Credit: *Pacific Gas and Electric Company*

Bear River Canal Near Colfax

STATE OF CALIFORNIA
GOODWIN J. KNIGHT
GOVERNOR

PUBLICATION OF
STATE WATER RESOURCES BOARD

Bulletin No. 10

PLACER COUNTY INVESTIGATION

June, 1955

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GOVERNOR

STATE OF CALIFORNIA

STATE WATER RESOURCES BOARD

PUBLIC WORKS BUILDING
SACRAMENTO 5, CALIFORNIA

June 30, 1955

ADDRESS ALL COMMUNICATIONS TO THE SECRETARY

HONORABLE GOODWIN J. KNIGHT, *Governor, and*
Members of the Legislature of the
State of California

GENTLEMEN: I have the honor to transmit herewith Bulletin No. 10 of the State Water Resources Board, entitled "Placer County Investigation," as authorized by Chapter 1514, Statutes of 1945, as amended.

The Placer County Investigation was conducted and Bulletin No. 10 was prepared by the Division of Water Resources of the Department of Public Works, under the direction of the State Water Resources Board.

Bulletin No. 10 contains an inventory of the surface and underground water resources of Placer County, estimates of present and probable ultimate supplemental water requirements, and preliminary plans and cost estimates for water development works.

Very truly yours,

Clair A. Hill

Clair A. Hill
Chairman

ACKNOWLEDGMENT

Valuable assistance and data used in the investigation were contributed by agencies of the Federal Government, cities, counties, public districts, and by private companies and individuals. This cooperation is gratefully acknowledged.

Special mention is also made of the helpful cooperation of the Board of Supervisors of Placer County, the Placer County Water Committee, the Nevada Irrigation District, and the Pacific Gas and Electric Company.

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CHAPTER I

INTRODUCTION

Placer County, in common with many other parts of California, has recently experienced an increase in water utilization, and as a result is confronted with a need for more complete conservation of its water resources. An accelerated increase in ground water use on the valley floor in recent years, combined with progressive lowering of pumping levels, has brought about local concern regarding the adequacy of the ground water resources. Furthermore, increased demands on the water supplies originating in the area by agencies situated outside the area have brought about local concern regarding the sufficiency of the water supply to meet both future needs of the area and the increasing demands of these agencies.

AUTHORIZATION FOR INVESTIGATION

In consideration of the need for more complete conservation of its water resources and concern over progressive lowering of ground water levels together with increased demands on local supplies by agencies outside the area, a representative of the Board of Supervisors of Placer County appeared before the State Water Resources Board at Sacramento on September 3, 1948, and proposed a state-county cooperative survey of the water supply and water conditions in Placer County. The Board referred the request to the State Engineer for preliminary examination and report on the need for such an investigation, and an estimate of its scope, duration, and cost.

The State Water Resources Board on October 1, 1948, approved a recommendation by the State Engineer, based on findings of the preliminary examination, for a three-year cooperative investigation, and authorized negotiation of an agreement with local agencies. The agreement, between the State Water Resources Board, the County of Placer, and the State Department of Public Works acting through the agency of the State Engineer, was executed on December 23, 1948. It provided that the work under the agreement

> "shall consist of an investigation and report on the water resources of Placer County, both surface and underground, comprising (a) an inventory of the water resources of the county, (b) a classification of lands for agricultural use, (c) a survey of the location, extent and type of use of water under existing conditions, (d) an estimate of water requirements under ultimate development of the county, and (e) a general plan for the ultimate development and utilization of the water resources in or available to said county and estimates of the cost of such a plan."

This agreement authorized the provision of funds to meet the costs of investigation for one year. A supplemental agreement executed by the same parties on November 21, 1949, authorized funds to meet the costs of the investigation for the second year. A second supplemental agreement executed on November 9, 1950, authorized funds to complete the investigation and bulletin.

Funds to meet the costs of the investigation and bulletin to the extent of $59,000 were provided as follows: State of California (State Water Resources Board), $29,500; County of Placer, $29,500. Additional funds have been expended in investigation of Placer County by the State Water Resources Board in connection with the current State-wide Water Resources Investigation, authorized by Chapter 1541, Statutes of 1947, and by the State Division of Water Resources in connection with the "Survey of Mountainous Areas," authorized by Chapter 30, Statutes of 1947, as mentioned hereinafter.

Copies of the agreements between the State Water Resources Board, the County of Placer, and the Department of Public Works, are included as Appendix A.

The State Water Resources Board, at its regular meeting on July 2, 1954, approved release of the preliminary draft of Bulletin No. 10, "Placer County Investigation," to concerned agencies for their review and comment. Comments were received from seven agencies, and are included in Appendix C. These comments were reviewed, and suggested changes in the bulletin were adopted where it was considered they would improve it, and where the Division of Water Resources was in agreement with the changes suggested.

RELATED INVESTIGATIONS AND REPORTS

The following reports of prior investigations, containing information pertinent to evaluation of water resources and water problems in Placer County, were reviewed in connection with the current investigation:

Board of Consulting Engineers. "Proposed Silver Creek Project." Sacramento Municipal Utility District. January, 1927.

Bonner, Frank E. "Report to the Federal Power Commission on the Water Powers of California." Federal Power Commission. 1928.

Bryan, Kirk. "Geology and Ground Water Resources of the Sacramento Valley, California." United States Department of the Interior, Geological Survey. Water-Supply Paper 495. 1923.

California Power Board. "Report to the Federal Power Commission on the Uses of the American River, California." Federal Power Commission. 1927.

California State Department of Public Works, Division of Engineering and Irrigation. "Flow in California Streams." Bulletin No. 5. 1923.

———. "Irrigation Requirements of California Lands." Bulletin No. 6. 1923.

California State Department of Public Works, Division of Water Resources. "A Proposed Major Development on American River." Bulletin No. 24. 1929.

———. "Report to Legislature of 1931 on State Water Plan." Bulletin No. 25. 1930.

———. "Sacramento River Basin." Bulletin No. 26. 1931.

———. "Permissible Economic Rate of Irrigation Development in California." Bulletin No. 35. 1930.

———. "Irrigation Requirements of California Crops." Bulletin No. 51. 1945.

California State Water Resources Board. "Water Resources of California." Bulletin No. 1. 1951.

———. "Sutter-Yuba Counties Investigation." Bulletin No. 6. September, 1952.

Central Valley Regional Water Pollution Control Board. "Pollution Study, American River, Sacramento River Watershed." January, 1952.

Cosby, Stanley W., Watson, E. B., and Harper, W. G. "Soil Survey of the Auburn Area, California." United States Department of Agriculture, Bureau of Chemistry and Soils, in Cooperation With University of California Agricultural Experiment Station. 1928.

Means, Thomas H. "Bear River Development in Connection With Irrigation in Nevada and Placer Counties." February, 1927.

State Engineers of Nevada and California. "Joint Report on the Use of Water in the Lake Tahoe Watershed." June, 1949.

Tibbetts, Fred H. "Report to the Nevada Irrigation District, Nevada County, California, on Water Supply, Power Development, and Irrigation Distribution." February, 1922.

———. "Report of the District's Engineer to the Nevada Irrigation District, Nevada County, California, on Proposed Irrigation System." April, 1924.

———. "Report to the Board of Directors of the Nevada Irrigation District on Completion of Irrigation System, Particularly in Placer County." June, 1927.

———. "Supplemental Report to the Board of Directors of the Nevada Irrigation District on Proposed Irrigation System." November, 1927.

United States Department of Agriculture, Bureau of Agricultural Economics. "Sacramento Valley Water Investigation, Agricultural Aspects." Mimeographed. March, 1944.

The Division of Water Resources is presently conducting surveys and studies for the State-wide Water Resources Investigation, authorized by Chapter 1541, Statutes of 1947. This investigation, under direction of the State Water Resources Board, has as its objective the formulation of The California Water Plan for full conservation, control, and utilization of the State's water resources to meet present and future water needs for all beneficial purposes and uses in all parts of the State insofar as practicable. Surveys and studies of the mountainous areas are also being conducted by the Division of Water Resources as authorized by Chapter 30, Statutes of 1947. This investigation, which is coordinated with the state-wide investigation, has as its primary objective the determination of probable ultimate water requirements of certain counties of the Sierra Nevada, and the formulation of plans for projects which will meet those requirements. Results of both of the foregoing investigations will have direct bearing on solutions of the water problems of Placer County, particularly with regard to plans to meet supplemental water requirements of the county under ultimate conditions of cultural development.

SCOPE OF INVESTIGATION AND REPORT

It has been stated that under provisions of the authorizing agreements the general objectives of the Placer County Investigation included investigation and study of the water supply, both surface and underground, in and available to the county, a classification of lands for agricultural use, a survey of the location, extent, and type of use of water under present conditions, an estimate of water requirements under ultimate development, and a general plan for the ultimate development and utilization of the water resources of the county and estimates of the cost of such a plan. In attaining these objectives it was necessary that the scope of the investigation include full consideration of surface and ground water supplies, and determination of present and ultimate water utilization and supplemental water requirements.

Field work in the investigational area and office studies, as authorized by the initial and supplemental cooperative agreements, commenced in December, 1948, and continued into 1953.

In the course of the investigation, available precipitation and stream flow records, including records of flow of water in canals, were collected and compiled in order to evaluate water supplies available to the investigational area. Four stream gaging stations were installed and maintained to supplement the available hydrographic data. These stations were on Auburn Ravine at U. S. Highway 99E, Coon Creek at U. S. Highway 99E, Linda Creek at Roseville, and Reclamation District No. 1001 Channel at Pacific Avenue. The gaging stations installed on Auburn Ravine and Coon Creek were also utilized in studies for the Sutter-Yuba Counties Investigation.

The ground water storage capacity and yield, and geologic features of the ground water basin underlying the valley floor of the investigational area were investigated and reported on by the Ground Water Branch of the United States Geological Survey in its report on "Ground-Water Storage Capacity of the Sacramento Valley, California." This report is included as an appendix to Bulletin No. 1 of the State Water Resources Board, "Water Resources of California." Additional geologic data resulting from investigation by the Ground Water Branch of the Geological Survey covering portions of Placer County are contained in an appendix to Bulletin No. 6 of the State Water Resources Board, entitled "Sutter-Yuba Counties Investigation." The foregoing data, supplemented by additional geologic data resulting from investigation by the Division of Water Resources, were utilized in the preparation of a geologic report covering Placer County, which is included as Appendix B of this bulletin.

The effects of draft on the replenishment of the ground water basin were determined by measurements of static ground water levels made at about 180 wells during each spring and fall of the period of investigation. These wells were chosen to form a comprehensive measuring grid over the entire area. Wells in an adjacent area in Sutter County were similarly measured, since data on them were required in hydrologic studies of Placer County. In addition, measurements to determine monthly fluctuations of water levels were made at approximately 35 control wells.

Present land use in the investigational area was determined by a complete survey of all lands in the county lying outside the boundaries of the Tahoe and El Dorado National Forests. This survey was conducted in 1949. The total area surveyed was about 648,000 acres. The land use survey data were used in conjunction with available data on unit water use to determine total present water utilization in the county. Information on the extent of irrigated lands in the national forests in Placer County was furnished by the United States Forest Service. The valley floor lands, comprising about 110,000 acres, were resurveyed in 1950 and again in 1951 to obtain data on changes in land use.

In order to estimate future water utilization, all lands lying outside the national forests were classified by the Division of Water Resources with regard to their suitability for irrigated agriculture. Data on irrigable lands in the national forests which are not irrigated at the present time were obtained from the Forest Service.

Current irrigation practices in the county were surveyed in order to determine unit application of water to important crops on lands at different elevations and of various soil types. During the 1949 irrigation season, records of application of water were collected at nine plots on the valley floor. In 1950 twenty-six plots were maintained on the valley floor and eleven were maintained in the foothills. In 1951 eighty plots were maintained on the valley floor, and four small watershed studies were made in the foothills. The data collected included records of water application, acreage served, crops irrigated, and in some instances the quantity of water wasted from plots.

Studies were made of the mineral quality of surface and ground waters in order to evaluate their suitability for irrigation use. Data used in these studies included 218 partial and 29 complete mineral analyses of ground water. In addition, data included 44 partial and 39 complete mineral analyses of surface water supplies.

Field reconnaissance surveys, topographic surveys, and geologic examinations were made to locate and evaluate possible dam and reservoir sites for conservation of surface runoff. Reconnaissance surveys were also made of possible routes for conveyance of water to areas of use.

Results of the Placer County Investigation are presented in this bulletin in the four ensuing chapters. Chapter II, "Water Supply," contains evaluations of precipitation, surface and subsurface inflow and outflow, and imports of water. It also includes results of investigation and study of the ground water basin, and contains data regarding mineral quality of surface and ground waters. Chapter III, "Water Utilization and Supplemental Requirements," includes data and estimates of present and probable ultimate land use and water utilization, and contains estimates of present and probable ultimate supplemental water requirements. It also includes available data on demands for water with respect to rates, times, and places of delivery. Chapter IV, "Plans for Water Development," describes preliminary plans for conservation and utilization of available water supplies to meet supplemental water requirements, including operation and yield studies, design considerations and criteria, and cost estimates. Chapter V, "Summary of Conclusions, and Recommendations," comprises a summary statement of the conclusions resulting from the investigation and studies, together with recommendations for action relating to solution of water problems on the part of concerned local interests.

AREA UNDER INVESTIGATION

The area under investigation comprises all of Placer County and covers about 965,000 acres, including about 49,000 acres of water surface.

Placer County is situated on the east side of the lower Sacramento Valley. It extends from a line about 10 miles west of the City of Roseville on the west to the California-Nevada state boundary on the east. Its northern boundary follows the Bear River upstream to its source in Bear Valley and continues easterly to the California-Nevada state boundary. Its southern boundary extends easterly from a point about 10 miles north of the City of Sacramento to a point about two miles north of the City of Folsom, and then follows the North Fork of the American River to the Middle Fork, the Middle Fork to the Rubicon River, and the Rubicon River upstream for about 25 miles, and then runs generally east to the California-Nevada state boundary. The location of Placer County is indicated on Plate 1, entitled "Location of Placer County."

In order to facilitate reference to its several parts and to aid in hydrologic analyses, Placer County was divided into six principal hydrographic units, based on geographical considerations and on respective types of water service and sources of water supply. These were designated "Valley Unit," "Foothill Unit," "American River Unit," "Bear River Unit," "Yuba River Unit," and "Tahoe Unit," and are shown on Plate 2, entitled "Hydrographic Units, Organized Water Agencies, and Existing Water Conservation

Works, 1953.'' The Valley Unit embraces the valley floor of western Placer County, and generally includes all lands below an elevation of about 200 feet. The Foothill Unit comprises the area lying between an elevation of about 200 feet on the west and an elevation of approximately 2,000 feet near Applegate, and extends from the southern boundary of the Bear River watershed on the north to the northern boundary of the American River watershed on the south. The American River Unit extends generally from the vicinity of Auburn on the west to the crest of the Sierra Nevada on the east. It is bounded on the north by the southern boundary of the Bear and Yuba River watersheds and on the south by the southern boundary of Placer County. The Bear River Unit comprises the portion of Bear River watershed lying south of Bear River and extending from the vicinity of Wheatland easterly to below Lake Spaulding. The Yuba River Unit includes the portion of its watershed lying between its southern boundary and the northern boundary of Placer County. The Tahoe Unit extends from the crest of the Sierra Nevada on the west to the California-Nevada state boundary on the east, and is bounded on the north and south by the boundary lines of Placer County.

Natural Features

The western portion of Placer County consists of treeless plains sloping upward to the east. These plains range in elevation from about an average of 60 feet to about 125 feet where they blend into gently rolling hills with scattered oaks. At approximately the 500-foot elevation the oak growth becomes dense, and in its virgin state continues so until it gradually merges with the coniferous forests at about the 1,500- to 2,000-foot elevation. Forests of pine, fir, and cedar extend to the east, broken by the bare granitic peaks of the summit of the Sierra Nevada, which crosses the county from north to south at an elevation of about 9,000 feet. To the east, the elevation drops abruptly to Lake Tahoe at an elevation of about 6,230 feet, and to the Truckee River which drains northward from the lake.

Drainage Basins

The Bear River generally forms the northern boundary of Placer County from Sutter County to its source between Emigrant Gap and Lake Spaulding. Seventy-two square miles of its 295-square-mile watershed above Wheatland lie in Placer County and consist largely of a steep-sloped canyon a few miles in width.

The North and Middle Forks of the American River drain most of the mountainous area of Placer County from their confluence near Auburn eastward to the crest of the Sierra Nevada. The portion of the watershed of the North Fork of the American River below Auburn, and lying in Placer County, consists of a narrow canyon. The total drainage area of the American River watershed above the Fair Oaks stream gaging station is 1,921 square miles, of which 792 square miles are in Placer County.

Lake Tahoe receives a large portion of the drainage arising in the eastern part of Placer County. A control structure, located on the natural rim of the lake near Tahoe City, regulates the lake levels and controls discharges into the Truckee River. This river flows west for about two miles and then north until it crosses the Placer county line, from which point it flows northeasterly to the California-Nevada state boundary and then continues easterly and northerly to its terminus in Pyramid Lake in Nevada. The total area of the Truckee watershed above the Farad stream gaging station is 928 square miles, of which 172 square miles are in Placer County. About 76 square miles of the 193 square miles of water surface of Lake Tahoe lie in Placer County.

