw, spruce, aspen, cottonwood, scrub oak, chokecherry, elder, and sage among other tree and shrub growth.

Present recreational evaluation of reservoir site

A possible indication of the current recreational value of the East Canyon Creek area is found in the popularity of the East Canyon Creek Reservoir, some 8 to 10 miles north of the Jeremy site. According to reports, the East Canyon Reservoir is a favorite haunt for fishermen on the opening days of the season, which should indicate fishery values further up the stream. Also, according to Mr. James B. Kilby, of the Welcome Inn, on U S 40 near the south end of the proposed reservoir, there are approximately 500 people each Sunday during the winter to use the ski area nearby. He also estimates at least that many people during the summer for fishing alone.

In general, the indication is that considerable recreational values exist in the vicinity of the Jeremy Reservoir, pending the impoundment, but that these involve very largely those associated with fishing and winter sports.

Types of recreation for which area is suitable

Convenient access, particularly from Salt Lake City, scenic location, and the general indication of the plan of operation denote favorable recreational possibilities for the Jeremy Reservoir. Although the plan of operation is still indefinite, there is reason to believe that the reservoir and area could be used for fishing, boating, camping, picnicking, hiking, and possibly some winter sports. The latter is mentioned with special reference to possible enlargement of the winter sports area south of U S 40. It might be feasible to provide a lodge or cabins or both for use of summer visitors in the vicinity of the Jeremy Reservoir and, if convenient, a coordinated arrangement could be made for visitors to the nearby winter sports area to use the same accommodations. This would be especially desirable if the lodge and/or cabins were developed by private interests under special permit, thereby extending their operating season to make such an enterprise more attractive economically.

Factors influencing recreational development

Region served and population.—Located near Salt Lake City and available over some 20 miles of U S 40, one of the major east-west highways, Jeremy is well located in relation to population. Primarily because of the proximity to Salt Lake City, it is estimated that the Jeremy Reservoir would have an estimated population of at least 208,000 from which to draw. This includes 1940 population figures from the following counties and precincts:

Morgan County			2,611
Summit County			8,714
Wasatch County:			
Keetley Precinct		250	
Midway Precinct		993	
			1,243
Utah County: Alpine Precinct			534
Salt Lake County (except)		211,623	
Precinct 4	6,772		
Precinct 10	6,030		
Precinct 8	3,654		
		−16,456	
			195,167
Total (round figures 208,000)			208,269

The area of influence indicated for the Jeremy Reservoir might have been considered more extensive were it not for Deer Creek and Strawberry Reservoirs on the south, Great Salt Lake on the west, and East Canyon, Echo and Pineview on the north as well as other proposed sites in the area.

Considering the recreational potential at Jeremy in relation to available population, it seems reasonable to estimate a possible 75,000 visits annually. This includes the possibility of winter attendance at the proposed winter sports area south of Jeremy and depends upon recreational development sufficient to attract and accommodate that number of people during the summer season and upon efficient administration, operation and maintenance of the development.

Existing and proposed areas of competitive interest.—As previously mentioned, the potential area of influence considered for Jeremy has purposely been restricted because of other nearby reservoirs. By limiting the area to that considered local for the Jeremy site and not extending it into the sphere of influence from which related areas could draw, it should be possible to recommend developments on a scale commensurate with the recreational value of the reservoir and its surrounding local population.

Deer Creek is approximately 30 miles from the Jeremy site, Strawberry some 65 to 70, and Pineview more than 50; whereas East Canyon and Echo Reservoirs are only 10 and 20 miles respectively from Jeremy. (All distances estimated by road.) These reservoirs are either too small to conflict with the potential recreational use of Jeremy or too far away to interfere with the local use anticipated.

Proposed areas of interest include—

Perdue approximately 30 miles.

Lost Creek slightly more than 30 miles and estimated to have a very limited recreational potential.

Utah Lake, some 50 miles by road from Jeremy, is a large fresh-water lake used for irrigation. Although there is very limited recreational development at the present time, there are definite possibilities for future development and use. However, proximity to Provo and other larger urban centers is likely to assure patronage for any recreational development, and reduce tendencies to draw heavily upon anticipated attendance at the Jeremy area.

Estimate of recreational need and use

While the proposed Jeremy Reservoir has been appraised as of local recreational value only, the local area of influence includes Salt Lake City. This is of significance not only concerning the available population but in respect to the actual need and recreational service to these people. Within 25 miles of Salt Lake City, it would be difficult, at present, to visualize any overdevelopment for recreational use. The subject of urban versus rural population and the definite trend toward further urban growth in this area has been covered in other sections of the report. It should be apparent that the need for further recreational outlet is pressing and that if an adequate conservation pool is maintained the Jeremy Reservoir could provide day-use, week-end, and some vacation opportunities.

Recommended recreational development

In view of recreational needs in this area, general accessibility of the site particularly in relation to Salt Lake City, the scenic surroundings and indicated potentiality of the site for recreational use, it is recommended that the proposed Jeremy Reservoir be considered for recreational development, providing the ultimate plan of operation does not conflict with the use of the reservoir for this purpose. Such development should include general public facilities usually associated with areas of this description:

(*a*) Boating: for small craft, only with the usual arrangements for launching, repair, storage, etc. (such as rentals and servicing).

(*b*) Swimming: to include beach, bath house, etc.

(*c*) Picnicking: including tables, fireplaces, potable water, garbage disposal, and toilet facilities. Picnicking, here as elsewhere, may be considered on its own merit as well as in connection with other activities.

(*d*) Camping: to include the usual facilities.

(*e*) Play areas: Space limitations imposed by topography could eliminate accommodations of this sort. However, these would be desirable developments providing suitable space is available.

(*f*) Concessions: Considering the anticipated use of the reservoir area and possible patronage from the proposed winter sports area to the south, an attractive lodge should receive ample patronage. There should be accommodations for dining and refreshments, lounge, and some rooms for overnight use. Later expansion could include overnight cabins to supplement housing accommodations if justified by need.

There should also be a provision for employees' quarters and a service area.

(*g*) Administrative group should consist of quarters for a manager, offices, and utility area.

(*h*) Incidental areas for picnicking and boat docking may be considered where indicated by use and need in accordance with comprehensive planning. Otherwise, it is possible that one major development area could serve the reservoir, particularly in view of the limited selection of sites.

Final selection of development sites should be made as a result of further study of the project, but present indications are that a development site could be found, near U S 40, possibly somewhere in the western half of section 18, T. 1 S., R. 4 E., or in the northeast quarter of section 13, T. 1 S., R. 3 E. While detailed topography above the proposed high-water level is not available, there is sufficient indication to recommend these general areas for at least further consideration. There could be desirable sites for either major or secondary development closer to the dam site, but the available map indicates more canyon-like topography in this region.

Recommended land acquisition

Although definite selection of recreational development sites should be based upon further field study of the area, it is desirable at least to consider the potential sites suggested under recommended

recreational development. If the project is approved, it is preferable to acquire recreational development lands at the same time other project lands are obtained.

Estimated cost of development

It is broadly estimated that recreational developments at Jeremy could be provided for $257,500 in round figures. This includes approximately $126,000 for nonrepayment items and $131,500 for repayment features. Annual maintenance and operation is estimated at $5,400.

Recommended agency for administration

Considering the importance of proper administration for an area of this type, it is suggested that any one of the following could become interested: Salt Lake City or Salt Lake County, the United States Forest Service (by including the area as part of Wasatch National Forest) or the State department of publicity and industrial development. It is conceivable that any one of these agencies could be interested in the planning and consequent administration of this area.

PERDUE RESERVOIR

Location

The site for the Perdue Dam is on the Weber River about 6 miles northeast of Oakley, Utah. The reservoir will be in sections 5 and 6, T. 1 S., R. 7 E., and sections 31 and 32, T. 1 N., R. 7 E., Salt Lake base and meridian. This is in western Summit County some 50 miles by road from Salt Lake City and Provo.

Direct access to Oakley is via improved U S 189 and thence to the Perdue site over 6 miles of unimproved county road. State road 150 joins U S 189 at Kamas about 6 miles south of Oakley. State 150 is the principal access to the sparsely populated southern and central Summit County. U S 40 does not connect with U S 189 at any point, but State 530 is an improved highway which connects Kimball Junction on U S 40 with U S 189 at Wanship, some 9 miles from Oakley. State 196 and 34 are unimproved roads, connecting U S 40 with 189.

While the Perdue site is not immediately accessible over paved highways, the general access is convenient and should be adequate for the local need anticipated.

Purpose of reservoir

According to the most recent information from the sponsor, this reservoir is planned for a capacity of 50,000 acre-feet at elevation 7,060. Water surface area at this elevation will be 650 acres. The reservoir will regulate the stream flow for irrigation use and flood control. The reservoir will fill about June 1 each year. Maximum draw-down in any single year may be to elevation 6,945, capacity 5,000 acre-feet, and surface area slightly more than 150 acres. Operating conditions have not been definitely determined, but the reservoir will be operated jointly with Echo Reservoir and release will be made only after Echo is near maximum draw-down. This reservoir is under consideration as an alternate to Chalk Creek Reservoir and only one will be constructed for the ultimate development of the Weber Basin project.

Since the Bureau of Reclamation will require additional study before establishing the final operational plan for this reservoir, it is necessary to base estimates of possible recreational development on the preliminary proposal. It is assumed that only in years of extreme water shortage will it be necessary to draw the Perdue Reservoir down the full 115 feet to the 6,945 elevation. It could even be expected that during many years the reservoir would remain fairly constant during the summer months and would be very adaptable to recreational development and use.

Although operational data at this time is indefinite, it is nevertheless desirable to consider possible recreational development and use because of the general attractiveness of the area and the extensive use that could occur providing the operation of the reservoir does not unduly conflict with such use.

Physical characteristics

The rather broad valley with surrounding mountains is attractive and pleasant, though without spectacular appeal. Plant cover consists mainly of cottonwood, aspen, juniper and some spruce and other evergreens. The area appears to be fair grazing land and is reputedly used for sheep grazing.

The valley above the reservoir site is broad and pleasant which could attract attention for camping areas and cabins were it not for the prospect of the unattractive mud flats at this end of the reservoir. However, if the valley road is located along either edge of the reservoir, there should be occasional benches near the reservoir to invite camping and picnicking.

Present recreational evaluation of site

Present recreational value of the site appears to be limited to fishing which is reported to be good, with visitors from Provo, Salt Lake City, and other Utah points but only a few from out-of-State visitors.

There are about 50 summer homes in the valley, but only a few could be inundated by the reservoir. While they appear attractive, it is not felt that they involve any great value.