The minor streams which drain Placer County are generally limited to the Valley and Foothill Units. From north to south these streams are Yankee Slough, Coon Creek, Markham Ravine, Auburn Ravine, Pleasant Grove Creek, and Linda Creek. Runoff from Yankee Slough drains into the Bear River in Sutter County, west of Placer County. Linda Creek on the south drains the area between U. S. Highway 40 and the American River from Auburn to Roseville, and then flows to the Natomas East Main Drainage Canal and into the Sacramento River near Sacramento. The remaining minor streams are intercepted by Reclamation Districts 1000 and 1001 drains in Sutter County. The intercepted flow then passes through the Natomas Cross-Canal into the Sacramento River near Verona.

Climate

The climate of Placer County, like its topography, is varied. The valley floor and foothill areas are favored with long growing seasons. Summers are warm and dry

TABLE 1

CLIMATOLOGICAL DATA AT SELECTED STATIONS IN OR ADJACENT TO PLACER COUNTY

Station	Elevation, in feet	Growing season, in days	Maximum and minimum temperatures for period of record, in degrees F.		Mean seasonal precipitation, in inches
			Maximum	Minimum	
Tahoe	6,230	78	94	—15	30.60
Blue Canyon	5,280	142	99	—5	57.60
Colfax	2,418	217	110	8	46.22
Auburn	1,234	265	112	12	33.12
Rocklin	239	234	118	14	23.14
Sacramento	25	308	114	17	16.37

with occasional dry north winds. The mean seasonal rainfall on the valley floor is about 20 inches.

The quantity of precipitation increases with elevation to over 60 inches near the crest of the Sierra Nevada. Approximately 80 per cent of the seasonal precipitation in Placer County occurs during the five-month period from November through March. Most of the precipitation at the higher elevations occurs as snowfall and is retained at these elevations until the spring and summer snowmelt runoff period. At higher elevations the growing season is short and nights are cold.

Table 1 contains a summary of pertinent climatological data for six stations in or adjacent to Placer County.

Geology

The Sierra Nevada block, composed of igneous and metamorphic rocks, underlies the surface of most of Placer County, although in the western or valley portion of the county the Sierran rocks are covered by more recent sedimentary fill. Volcanic rocks, principally rhyolites, andesites, and basalts, are widespread in the eastern part of the county. These also occur to a more limited extent along the eastern edge of the Valley Unit. Granitic rocks appear in places from the edge of the valley eastward. Much of the Sierran block is composed of quartzite, slate, crystalline limestone, and other metamorphic rocks ranging in age from Carboniferous to Jurassic.

Continental sediments occurring in the fill of the Valley Unit are the principal water-bearing formations of Placer County. Some of the volcanic rocks at the edge of the valley are also water-bearing. The ground water basin is thus composed of continental sands, gravels, and clays, principally of Pleistocene and Recent age, underlain in places by Tertiary volcanics, all lying on a basement of Sierran crystalline rocks. A more detailed discussion of the geology of Placer County is included in Appendix B of this bulletin.

Soils

The soils of Placer County capable of sustaining agriculture are located mostly in the western portion of the county in the Valley and Foothill Units. Suitable soils are also found on the Colfax Ridge lying between the Bear and American River Units, and on the ridge above the American River near and extending southwest from Auburn in the American River Unit. Soils of a limited area, located on the Foresthill Divide between the North and Middle Forks of the American River in the American River Unit, are also considered capable of sustaining agriculture. The remaining portions of the county are generally rugged, with mountains too steep and rocky, or climatically unfavorable, to permit cultivated agriculture. These areas are restricted to timber or brush with occasional native mountain meadows.

The soils of the Valley Unit have developed predominantly from old sediments. However, small patches of recent alluvial soils may be found along stream channels. There are also several small areas of rolling land included within the Valley Unit which are composed of residual soil. The soils found in the Valley Unit vary in their physical characteristics and adaptabilities, depending on their age, or the degree of weathering which the soils have undergone subsequent to their deposition. The soils developed from alluvial depositions vary from old soils, having indurated iron-cemented hardpan generally two to four feet below the surface, to recent soils, showing little or no profile development. The residual soils have developed from softly consolidated sandstone and shale-like material. All of the soils in the Valley Unit have supported native grasses, hay, and grain in the past. Orchards and vineyards have been grown for many years along Linda Creek on residual soils and in the flood plain of Bear River on recent alluvial soils. Rice and pasture are presently grown on the older alluvial soils and hardpan lands.

The soils of the Foothill Unit have developed primarily from igneous rock materials. However, the soils of a small area in the vicinity of Bowman have been derived from sedimentary rock material. The largest portion of the unit covered by soils derived from igneous rock is composed of weathered granitic materials. This includes the portion of the unit south of Doty Ravine, with the exception of a large triangular area between Newcastle, Rocklin, and Lincoln, which consists of volcanic scab land. Soils derived from granitic materials tend to be coarser textured and have lower inherent fertility than soils derived from igneous materials which are high in basalt. The soils are well drained and generally of sufficient depth to be well suited for the production of pears, plums, cherries, and scattered areas of pasture, which are the principal crops now grown. The volcanic scab land is a slightly weathered ridge with large amounts of angular rock and stone on its surface. This area is not suitable for cultivated agriculture, but small patches of shallow soil support native vegetation which is grazed during the spring months.

The soils of the Foothill Unit north of Doty Ravine are derived from basic igneous materials. These soils are generally medium- to fine-textured and somewhat limited in depth. A portion of the area has soils of sufficient depth to be suitable for orchards, but the remainder is best suited for irrigated pasture crops.

The soils in the vicinity of Bowman and Colfax in the Bear and American River Units have developed from sedimentary rocks. In general, these soils are medium- to fine-textured, and have about the same crop adaptability as soils derived from basic igneous materials.

The soils located on the Foresthill Divide in the American River Unit have developed from sedimentary and basic igneous rock materials. These soils are medium- to fine-textured and fairly deep, and are suitable for a wide variety of crops. Timber, brush, and grass presently grow on these soils.

Present Development

The history and development of Placer County began with the discovery of gold in 1848 near the present site of Ophir on Auburn Ravine. Mining flourished as the basic industry and has held an important place in the economy until recent years. It has accounted for the establishment of such settlements as Gold Run, Michigan Bluff, Dutch Flat, Ophir, and Auburn. All of these towns had a brief colorful mining history, and, except for Auburn, declined to historical landmarks with the decline of gold mining.

Auburn, the county seat, and Colfax, Newcastle, Loomis, and Rocklin, all in the foothills, have continued to grow with the fruit industry, which began with the experimental plantings of peach and almond seeds in 1846 along the Bear River flood plain. Results were so satisfactory that soon the river-bottom lands and ravines were utilized for orchard farming. Barley, in demand for feed, also became an important crop. In 1856 there were 5,884 acres of land under cultivation, according to records of the County Assessor.

As the population increased and irrigation facilities were constructed, the lower foothills became a region of diversified orchard and truck crops. By 1923 there were about 10,000 acres of peaches, 6,800 acres of plums, and lesser acreages of grapes, pears, cherries, nuts, and miscellaneous tree crops. In 1949 a land use survey made by the Division of Water Resources in connection with the current investigation showed that there were about 10,000 acres of plums, 5,500 acres of pears, 2,900 acres of grapes, and 1,500 acres of peaches. Irrigated pasture has shown a recent increase in the foothill region, from less than 1,000 acres in 1940 to more than 5,600 in 1949. The pasture supports dairy and beef cattle.

The growing of wheat on the valley floor became established about 1850. Wheat was the major crop during World War I when the area of this crop attained a maximum of about 23,500 acres. The acreage devoted to wheat remained fairly stable until World War II, after which it decreased to about 10,000 acres in 1951. Oats and barley have been grown for a number of years on approximately 5,000 and 1,500 acres, respectively. Rice was grown to some extent during the World War I period, but production ceased when prices declined immediately after the war. The acreage devoted to rice in 1940 was about 148 acres, and since then rice acreage has increased each year, reaching 5,610 acres in 1951. The growing of irrigated pasture and the production of pasture grasses for seed have become important on the valley floor as well as in the foothills. The total acreage in 1940 was 912 acres. The acreage of irrigated pasture grown on the valley floor in 1951 was 3,170 acres, while 6,340 acres were mapped in the foothills in 1949. The pasture grown on the valley floor is irrigated almost entirely by ground water, while that in the foothills is all irrigated from surface water supplies. In 1951 about 664 acres of ladino clover and 185 acres of bird's-foot trefoil were grown for seed. Plantings of irrigated pasture do well on the shallow soils which predominate in the valley, and good stands have developed even on hardpan exposed by land leveling.

In addition to the growing of field and orchard crops, the production of livestock makes an important contribution to the economy of Placer County.

The timber resources of Placer County exceed five billion board feet, more than one-half of which is privately owned. Timber land covers about 40 per cent of the land area of the county, and most of the timber is available for commercial purposes. Since construction of an access road to Mosquito Ridge on the Foresthill Divide in 1950, approximately 35,000,000 board feet of lumber have been cut annually in that area. A total of 66,678,000 board feet of lumber was cut in the county during 1951. Ponderosa and sugar pine, and Douglas and white fir are the most abundant species.

The mining, shipping, and processing of clay is another industry of importance. About 95,000 tons of clay are mined annually, about one-half of which is processed in the county into tile products. Other important mineral products are asbestos, chrome, slate, granite, gravel, and gold.

The mountains and lakes of Placer County offer vacationists and tourists a year-round opportunity to enjoy outdoor sports such as swimming, boating and fishing in the summer, and skiing in the winter. Furthermore, the accommodation of these part-time residents contributes an appreciable portion of the income of the county.

Transportation facilities in Placer County include about 1,200 miles of roads and highways, more than half of which are surfaced. The state highway system consists of four major highways. U. S. Highways 40 and 99E enter the county from the west near Roseville. They separate at Roseville, with U. S. Highway 40 following the main divide over the Sierra Nevada, and U. S. Highway 99E extending north along the base of the foothills. State Highway 49 crosses the county from north to south through Auburn, connecting that city with Grass Valley to the north and Placerville to the south. State Highway 89 extends southward from U. S. Highway 40 near Truckee to and around Lake Tahoe.

In addition to roads, the transcontinental line of the Southern Pacific Railroad traverses the county from Roseville to Truckee, paralleling U. S. Highway 40. A second line of the same company parallels U. S. Highway 99E through the county.

Roseville is the junction point of all the major highways and railways and is important as a motor and rail transportation center. Extensive railway yards and shops are located here, as well as one of the West's largest icing plants to service refrigerator cars. Olive and wine processing plants are also located in the vicinity.

The town of Lincoln, 12 miles north of Roseville, is the center of the clay mining and processing industry, as well as a shipping point for grain and turkeys. Northeast of Roseville are the communities of Rocklin, Loomis, Penryn, Newcastle, Auburn, and Colfax. All are important centers for processing, packing, and shipping of fruit. Rocklin also has granite quarries and works. Auburn, the county seat, is also the center of lumbering, milling, and mining interests.

Five hydroelectric power houses in the county, included in the Drum System of the Pacific Gas and Electric Company, have a total capacity of about 105,000 kilowatts. Water from this hydroelectric development meets the irrigation and domestic requirements of most of the western portion of Placer County, from Gold Run to the base of the foothills along U. S. Highway 99E. The Pacific Gas and Electric Company and the Nevada Irrigation District convey and distribute water to consumers in this area.

There are about 916,000 land acres in Placer County and about 49,000 acres of water surface. Of the total land area, 293,000 acres are nontaxable. Some 225,000 acres of the nontaxable lands are in the Tahoe National Forest, 43,000 acres in the El Dorado National Forest, 10,800 acres in the public domain under the jurisdiction of the Department of the Interior, and 60 acres in an Indian reservation. The State of California owns 12 acres of park at Lake Tahoe, 1,320 acres of school lands, 574 acres as part of the Donner Memorial, 662 acres under Folsom Prison jurisdiction, 225 acres for DeWitt State Hospital, and 12,000 acres of tax-deeded lands. There are about 31,000 parcels of privately owned land, one-third of which are improved.

The 1950 census reports a total county population of 41,649, of which 13,376 lived in urban and 28,273 in rural areas. The following tabulation indicates the rate of population increase in Placer County since 1880:

Year	*Population*	*Year*	*Population*
1880	14,232	1930	24,468
1910	18,237	1940	28,108
1920	18,584	1950	41,649

Credit: Roseville Area Chamber of Commerce

Roseville and Surrounding Area, Looking Northeast

CHAPTER II
WATER SUPPLY

The sources of water supply of Placer County are direct precipitation on overlying lands, tributary surface and subsurface inflow, and imports of water for irrigation and hydroelectric power production. The water supply of the county is considered and evaluated in this chapter under the general headings "Precipitation," "Runoff," "Imported and Exported Water," "Underground Hydrology," and "Quality of Water."

The following terms are used as defined in connection with the discussion of water supply in this bulletin:

Annual—This refers to the 12-month period from January 1st of a given year through December 31st of the same year, sometimes termed the "calendar year."

Seasonal—This refers to any 12-month period other than the calendar year.

Precipitation Season—The 12-month period from July 1st of a given year through June 30th of the following year.

Runoff Season—The 12-month period from October 1st of a given year through September 30th of the following year.

Investigational Seasons—The three runoff seasons of 1948-49, 1949-50, and 1950-51, during which most of the field work on the Placer County Investigation was performed.

Mean Period—A period chosen to represent conditions of water supply and climate over a long series of years.

Base Period—A period chosen for detailed hydrologic analysis because prevailing conditions of water supply and climate were approximately equivalent to mean conditions, and because adequate data for such hydrologic analysis were available.

Mean—This is used in reference to arithmetical averages relating to mean periods.

Average—This is used in reference to arithmetical averages relating to periods other than mean periods.

In studies for the current State-wide Water Resources Investigation it was determined that the 50 years from 1897-98 through 1946-47 constituted the most satisfactory period for estimating mean seasonal precipitation generally throughout California. Similarly, the 53-year period from 1894-95 through 1946-47 was selected for determining mean seasonal runoff. In studies for Placer County, conditions during these periods were considered representative of mean conditions of water supply and climate.

Studies were made to select a base period for hydrologic analysis of Placer County during which conditions of water supply and climate would approximate mean conditions, and for which adequate data on stream flow, ground water levels, and water development and utilization would be available. It was determined that the three-year period from 1948-49 through 1950-51 was the most satisfactory in this respect. Conditions during this chosen base period approached conditions prevailing during the mean period and were considered to be equivalent. For this reason, determined relationships between base period water supply and present and probable ultimate water utilization were assumed to be equivalent to corresponding relationships which might be expected under mean conditions of water supply and climate.

PRECIPITATION

Placer County lies within the southern fringe of storms which periodically sweep inland from the North Pacific during winter months. The precipitation resulting from these storms is moderate on the average and increases to the east with elevation. Direct precipitation as rain or snow provides a substantial portion of the water supply of the area.

Precipitation Stations and Records

Thirty-four precipitation stations in or adjacent to Placer County have unbroken records of 10 years' duration or longer. In addition, there are 10 stations with records of less than 10 years. These stations are fairly well distributed areally and their records were sufficient to provide an adequate representation of the pattern of precipitation. Most of the records of precipitation at these stations have been published in bulletins of the United States Weather Bureau. The unpublished records are included in Appendix D. Locations of the precipitation stations are shown on Plate 3, entitled "Lines of Equal Mean Seasonal Precipitation," with map reference numbers for most stations corresponding to those utilized in State Water Resources Board Bulletin No. 1, "Water Resources of California." The stations and map reference numbers are listed in Table 2, together with elevations of the stations, periods and sources of record, and mean, maximum, and minimum seasonal pre-

TABLE 2

MEAN, MAXIMUM, AND MINIMUM SEASONAL PRECIPITATION AT SELECTED STATIONS IN OR NEAR PLACER COUNTY

Map reference number	Station	Elevation, in feet	Period of record	Source of record	Mean seasonal precipitation, in inches	Maximum and minimum seasonal precipitation	
						Season	Inches
5-77	North Bloomfield	3,160	1870-1944*	U.S.W.B.	51.11	1906-07 1923-24	77.84 21.47
5-78	Bowman Dam	5,347	1871-1955	U.S.W.B.	66.50	1903-04 1887-88	142.07 29.40
5-79	Lake Spaulding	5,075	1894-1955	U.S.W.B.	65.31	1903-04 1923-24	102.56 34.39
5-80	Fordyce Dam	6,500	1894-1929	U.S.W.B.	64.47	1894-95 1923-24	116.52 35.78
5-83	Grass Valley	2,690	1872-1955	U.S.W.B.	52.62	1889-90 1923-24	89.82 24.55
5-85	Gold Run	3,222	1899-1955*	U.S.W.B.	48.65	1950-51 1907-08	82.72 28.06
5-86	Deer Creek Power House	3,700	1907-1955	U.S.W.B.	64.46	1937-38 1923-24	103.89 28.89
5-87	Towle	3,704	1871-1920*	U.S.W.B.	59.12	1913-14 1876-77	85.86 32.34
5-88	Drum Forebay	4,563	1916-1955	P.G.&E.	55.56	1950-51 1923-24	95.19 25.96
5-89	Blue Canyon	5,280	1899-1955	U.S.W.B.	57.60	1951-52 1923-24	101.67 28.04
5-90	Emigrant Gap	5,220	1870-1945*	U.S.W.B.	52.52	1906-07 1874-75	94.30 17.35
5-91	Cisco	5,800	1870-1955	U.S.W.B.	47.22	1889-90 1874-75	97.63 28.19
5-92	Soda Springs	6,752	1930-1955	U.S.W.B.	48.96	1951-52 1930-31	79.45 26.23
5-93	Donner Summit	6,871	1871-1951*	U.S.W.B.	45.36	1879-80 1923-24	80.10 20.76
5-98	Wheatland	84	1887-1952*	U.S.W.B.	20.84	1889-90 1887-88	33.69 11.07
5-99	Colfax	2,418	1870-1955*	U.S.W.B.	46.22	1889-90 1923-24	89.80 20.40
5-99A	Applegate	2,130	1906-1929	Private	47.23	1910-11 1923-24	71.87 18.69
5-100	Iowa Hill	2,970	1879-1955*	U.S.W.B.	48.93	1889-90 1897-98	91.04 29.47
5-107	Nicolaus	47	1912-1955	U.S.W.B.	18.32	1940-41 1912-13	32.46 7.07
5-108	Newcastle	970	1891-1940*	U.S.W.B.	28.38	1906-07 1938-39	48.05 16.63
5-109	Auburn	1,234	1871-1955	U.S.W.B.	33.12	1906-07 1911-12	56.73 12.63
5-109A	Werner Ranch	1,200	1933-1955	Private	29.40	1940-41 1946-47	43.39 21.00
5-109B	Mount Pleasant	500	1944-1955	Private	------	------	------
5-109C	Cranston Ranch	1,225	1948-1955	Private	------	------	------
5-110	Georgetown	2,210	1872-1955*	U.S.W.B.	50.97	1889-90 1938-39	95.27 28.63
5-111	Pilot Creek	4,000	1894-1914	U.S.W.B.	64.87	1903-04 1897-98	95.54 37.46