There is a Forest Service camp ground on Smith and Morehouse Creek 2 or 3 miles from the reservoir. It is a very attractive area with about 25 camping units equipped with fireplaces, tables, spring water, and pit toilets. The Forest Service estimates that 500 to 600 people used this area on July 4, 1948, and that the usual 75 days of recreation for a single season would find approximately 6,200 people to have used the area. This area would not be affected by the impoundment, but a nearby reservoir should add to the general appeal of this already very attractive development.

In general, impoundment of the reservoir and development of suitable recreational facilities should attract many more people, providing the operation of the reservoir lends itself to such use.

Types of recreation for which area is suitable

Taking into account the indefinite status of operational plans, the possibility of mud flats at the upper end of the reservoir and the fairly remote location, development for general recreational use probably should not be unduly emphasized. However, camping, fishing,

picnicking, and boating (small only) could become very popular. The area should also be suitable for cabin and summer home sites, as well as a small lodge and concession.

Factors influencing recreational development

Region served, population.—As the principal attraction to this area will probably be for fishing in the reservoir and the streams above and below, it is likely that the population within 50 miles may be interested, but that within 25 miles will be of most probable influence on attendance at the reservoir. Population estimates are, therefore, based more specifically on the following county and precinct areas:

Summit County		8,714
Wasatch County, including—		
Heber City	2,748	
Center	226	
Midway	993	
Keetley	250	
		4,217
Total (round figures, 13,000)		12,931

While it has been mentioned that fishermen from Salt Lake City and Provo come to this area now, it is anticipated that later recreational developments at Utah Lake, Deer Creek, and Strawberry, and others to the north may draw many from those cities. Local attendance may also be anticipated at the proposed Little Diamond, Currant Creek, Hades, and others which would attract people who now go as far as the Perdue area. It, therefore, seems reasonable to assume that the influence of the Perdue Reservoir may tend to become gradually more local as other recreational areas materalize. The local population has been estimated in round figures at 13,000 according to 1940 census figures. This does not include any large cities, but some attendance is anticipated from Provo and Salt Lake City.

Existing areas which might compete.—Describing the proposed Perdue Reservoir as local in significance makes it reasonable to appraise it on the independent basis of its own merit. It will, for the present at least, be the only reservoir within an approximate 25-mile radius. However, on the periphery of this 25-mile radius or slightly beyond are several reservoirs of potential recreational value:

Approximate miles from Perdue site (by road)	
Reservoir:	
Existing:	*Miles*
Deer Creek	40
Strawberry	50
Echo	30
East Canyon	40
Proposed:	
Jeremy	30
Lost Creek	45

These areas, existing and proposed, have all been described in this report. Granting that there is overlap in mileage estimates for relative spheres of population influence, it is believed that the local sphere indicated for the Perdue Reservoir will be of primary influence for that reservoir, but that same attendance will come from beyond. On this basis and considering the local population at about 13,000, it is estimated that some 8,000 visits could be expected at this site annually,

providing, of course, that suitable recreational development is realized as recommended and that operation of the reservoir is compatible with such use.

Estimate of recreational need and use

While it is not anticipated that the Perdue Reservoir will provide a recrational outlet for all general recreational purposes, it is recognized that it would have value for fishing, boating, camping, and picnicking, and perhaps some swimming. Use currently made of the area is indicative of need which may be served by limited developments. According to report, fishermen now come from Salt Lake City and Provo. While it is expected that some of the attendance from those cities may gradually be diverted to other reservoirs, there does seem to be a need for recreational development at the Perdue site if quality fishing is maintained after impoundment. The general local use anticipated as well as the limited patronage from beyond the local area should warrant the provision of limited recreational facilities, primarily for week-end and vacation use but not entirely excluding day use.

Recommended recreational development

With the purpose of accommodating the local patronage expected in the area after impoundment, it is recommended that facilities include the following:

(*a*) Boating: For small boats only and chiefly for rowboats with a few outboards. Limited facilities for launching, repair, and service should be sufficient.

(*b*) Picnicking: Including tables, fireplaces, potable water, garbage disposal, and pit toilets. There should be suitable locations for picnicking along the edge of the reservoir near the road, regardless of which side relocation takes place. Other picnic sites should appear further up the valley beyond the mud flat area, possibly in connection with camp site developments.

(*c*) Camping: There may be limited space for camping along the edge of the reservoir, but relocation of the road will largely determine the access to such potential sites. It might be desirable to develop some camp sites farther up the valley beyond the mud flat area of the reservoir but yet within convenient access of the reservoir.

The valley is broad and sufficiently flat above the reservoir area to develop play areas in connection with camping developments and to allow for some cabin sites if requested.

Lodge accommodations for week-end and vacation visitors could augment use of that type considerably and could be provided on a small scale at the beginning.

Recommended land acquisition

Until definite information is available on the rerouting of the county road, it will be difficult to choose and recommend actual recreational development sites for acquisition. At such time as this information is available, including definite recommendations from the sponsor concerning boundaries for primary project purposes, it should be possible for the National Park Service to make specific recommendations for additional lands required for recreational development purposes.

In the meantime, it is desirable to realize the importance of securing sufficient lands for recreational use at the time other lands are acquired.

Estimated cost of development

It is estimated that facilities recommended could be provided for approximately $90,750 in round figures. This includes $60,500 for nonrepayment items and $30,250 for repayment features. Providing the recreational developments are administered by the Forest Service and the area is integrated into the over-all program of recreational maintenance and administration of the Wasatch National Forest, it is believed that additional expense for that purpose could be covered by $1,700 annually for this area.

Recommended agency for administration

Present indications point toward possible Forest Service administration of recreational phases at Perdue. This is predicated upon the probability of the reservoir filling to the boundary of the Wasatch National Forest in at least one area near the dam site. Recent agreements between the United States Forest Service and the Bureau of Reclamation indicate that in such cases the Forest Service can administer lands which are not used in connection with reclamation works. Later phases of study will, of course, produce a more specific basis for making final agreements upon ultimate administration.

APPENDIX

TO

NATIONAL PARK SERVICE REPORT

63961—50——11

SUMMARY

Recreational use and development costs, Weber Basin Project

Reservoir	Estimated visits	Estimated cost of development	Estimated annual operation and maintenance
Willard Bay	150,000	$319,000	$6,000
Pineview	200,000	377,500	6,000
Magpie	75,000	142,000	5,200
Lost Creek			
Jeremy	75,000	257,500	5,400
Perdue	8,000	90,750	1,700
Total		[1] 1,186,750	24,300

[1] This amount represents the "judgment value" of the National Park Service for the Weber Basin project. When adequately developed for recreational purposes, additional values in a like amount should also be realized, the total of which or $2,374,000 represents, in monetary terms, the benefits which could accrue to the project as a result of recreational development and use. Individual values for each reservoir may, of course, be calculated in a similar manner. In the case of alternate sites such as the Perdue and Chalk Creek sites, it will be necessary to reduce the total figure for the project by the amount of the value attributed to the abandoned site, i. e. using only the values allocable to sites finally selected.

Recreational development and annual cost, Weber Basin project, Utah

WILLARD RESERVOIR

	Cost	Annual cost
A. Nonrepayment items:		
Roads, access and parking areas	$25,000	
Boating facilities	12,500	
Beach development	4,000	
Picnic facilities	8,000	
Camping area	18,000	
Utilities, water, sewerage systems, power	23,000	
Public toilets	8,000	
Utility area	8,500	
Planting	6,500	
Miscellaneous	1,000	
Subtotal	114,500	
Contingencies, 10 percent	11,450	
Subtotal	125,950	
Plans, surveys, supervision of construction, 25 percent	31,487	
Total nonrepayment cost (rounded $157,500)	157,437	
B. Repayment items:		
Lodge and appurtenances	100,000	
Bath house	25,000	
Custodian's quarters	8,500	
Subtotal	133,500	
Contingencies, 10 percent	13,350	
Subtotal	146,850	
Plans, surveys, supervision of construction 10 percent	14,685	
Total repayment cost (rounded $161,500)	161,535	
C. Administration, operation, and maintenance:		
Salary (ranger-manager, part time)	3,000	
Salary, labor (part time)	1,800	
Equipment (partly prorated)	700	
Materials, supplies, etc	500	
Total annual operation and maintenance	6,000	$6,000

Recreational development and annual cost, Weber Basin project, Utah—Continued

PINEVIEW RESERVOIR

	Cost	Annual cost
A. Nonrepayment items:		
Roads, access and parking areas	$20,000	
Boating facilities	25,000	
Beach developments	5,000	
Picnic facilities	10,000	
Camping areas	10,000	
Utilities, water, sewerage, power	30,000	
Public toilets	15,000	
Utility area	10,000	
Planting	5,000	
Miscellaneous	500	
Subtotal	130,500	
Contingencies, 10 percent	13,050	
Subtotal	143,550	
Plans, surveys, supervision of construction, 25 percent	35,887	
Total nonrepayment cost (rounded $179,500)	179,437	
B. Repayment items:		
Lodge and appurtenances	100,000	
Bath house (2)	25,000	
Custodian's quarters [1]	8,500	
Group camp	30,000	
Subtotal	163,500	
Contingencies, 10 percent	16,350	
Subtotal	179,850	
Plans, surveys, supervision of construction, 10 percent	17,985	
Total repayment cost (rounded $198,000)	197,835	
C. Administration, operation and maintenance:		
Salary (ranger-manager, part time)	3,000	
Salary (laborer, part time)	1,800	
Equipment (prorated)	700	
Materials, supplies, etc	500	
Total annual operation and maintenance	6,000	$6,000

MAGPIE RESERVOIR

A. Nonrepayment items:		
Roads, access and parking areas	$20,000	
Boating facilities	10,000	
Beach development	3,000	
Picnic facilities	5,000	
Camp grounds	10,000	
Utilities, water, and sewerage system (including toilet facilities)	25,000	
Planting	5,000	
Miscellaneous	500	
Subtotal	78,500	
Contingencies, 10 percent	7,850	
Subtotal	86,350	
Plans, surveys, and supervision of construction, 25 percent	21,587	
Total nonrepayment cost (rounded $108,000)	107,937	

[1] It could possibly be feasible to provide only one set of housing accommodations at either Willard or Pineview, but pending arrangements for such an agreement provision is included for both reservoirs.