TABLE 2—Continued

MEAN, MAXIMUM, AND MINIMUM SEASONAL PRECIPITATION AT SELECTED STATIONS IN OR NEAR PLACER COUNTY

Map reference number	Station	Elevation, in feet	Period of record	Source of record	Mean seasonal precipitation, in inches	Maximum and minimum seasonal precipitation	
						Season	Inches
5-119	Roseville High School	160	1926-1955	Private	17.12	1951-52 1938-39	25.34 10 78
5-120	Rocklin	239	1870-1955	U.S.W.B.	23.14	1906-07 1923-24	38.63 10.42
5-120A	Lincoln	160	1946-1955	Private	------	------	------
5-120B	Loomis	380	1947-1955	Private	------	------	------
5-120C	Penryn	600	1948-1955	Private	------	------	------
5-121	Represa	305	1893-1955*	U.S.W.B.	23.94	1906-07 1923-24	43.12 11.54
5-122	Shingle	1,425	1849-1955*	U.S.W.B.	30.04	1861-62 1897-98	79.24 14.60
5-123	Placerville	1,925	1874-1955	U.S.W.B.	38.55	1889-90 1923-24	78.23 20.13
5-131	Sacramento	25	1849-1955	U.S.W.B.	16.37	1852-53 1850-51	36.35 4.71
5-134	Folsom	252	1871-1955	U.S.W.B.	23.70	1889-90 1876-77	43.31 10.19
5-0136	Lincoln	200	1898-1900	U.S.W.B.	------	------	------
5-0137	McKinney	6,225	1913-1918*	U.S.W.B.	------	------	------
5-0138	Michigan Bluff	3,200	1940-1955	U.S.W.B.	------	------	------
5-0139	Newcastle	970	1936-1939	Private	------	------	------
5-0142	Wirebridge	565	1897-1901	U.S.W.B.	------	------	------
6-6	Truckee	6,000	1870-1955	U.S.W.B.	25.39	1889-90 1887-88	54.84 9.35
6-7	Boca	5,535	1870-1955	U.S.W.B.	19.88	1889-90 1876-77	52.15 7.60
6-8	Tahoe	6,230	1910-1955	U.S.W.B.	30.60	1951-52 1923-24	54.87 14.18

* Broken record.
U.S.W.B.—United States Weather Bureau.
P.G.&E.—Pacific Gas and Electric Company.

cipitation. In those instances where it was necessary to estimate the mean seasonal precipitation, the available records were extended to cover the 50-year mean period by comparison with records of nearby stations having records covering this period.

Precipitation Characteristics

The general precipitation pattern in Placer County, as indicated on Plate 3, increases from west to east with increasing elevation. Because of the large differences in precipitation on the area, no single station is representative of rainfall over the county. However, the seasonal rainfall measured at Sacramento was considered to be a suitable index of general precipitation over the Valley Unit. Similarly, Auburn was considered to be a representative index of general precipitation on the Foothill and Bear River Units. Records of precipitation at Sacramento and Auburn are available since 1849-50 and 1871-72, respectively. A record of precipitation is available at Blue Canyon since 1899-1900, and was considered to be a representative index of general precipitation on the American River, Yuba River, and Tahoe Units. Recorded seasonal precipitation at these stations is presented in Table 3, and is shown for Auburn on Plate 4, entitled "Recorded Seasonal Precipitation at Auburn."

Precipitation on the Valley and Foothill Units consists almost entirely of rainfall. However, heavy snowfall is general in the winter at elevations above about 3,500 feet. Depths of snowfall in the Sierra Nevada are exceeded in few parts of the United States. In March, 1907, and again in 1911, 308 inches of snow were measured at Donner Summit. Depth of snow on markers at railroad stations on the transcontinental

TABLE 3

RECORDED SEASONAL PRECIPITATION AT SACRAMENTO, AUBURN, AND BLUE CANYON

(In inches)

Season	Sacramento	Auburn	Blue Canyon	Season	Sacramento	Auburn	Blue Canyon
1849-50	36.00	----	----	1904-05	21.98	35.35	58.32
50-51	4.71	----	----	05-06	23.93	46.57	93.26
51-52	17.98	----	----	06-07	24.04	56.73	100.47
52-53	36.35	----	----	07-08	12.20	22.66	49.05
53-54	20.06	----	----	08-09	21.78	44.44	87.07
1854-55	18.62	----	----	1909-10	12.18	36.12	64.11
55-56	13.76	----	----	10-11	21.98	39.59	73.86
56-57	10.46	----	----	11-12	9.55	12.63	41.17
57-58	14.99	----	----	12-13	8.03	16.12	52.59
58-59	16.04	----	----	13-14	20.44	29.79	82.77
1859-60	22.06	----	----	1914-15	17.20	27.86	78.89
60-61	16.18	----	----	15-16	18.29	29.98	65.12
61-62	36.10	----	----	16-17	12.95	29.99	55.09
62-63	11.59	----	----	17-18	10.61	25.29	40.78
63-64	7.79	----	----	18-19	17.20	34.95	49.34
1864-65	22.59	----	----	1919-20	8.90	25.61	36.26
65-66	17.91	----	----	20-21	16.80	45.10	77.44
66-67	25.32	----	----	21-22	14.16	37.87	71.10
67-68	32.79	----	----	22-23	15.69	39.40	54.91
68-69	16.64	----	----	23-24	7.99	14.77	28.04
1869-70	13.57	----	----	1924-25	17.70	31.99	64.66
70-71	8.47	----	----	25-26	16.05	23.80	41.06
71-72	23.65	39.98	----	26-27	17.75	39.05	63.59
72-73	14.19	25.19	----	27-28	11.60	28.60	46.42
73-74	22.92	34.55	----	28-29	10.39	23.39	33.36
1874-75	17.70	27.73	----	1929-30	13.62	24.87	24.87
75-76	26.30	44.15	----	30-31	8.43	19.68	31.73
76-77	9.19	18.86	----	31-32	12.57	33.18	53.89
77-78	24.86	36.11	----	32-33	8.12	20.38	29.18
78-79	17.85	34.94	----	33-34	11.58	28.12	32.87
1879-80	26.47	41.55	----	1934-35	21.10	36.75	53.60
80-81	26.57	37.18	----	35-36	20.53	41.99	57.84
81-82	16.51	33.60	----	36-37	19.76	38.93	41.74
82-83	18.11	25.64	----	37-38	24.83	40.74	63.98
83-84	24.78	40.96	----	38-39	9.74	21.48	36.03
1884-85	16.58	25.56	----	1939-40	25.07	43.00	77.74
85-86	32.27	42.32	----	40-41	31.83	50.35	81.75
86-87	13.97	27.59	----	41-42	24.94	49.13	78.54
87-88	11.56	21.68	----	42-43	19.98	43.16	73.26
88-89	19.95	26.75	----	43-44	17.58	27.13	39.41
1889-90	33.80	48.68	----	1944-45	17.06	34.22	47.70
90-91	15.81	24.78	----	45-46	13.91	32.10	60.44
91-92	15.18	32.17	----	46-47	11.59	27.38	47.49
92-93	23.95	40.79	----	47-48	15.44	32.16	57.80
93-94	16.35	35.31	----	48-49	14.87	29.61	44.68
1894-95	24.11	44.42	----	1949-50	14.31	30.13	66.10
95-96	23.23	35.78	----	50-51	19.54	51.55	94.28
96-97	17.32	39.89	----	51-52	26.58	50.61	101.67
97-98	10.51	20.36	----	52-53	18.33	34.03	76.56
98-99	15.04	29.77	----				
1899-1900	20.24	37.32	61.35	Average for 3-year base period, 1948-49 through 1950-51	16.24	37.10	68.35
00-01	20.21	36.96	65.47				
01-02	17.27	40.53	65.41				
02-03	16.62	36.30	58.98	Mean	16.37	33.12	57.60
03-04	16.87	44.72	98.94				
				Average for period of record	18.08	33.78	62.10

railroad crossing the Sierra Nevada indicated that during the season of 1879-80 and 1889-90 the snowfall was 370 inches. On March 20,1952, a new official record of snowfall was established when a snow depth of 314 inches was measured at Donner Summit. The foregoing figures of snowfall are given for snow depth at time of measurement.

Seasonal precipitation in Placer County increases with elevation from west to east, as is shown on Plate 3. Mean seasonal depth of precipitation ranges from about 18 inches at Nicolaus, about six miles west of the county line, to about 65 inches at Lake Spaulding where the elevation is 5,075 feet. Short-term precipitation records, measurements of snow depth, and runoff considerations indicate that mean seasonal depths of precipitation in excess of 70 inches occur on the higher watersheds of the American River.

Precipitation varies over wide limits from season to season, ranging at Auburn from about 38 per cent of the seasonal mean to about 171 per cent. Maximum seasonal precipitation at Auburn occurred in 1906-07 when 56.73 inches of rain were recorded. In 1911-12, the minimum season at this station, precipitation was only 12.63 inches. Long-term trends in precipitation in Placer County are indicated on Plate 5, entitled "Accumulated Departure From Mean Seasonal Precipitation at Auburn."

Nearly 80 per cent of the seasonal precipitation in Placer County occurs during the five months from November through March on the average, and the summers are dry. Mean monthly distribution of precipitation as recorded at Auburn is presented in Table 4.

TABLE 4

MEAN MONTHLY DISTRIBUTION OF PRECIPITATION AT AUBURN

Month	Precipitation: In inches	Precipitation: In per cent of seasonal total	Month	Precipitation: In inches	Precipitation: In per cent of seasonal total
July	0.01	0.0	January	6.30	19.0
August	0.01	0.0	February	5.96	18.0
September	0.43	1.3	March	5.07	15.3
October	1.72	5.2	April	2.86	8.7
November	3.44	10.4	May	1.25	3.8
December	5.66	17.1	June	0.41	1.2
			TOTALS	33.12	100.0

Quantity of Precipitation

Determination of seasonal quantity of precipitation in Placer County was limited to the Valley and Foothill Units. As discussed later in this chapter, the Valley Unit was the only unit for which determinations of safe ground water yield and overdraft were made, requiring an estimate of the quantity of precipitation. A determination of seasonal quantity of precipitation on the Foothill Unit was required for derivation of seasonal consumptive use in the unit, as presented in Chapter III. The mean seasonal quantity of precipitation on the Valley and Foothill Units was estimated by plotting mean seasonal depth of precipitation at stations in or adjacent to Placer County on a map. Lines of equal mean seasonal precipitation, or isohyets, were then drawn, as shown on Plate 3. By planimetering the areas between these isohyets, the weighted mean seasonal depths and total quantity of precipitation for the two units were estimated.

The estimated value of weighted mean seasonal depth of precipitation on the Valley Unit was found to agree closely with the arithmetic average of mean seasonal rainfall at Rocklin, Roseville, and Sacramento, while the value of weighted mean seasonal depth of precipitation on the Foothill Unit was found to agree closely with the arithmetic average of mean seasonal rainfall at Auburn, Rocklin, and Roseville. The seasonal depth and quantity of precipitation for the two units during the investigational seasons were therefore determined as the arithmetic averages of the recorded precipitation at the above stations for the selected seasons. The results of these estimates for the investigational seasons, and base and mean periods, are presented in Table 5. The precipitation index for each of the investigational seasons is also shown in Table 5. The term "precipitation index" refers to the ratio of the amount of precipitation during a given season to the mean seasonal amount, and is expressed as a percentage.

TABLE 5

ESTIMATED WEIGHTED SEASONAL DEPTH AND TOTAL QUANTITY OF PRECIPITATION ON VALLEY AND FOOTHILL UNITS OF PLACER COUNTY

Season	Valley Unit: Precipitation index	Valley Unit: Precipitation: Depth, in inches	Valley Unit: Precipitation: Quantity, in acre-feet	Foothill Unit: Precipitation index	Foothill Unit: Precipitation: Depth, in inches	Foothill Unit: Precipitation: Quantity, in acre-feet
1948-49	87	16.4	149,600	87	21.4	251,700
1949-50	85	16.1	146,900	87	21.3	250,500
1950-51	113	21.4	195,200	130	31.9	375,300
Average for 3-year base period, 1948-49 through 1950-51	95	18.0	164,200	102	24.9	293,600
Mean	100	18.9	172,400	100	24.5	287,900

RUNOFF

Runoff from the highly productive watersheds of the Sierra Nevada constitutes the most important source of water supply available to Placer County. Portions of the watersheds of the American, Yuba, and Bear Rivers, together with those of numerous minor streams, and a part of the Lahontan Basin east of the crest of the Sierra Nevada, are included within Placer County. A substantial portion of these water resources is largely unregulated and undeveloped, and is a potential source of water to meet further requirements not only in Placer County but in water-deficient areas in other parts of California.

Stream Gaging Stations and Records

Available records of runoff of the principal streams of Placer County were sufficient in number, length, and reliability for purposes of required hydrographic

TABLE 6

STREAM GAGING STATIONS IN AND ADJACENT TO PLACER COUNTY

Map reference number	Stream	Station	Drainage area, in square miles	Period of record	Source of record
	Valley and Foothill Units				
5-243A	Coon Creek	at U. S. Highway 99E	84	1947-55	DWR
5-243B*	Diversion to Gold Hill from South Canal	at Wise Power House	----	1939-55	NID
5-243C*	Diversion to Gold Hill	at Tunnel 11	----	1939-55	NID
5-243D*	Auburn Ravine Canal	at head	----	1939-55	NID
5-243E	Auburn Ravine	at U. S. Highway 99E	32	1947-55	DWR
5-243F	Pleasant Grove Creek	at Lincoln Road	13	1950	DWR
5-243G	Linda Creek	at Roseville	85	1948-55	DWR
5-243H*	Reclamation District 1001 Channel	at Pacific Avenue	222	1949-55	DWR
	American River Unit				
5-263*	Lake Valley Canal	at intake	----	1930-37	PG&E
5-264	North Fork of American River	near Colfax	308	1911-41	USGS
5-265	North Fork of American River	at North Fork Dam	343	1941-55	USGS
5-265A	Middle Fork of American River	at French Meadows	----	1951-55	USGS
5-266	Rubicon River	at Rubicon Springs	----	1910-14	USGS
5-267	Little Rubicon River	near Rubicon Springs	----	1911	USGS
5-268	Gerle Creek	near Rubicon Springs	----	1910-14	USGS
5-269	Little South Fork Ditch	at Sawmill	----	1910-13	USGS
5-270	Little South Fork of Rubicon River	at Sawmill	----	1910-14	USGS
5-271	Little South Fork of Rubicon River	below Gerle Creek	----	1910-14	USGS
5-278	Little South Fork of Rubicon River	at mouth	----	1909-11	USGS
5-279	Rubicon River Rubicon River	near Quintette near Georgetown	198 198	1909-14 1943-55	USGS USGS
5-280	Pilot Creek	near Quintette	15	1910-14 1946-55	USGS
5-281	Pilot Creek Ditch Georgetown Ditch	near Quintette near Georgetown	---- ----	1910-14 1947-55	USGS USGS
5-281A	Georgetown Ditch	above Pilot Creek	----	1947-55	USGS
5-282	Middle Fork of American River	near Auburn	619	1911-55	USGS
5-283*	South Canal	near Newcastle	----	1930-55	PG&E
5-284	North Fork of American River	at Rattlesnake Bridge	999	1930-37 1938-55	USGS
5-309	American River	at Fair Oaks	1,921	1904-55	USGS
	Bear River Unit				
5-233B	Dry Creek	near Wheatland	----	1946-55	USGS
5-235	Bear River	near Colfax	----	1912-17 1949-55	USGS
5-236	Bear River	near Auburn	140	1922, 25 28, 29, 33 1940-55	USGS
5-237	Bear River	at Van Trent	----	1904-28	USGS
5-238	Bear River	near Wheatland	295	1928-55	USGS
5-239*	Boardman Canal	near intake	----	1930-55	PG&E
5-240*	Lake Valley Canal	near Emigrant Gap	----	1930-55	PG&E

TABLE 6—Continued

STREAM GAGING STATIONS IN AND ADJACENT TO PLACER COUNTY

Map reference number	Stream	Station	Drainage area, in square miles	Period of record	Source of record
	Bear River Unit—Continued				
5-241	Drum Canal (Towle Canal)	below Drum Forebay (at head)		1930-55	PG&E
5-242	Bear River Canal	near Colfax	----	1912-55	USGS, PG&E
5-242A*	Bear River Canal	near Halsey Forebay	----	1938-55	PG&E
5-243*	Gold Hill Canal	below Combie Dam	-	1930-55	NID
	Yuba River Unit				
5-209	Canyon Creek	above Jackson Creek	19	1926-30	USGS
5-210	Jackson Creek	at mouth	6	1926-30	USGS
5-211	Milton-Bowman Tunnel	at outlet	----	1928-30 1931-55	USGS
5-212	Bowman-Spaulding Canal	at intake	----	1927-55	USGS
5-213	Canyon Creek	below Bowman Lake	32	1927-55	USGS
5-214	South Fork of Yuba River	near Cisco	50	1942-55	USGS, USBR
5-215*	Drum Canal	near Lake Spaulding	----	1930-55	PG&E
5-216*	Spaulding Spillway	at Lake Spaulding	----	1941-55	PG&E
5-217*	South Yuba Canal	at Lake Spaulding	----	1930-55	PG&E
5-219*	South Fork of Yuba River	at Langs Crossing	----	1933-55	PG&E
	Tahoe Unit				
6-24	Truckee River	at Tahoe	519	1900-43	USGS
6-25	Truckee River	near Truckee	548	1944-55	USGS

DWR—Division of Water Resources.
NID—Nevada Irrigation District.
PG&E—Pacific Gas and Electric Company.
USGS—United States Geological Survey.
USBR—United States Bureau of Reclamation.
* Records of runoff in Placer County not previously published.

studies. With respect to certain of the smaller streams, however, records of runoff were nonexistent or confined principally to measurements made during the investigational seasons. By comparison with records of nearby stations, estimates were made of runoff of these smaller streams.