Recreational development and annual cost, Weber Basin project, Utah—Continued

MAGPIE RESERVOIR—Continued

	Cost	Annual cost
B. Repayment items:		
Bath shelter	$8,000	
Group camp	20,000	
Subtotal	28,000	
Contingencies, 10 percent	2,800	
Subtotal	30,800	
Plans, surveys, and supervision of construction, 10 percent	3,080	
Total repayment cost (rounded $34,000)	33,880	
C. Administration, operation, and maintenance:		
Salary (ranger-manager, part time)	2,500	
Salary (laborer, part time)	1,500	
Equipment (prorated)	700	
Materials, supplies, etc	500	
Total annual operation and maintenance	5,200	$5,200

JEREMY RESERVOIR

A. Nonrepayment items:		
Roads, access and parking areas	$20,000	
Boating facilities	10,000	
Picnic facilities	10,000	
Camping area	10,000	
Utilities, water, sewage, power (including toilet facilities)	25,000	
Utility area	15,000	
Planting	1,000	
Miscellaneous	500	
Subtotal	91,500	
Contingencies, 10 percent	9,150	
Subtotal	100,650	
Plans, surveys, and supervision of construction, 25 percent	25,162	
Total nonrepayment cost (rounded $126,000)	125,812	
B. Repayment items:		
Lodge and concession	100,000	
Manager's quarters	8,500	
Subtotal	108,500	
Contingencies, 10 percent	10,850	
Subtotal	119,350	
Plans, surveys, supervision of construction, 10 percent	11,935	
Total repayment costs (rounded $131,500)	131,285	
C. Administration, operation, and maintenance:		
Salary (manager)	3,600	
Salary, laborer (part time)	1,200	
Equipment (prorated)	300	
Materials, supplies, etc	300	
Total annual operation and maintenance	5,400	$5,400

Recreational development and annual cost, Weber Basin project, Utah—Continued

PERDUE RESERVOIR

	Cost	Annual cost
A. Nonrepayment items:		
Roads, access and parking areas	$15,000	
Boating facilities	5,000	
Picnic facilities	5,000	
Camping areas	10,000	
Pit toilets	4,500	
Potable water	3,000	
Planting	1,000	
Miscellaneous	500	
Subtotal	44,000	
Contingencies, 10 percent	4,400	
Subtotal	48,400	
Plans, surveys, and supervision of construction, 25 percent	12,100	
Total, nonrepayment items	60,500	
B. Repayment items:		
Lodge and concession	25,000	
Contingencies, 10 percent	2,500	
Subtotal	27,500	
Plans, surveys, supervision of construction, 10 percent	2,750	
Total repayment cost	30,250	
C. Administration, operation, and maintenance:		
Salary, laborer (part time)	1,200	
Equipment (prorated)	300	
Material, supplies, etc	200	
Total annual operation and maintenance	1,700	$1,700

FISH AND WILDLIFE SERVICE REPORT

FISH AND WILDLIFE SERVICE REPORT

UNITED STATES DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE,
Albuquerque, N. Mex., June 15, 1949.

Mr. E. O. LARSON,
Regional Director, Region 4,
Bureau of Reclamation, Salt Lake City, Utah.

DEAR MR. LARSON: Pursuant to your request, made during a meeting in your office with Messrs. Burwell and Romero of our Service on June 7, 1949, there are furnished below the tentative views and opinions of our Service with respect to the fish and wildlife aspects of your proposed plan for the ultimate development of the Weber River Basin, Utah.

The Weber River and its principal tributary, the Ogden River, originate in the mountains to the east of the precipitous Wasatch Range in northern Utah. The Weber River flows in a northwesterly direction and cuts through the Wasatch Front Range southeast of the city of Ogden. The Ogden River flows in a westerly direction, cutting through the Wasatch Range east of Ogden to join the Weber River within the city limits. From this point, the stream flows into the Great Salt Lake at the site of the Ogden Bay Bird Refuge.

Flows of the Weber River without the project will be greatly decreased by a diversion from the Weber to the Provo River as part of the operation of the Deer Creek project now under construction. This diversion could shut off the flow of the Weber River at the diversion site and alter the operation of the existing Echo Reservoir to such an extent that adequate flows on the Weber River below Echo Reservoir and the diversion could not be assured.

There are at present on the Weber River system a number of irrigation and power developments which affect fisheries. They are principally the three major reservoirs: The Pine View Reservoir on the Ogden River, the Echo Reservoir on the Weber River, and the East Canyon Reservoir on East Canyon Creek above the town of Morgan. The Utah Power & Light Co. has a diversion, penstock, and power plant on the Weber River where it cuts through the Wasatch Range and another on the Ogden River utilizing the Pine View Reservoir water supply. There are also several smaller reservoirs and irrigation diversions along the Weber and Ogden Rivers from the towns of Kamas and Huntsville to the salt flats of the Great Salt Lake, with the largest existing irrigation developments on the lowlands west of the Wasatch Range.

The Utah State Fish and Game Department operates the Ogden Bay Bird Refuge at the mouth of the Weber River and the Farmington Bay Bird Refuge south of the project on the Jordan River. The Fish and Wildlife Service operates the Bear River Migratory Bird Refuge to the north of the proposed project utilizing water from the Bear River.

Fishery values along the Weber River are relatively high regardless of the present adverse water manipulations for irrigation and power. The fishery will, however, materially deteriorate with the operation of the Deer Creek project which was authorized prior to 1946 and is now nearing completion. Fishing on the Ogden River is already on a put-and-take basis with the Utah State Fish and Game Commission supplying the planting stock. The Weber River, supplemented by the planting program, sustains a fairly heavy fishing pressure.

Existing contracts and water rights have oversubscribed the normal flow of the Weber River throughout the irrigation season. The Bureau of Reclamation proposes to construct six reservoirs on the Weber River system to capture for redistribution the run-off during the nonirrigating season. The anticipated effects of the proposed construction are outlined in the following paragraphs.