Table 6 lists those stream gaging stations pertinent to the hydrography of Placer County, together with their map reference numbers, drainage areas above stations where significant, and periods and sources of records. These stations are also shown on Plate 3. The map reference numbers for most stations listed correspond to those used in State Water Resources Board Bulletin No. 1, "Water Resources of California." New map reference numbers were assigned to stations installed, operated, and maintained as a part of the Placer County Investigation. Most of the records listed in Table 6 have been published by the United States Geological Survey in its Water-Supply Papers, or by the Division of Water Resources in its Reports of Sacramento-San Joaquin Water Supervision, or in Bulletin No. 6 of the State Water Resources Board, "Sutter-Yuba Counties Investigation." Runoff records not published elsewhere are included in Appendix E of this bulletin.

Runoff Characteristics

An excellent continous record of flow of the American River at Fair Oaks is available for the period since November, 1904, when a stream gaging station was established at Fair Oaks by the United States Geological Survey. Although this record does not provide an exact measure of runoff from watersheds in Placer County, it is the most important record of the American River system, and does reflect characteristics of tributary mountain runoff in Placer County.

Flow of the American River to the valley floor is impaired by operation of upstream reservoirs and by operation of hydroelectric power plants. An estimate of the natural runoff of the American River at Fair Oaks, as it would be if unaltered by upstream diversion, storage, import, export, or change in upstream consumptive use of water caused by development, is included in State Water Resources Board Bulletin No. 1, "Water Resources of California." This estimate, extended to include the season of 1951-52, together with recorded seasonal runoff of the American River at Fair Oaks, is presented in Table 7. The estimate of natural flow is also shown graphically on Plate 6, entitled "Estimated Seasonal Natural Runoff of American River at Fair Oaks."

TABLE 7

RECORDED AND ESTIMATED NATURAL SEASONAL RUNOFF OF AMERICAN RIVER AT FAIR OAKS

(In acre-feet)

Season	Recorded runoff	Estimated natural runoff	Season	Recorded runoff	Estimated natural runoff
1894-95		5,182,000	1925-26	1,370,000	1,386,000
95-96		3,564,000	26-27	3,630,000	3,652,000
96-97		3,064,000	27-28	2,530,000	2,521,000
97-98		938,000	28-29	1,160,000	1,147 000
98-99		1,854,000	29-30	1,580,000	1,652,000
1899-1900		3,297,000	1930-31	655,000	716,000
00-01		3,396,000	31-32	2,570,000	2,595,000
01-02		2,592,000	32-33	1,330,000	1,270 000
02-03		2,515,000	33-34	1,130,000	1,124,000
03-04		5,390,000	34-35	2,572,000	2,581,000
1904-05	*1,960,000	2,174,000	1935-36	3,415,000	3,393,000
05-06	4,762,000	4,838,000	36-37	2,401,000	2,328,000
06-07	5,710,000	5,786,000	37 38	4,552,000	4,507,000
07-08	1,450,000	1,526,000	38-39	1,086,000	1,040,000
08-09	4,540,000	4,624,000	39-40	3,442,000	3,403,000
1909-10	3,540,000	3,614,000	1940-41	3,213,000	3,142,000
10-11	6,480,000	5,554,000	41-42	3,991,000	3,914,000
11-12	1,260,000	1,338,000	42-43	3,931,000	3,875,000
12-13	1,430,000	1,513,090	43-44	1,537,000	1,462,000
13-14	3,950,000	4,045,000	44-45	2,564,000	2,514,000
1914-15	3,060,000	3,154,000	1945-46	2,858,000	2,866,000
15-16	3,850,000	2,940,000	46-47	1,419,000	1,417,000
16-17	2,830,000	2,923,000	47-48	2,262,000	2,239,000
17-18	1,420,000	1,503,000	48-49	1,906,000	1,857,000
18-19	2,150,000	2,229,000	49-50	2,705,000	2,664,000
1919-20	1,390,000	1,467,000	50-51	4,667,000	4,631,000
20-21	3,220,000	3,204,000	51-52	5,028,000	4,974,000
21-22	3,350,000	3,279,000			
22-23	2,750,000	2,751,000	Mean seasonal natural runoff		2,774,000
23-24	530,000	543,000			
24-25	2,760,000	2,717,000			

* Partial record.

Estimates of natural flow of the North Fork of the American River near Colfax and of the American River at Fair Oaks indicate that average seasonal runoff during the three-year base period approximated the seasonal mean during the 53-year period. The estimates of natural flow for each season of the three-year base period and for 1951-52 are presented in Table 8, together with runoff indices for natural flow at both stations. The term "runoff index" refers to the ratio of the amount of runoff during a given season to the mean seasonal amount, and is expressed as a percentage.

Discharge of streams of the American River system varies between wide limits from season to season, and within the season. This is indicated by flow of the American River at Fair Oaks, where the maximum recorded seasonal runoff occurred in 1910-11, and amounted to more than 6,480,000 acre-feet. The mini-

TABLE 8

ESTIMATED SEASONAL NATURAL FLOW OF NORTH FORK OF AMERICAN RIVER NEAR COLFAX AND OF AMERICAN RIVER AT FAIR OAKS, 1948-49 THROUGH 1951-52

(In acre-feet)

Season	Runoff index	North Fork of American River near Colfax	Runoff index	American River at Fair Oaks
1948-49	67	393,000	68	1,857,000
1949-50	97	568,000	96	2,664,000
1950-51	166	972,000	167	4,631,000
1951-52	190	1,106,000	179	4,974,000
Average for 3-year base period, 1948-49 through 1950-51	110	644,000	110	3,051,000
Mean	100	584,000	100	2,774,000

mum seasonal runoff recorded at this station occurred in 1923-24, and was about 530,000 acre-feet. Maximum recorded instantaneous discharge was 169,000 second-feet on November 21, 1950, and the minimum discharge was about 3.6 second-feet on August 16, 1924. Estimated average monthly distribution of seasonal runoff of the American River at Fair Oaks for the period of record is presented in Table 9. Long-term trends in runoff of this stream are indicated on Plate 7, entitled "Accumulated Departure From Mean Seasonal Natural Runoff of American River at Fair Oaks."

TABLE 9

ESTIMATED AVERAGE MONTHLY DISTRIBUTION OF AVERAGE SEASONAL RUNOFF OF AMERICAN RIVER AT FAIR OAKS, 1904-05 THROUGH 1951-52

Month	Runoff, in acre-feet	Per cent of seasonal total
October	20,000	0.9
November	60,000	2.2
December	130,000	4.9
January	270,000	9.9
February	330,000	12.5
March	420,000	15.6
April	490,000	18.1
May	540,000	20.0
June	310,000	11.7
July	80,000	3.0
August	20,000	0.7
September	10,000	0.5
TOTALS	2,680,000	100.0

Quantity of Runoff

Available records of stream flow, including those obtained from measurements made in connection with the investigation, were sufficient to permit estimates of the amount of runoff of various streams in and adjacent to Placer County. The mean seasonal quantity of runoff was determined for the more important stations in the Valley, Foothill, American River, Bear River, Yuba River, and Tahoe Units. For purposes of required hydrologic analysis, it was necessary to make detailed study of measured or estimated runoff of the various streams and canals in the Valley and Foothill Units during the investigational seasons.

In general, mean seasonal natural runoff of streams in and adjacent to Placer County was estimated from available records, from correlation with runoff of nearby streams having records over long periods, and from correlation with precipitation indices. Estimates of seasonal natural runoff of the Bear, American, and Truckee Rivers were taken from State Water Resources Board Bulletin No. 1. Mean seasonal natural runoff of the Bear River near Wheatland and of the American River at Fair Oaks was computed by extending their periods of record back over the remaining seasons of the 53-year mean period by correlation with precipitation indices of adjacent stations. Mean seasonal natural runoff of the South Fork of the Yuba River near Cisco was obtained by correlation with the runoff of the South Fork of the Yuba River at Langs Crossing and the Yuba River at Smartville. Estimates of seasonal natural runoff of the North Fork of the American River near Colfax, and of the Middle Fork of the American River near Auburn were obtained by correlation with seasonal natural runoff of the American River at Fair Oaks. Mean seasonal natural runoff of the Truckee River at Tahoe was obtained by correlation with runoff of the Tuolumne River near La Grange. Mean seasonal natural runoff of Coon Creek and of Auburn Ravine was estimated by correlation with the Bear River at Wheatland. The results of the above estimates of mean seasonal natural runoff are presented in Table 10.

TABLE 10

ESTIMATED MEAN SEASONAL NATURAL RUNOFF OF STREAMS IN AND ADJACENT TO PLACER COUNTY

Unit and stream	Drainage area, in square miles	Runoff, in acre-feet
Valley and Foothill Units		
Coon Creek at U. S. Highway 99E	84	50,400
Auburn Ravine at U. S. Highway 99E	32	36,300
American River Unit		
North Fork of American River near Colfax	308	584,000
Middle Fork of American River near Auburn	619	1,178,000
American River at Fair Oaks	1,921	2,774,000
Bear River Unit		
Bear River at Wheatland	295	356,000
Yuba River Unit		
South Fork of Yuba River near Cisco	50	135,000
Tahoe Unit		
Truckee River at Tahoe	519	173,000

Inflow to the Foothill Unit was taken as the sum of flow of the Bear River Canal of the Pacific Gas and Electric Company, measured at Halsey Forebay, and of the Gold Hill Canal of the Nevada Irrigation District, measured below Combie Dam. Outflow from the Foothill Unit was taken as the sum of flows of the South Canal of the Pacific Gas and Electric Company measured above spill to the American River, Coon Creek at U. S. Highway 99E, Auburn Ravine at U. S. Highway 99E, and Linda Creek at Roseville. The flow of water in the Boardman Canal entering the unit, and the flow of water in the Shirland Ditch leaving the unit, were omitted, since the flow in each is about equal.

Inflow to the Valley Unit was taken as the sum of the flows of Coon Creek at U. S. Highway 99E and Auburn Ravine at U. S. Highway 99E. Outflow from the Valley Unit was taken as the sum of the flows of Reclamation District 1001 Channel at Pacific Avenue, Yankee Slough at Sutter county line, and Pleasant Grove Creek at Fifield Road, and the runoff from the

TABLE 11

MEASURED AND ESTIMATED SEASONAL SURFACE INFLOW TO AND OUTFLOW FROM FOOTHILL AND VALLEY UNITS, 1948-49 THROUGH 1950-51

(In acre-feet)

Source	Season			Average for 3-year base period, 1948-49 through 1950-51
	1948-49	1949-50	1950-51	
FOOTHILL UNIT				
Inflow				
Bear River Canal at Halsey Forebay	251,700	227,200	235,200	238,000
Gold Hill Canal below Combie Dam	25,700	30,700	24,000	26,800
TOTALS	277,400	257,900	259,200	264,800
Outflow				
South Canal above spill	139,100	135,100	124,700	133,000
Coon Creek at U. S. Highway 99E	36,300	39,500	90,400	55,400
Auburn Ravine at U. S. Highway 99E	47,400	34,600	67,600	49,900
Linda Creek at Roseville	**30,000	34,900	65,500	43,500
TOTALS	252,800	244,100	348,200	281,800
VALLEY UNIT				
Inflow				
Coon Creek at U. S. Highway 99E	36,300	39,500	90,400	55,400
Auburn Ravine at U. S. Highway 99E	47,400	34,600	67,600	49,900
TOTALS	83,700	74,100	158,000	105,300
Outflow				
Reclamation District 1001 Channel at Pacific Avenue	*64,800	**53,300	165,600	94,600
Yankee Slough at Sutter county line	*2,200	*1,000	*7,300	*3,500
Pleasant Grove Creek at Fifield Road	*3,400	*1,600	*11,400	*5,500
Linda Creek	*1,800	*800	*6,000	*2,900
TOTALS	72,200	56,700	190,300	106,500

* Estimated.
** Partially estimated.

portion of Linda Creek drainage area contained within the Valley Unit.

Measured and estimated seasonal surface inflow to and outflow from the Foothill and Valley Units during the investigational seasons and base period are presented in Table 11.

IMPORTED AND EXPORTED WATER

Water is imported to Placer County through the Bowman-Spaulding System of the Nevada Irrigation District and the Pacific Gas and Electric Company, for irrigation of lands in the Valley and Foothill Units and for power development. The Drum Canal, owned by the Pacific Gas and Electric Company, conveys water from Lake Spaulding to the Drum Power House forebay, where limited amounts of water are occasionally spilled into Canyon Creek, and thence to the Boardman Canal which conveys irrigation water to areas of use. Water imported through the Drum Canal in 1948-49, 1949-50, and 1950-51 amounted to about 285,100 acre-feet, 276,800 acre-feet, and 348,800 acre-feet, respectively. From the Drum Power House afterbay water is conveyed through a pressure tunnel to the Dutch Flat Power House. Water returned to the Bear River from the Dutch Flat Power House is diverted to Placer County at the Bear River Canal intake near Colfax.

Water was formerly exported from Placer County through the North Fork Ditch of the North Fork Ditch Company, for domestic and irrigation use in Sacramento County. This water was diverted from the North Fork of the American River and delivered to areas of use in Sacramento County through a ditch and steel pipe line. However, since the completion of Folsom Dam and Reservoir, the diversion is made at the dam. Although accurate data are not available, it is estimated that from 25,000 to 30,000 acre-feet of water per season are exported through the North Fork Ditch at the present time.

UNDERGROUND HYDROLOGY

Detailed studies of underground hydrology in Placer County were limited to the Valley Unit, which overlies a portion of the Sacramento Valley ground water basin. Preliminary examination and study revealed that the relatively small yield of ground water obtainable from ground water basins in the other units of the county was generally limited to that required for domestic use and, furthermore, would be of little importance in meeting probable ultimate water requirements of those units. For these reasons the ensuing discussion of underground hydrology has been limited to the Valley Unit.

Ground water pumped from storage in the basin underlying the Valley Unit presently serves nearly two-thirds of the lands irrigated in the unit. Percolation of stream flow and of the unconsumed portion of applied irrigation water is the most important source of ground water replenishment. However, it is probable that direct rainfall penetration and subsurface inflow constitute minor sources of ground water replenishment.

The term "free ground water," as used in this bulletin, generally refers to a body of ground water not overlain by impervious materials, and moving under control of the water table slope. "Confined ground water" refers to a body of ground water overlain by material sufficiently impervious to sever free hydraulic connection with overlying water, and moving under pressure caused by the difference in head between intake and discharge areas of the confined water body. In areas of free ground water the ground water basin provides regulatory storage to smooth out fluctuations in available water supplies, and changes in ground water storage are indicated by changes in ground water levels.

Data and information collected during the Placer County Investigation indicate that free ground water exists in present zones of pumping in the Valley Unit. However, a relatively unbroken and extensive layer of hardpan appears to limit percolation of stream flow or of the unconsumed portion of applied water to the water table in portions of the unit. Study of recent fluctuations of the water table in the Valley Unit, under varying conditions of draft and replenishment, permitted a determination of changes in ground water storage in the underlying basin, and its safe yield of water under stated conditions.

Ground Water Geology

Geologic features of a portion of the Valley Unit of Placer County were investigated by the Ground Water Branch of the United States Geological Survey as part of an investigation of the Sacramento Valley conducted in cooperation with the Division of Water Resources. The results of this investigation have been published in part as a report entitled "Ground-Water Storage Capacity of the Sacramento Valley, California," which is included as an appendix to "Water Resources of California," Bulletin No. 1 of the State Water Resources Board. The results of additional cooperative geologic investigation by the United States Geological Survey, covering portions of Placer County, are contained in an appendix to the "Sutter-Yuba Counties Investigation," Bulletin No. 6 of the State Water Resources Board. The foregoing investigations, supplemented by additional geologic investigation by the Division of Water Resources, were utilized in preparation of the geologic report included as Appendix B of this bulletin. Appendix B comprises a report of the geologic features of Placer County, and an estimate of ground water storage capacity of the ground water basin underlying the Valley Unit within given pumping lifts. An abstract of the geologic report follows:

Placer County lies in the Sierra Nevada and Great Valley geomorphic provinces of California. The Sierra Nevada, which consists of a huge tilted fault block, covers most of the county and looms above the flat alluviated low-lying bottom of the Sacramento Valley which lies to the west. This portion of the Great Valley has been subdivided into dissected alluvial uplands, low alluvial plains and fans, and flood plains.

The geologic formations of Placer County range from Paleozoic to Recent in age. The nonwater-bearing group includes granitic rocks and greenstones, as well as metamorphics of the Calaveras group, Sailor Canyon formation, and Mariposa formation. The water-bearing group includes all formations of Tertiary or Quaternary age occurring in the county, although only in the Sacramento Valley do these materials serve as ground water aquifers. The materials comprising these formations consist of volcanics of widely varying types, and continental and marine sediments. The sedimentary formations which are water-bearing include Tertiary stream gravel of the Sierra Nevada, mixed sediments of the deltaic Ione formation, "old alluvium" and "intermediate alluvium" of the Sacramento Valley, and recent active stream channel deposits.

Specific Yield and Ground Water Storage Capacity in Valley Unit

The term "specific yield," when used in connection with ground water, refers to the ratio of the volume of water a saturated soil will yield by gravity to its own volume, and is commonly expressed as a percentage. Ground water storage capacity is estimated as the product of the specific yield and the volume of material in the depth intervals considered.

In the investigation of the ground water basin underlying the Valley Unit, the specific yield of different depth zones was estimated after study of some 50 well logs. The estimates were based on previously determined characteristics of various types of material classified in the well logs. Ground water storage capacity of the Valley Unit was estimated for depth intervals from 20 to 50 feet, 50 to 100 feet, 100 to 200 feet, and for the entire interval from 20 to 200 feet below ground surface. Storage capacity of the ground water basin underlying the Valley Unit, and the weighted average specific yield, are shown in Table 12.

TABLE 12

ESTIMATED SPECIFIC YIELD AND GROUND WATER STORAGE CAPACITY IN VALLEY UNIT OF PLACER COUNTY

Depth interval, in feet from ground surface	Weighted average specific yield, in per cent	Ground water storage capacity, in acre-feet
20 to 50	5.1	168,000
50 to 100	4.9	270,000
100 to 200	5.3	584,000
20 to 200	5.2	1,022,000

Ground Water Levels in Valley Unit

The first study of ground water conditions in Placer County was made by Kirk Bryan in 1913, and reported in United States Geological Survey Water-Supply Paper No. 495. No indications of a depression cone were found to exist in the ground water table at that time. The slope of the ground water table was uniformly westward from the higher lands located along the edge of the valley toward the Feather and Sacramento Rivers. Three wells west of Lincoln were located by Bryan, serving 20 acres of irrigated land. The average depth to ground water measured in 1913 at two of these wells was 11.3 feet. In 1951 there were about 130 operating irrigation wells in the Valley Unit of Placer County.

The Division of Water Resources has measured fall water levels at a series of control wells throughout the Sacramento Valley during most years from 1929 through 1940, and each year from 1947 to date. Ten of these control wells are in Placer County. The Pacific Gas and Electric Company furnished records of standing and operating ground water levels measured during pump tests, together with results of the tests.

A complete series of measurements of static ground water levels at approximately 180 wells in Placer County was made in the spring and fall of each year during the period of the investigation, beginning with the fall of 1948 and continuing through 1952. The grid of measuring wells included nearly all operating irrigation wells, and certain domestic and abandoned wells in areas where irrigation wells could not be found. In addition, monthly measurements were made in most months during the investigation at approximately 35 uniformly distributed control wells, in order to observe behavior of the ground water table under conditions of draft and recharge. Available records of depth to ground water at wells in or adjacent to the Valley Unit are included as Appendix F.

Wells were numbered by the system utilized by the United States Geological Survey, according to township, range, and section. Under this system each section is divided into 40-acre plots which are lettered as follows:

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Wells are numbered within each of these 40-acre plots according to the order in which they are located. For example, a well having a number 12N/5E-2B1 would be found in Township 12 North, Range 5 East, and

2—81627

in Section 2. It would be further identified as the first well located in the 40-acre plot lettered B.

Depths to ground water throughout the Valley Unit, as measured each fall from 1948 through 1952, were plotted on maps and lines of equal depth were drawn. Depths to ground water in the fall of 1952 are shown on Plate 8, entitled "Lines of Equal Depth to Ground Water, Valley Unit, Fall of 1952." Plate 9 entitled "Lines of Equal Elevation of Ground Water, Valley Unit, Fall of 1952," was prepared from the data used for Plate 8, depths to ground water being subtracted from elevations of the measuring points above sea level to obtain elevations of the water table.

Table 13 shows depths from the surface of the ground to the water table at selected representative wells during the fall of most years from 1929 through 1952. The measurements were generally made following the summer period of irrigation pumping draft and prior to recovery in ground water storage resulting from winter rains. Fluctuations in depth to ground water at these wells are depicted graphically on Plate 10, entitled "Measured Fall Depths to Ground Water at Representative Wells, Valley Unit."

TABLE 13

MEASURED FALL DEPTHS TO GROUND WATER AT REPRESENTATIVE WELLS IN VALLEY UNIT OF PLACER COUNTY

(In feet)

Year	Well number				
	12N/5E-2B1	12N/5E-19R1	12N/5E-20M1	12N/6E-19A1	13N/5E-35M1
1929	----	18.0	----	17.3	----
1930	----	17.3	----	17.3	----
1931	----	19.1	----	17.4	16.3
1932	----	18.5	----	17.5	16.5
1933	23.6	19.6	----	16.9	----
1934	23.3	19.5	----	17.8	16.2
1936	19.9	17.3	----	17.4	16.2
1937	20.0	----	17.5	18.7	14.8
1938	19.2	----	16.6	18.7	13.6
1940	18.7	----	16.1	12.8	13.0
1947	21.2	----	18.3	16.0	14.5
1948	23.3	----	19.8	16.2	18.0
1949	24.3	----	23.3	----	19.0
1950	26.9	----	26.3	----	21.4
1951	28.9	----	31.8	----	22.7
1952	----	----	36.1	----	26.6
1953	40.4	----	39.8	----	37.5

From study of all available well measurements, estimates were made of the approximate average depth to ground water in the Valley Unit in the fall of most years from 1929 through 1952. These estimates are presented in Table 14, and are illustrated graphically on Plate 11, entitled "Average Fall Depth to Ground Water, Valley Unit."

It is indicated that from 1929 until 1940 depth to ground water generally varied with differences in

TABLE 14

ESTIMATED AVERAGE FALL DEPTH TO GROUND WATER IN VALLEY UNIT OF PLACER COUNTY

(In feet)

Year	Depth to ground water	Year	Depth to ground water
1929	23.4	1942	----
1930	23.2	1943	----
1931	23.1	1944	----
1932	23.2	1945	----
1933	24.1	1946	----
1934	25.3	1947	21.1
1935	----	1948	30.0
1936	24.6	1949	31.7
1937	24.0	1950	33.1
1938	22.4	1951	35.1
1939	----	1952	37.8
1940	21.0	1953	45.5
1941	----	1954	51.5

seasonal precipitation. Although no measurements are available from 1941 through 1946, records of measurements made in Sutter and Yuba Counties indicate that the water table continued to rise during a generally wet series of years until 1943. Since 1943, coincidental with several dry years and expansion of irrigation, a continuous lowering of the water table has occurred, reaching its greatest average depth in the fall of 1954.

Estimates were made of the average depth to ground water in the Valley Unit in most months of the investigation. For all months except November, these estimates constitute arithmetical averages of measurements of a group of wells chosen to be as uniformly distributed as possible throughout the Valley Unit. In order to estimate more accurately weighted average depths for November, when complete series of measurements were available, maps were drawn showing lines of equal change in ground water elevation during each season from 1948-49 through 1951-52. By planimetering the areas between lines of equal change, the weighted average change in elevation of water levels was estimated. These estimates together with average depths from more recent measurements are presented in Table 15.

Table 15 shows that maximum elevations of the water table were reached in March or April, after replenishment of the ground water basin by winter rainfall had occurred, and that ground water levels then lowered during the pumping season, reaching their lowest points during August or September, near the end of the irrigation season.

Average changes in ground water elevations in the Valley Unit during the three-year base period and each investigational season were determined from the aforementioned maps showing lines of equal change in ground water elevation. An example of these maps is presented as Plate 12, entitled "Lines of Equal Change in Ground Water Elevation, Valley Unit, Fall

TABLE 15

ESTIMATED WEIGHTED AVERAGE MONTHLY DEPTH TO GROUND WATER IN VALLEY UNIT OF PLACER COUNTY

(In feet)

Month	1948-49	1949-50	1950-51	1951-52	1952-53	1953-54	1954-55
October	----	----	36.2	----	----	----	----
November	30.0	31.7	33.1	35.1	37.8	45.5	51.5
December	----	----	33.2	----	----	----	----
January	----	----	32.2	33.7	-	----	----
February	----	31.5	31.1	32.4	----	----	----
March	----	----	30.5	----	----	----	----
April	28.2	31.3	31.7	32.5	35.2	----	----
May	31.3	31.9	32.8	----	----	----	----
June	34.8	34.8	36.1	----	----	----	----
July	34.2	36.1	37.6	----	----	----	----
August	35.5	37.0	38.3	----	----	----	----
September	34.0	37.6	38.5	----	----	----	----

of 1948 to Fall of 1952," which shows the changes over the four-year period of measurements made for the current investigation. The results of these estimates for the Valley Unit are presented in Table 16.

TABLE 16

ESTIMATED WEIGHTED AVERAGE SEASONAL CHANGES IN FALL GROUND WATER ELEVATION IN VALLEY UNIT OF PLACER COUNTY

(In feet)

Average, 3-year base period, 1948-49 through 1950-51	1948-49	1949-50	1950-51	1951-52
—1.7	—1.7	—1.4	—2.0	—2.7

Change in Ground Water Storage in Valley Unit

In an area of free ground water, the volume of soil unwatered or resaturated over a period of time, when multiplied by the specific yield, measures the change in ground water storage during that time. Available data on fluctuations of water levels at wells in the Valley Unit were sufficient to estimate the volume of soil unwatered or resaturated during the base period, and during the investigational seasons. Changes in ground water storage were estimated by multiplying changes in elevation of ground water, presented in Table 16, by the total area of the Valley Unit and by the weighted average value of specific yield of 5.1 per cent, for the depth interval from 20 to 50 feet below ground surface, presented in Table 12. The results of these estimates are presented in Table 17.

TABLE 17

ESTIMATED WEIGHTED AVERAGE SEASONAL CHANGES IN GROUND WATER STORAGE IN VALLEY UNIT OF PLACER COUNTY

(In acre-feet)

Area, in acres	Average, 3 year base period, 1948-49 through 1950-51	1948-49	1949-50	1950-51	1951-52
110,000	—9,500	—9,500	—7,900	—11,200	—15,200

It is indicated that an average seasonal net decrease in ground water storage in the Valley Unit of about 9,500 acre-feet occurred during the three-year base period, during which conditions of water supply and climate were approximately equivalent to conditions during the mean period. The estimated net decrease in ground water storage during the three investigational seasons was approximately 9,500 acre-feet in 1948-49, 7,900 acre-feet in 1949-50, and 11,200 acre-feet in 1950-51. Additional measurements made in November, 1952, indicated that a further decrease in ground water storage of about 15,200 acre-feet had occurred during the 1951-52 season. It may be noted from Plate 12 that a general lowering of water levels occurred during the period from the fall of 1948 to the fall of 1952, and that the lowering was particularly pronounced in a limited area south of Auburn Ravine and west of U. S. Highway 99E, and also along the western edge of the county.

Subsurface Inflow and Outflow in Valley Unit

Lines of equal elevation of ground water in the Valley Unit in the fall of 1952 are shown on Plate 9. Slopes of the water table as defined by these ground water contours, together with information on the permeabilities of the various subsurface geologic formations, indicate that the greatest portion of subsurface inflow to the unit probably came from the northeast. The slope of the ground water table is generally westward from the higher land toward the Feather and Sacramento Rivers, with subsurface outflow indicated across the county line into Sutter County.

A ground water trough is indicated on Plate 9 in an area south of Auburn Ravine and west of U. S. Highway 99E. Seasonal recovery of water levels is slow in this area, and replenishment is probably restricted by a barrier of less permeable material immediately to the east. A cone of depression in the water table is also indicated several miles south of Pleasant Grove. The depression is probably the result of heavy pumping for irrigation of rice in the immediate vicinity of the cone. Plate 8 indicates that there is some contribution to the ground water basin from surface streams of the Valley Unit in spite of the extensive layer of hardpan generally underlying the ground surface throughout the unit.

Ground water gradients shown on Plate 8 indicate that there was subsurface outflow across the western boundary of Placer County into Sutter County even during 1951-52, which was the season of heaviest pumping draft and lowest water levels during the current investigation. Maps of lines of equal elevation of ground water, drawn for each fall of the period of investigation, indicated that this condition also existed in 1948, 1949, 1950, and 1951. Sufficient data were not available for years prior to the beginning of the investigation to enable the determination of accurate contours of ground water elevation. Information obtained in areas adjacent to the Valley Unit, and measurements from a few wells in the unit prior to the time of substantial pumping draft, indicate that under natural conditions ground water moved across the western boundary of Placer County into Sutter County. It is probable that this was a significant source of replenishment to the ground water basin underlying Sutter County. Subsequent to 1948, which marks the approximate beginning of heavy agricultural use of ground water in the Valley Unit, ground water levels have been lowered and subsurface outflow to Sutter County has been reduced. Continued increase in pumping draft in the Valley Unit will further reduce subsurface outflow and will probably result in further lowering of water levels not only in the Valley Unit but also in Sutter County.

An indirect method was used to estimate the net effect of subsurface inflow to and outflow from the Valley Unit. This involved evaluation of the difference between subsurface inflow and outflow as the item necessary to effect a balance between water supply and disposal. The sum of the items comprising the water supply of a given hydrologic unit or area must be equal to the sum of the items of water disposal. This is a statement of what is referred to as the "equation of hydrologic equilibrium." In the case of the Valley Unit, values for pertinent items other than the difference between subsurface inflow and outflow, including surface inflow and outflow, precipitation, change in ground water storage, and consumptive use of water, were quantitatively measured or estimated. Determination of values for consumptive use of water is explained in Chapter III. The difference between subsurface outflow and inflow was the remaining unknown quantity in the equation. Table 18 sets forth this equation for the Valley Unit of Placer County.

TABLE 18

ESTIMATED EXCESS OF SEASONAL SUBSURFACE OUTFLOW OVER SUBSURFACE INFLOW IN VALLEY UNIT OF PLACER COUNTY

(In acre-feet)

Item	Average for 3-year base period, 1948-49 through 1950-51	1948-49	1949-50	1950-51
Water supply				
Precipitation	164,200	149,600	146,900	195,200
Surface inflow	105,300	83,700	74,100	158,000
Decrease in ground water storage	9,500	9,500	7,900	11,200
TOTALS	279,000	242,800	228,900	364,400
Water disposal				
Surface outflow	106,500	72,200	56,700	190,300
Consumptive use of water	159,100	147,700	162,500	166,500
TOTALS	265,600	219,900	219,200	356,800
REMAINDER—EXCESS OF SUBSURFACE OUTFLOW OVER SUBSURFACE INFLOW	13,400	22,900	9,700	7,600

Certain of the values in the equation presented in Table 18 are of large magnitude as compared to the derived excess of subsurface outflow over subsurface inflow. Small percentage errors in these larger quantities might introduce relatively large errors in the derived remainders. However, the derived remainders for the base period and for the investigational seasons appear to be of about the proper order and sequence, based upon general knowledge of ground water levels and pumping drafts. It is indicated in Table 18 that the contribution to the subsurface outflow from the water supply available to the Valley Unit was about 13,400 acre-feet per season during the three-year base period. It is also shown that the contribution to the subsurface outflow was about 22,900 acre-feet, 9,700 acre-feet, and 7,600 acre-feet during the three investigational seasons, respectively. From these values it may be noted that, coincidental with the increase in pumping draft during the base period and during the investigational seasons, the contribution to the subsurface outflow from within the Valley Unit progressively decreased.

Yield of Wells in Valley Unit

Yield of wells is an important factor in the use of ground water in Placer County. In certain small areas, ground water is not utilized for irrigation because of inability to obtain wells of adequate capacity to meet agricultural requirements. On the other hand, throughout most of the Valley Unit adequate irrigation wells can be obtained.

Yield of wells in the Valley Unit was analyzed by the Division of Water Resources, as reported in Appendix B, utilizing data obtained from well pumping tests made in 1951 by the Pacific Gas and Electric Company and by the Division. Results of this analysis are summarized in Table 19, which shows the number of wells of known depth which were tested, average discharge, average specific capacity, average depth, and average yield factor. The term "specific capacity" refers to the number of gallons of water per minute produced by a pumping well per foot of drawdown. "Drawdown" refers to the lowering of the water elevel in a well caused by pumping, and is measured in feet. The "yield factor" reflects the production of water per foot of depth of well, and is determined by multiplying the specific capacity by 100 and dividing by the depth of the well, in feet.

TABLE 19

ESTIMATED AVERAGE YIELD OF WELLS IN VALLEY UNIT OF PLACER COUNTY, 1951

Number of wells tested	Average discharge, in gallons per minute	Average specific capacity, in gallons per minute per foot of drawdown	Average depth of wells, in feet	Average yield factor
13	752	35.6	486	7.3

A comparison of the average yield factors shown in Table 19 with factors derived in connection with the Sutter-Yuba Counties Investigation for neighboring zones to the north and west, reveals that it is generally necessary to drill wells to greater depths in Placer County to obtain equivalent yields. The average yield factor for the portion of Yuba County to the north was determined to be 16.7, and for the portion of Sutter County to the west was 14.7. No significant variations in yield factors were noted between the various sections of the Valley Unit. There are, however, large parts of the Valley Unit where deep wells have not yet been drilled, and other areas as previously stated where wells of adequate capacity to meet agricultural requirements have not been found.