Construction of the proposed Perdue Reservoir and power plant on the upper Weber River would provide sustained flows from the power plant to the Echo Reservoir. These flows would be smaller than present flows, but would be greater than can be anticipated with the Deer Creek project in operation, which may cut off Weber River flows below Echo Reservoir. The Lost Creek Reservoir would maintain flows in Lost Creek and some in the Weber River below the Echo Reservoir as far downstream as the proposed Stoddard diversion dam where the entire stream would be diverted for power and irrigation. The Jeremy Reservoir on the headwaters of East Canyon Creek should provide for some additional fishing and would maintain more uniform flows in East Canyon Creek downstream to East Canyon Reservoir, where leakage from the reservoir now provides most of the sustained flows found in East Canyon Creek below the reservoir. Should the water users plug the East Canyon Reservoir seeps, the reach of stream below the dam cannot be assured a continuous water supply but would receive releases principally during the irrigation season. A proposed major diversion of the Weber River at Stoddard would periodically dewater the Weber River below the diversion to the Utah Power & Light Co. plant which already controls the water supply of the river at that point. The present operation of the Slaterville diversion canal below Ogden picks up any residual flows in the Weber and Ogden Rivers for irrigation.

On the Ogden River the Magpie Reservoir and power plant would provide continuous flows suitable for fishing to the Pine View Reservoir which would be enlarged without material change to the fishery in the already intermittent Ogden River. Flows released from the Pine View Reservoir pass through an aqueduct to the power plant northeast of the city of Ogden. Flows passing through this power plant and the Weber River would be stored in a dike-formed reservoir at Willard Bay, which should provide excellent warm-water fishing, but may not materially change the waterfowl and fur animal situations in that area. Some water from the Willard Bay Reservoir might become available to the Bear River Migratory-Bird Refuge.

The effect of the project on existing fish and wildlife values can be determined only after thorough investigations. Such investigations are under way at this time by the Fish and Wildlife Service and the Utah Game and Fish Department; however, sufficient data have not as yet been collected to indicate the full impact that the project would have on these resources.

On the basis of our very preliminary investigations, it appears that the project would reflect losses to big game, which may be compensated by gains in the form of upland-game habitat. Fishery values, on the whole, would probably be reduced, but if necessary sustained stream flows can be included as a part of the project operation, it is entirely possible that the project may result in a benefit to fish and wildlife. We urge that consideration be given to the maintenance of stream flows, to be predicated on later, more detailed studies by the Service and the Utah Game and Fish Department, in the reaches of the affected streams below each of the proposed dams and diversion structures, and below the existing Echo, Pine View, and East Canyon Reservoirs where present allowable water manipulations during extensive dry periods would shut off stream flows.

Under postproject conditions, fisheries values could be greatly enhanced if the project operation could be developed to permit releases of water at certain critical periods. We wish to stress this point particularly.

If the Service can furnish you with any additional information on this matter, please do not hesitate to call upon us. In the meantime, we propose to continue our investigations in the Weber Basin project area for the purpose of securing the detailed information necessary to fully consider the fish and wildlife aspects of the project.

Very truly yours,

JOHN C. GATLIN, *Regional Director.*

PUBLIC HEALTH ASPECTS OF THE WEBER BASIN PROJECT

MAY 1949

BY

C. T. WRIGHT, REGIONAL ENGINEER
PUBLIC HEALTH SERVICE, REGION 9
FEDERAL SECURITY AGENCY

DENVER 2, COLO.

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PUBLIC HEALTH ASPECTS OF THE WEBER BASIN PROJECT

The Weber Basin project area, located in the north-central portion of the State of Utah, covers approximately 2,500 square miles, or 3 percent of the total area of the State. The area is part of the Bonneville Basin, comprising the drainage basins of the Weber River and a series of small streams draining the western slope of the Wasatch Mountains and flowing directly into Great Salt Lake. The west flank of the Wasatch Mountains, commonly called the Wasatch Front, partitions the Weber Basin into two general areas. To the west of the mountainous recline is a generally sloping area bordered on the west by Great Salt Lake. The major part of the agricultural and industrial development of the area, as well as 90 percent of the existing population of about 127,000, is concentrated in this section of the basin. East of the Wasatch Front, the area is mountainous with a few small valleys where agricultural lands are situated.

The plan of development for the Weber Basin project involves the construction of five reservoirs and enlargement of the existing Pineview Reservoir to regulate the widely fluctuating flows of Weber Basin streams for irrigation, municipal use, flood control, power production, fish and wildlife, and recreation. The project also involves the construction of three power plants, four diversion dams, and approximately 100 miles of canals, conduits, and tunnels. The attached map of the Weber Basin shows the location of these features.

A preliminary sanitary survey of the Weber River Basin was made during October 1948 to evaluate public-health problems to be encountered in connection with the development of the Weber Basin project, and the following discussion is based on observations that were made during the survey.

WATER SUPPLIES

The small communities in the upper Weber Basin have adequate water supplies for present needs and are assured a sufficient future supply for anticipated growth without having to rely on water from the Weber Basin development. However, ample water supplies of satisfactory quality are essential to future industrial development and growth of Wasatch Front communities from Brigham City south to Bountiful. Most of the communities in this area have developed beyond the safe limits of their existing water-supply systems. The springs, deep wells, and unregulated minor Wasatch front streams that serve as sources of supply for most of these communities are considered inadequate during periods of low rainfall and dry years. The population in the Wasatch Front communities has increased from 75,000 in 1940 to an estimated 115,000 in 1947, emphasizing the acute need for expanding the water-supply systems of these communities.

Present growth trends indicate a future population of at least double the present 115,000 persons. This can be justified by the planned

industrial expansion in the Provo, Salt Lake City, and Ogden areas. Studies based on a population increase to more than 200,000 within the period of project development indicate that at least 40,000 acre-feet of water must be developed for municipal and industrial use. These studies further revealed that at least 12,000 acre-feet of water should be developed immediately to maintain the rapid growth of Wasatch Front communities.