Safe Ground Water Yield of Valley Unit

The term "safe ground water yield" refers to the maximum rate of extraction of water from a ground water basin which, if continued over an indefinitely long period of years, would result in the maintenance of certain dsirable fixed conditions. Commonly, safe ground water yield is determined by one or more of the following criteria:

1. Mean seasonal extraction of water from the ground water basin does not exceed mean seasonal replenishment to the basin.

2. Water levels are not so lowered as to cause harmful impairment of the quality of the ground water by intrusion of other water of undesirable quality, or by accumulation and concentration of degradants or pollutants.

3. Water levels are not so lowered as to imperil the economy of ground water users by excessive costs of pumping from the ground water basin or by exclusion of users from a supply therefrom.

Safe ground water yield, as derived in this bulletin, was measured by net extraction of water from the Valley Unit ground water basin, as differentiated from total pumpage from the basin. Since the Valley Unit overlies what is considered to be a free ground water basin, the unconsumed portion of total pumpage may return to the ground water basin and become available for re-use. The net rate of extraction, therefore, was considered to be only that portion of total pumpage from the ground water basin which was consumptively used.

Under natural conditions, ground water is expended by consumptive use from seep lands and from lands where the water table is close to the ground surface, by effluent stream flow, and by subsurface outflow. Artificial development and utilization of ground water salvages all or a portion of such natural disposal, by lowering ground water levels. This, in turn, affords opportunity for additional replenishment of ground water.

With the present general patterns of water utilization in the Valley Unit, the extraction of water from the ground water basin might be increased. Such increase in draft would undoubtedly be accompanied by recession of ground water levels in areas of pumping and in adjacent areas. However, this lowering of the water table would probably induce increased subsurface inflow to the areas of pumping and reduce natural disposal of the ground water, the probable effects of which would be to increase replenishment in an amount approximately equal to the increase in draft, although adjustment of water levels in adjacent areas would probably take place. For this reason, the first of the foregoing criteria for determination of safe yield was not considered to be applicable in the Valley Unit.

The second of the foregoing criteria is not considered presently applicable, since the mineral quality of surface and ground waters is generally well suited for nearly all uses. However, there is some evidence that saline deterioration in mineral quality of ground water in the extreme western portion of the investigational area might occur with substantial lowering of water levels.

Because of expressed local concern over recent progressive lowering of pumping levels, the third of the foregoing criteria for determination of safe ground water yield was adopted as applicable to the Valley Unit. Therefore, it was arbitrarily assumed that seasonal net extraction of ground water in 1950-51, with ground water levels prevailing at that time, defined the desirable limit beyond which net extraction should not be increased at the expense of further lowering of ground water levels.

As previously stated, consumptive use of ground water was considered to be equal to net extraction of water from the Valley Unit ground water basin. An estimate of average seasonal consumptive use of ground water in the Valley Unit during the three-year base period is presented and explained in Chapter III. After correction for average seasonal change in ground water storage, this value was considered to represent average seasonal replenishment of the ground water basin during the base period. When further corrected for the increase in replenishment during 1950-51, over and above the base period average, as measured by decrease in subsurface outflow, the value was considered to be equal to safe seasonal ground water yield. The estimate of safe seasonal ground water yield is presented in Table 20.

TABLE 20

ESTIMATED SAFE SEASONAL GROUND WATER YIELD IN VALLEY UNIT OF PLACER COUNTY

Item	Acre-feet
Average seasonal consumptive use of ground water for 3-year base period, 1948-49 through 1950-51	23,900
Average seasonal decrement in ground water storage for base period	9,500
Average seasonal replenishment of ground water basin for base period	14,400
Increase in replenishment in 1950-51 over base period seasonal average	5,800
SAFE SEASONAL GROUND WATER YIELD	20,200

Certain of the items included in the estimated safe ground water yield are based on the assumption that present practices of irrigation by surface water supplies in and adjacent to the Valley Unit will continue indefinitely. Under such circumstances, adjacent portions of the common ground water basin, together with an indicated movement of underground water from the east and northeast, will remain the sources of sufficient subsurface inflow to areas of ground water pumping in the Valley Unit to meet reasonable increases in pumping draft. While there is no assurance that surface irrigation practices will continue indefinitely as at present, there is reason to believe that any changes will not be of material significance to the estimated yield for several years in the future.

The foregoing estimate of safe seasonal ground water yield may be considered to represent the net seasonal extraction from the ground water basin that might be maintained without permanent lowering of the water table beyond conditions prevailing in 1950-51. Having so chosen the determining criterion, estimated safe seasonal ground water yield may be considered to be a property of the ground water basin, not affected by changes in irrigation efficiency, patterns, or practices.

The indicated value of safe yield of 20,200 acre-feet has been determined from studies of the three-year base period for which data on water supply and utilization were available. Although it would have been desirable to use a longer base period to reduce the variability in results due to possible errors in measurements of values during a single year of observation, there had been no substantial use of ground water for agricultural purposes prior to 1947-48. This lack of data therefore precluded the use of a longer base period. It is also desirable to point out that the development in the use of ground water in the Valley Unit has been rapid since 1947-48, and consequently it has not been possible to study water supply and disposal during a season or a period when conditions of supply and disposal were essentially stabilized. For these reasons, it is felt that further examination of ground water conditions in the Valley Unit is necessary in the future, and that such may suggest revision of the value of safe seasonal ground water yield derived herein.

QUALITY OF WATER

The surface water supplies of Placer County are of excellent mineral quality and well suited from that standpoint for irrigation and other beneficial uses. Ground water of good mineral quality occurs in all parts of the Valley Unit except in scattered areas adjacent to the foothills. The principal objectives of the water quality investigation were to investigate the general conditions with respect to quality of water and to determine, if possible, the location and extent of areas presently affected by saline ground water.

It is desirable to define certain terms commonly used in connection with discussion of quality of water:

Quality of Water—Those characteristics of water affecting its suitability for beneficial uses.

Mineral Analysis—The quantitative determination of inorganic impurities of dissolved mineral constituents in water.

Degradation—Impairment in the quality of water due to causes other than disposal of sewage and industrial wastes.

Contamination—Impairment of the quality of water by sewage or industrial waste to a degree which creates a hazard to public health through poisoning or spread of disease.

Pollution—Impairment of the quality of water by sewage or industrial waste to a degree which does not create a hazard to public health, but which adversely and unreasonably affects such water for beneficial uses.

Complete mineral analysis included a determination of three cations, consisting of calcium, magnesium, and sodium; four anions, consisting of bicarbonate, chloride, sulphate, and nitrate; total soluble salts; boron; and computation of per cent sodium. Partial analysis included determination of chlorides and total mineral solubles only.

With the exception of boron, the concentrations of cations and anions in a water sample are expressed in this bulletin in terms of "equivalents per million." This was done because ions combine with each other on an equivalent basis, rather than on basis of weight, and a chemical equivalent unit of measurement provides a better and more convenient expression of concentration. This is especially true when it is desired to compare the composition of waters having variable concentrations of mineral solubles. In the case of boron, concentrations are expressed on a weight basis of "parts per million" of water. In order to convert equivalents per million to parts per million, the concentration, expressed in equivalents per million, should be multiplied by the equivalent weight of the cation or the anion in question. Equivalent weights of the common cations and anions are presented in the following tabulation:

Cation	*Equivalent weight*	*Anion*	*Equivalent weight*
Calcium	20.0	Bicarbonate	61.0
Magnesium	12.2	Chloride	35.5
Sodium	23.0	Sulphate	48.0
		Nitrate	62.0

Data used to determine the quality of water in Placer County included complete mineral analyses of 39 surface water samples and 29 ground water samples. The data also included partial analyses of 44 surface water samples and 218 ground water samples. Other data used during the course of the investigation included analyses reported in United States Geological Survey Water-Supply Paper 495, dated 1923, and entitled "Geology and Ground Water Resources of Sacramento Valley, California." Results of mineral analyses of water are presented in Appendix G of this bulletin.

Standards of Quality for Water

Investigation and study of the quality of surface and ground waters of Placer County, as reported herein, were largely limited to consideration of mineral constituents of the waters, with particular reference to their suitability for irrigation use. However, it may be noted that, within the limits of the mineral analyses herein reported, a water which is determined to be suitable for irrigation may also be considered as being either generally suitable for municipal and domestic use, or susceptible to such treatment as will render it suitable for that purpose.

The major criteria which were used as a guide to judgment in determining suitability of water for irrigation use were the following: (1) chloride concentration, (2) total soluble salts, (3) boron concentration, and (4) per cent sodium.

1. The chloride anion is usually the most troublesome element in most irrigation waters. It is not considered essential to plant growth, and excessive concentration will inhibit growth.

2. Total soluble salts furnishes an approximate indication of the over-all mineral quality of water. It may be approximated by multiplying specific electrical conductance ($Ec \times 10^6$ at 25° C.) by 0.7. The presence of excessive amounts of dissolved salts in irrigation water will usually result in reduced crop yield.

3. Crops are sensitive to boron concentration, but require a small amount, less than 0.1 part per million, for growth. They will usually not tolerate more than 0.5 to 2 parts per million, depending on the crop in question.

4. Per cent sodium reported in the analyses is the proportion of the sodium cation to the sum of all cations, and is obtained by dividing sodium by the sum of calcium, magnesium, and sodium, all expressed in equivalents per million, and multiplying by 100. Water containing a high per cent sodium has an adverse effect upon the physical structure of the soil by dispersing the soil colloids and making the soil "tight," thus retarding movement of water through the soil, retarding the leaching of salts, and making the soil difficult to work.

The following excerpts from a paper by Dr. L. D. Doneen, of the Division of Irrigation of the University of California at Davis, may assist in interpreting water analyses from the standpoint of their suitability for irrigation:

"Because of diverse climatological conditions, crops, and soils in California, it has not been possible to establish rigid limits for all conditions involved. Instead, irrigation waters are divided into three broad classes based upon work done at the University of California, and at the Rubidoux, and Regional Salinity laboratories of the U. S. Department of Agriculture.

"Class 1. *Excellent to good*—Regarded as safe and suitable for most plants under any condition of soil or climate.

"Class 2. *Good to injurious*—Regarded as possibly harmful for certain crops under certain conditions of soil or climate, particularly in the higher ranges of this class.

"Class 3. *Injurious to unsatisfactory*—Regarded as probably harmful to most crops and unsatisfactory for all but the most tolerant.

"Tentative standards for irrigation waters have taken into account four factors or constituents, as listed below.

Factor	Class 1 Excellent to good	Class 2 Good to injurious	Class 3 Injurious to unsatisfactory
Conductance (Ec × 10^6 at 25°C.)	Less than 1000	1000-3000	More than 3000
Boron, ppm	Less than 0.5	0.5-2.0	More than 2.0
Per cent sodium	Less than 60	60-75	More than 75
Chloride, epm	Less than 5	5-10	More than 10

(end of quotation)

Quality of Surface Water

Analyses of surface water samples, collected in May, 1952, from the American River and three of its branches, showed that at that time the waters in these streams were of excellent mineral quality and well suited for irrigation and other beneficial uses. The waters were characterized by a very low content of total mineral solubles, chloride, and boron, and by low per cent sodium. The occurrence of excellent quality water in the American River is also indicated by analyses of water from that stream which are presented in the Sacramento-San Joaquin Water Supervision Reports of the Division of Water Resources, dating from 1946. Analyses of surface water samples from minor streams and canals in the county indicate that these waters contain higher concentrations of mineral solubles than waters of the American River, but that they are well within the limits of Class 1 irrigation water. Selected mineral analyses of representative surface waters in and adjacent to Placer County are presented in Table 21. Additional analyses of representative surface waters are presented in Appendix F.

Quality of Ground Water

In the course of the present investigation surveys were made of the mineral quality of ground water throughout the Valley Unit. The general mineral quality of water from wells was found to be good. However, in an area east of and adjacent to U. S. Highway 99E, and extending to about six miles south from the City of Lincoln, waters from several wells and a spring were found to contain excessive concentrations of mineral solubles. Analyses of water from two wells west of Sheridan also showed moderately high concentrations of mineral solubles. Since other mineral analyses of water from wells in the same vicinities indicate low concentrations of mineral solubles, no definite area could be delimited which only yielded ground water of poor mineral quality. In this connection, ground water analyses collected in connection with other investigations indicate that waters containing high concentrations of mineral solubles are found at other scattered localities along the eastern edge of the Sacramento Valley.

Analyses of water samples collected from wells in the Valley Unit, grouped into the three broad classes described by Dr. Doneen, are presented in Appendix F. A summary showing the arithmetical average of the mineral constituents of each group of ground water analyses falling within a given class is given in Table 22.

TABLE 21

SELECTED COMPLETE MINERAL ANALYSES OF REPRESENTATIVE SURFACE WATERS IN PLACER COUNTY

Station	Date of sample	Conductance, Ec x 10^6 at 25°C.	Boron, in ppm	Mineral constituents, in equivalents per million							Per cent sodium
				Ca	Mg	Na	HCO_3 + CO_3	Cl	SO_4	NO_3	
Coon Creek at U. S. Highway 99E	5 11 51	204	0.00	0.24	0.98	0.32	1.80	0.13	0.11	0.01	15
Linda Creek at Roseville	5/11/51	174	0.02	0.75	0.64	0.48	1.38	0.22	0.20	0.01	25
Big Reservoir, tributary to Forbes Creek	9/ 49	37.8	0.00	0.00	0.11	0.25	0.12	0.02	0.01	0.00	69
Middle Fork American River near junction with North Fork	5/ 8 52	27.4	0.00	0.18	0.07	0.02	0.26	0.01	0.02	0.00	8
Bear River near Auburn	5/14/51	44.7	0.02	0.20	0.23	0.06	0.36	0.03	0.08	0.01	12
Truckee River at Truckee	5/14/51	71.3	0.06	0.38	0.22	0.14	0.66	0.03	0.10	0.01	18

TABLE 22

SUMMARY OF COMPLETE MINERAL ANALYSES OF REPRESENTATIVE GROUND WATER BY CLASSES IN VALLEY UNIT OF PLACER COUNTY

Class	Number of samples	Conductance, Ec x 10^6 at 25°C.	Boron, in ppm	Mineral constituents, in equivalents per million							Per cent sodium
				Ca	Mg	Na	HCO_3 + CO_3	Cl	SO_4	NO_3	
Excellent to good	16	268	0.23	0.84	0.75	1.18	1.90	0.59	0.16	0.04	40
Good to injurious	7	750	1.40	1.81	0.91	4.28	1.75	4.54	0.58	0.05	60
Injurious to unsatisfactory	5	1,494	2.06	3.10	1.15	9.63	1.20	11.44	1.48	0.10	68
Unsatisfactory	1*	20,200	32.00	47.45	1.56	180.43	0.33	202.25	27.50	0.02	78

* Spring.

CHAPTER III

WATER UTILIZATION AND SUPPLEMENTAL REQUIREMENTS

The nature and extent of water utilization and of requirements for supplemental water in Placer County, both at the present time and under probable conditions of ultimate development, are considered in this chapter. In connection with the discussion, the following terms are used as defined:

Water Utilization—This term is used in a broad sense to include all employments of water by nature or man, whether consumptive or nonconsumptive, as well as irrecoverable losses of water incidental to such employment, and is synonymous with the term "water use."

Demands for Water—Those factors pertaining to rates, times, and places of delivery of water, quality of water, losses of water, etc., imposed by control, development, and use of the water for beneficial purposes.

Water Requirement—The amount of water needed to provide for all beneficial uses of water and for irrecoverable losses incidental to such uses. As used in this bulletin, the term refers only to consumptive uses of water unless otherwise specified.

Supplemental Water Requirement—The water requirement over and above the sum of safe ground water yield and safe surface water yield.

Consumptive Use of Water—This refers to water consumed by vegetative growth in transpiration and building of plant tissue, and to water evaporated from adjacent soil, from water surfaces, and from foliage. It also refers to water similarly consumed and evaporated by urban and nonvegetative types of land use.

Applied Water—The water delivered to a farmer's headgate in the case of irrigation use, or to an individual's meter in the case of urban use, or its equivalent. It does not include direct precipitation.

Ultimate—This term is used in reference to conditions after an unspecified but long period of years in the future when land use and water supply development will be at a maximum and essentially stabilized. It is realized that any present forecasts of the nature and extent of such ultimate development, and resultant water utilization, are inherently subject to possible large errors in detail and appreciable error in the aggregate. However, such forecasts, when based upon best available data and present judgment, are of value in establishing long-range objectives for development of water resources. They are so used herein, with full knowledge that their re-evaluation after the experience of a period of years may result in considerable revision.

The present water requirement in Placer County was estimated by the application of appropriate factors of unit water use to the present land use pattern as determined from survey data. The probable ultimate water requirement was similarly estimated, by use of an ultimate land use pattern projected from the present pattern on the basis of land classification data, the assumption being made that under ultimate conditions of development all irrigable lands would be irrigated.

As indicated by the foregoing definition, the present supplemental requirement for water in the Valley Unit of Placer County was estimated as the difference between derived values of safe yield of the ground water basin and present consumptive use of ground water. The probable ultimate requirement for supplemental water in the Valley Unit was evaluated as the difference between present and probable ultimate consumptive use of water, plus the present requirement for supplemental water. In other units of Placer County the present development is to a large extent determined by the available water supplies, and no present supplemental requirements are generally apparent. However, in some local areas further development is restricted because of limited water supplies and works. These minor present supplemental requirements were not subject to evaluation within the scope of the current investigation. Ultimate supplemental requirements in units of Placer County other than the Valley Unit were evaluated as the difference between present and probable ultimate consumptive use of applied water, adjusted to account for estimated re-use of return flows and losses in conveyance and application.

Certain possible nonconsumptive requirements for water, such as those for hydroelectric power generation, flood control, conservation of fish and wildlife, recreation, etc., will be of varying significance in the design of works to meet supplemental consumptive requirements for water in Placer County. In most instances, the magnitudes of such nonconsumptive requirements are relatively indeterminate and dependent upon allocations made in design after consideration of factors of economics. For these reasons, water requirements for hydroelectric power, flood control, conservation of fish and wildlife, and recreation are discussed in general terms in this chapter, but not specifically evaluated.

Water utilization is considered and evaluated in this chapter under the general headings "Present Water Supply Development," "Land Use," "Unit Use of Water," "Present Water Requirements," "Probable Ultimate Water Requirements," "Nonconsumptive Water Requirements," and "Demands for Water." Supplemental water requirements are similarly treated under the two general headings "Present Supplemental Water Requirement" and "Probable Ultimate Supplemental Water Requirement."

WATER UTILIZATION

Of the total amount of water presently utilized in the Valley Unit of Placer County, approximately 25 per cent is consumed in the production of irrigated crops, while the remainder is consumed by dry-farmed crops and fallow lands, native vegetation, and lands given over to miscellaneous types of use including domestic and municipal. Of the total amount of water presently applied within remaining units of the county, some 55,000 acre-feet, or about 90 per cent, is applied to irrigated lands.

Of the total area of about 916,000 acres in Placer County, it is indicated that ultimately about 212,000 acres will require organized water service. The remainder, of approximately 704,000 acres, comprises national forests and lands not considered suitable for irrigation. It is probable that the predominant importance of irrigated agriculture, as related to utilization of water in the county, will continue to prevail in the future.

Present Water Supply Development

Although there has been considerable development of the water resources of Placer County in the past, there remains a large amount of unregulated water susceptible of development for water conservation and use, hydoelectric power production, recreation, and other beneficial uses. Recently there has been an acceleration in irrigation development in the Valley Unit, and a resultant increase in the use of ground water pumped from wells. Substantial agricultural development has also taken place in the Foothill Unit. The agricultural areas of the Foothill Unit are served with water from canals and ditches of the Nevada Irrigation District and the Pacific Gas and Electric Company.

Present water supply developments in the several units of Placer County are described in the following sections, and are shown on Plate 2.

Valley and Foothill Units. Water developments and conservation facilities in the Foothill Unit include the canals and ditches of the Nevada Irrigation District and the Pacific Gas and Electric Company. These canals and ditches form an intricate network which crosses or intercepts most of the streams of the unit. Many small reservoirs are located in the Foothill Unit, serving as forebays or afterbays to regulate the flows of the Drum power system, or to provide storage and regulation of municipal and irrigation water supplies.

As has been stated, there has been a recent increase in the irrigation of lands in the Valley Unit by pumping from the underlying ground water basin. The irrigated lands utilizing ground water are served by individually owned wells and pumps. As of November, 1951, there were 137 wells with pumping plants of heavy draft, powered with motors of five horsepower or more, and of this number 129 were used for irrigation. The eight remaining wells supplied water for urban and industrial uses. A number of additional wells of light draft supplied water for domestic purposes. The beginning of the recent increase in use of ground water approximately coincided with the initiation of this investigation. During the investigational seasons an accurate record was obtained of the acreages irrigated with ground water. This record is given in Table 23, which also shows acreages served by surface water.

TABLE 23

AREA SERVED BY SURFACE AND GROUND WATER IN VALLEY UNIT OF PLACER COUNTY DURING INVESTIGATIONAL SEASONS

(In acres)

Type of service	1948-49	1949-50	1950-51
Surface water	4,130	3,800	3,710
Ground water	4,800	5,160	7,020
TOTALS	8,930	8,960	10,730

Water used for municipal, industrial, and domestic purposes in the Valley and Foothill Units is obtained almost entirely from reservoirs and canals, except that farmsteads and some small communities in the Valley Unit are served from privately owned wells. The largest nonagricultural use of water occurs in the vicinity of Roseville where that city, the Southern Pacific Company, and the Pacific Fruit Express Company utilize relatively large amounts of water. The amount of surface water distributed in the Valley and Foothill Units by the Pacific Gas and Electric Company to industrial and municipal users in 1950 is shown in Table 24.

In addition to the quantities of surface water listed in Table 24, the Pacific Fruit Express Company pumped about 3,150 acre-feet from wells in 1950. The City of Roseville also maintains emergency stand-by wells.

TABLE 24

ESTIMATED QUANTITY OF SURFACE WATER DISTRIBUTED FOR MUNICIPAL AND INDUSTRIAL USE IN VALLEY AND FOOTHILL UNITS BY PACIFIC GAS AND ELECTRIC COMPANY IN 1950

(In acre-feet)

User	Quantity
Auburn	1,260
Lincoln	1,150
Loomis	80
Newcastle	130
Rocklin	180
Roseville	2,860
Southern Pacific Company	1,310
TOTAL	6,970

American River Unit. Most of the existing water resource developments on the American River alter the natural regimen of the stream, and so affect the American River Unit of Placer County. The principal upstream development is on the South Fork of the American River and consists of a hydroelectric power system, as well as a small irrigation project. The North and Middle Forks of the American River are largely undeveloped at the present time.

Existing developments on the North Fork of the American River above its confluence with the South Fork consist of two small storage reservoirs. One of these, the Lake Valley Reservoir, with a stream bed elevation of 5,779 feet, is located about four miles east of Emigrant Gap on a tributary of the North Fork, and stores about 8,100 acre-feet of water. The stored water is conveyed from the American River Basin to the Bear River Basin for use in the Drum power system of the Pacific Gas and Electric Company. The other reservoir, created by the North Fork Dam, with a stream bed elevation of 571 feet, is located about two miles above the mouth of the Middle Fork of the American River, and is operated by the California Debris Commission. Total storage capacity created by the North Fork Dam is about 14,600 acre-feet, which is dedicated to storage of mining debris.

The only significant development on the Middle Fork of the American River is the water supply system of the Georgetown Divide Water Company, which serves irrigation, mining, and domestic consumers on the Georgetown Divide in El Dorado County. The company operates Loon Lake Reservoir, with a capacity of about 8,000 acre-feet and a stream bed elevation of 6,305 feet, located on Gerle Creek in the upper Rubicon River watershed in El Dorado County. Conveyance of water from Loon Lake to the Georgetown Divide service area is accomplished by some 40 miles of ditch, flume, and tunnel. Additional water is intercepted enroute by diversion of the natural flows of Pilot Creek and Little South Fork of Rubicon River. The average seasonal discharge of the Georgetown Ditch near Georgetown was about 9,500 acre-feet during the period from 1946-47 through 1948-49.

Developments on the South Fork of the American River are all situated outside of Placer County. The hydroelectric power system of the Pacific Gas and Electric Company on the South Fork includes several small reservoirs, a minor diversion from the Upper Truckee River, conduits and penstocks, and two power plants. The El Dorado Irrigation District serves agricultural, mining, industrial, and domestic water to consumers in the vicinity of Placerville. It receives a large part of its water supply from the Pacific Gas and Electric Company system, and another portion from a small reservoir on Webber Creek, a tributary of the South Fork. It also imports some water from the Cosumnes River Basin.

Existing developments on the main stem of the American River include the recently completed Folsom and Nimbus Dams and their reservoirs. Both are federally owned and operated and discharge through power houses located at the dams. A federally owned and state-operated spawning station and hatchery for salmon and steelhead has been constructed below Nimbus Dam to replace spawning beds made inaccessible to these fish.

The main section of Folsom Dam is located in Sacramento County about two miles upstream from the town of Folsom and impounds a reservoir of 1,000,000 acre-foot capacity. Diversions from Folsom Reservoir are made at the dam by pump and pipe line to Hinkle and Baldwin Reservoirs, which are located immediately below the right abutment. From these reservoirs further conveyance of the water is made by several agencies which serve agricultural, municipal, and domestic users in the area south of Roseville and north of the American River. From the same diversion at Folsom Dam additional water is conveyed by pipe line to the existing Natomas Ditch of the Natomas Company and which is located south of the American River.

Nimbus Dam, located about seven miles downstream from Folsom Dam, impounds Lake Natoma, which serves as an afterbay for Folsom Power House and as a forebay for Nimbus Power House, and has a gross storage capacity of about 8,900 acre-feet. A proposed main canal, the Folsom South Canal, would divert from Lake Natoma to a service area south of the American River.

Bear River and Yuba River Units. Many of the existing water resource developments on the Bear and Yuba Rivers relate to all units of Placer County except the Tahoe Unit. The joint project of the Nevada Irrigation District and the Pacific Gas and Electric Company on the Bear River, the upper South Fork of the Yuba River, and the Middle Fork of the Yuba River, utilizes a portion of the available hydroelectric

Credit: Pacific Gas and Electric Company

Spaulding Power Houses Nos. 1 and 2
Spaulding Dam in Background

power resources in the upper watersheds of these streams. To a large extent this project has been developed from the complicated network of reservoirs and ditches originally built for hydraulic mining. Although the principal source of water utilized by the project is the Yuba River, most of the power plants of the Pacific Gas and Electric Company, through which the Yuba River waters pass, are located on the Bear River. Under the present contract between the Pacific Gas and Electric Company and the Nevada Irrigation District, the regulated flow from works of the district is delivered to the Drum power system of the company for use through its power plants, and is then returned to the district at downstream points for irrigation use. A list of existing power houses located in Placer County, together with pertinent information, is presented in Appendix H of this bulletin.

Works of the Nevada Irrigation District under the joint project with the Pacific Gas and Electric Company include a diversion of about 500 second-foot capacity from the upper Middle Fork of the Yuba River at Milton. The stream bed elevation at the diversion point is 5,663 feet. The diverted water is conveyed through 4.1 miles of tunnel to Bowman Lake. Bowman Lake, with a capacity of 68,000 acre-feet and a stream bed elevation of 5,396 feet, is located on Canyon Creek, a tributary to the upper South Fork of the Yuba River. Several other reservoirs are located on Canyon Creek above Bowman Lake. Of these, French Lake is the largest with a capacity of 12,500 acre-feet. Its stream bed elevation is 6,564 feet. The controlled discharge from Bowman Lake is conveyed southerly in the Bowman-Spaulding Conduit, nine miles in length, and of 250 second-foot capacity, to Fuller Lake on Jordan Creek. This reservoir, owned by the Pacific Gas and Electric Company, has a stream bed elevation of 5,343 feet and a capacity of 1,130 acre-feet. The present contract between the district and the company requires that a total seasonal water supply of 135,500 acre-feet be delivered to the company by the district. About 73,000 acre-feet of this water is conveyed through the company's Drum System along the Bear River and returned to the district for irrigation in its service area in Placer County. The remainder of the water is conveyed in the company's South Yuba Canal to the Deer Creek Power House on Deer Creek, a tributary of the Yuba River, and is returned to the district for irrigation in its service area in Nevada County.

Works of the Pacific Gas and Electric Company include Lake Van Norden, located near the headwaters of the South Fork of the Yuba River at a stream bed elevation of 6,743 feet, with a capacity of about 5,900 acre-feet and Fordyce Lake on Fordyce Creek, a tributary of the South Fork of the Yuba River, with storage capacity of about 47,000 acre-feet, and at a stream bed elevation of 6,341 feet. The principal storage reservoir of the Pacific Gas and Electric Company under the joint project is Lake Spaulding, on the South Fork of the Yuba River, with a capacity of about 75,000 acre-feet and at a stream bed elevation of 4,739 feet. From Fuller Lake, previously mentioned, water delivered by the Nevada Irrigation District system is conveyed in a conduit with a capacity of 250 second-feet for a distance of about 1.5 miles to a point 318 feet above the high-water level of Lake Spaulding. Here it enters the penstock of Spaulding Power House No. 3, which has an installed capacity of 5,200 kilowatts. The company's system also includes Lake Valley Reservoir, previously described in the American River Unit. Releases from Lake Valley Reservoir are conveyed to the Drum Canal by means of a conduit which joins the canal near Emigrant Gap. Some 13 other small reservoirs owned by the Pacific Gas and Electric Company are scattered throughout the watershed of the South Fork of the Yuba River and in the Texas Creek and Fall Creek basins. Water from Texas and Fall Creeks is conveyed to Lake Spaulding by the Bowman-Spaulding conduit. Most of these small reservoirs are formed by low dams built in the mining days to raise the level of natural lakes, and their aggregate capacity is about 14,500 acre-feet.

The principal withdrawal of water from Lake Spaulding is made through Spaulding Power House No. 1, one of two power houses located just below Lake Spaulding Dam. After passing through the power plant, the released water is conveyed through a tunnel with a length of about one mile to the Drum Canal. The power plant operates under a maximum static head of 197 feet and has an installed capacity of 6,400 kilowatts. The Drum Canal, with a length of about eight miles and a capacity of about 500 second-feet, passes from the South Fork of the Yuba River across the low gap at the head of the Bear River and follows along the ridge on the south bank of the Bear River. The canal terminates at the forebay to the Drum Power House, which is located on the Bear River at an elevation of about 3,400 feet. This power plant operates under a maximum static head of 1,375 feet, and has an installed capacity of about 52,000 kilowatts. A pressure tunnel from the afterbay of the Drum Power House conveys released water a distance of four miles along the left bank of the Bear River to the penstock of the Dutch Flat Power House. This power plant operates under a maximum head of 643 feet and has installed capacity of about 22,000 kilowatts.

From the afterbay of the Dutch Flat Power House, the released water is conveyed in the natural channel of the Bear River to the diversion headworks of the Bear River Canal, located on the left bank of the river near Colfax. The Bear River Canal has a capacity of about 490 second-feet, and extends about 23 miles

Credit: *Pacific Gas and Electric Company*

Drum Canal

to the forebay and penstock of the Halsey Power House, which is located about six miles northeast of Auburn. The Halsey Power House, located on upper Dry Creek, operates under a maximum static head of 331 feet and has an installed capacity of about 10,600 kilowatts. From the afterbay of the Halsey Power House the water is conveyed in a southwesterly direction about six miles in the Wise Canal, with capacity of 450 second-feet, to the Wise Power House forebay. Enroute the water is regulated in Rock Creek Reservoir. The Wise Power House, located on Auburn Ravine near Auburn, operates under a maximum static head of 519 feet, and has an installed capacity of about 12,600 kilowatts.

During the irrigation season, releases from the Wise Power House into Auburn Ravine are diverted downstream for use in service areas of the Nevada Irrigation District, the Pacific Gas and Electric Company, and other users. During the remainder of the year most of the released water is spilled to the American River through the South Canal.

The Boardman Canal diverts from the Bear River about one mile west of Emigrant Gap, and spills into Canyon Creek near the Drum Power House forebay. Spill from the Boardman Canal and the Drum Power House forebay is diverted from Canyon Creek and conveyed in the Boardman-Towle Canal for a distance of about 3.5 miles to the Alta Power House. The Alta Power House, located about one mile west of Baxter, has a capacity of about 2,000 kilowatts, and operates under a maximum static head of 660 feet. Water discharged from the Alta Power House may be spilled to the Bear River and diverted downstream at the intake of the Bear River Canal for power generation. On the other hand, it may be conveyed in the Boardman Canal for distribution for irrigation along the watershed divide between the American and Bear Rivers, and in the vicinity of the Halsey Power House forebay.

In addition to the water discharged from Lake Spaulding through Spaulding Power House No. 1 and into the Drum Canal, water is also released through Spaulding Power House No. 2, located just below Lake Spaulding Dam. The power plant operates under a maximum static head of 344 feet and has an installed capacity of 3,750 kilowatts. Water released from Spaulding Power House No. 2 discharges into the South Yuba Canal which has a capacity of 125 second-feet. Water in the South Yuba Canal is conveyed for about 19 miles to the forebay and penstock of the Deer Creek Power House on Deer Creek. The Deer Creek Power House operates under a maximum static head of 837 feet and has an installed capacity of about 5,700 kilowatts. The water discharged from this plant is then released to Deer Creek for use by the Nevada Irrigation District. The district re-regulates the water in Scotts Flat Reservoir, of 26,300 acre-foot storage capacity, at a stream bed elevation of 2,910 feet on Deer Creek. The water is used for irrigation, domestic purposes, and mining in Nevada and Yuba Counties.