Sixteen communities in Davis County, and eight in Weber County that are faced with water shortages, have organized the Davis-Weber Counties Municipal Water Development Association for the purpose of financing a study of their water requirements. The report covering the studies has been released and plans are under way to form a metropolitan water district for the purpose of assisting in financing the water-purification plants and distribution systems required to supply supplemental water to these communities from the Weber River.

Municipal water will be diverted from the main stem of the Weber River at the Stoddard diversion dam from where it will flow through the Weber and Davis aqueducts en route to three turn-out points. The Weber aqueduct will convey the water 14½ miles to the mouth of Weber Canyon where the Weber and Davis aqueducts join. One-half of the water would be made available through the Weber aqueduct for use in Ogden and other communities in Weber County, and the remaining half would be made available through the Davis aqueduct for use by communities in Davis County. The treatment plants and distribution systems will be financed independently by the municipalities in the lower basin. Tentative plans call for the installation of three treatment plants—two along the Davis aqueduct, and one at the terminal of the Weber aqueduct.

Observations of the source of water supply indicate that the treatment plants should be provided with facilities for coagulation, sedimentation, rapid sand filtration, and postchlorination of the final effluent. Since adequate treatment under proper operation will provide water that meets the Public Health Service drinking water standards consistently, this source is considered desirable for both domestic and industrial purposes. A series of samples should be collected from the Weber River at the proposed point of diversion for chemical analysis. Samples collected under varying stream-flow conditions will provide data that will be of assistance in determining the extent of treatment that will be required to meet accepted standards.

The sources of water supply and methods of water treatment for the principal communities in the Weber Basin are listed in table I.

TABLE I.—*Water-supply systems, Weber River Basin*

Community	Population, 1940	Source of supply	Treatment
Bountiful	3,357	Creeks and deep wells	Disinfection of surface supplies.
Brigham City	5,641	Spring and deep wells	None.
Centerville	691	Creek and deep well	Disinfection.
Clearfield	1,053	Creek, spring, and deep well	Do.
Clinton	581	Springs	None.
Coalville	949	do	Do.
Devil's Slide	300	do	Do.
Echo	150	do	Do.
Eden	300	Spring	Do.

TABLE I.—*Water-supply systems, Weber River Basin*—Continued

Community	Population, 1940	Source of supply	Treatment
Farmington	1,211	Creek and springs	Disinfection.
Henefer	335	Springs	None.
Huntsville	496	do	Do.
Kamas	683	do	Do.
Kaysville	1,211	Springs and creek	Disinfection.
Layton	646	Creeks and infiltration gallery	Do.
Laytona	356	Springs	None.
Liberty	240	North Fork Ogden River	Do.
Morgan	1,078	Springs and deep well	Disinfection.
Oakley	305	Springs	None.
Ogden	43,688	Artesian wells and creeks	Disinfection.
North Ogden	687	Springs	None.
South Ogden	1,407	Creeks	Disinfection.
Park City	3,739	Spring and mine tunnel	None.
Peoa	260	Spring	Do.
Perry	383	Springs and deep well	Do.
Porterville	350	Springs	Do.
Richville	125	do	Do.
Roy	998	Springs and well	Do.
Sunset	276	Deep wells	Do.
Syracuse	732	Deep well	Do.
Uintah	264	Stream	Do.
Wanship	175	Springs	Do.
West Point	236	Deep well	Do.
Willard	541	Spring	Do.
Woodland	165	Springs	Do.
Military establishments:			
Hill Field	----------	Deep wells	Disinfection.
Ogden Arsenal	----------	Springs	Do.
Clearfield Naval Base	----------	Deep wells	None.

In general, all surface-water supplies for domestic purposes are obtained from tributaries of the Weber River or Wasatch Front streams that flow directly into Great Salt Lake above major sources of pollution. Under these conditions, it is possible to provide safe water with a limited degree of treatment. The high mineral content of the deep-well water supplies makes this source less desirable for domestic and industrial purposes without extensive treatment, including water softening in some cases.

STREAM-POLLUTION PROBLEMS

The discharge of untreated and partially treated domestic and industrial waste is responsible for the pollution of the Weber River and some of its tributaries. Since the major portion of the stream flow in the basin is appropriated for irrigation and domestic purposes, this problem is of special importance from a public-health standpoint. The irrigation of truck crops such as celery, cabbage, lettuce, and berries with water that has been polluted with domestic wastes is considered a health hazard when these products are consumed in the uncooked state.

The sewerage systems and the methods of treatment for the principal communities in the Weber Basin are listed in table II.

TABLE II.—*Sewerage systems and treatment plants, Weber River Basin*

Community	Population, 1940	Type sewer system	Treatment	Discharge to—
Brigham City	5,641	Separate (sanitary sewage and industrial wastes).	Primary treatment	Irrigation ditch.
Clearfield	1,053	do	None	Great Salt Lake through north Davis City metropolitan sewer.
Clinton	581	do	do	Do.
Devils Slide	300	do	Primary treatment	Weber River.
Farmington	1,211	do	do	Irrigation ditch.
Henefer	335	do	Complete treatment	Weber River.
Kaysville	1,211	do	Primary treatment	Irrigation ditch.
Layton	646	do		Great Salt Lake through north Davis City metropolitan sewer.
Laytona	356	do	None	Do.
Ogden	43,688	do	do	Weber River.
Park City	3,739	do	do	Silver Creek.
Roy	998	do	do	Great Salt Lake through north Davis City metropolitan sewer.
South Ogden	1,407	do	Primary treatment	Weber River.
Sunset	276	do	None	Great Salt Lake through north Davis City metropolitan sewer.
Syracuse	73?	do	do	Do.
West Point	23?	do	do	Do.
Military establishments:				
Hill Field		do	do	Do.
Ogden Arsenal		do	do	Do.
Clearfield		do	do	Do.
Naval base		do	do	Do.

The pollution of the Weber River and its tributaries above the proposed point of diversion for irrigation and municipal purposes is very limited due to the fact that all of the larger communities are located below this point. Of the seven communities located above the proposed point of diversion, Park City (population 3,739), Devils Slide (population 300), and Henefer (population 335) are the only communities with sewerage systems, and Devils Slide and Henefer are the only communities where treatment has been provided.

All domestic and industrial wastes that originate in this area should be adequately treated prior to being discharged into adjoining streams in order to protect the sources of water supply for irrigation and domestic purposes.

The discharge of untreated domestic and industrial wastes into the Weber River by Ogden, the largest city in the basin, is responsible for extensive pollution of the river below the city. Reports reveal that water from this source is diverted for irrigation purposes.

Three Wasatch Front communities with 1940 populations of 5,641, 1,211, and 1,211 convey their wastes to septic tanks from where the effluents flow to adjoining irrigation ditches. The treatment being provided is considered wholly inadequate and the irrigation ditches involved are subject to extensive pollution under these conditions.

The following communities and military establishments that discharge their wastes to the Great Salt Lake through the north Davis County metropolitan sewer do not create a pollution problem in the

Weber Basin: Clearfield, Clinton, Layton, Laytona, Roy, Sunset, Syracuse, West Point, Hill Field, Ogden Arsenal, and Clearfield Naval Base.

The extent to which irrigation waters are polluted in the Weber River Basin depends upon the volume of domestic and industrial wastes discharged, the degree of treatment provided, and the dilution available in the receiving stream. The Weber River below Ogden is the most critical area from the standpoint of pollution due to the untreated wastes that are discharged into the stream at Ogden. The discharge of partially treated wastes from Brigham City, Farmington, and Kaysville creates a local pollution problem of importance because these wastes are used for irrigation purposes.

The pollution problem will become more acute in the future with the increase in population and industrial expansion unless a water-pollution abatement program is initiated in the near future. The problem referred to can be solved only by proper treatment of all domestic and industrial wastes prior to final disposal. Since water-pollution abatement is a responsibility of the State and local health authorities, every effort should be made by the agencies involved to solve these problems prior to the development of the Weber Basin project.

RECREATIONAL AREAS

The proximity of the mountainous areas of the Weber Basin to large centers of population will increase the demand for the development of recreational facilities in the area. The construction of new storage reservoirs in the basin will enhance the adjacent watersheds as sites for picnic areas, camp sites, and summer homes, and provide opportunities for boating, fishing, and swimming.

Areas in the vicinity of Perdue, Magpie, and Jeremy Reservoirs, and Willard Bay appear to be the most desirable for recreational development. The watershed of Pineview Reservoir, including the area above the proposed Magpie Reservoir, has been extensively developed for recreational purposes.

The development of recreational facilities in the vicinity of existing and proposed impoundments may create public health problems if accepted sanitary standards are not enforced. In addition to the possible effects of these installations on the use of the impounded waters for domestic water supplies or for irrigation purposes, there are problems incident to the protection of the public health of those utilizing the recreational facilities. These problems include a safe and ample water supply, proper sewage disposal, adequate garbage and refuse disposal, insect and rodent control, proper food-handling facilities, and a safe source of milk supply. Proper design, construction, and operation of resorts, tourist courts, fishing camps, private cabins, boating and bathing facilities are essential both for the protection of the visitors and for the maximum benefit of subsequent water users. Sanitary requirements recommended by the Public Health Service or the State department of public health should be adopted to cover the public-health problems referred to.

MOSQUITO CONTROL

The development of the Weber Basin project may increase the population of mosquito vectors of certain diseases endemic within the boundaries of the project. These increases will probably not be significant over the whole project area. However, unless proper considerations are included in the project, there is a possibility that in certain locations these increases will be of considerable importance. Determinations of existing conditions relative to mosquito species and densities are necessary for proper evaluation of the future developments that may grow out of the project. Investigations for such purposes should be made by public-health authorities and completed in sufficient time to permit actions which will tend to minimize mosquito production where such action is deemed important to public health.

CONSTRUCTION PHASE OF PROJECT

Sanitary surveys of proposed construction camps would be of considerable value in revealing public-health problems which may arise during the construction phase of the project. The influx of construction workers into an area without proper facilities to care for their needs or to provide for their families can create public-health problems involving proper medical care and the provision of adequate sanitary facilities. Problems which may be encountered will include adequate housing, development of a safe and ample water supply, proper sewage disposal, insect and rodent control, adequate garbage and refuse disposal, proper operation and maintenance of adequate food-handling facilities, a safe source of milk supply, and adequate medical care.

In connection with industrial-health hazards that may be encountered on construction projects, provisions should be made for the prevention of health hazards and accidents and the treatment of injuries.

Advice and assistance regarding the procedure to be followed in solving the public-health problems referred to can be obtained from the Public Health Service, Federal Security Agency, and the State department of public health.

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