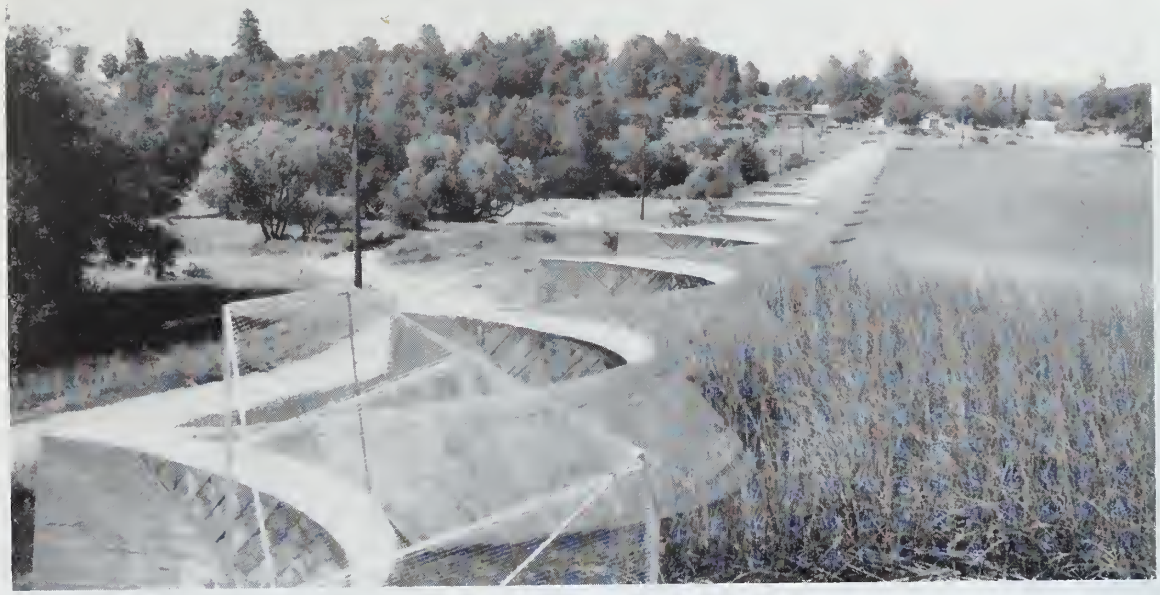
Other water conservation works on the Bear River include Combie and Camp Far West Reservoirs. Combie Reservoir of the Nevada Irrigation District is located on the Bear River north of Auburn and about 15 miles below the intake of the Bear River Canal. The reservoir has a capacity of about 9,000 acre-feet and a stream bed elevation of 1,525 feet. Water released from the reservoir for use in Placer County is diverted into the Gold Hill Canal and delivered to agricultural land served by the Nevada Irrigation District in northwestern Placer County.

Camp Far West Reservoir, owned and operated by the Camp Far West Irrigation District, has a storage capacity of about 5,000 acre-feet, and is located on the Bear River about 20 miles below Combie Reservoir and about 6 miles northeast of Wheatland, at a stream bed elevation of 136 feet. This reservoir supplies irrigation water to the lands of the Camp Far West District on both banks of the Bear River in Placer and Yuba Counties.

Tahoe Unit. Lands in the Tahoe Unit obtain their water supply from wells, springs, creeks, from nearby lakes lying at higher elevations, and from Lake Tahoe itself. The "Joint Report on the Use of Water in the Lake Tahoe Watershed," prepared by the State Engineers of Nevada and California, and dated June, 1949, estimated that the total consumptive use of applied water in the entire Lake Tahoe watershed did not exceed 350 acre-feet in 1948.

The Sierra-Pacific Power Company has five small power plants on the Truckee River below Lake Tahoe and a short distance north of Placer County. These power plants utilize about 60 per cent of the available head between the intake at Farad, at an elevation of about 5,300 feet, and the tailrace of the Reno power plant, at an elevation of about 4,500 feet. They have a total installed capacity of about 9,400 kilowatts. With the exception of the Verdi power plant, installed in 1912, all the developments were completed between 1899 and 1905. The lack of modern equipment, together with the impracticability of utilizing the water supply to best advantage because of prior irrigation rights, materially limits the power output of the system. During the irrigation season, substantial withdrawals of water for irrigation are made from the Truckee River by ditches diverting from the river above the canal intakes to downstream power plants.

Appropriation of Water. Since the effective date of the Water Commission Act on December 19, 1914, about 200 applications to appropriate water of streams of Placer County have been filed with the Division of Water Resources or its predecessors. These applications are listed in Appendix I, together with


Rock Creek Dam


Combie Dam

pertinent information on the proposed diversions and uses of water and present status of the applications.

The applications listed in Appendix I should not be construed as comprising a complete or even partial statement of water rights in Placer County. They do not include appropriative rights initiated prior to December 19, 1914, riparian rights, correlative rights of overlying owners in ground water basins, nor prescriptive rights which may have been established on either surface streams or ground water basins, none of which are of record with the Division of Water Resources. In general, water rights may only be firmly established by court decree.

Dams Under State Supervision. The Department of Public Works, acting through the agency of the State Engineer, supervises the construction, enlargement, alteration, repair, maintenance, operation, and removal of dams for the protection of life and property within California. All dams in the State, excepting those under federal jurisdiction, are under the jurisdiction of the department. "Dam" means any artificial barrier, together with appurtenant works, if any, across a stream, watercourse, or natural drainage area, which does or may impound or divert water, and which either (a) is or will be 25 feet or more in height from natural stream bed to crest of spillway, or (b) has or will have an impounding capacity of 50 acre-feet or more. Any such barrier, which is or will be not in excess of six feet in height, regardless of storage capacity, or which has or will have a storage capacity not in excess of 15 acre-feet, regardless of height, is not considered a dam. A list of dams in Placer County presently under state supervision, together with pertinent data, is presented in Appendix J.

Land Use

As a first step in estimating the amount of the water requirements in Placer County, determinations were made of the nature and extent of land use prevailing during the base period and investigational seasons. Similarly, the probable nature and extent of ultimate land use, as related to the water requirement, was forecast on the basis of land classification survey data which segregated lands of the county in accordance with their suitability for irrigated agriculture.

Present Pattern of Land Use. The Placer County Agricultural Commissioner for some years has made annual surveys of acreage, production, and value of agricultural products in Placer County. In 1946 the United States Bureau of Reclamation made a land use survey which included most of the Valley Unit of Placer County. A comprehensive land use survey was made by the Division of Water Resources in 1948-49 as a part of the current investigation. This survey included all lands in the county outside of the national forests. The Valley Unit, comprising about 110,000 acres, was resurveyed in 1949-50, and again in 1950-51, to obtain data on changes in land use and on increases in surface and ground water utilization.

Data available from the foregoing surveys were sufficient to determine the average land use pattern in the Valley Unit during the three-year base period. For purposes of this bulletin, the most recent land use pattern available, that for the 1950-51 season, was considered to represent "present conditions of land use and development in the Valley Unit," and is so referred to in subsequent discussion. Summaries of the results of the land use surveys of the Valley Unit for the investigational seasons of 1948-49, 1949-50, and 1950-51, and the average land use pattern for the base period, are presented in Table 25. The land use pattern existing during the 1948-49 season was considered to represent present conditions of development in the Foothill, American River, Bear River, Yuba River, and Tahoe Units. Summaries of the results of the land use surveys for Placer County are presented in Table 26. Lands presently irrigated in Placer County are shown on Plate 13, entitled "Irrigated and Irrigable Lands, 1951."

TABLE 25

PATTERNS OF LAND USE IN VALLEY UNIT OF PLACER COUNTY DURING INVESTIGATIONAL SEASONS

(In acres)

Class and type of land use	Base period average, 1948-49 through 1950-51	1948-49	1949-50	1950-51
Irrigated lands				
Hops	440	430	430	460
Orchard	880	820	780	1,050
Pasture	2,650	1,920	2,860	3,170
Rice	5,110	5,320	4,400	5,610
Truck	150	160	170	120
Vineyard	310	280	320	320
Subtotals	9,540	8,930	8,960	10,730
Dry-farmed and fallow lands				
Fallow	21,030	24,800	17,600	20,680
Grain	26,070	26,120	31,390	20,710
Orchard	370	420	450	250
Rice, idle	2,510	1,950	2,570	3,000
Vineyard	1,290	1,460	1,210	1,210
Subtotals	51,270	54,750	53,220	45,850
Native vegetation				
Brush and trees	2,510	2,640	2,640	2,240
Native grass	42,890	39,900	41,390	47,370
Wasteland	150	150	150	150
Subtotals	45,550	42,690	44,180	49,760
Miscellaneous				
Airports	80	80	80	80
County and farm roads	690	690	690	690
Farm lots and urban	2,180	2,170	2,180	2,200
Highways and railroads	160	160	160	160
Subtotals	3,110	3,100	3,110	3,130
TOTALS	109,470	109,470	109,470	109,470

TABLE 26

PRESENT PATTERN OF LAND USE IN UNITS OF PLACER COUNTY

(In acres)

Class and type of land use	Valley Unit	Foothill Unit	American River Unit	Bear River Unit	Yuba River Unit	Tahoe Unit	Totals
Irrigated lands							
Hops	460	0	0	0	0	0	460
Orchard	1,050	17,750	2,260	960	0	0	22,020
Pasture	3,170	5,680	140	480	0	0	9,470
Rice	5,610	0	0	0	0	0	5,610
Truck	120	0	0	0	0	0	120
Vineyard	320	1,020	0	0	0	0	1,340
Subtotals	10,730	24,450	2,400	1,440	0	0	39,020
Dry-farmed and fallow lands							
Fallow	20,680	0	0	0	0	0	20,680
Grain	20,710	7,110	50	90	0	0	27,960
Orchard	250	3,490	760	170	0	0	4,670
Pasture and range	0	26,480	2,100	1,360	0	0	29,940
Rice, idle	3,000	0	0	0	0	0	3,000
Vineyard	1,210	650	130	0	0	0	1,990
Subtotals	45,850	37,730	3,040	1,620	0	0	88,240
Native vegetation							
Brush and trees	2,240	67,990	349,920	36,490	0	0	456,640
Native grass	47,370	4,330	250	0	0	0	51,950
Wasteland	150	0	0	0	0	0	150
Woodland pasture		2,740	380	710	0	0	3,830
Subtotals	49,760	75,060	350,550	37,200	0	0	512,570
Miscellaneous							
Airports	80	80	0	0	0	0	160
County and farm roads	690	1,660	640	130	10	110	3,240
Farm lots and urban	2,200	1,880	80	0	10	130	4,300
Highways and railroads	160	280	210	80	60	260	1,050
National forests	0	0	142,810	1,580	13,450	109,580	267,420
Lake Tahoe	0	0	0	0	0	48,900	48,900
Subtotals	3,130	3,900	143,740	1,790	13,530	158,980	325,070
TOTALS	109,470	141,140	499,730	42,050	13,530	158,980	964,900

Probable Ultimate Pattern of Land Use. Lands of Placer County were classified with respect to their suitability for irrigated agriculture. The lands so classified included those lying generally west of the national forest boundaries, below an elevation of about 4,000 feet. The national forest lands were excluded since it is believed that they will be preserved in the public domain and dedicated generally to grazing, lumbering, and recreation. This, together with the limitations imposed by climatic and topographic conditions, and the abundant precipitation in the higher elevations, led to the conclusion that large-scale water supply developments to supply water within the national forests would never be required.

General information regarding the extent of irrigated and irrigable lands in the national forests in Placer County was obtained, however, from the United States Forest Service. The irrigable lands are generally located in small valleys where the terrain is nearly flat, and where water for irrigation is available by direct diversion from local streams. Data furnished by the Forest Service indicate that only about 20 acres of such land are irrigated at the present time, and that an additional 610 acres are considered to be irrigable, or a total of about 630 acres. In a few instances, portions of the national forests along their western boundaries were included within the land use and land classification surveys made by the Division of Water Resources in the current investigation. The foregoing figures furnished by the United States Forest Service do not include these areas.

The land classification made during the investigation was based on standards involving physical factors and known inherent conditions of soils, topography, and drainage. The conditions relative to the soils that largely determine their suitability for irrigation are depth, texture, and structure. These physical factors to a large extent determine the moisture-holding capacity, the root zone area, the ease of irrigation and cultivation, and the available nutrient capacity of the soil. Topographic conditions considered were the degree of slope and undulations. These affect the ease of irrigation and the type of irrigation practice required to provide water at a proper rate to cropped land. A proper rate of irrigation application will permit the soil to absorb and hold moisture without erosion or excessive losses through runoff or percolation. As a general rule, no lands with smooth slopes in excess of a 30-foot rise in 100 feet of horizontal distance were considered to be suitable for development by irrigation. Drainage is highly important and is closely associated with problems of salinity and alkalinity, and waterlogging of lands. It was assumed that under conditions of ultimate development all land suitable for reclamation will be reclaimed.

Economic factors relating to the development, production, or marketing of adaptable crops were not considered in making the land classification, nor were costs of clearing, leveling, or other operations required to prepare lands for cultivation. The classification was predicated on the ultimate potential of the land, without regard to availability of water or present land utilization. On the basis of the foregoing standards, agricultural lands of Placer County were segregated into the following seven classes:

Class 1. This class comprises lands that are highly desirable in every respect for continuous irrigated agriculture, and capable of producing all climatically adapted crops. The soils are deep, with good surface and subsoil drainage, of medium to fairly fine texture, and good water-holding capacity. The soil structure is such as to permit easy penetration of roots, air, and water, and the land surface is smooth and gently sloping.

Class 2. This class comprises lands that are generally limited to climatically adapted medium-rooted crops, due to the restrictive features of the soil depth, and, to a minor extent, of topography or drainage. They are well suited for development under irrigation.

Class 3. This class comprises lands that are generally limited in their use to climatically adapted shallow-rooted crops, owing to deficiencies in soil depth, moisture-holding capacity, topography, or to drainage characteristics. This class of lands is suitable for development under irrigation, but because of shallow soil depths, greater care and skill are required in the application of water.

Class 4-2. This class comprises lands which fail to meet the standards for Classes 1, 2, and 3 land, especially with regard to topographic conditions. These lands are suitable, through special irrigation practices, for the production of certain crops, not precluded by climatic conditions. Owing to their more rolling topography, they are more susceptible to erosion, and greater care must be taken in applying water and maintaining cover crops where the lands are under cultivation. Thus, these lands are best suited for crops which can be irrigated with small heads of water, including orchards, vineyards, and permanent pasture. In coarse-textured granitic soils, rapid percolation from the root zone may prohibit production of very shallow-rooted grass crops.

Class 4-3. This class comprises lands which fail to meet the requirements of Classes 1, 2, and 3, mainly on account of topographic conditions, and fail to meet the standards of Class 4-2 lands on account of shallower soil depths as well as steeper topography. Lands in this class are suitable for the production of shallow-rooted orchards and permanent pasture. However, irrigation on the steep slopes requires great skill and care.

Class 5-P. This class comprises lands which are generally desirable in all respects other than depth of soil, which greatly restricts their adaptability for crops other than permanent pasture. Owing to their shallow depths, these lands require frequent irrigation.

Class 6. This class comprises all lands that do not meet the minimum requirements of suitability for irrigation use.

In connection with the "Survey of Mountainous Areas," authorized by Chapter 30, Statutes of 1947, a land classification survey was made of all lands in the Mother Lode Region, extending from Butte County on the north to Mariposa County on the south. Most of Placer County is included in this region. Consequently, the land classification survey in Placer County, which for purposes of the current investigation included the entire county, was conducted concurrently with, and using the same methods and standards as the classification survey for the Mother Lode Region. In order to insure that land classification standards and field mapping were appropriate, an independent and highly qualified board reviewed the standards, the survey procedures, and the degree of conformity of the field work with the established standards. Members of the board were: Dr. Ralph C. Cole, Chief, Land Classification Section, Bureau of Reclamation, United States Department of the Interior; Robert A. Gardner, Senior Soil Correlator, Division of Soil Survey, United States Department of Agriculture; and Walter W. Weir, Drainage Engineer, Division of Soils, College of Agriculture, University of California. The board made its review by checking, as a sample, the land classification survey in Calaveras and Tuolumne Counties. The report of the board is presented in Appendix K.

Results of the land classification of Placer County, including lands within the national forests, are presented in Table 27. Locations of the irrigable and nonirrigable lands are shown on Plate 13.

TABLE 27

CLASSIFICATION OF LANDS IN UNITS OF PLACER COUNTY

(In acres)

Land class	Valley Unit	Foothill Unit	American River Unit	Bear River Unit	Yuba River Unit	Tahoe Unit	Totals
1	1,320	0	0	0	0	0	1,320
2	13,960	6,150	30	20	0	0	20,160
3	56,490	3,190	0	40	0	0	59,720
4-2	5,810	35,230	17,050	1,660	0	0	59,750
4-3	2,320	29,890	6,940	5,660	0	0	44,810
5-P	18,910	5,280	0	0	0	0	24,190
6	10,660	61,400	332,900	33,090	0	0	438,050
National Forest	0	0	142,810	1,580	13,530	110,080	268,000
TOTALS	109,470	141,140	499,730	42,050	13,530	*110,080	*916,000

* Does not include 48,900 acres of water surface of Lake Tahoe.

TABLE 28

PROBABLE ULTIMATE PATTERN OF LAND USE IN UNITS OF PLACER COUNTY

(In acres)

Class of land use	Valley Unit	Foothill Unit	American River Unit	Bear River Unit	Yuba River Unit	Tahoe Unit	Totals
Irrigated lands	68,300	65,600	20,200	6,000	0	0	160,100
Dry-farmed lands	16,000	0	0	0	0	0	16,000
Native vegetation	8,870	61,440	475,730	34,650	13,530	110,080	704,300
Miscellaneous	16,300	14,100	3,800	1,400	0	0	35,600
TOTALS	109,470	141,140	499,730	42,050	13,530	*110,080	*916,000

* Does not include 48,900 acres of water surface of Lake Tahoe.

By use of the land classification data a probable ultimate pattern of land use for Placer County was forecast. The general assumption was made that under an increasing pressure of demand for agricultural products all irrigable but presently dry lands would eventually be provided with irrigation service. Provision was also made for probable increase in lands devoted to farmsteads, roads, urban, and other miscellaneous purposes under conditions of probable ultimate development.

The estimated ultimate land use pattern of Placer County, summarized by general classes of land use and by units of the county, is presented in Table 28. Irrigable lands, as determined by the land classification survey data and as indicated by the probable ultimate land use pattern, are shown on Plate 13.

Unit Use of Water

The second step in evaluation of water requirements involved the determination of unit values of consumptive use of water for each type of land use. Estimates of these unit values were based on the results of studies in the investigational area and of prior investigations in other areas.

A procedure suggested in part by Harry F. Blaney and Wayne D. Criddle of the Soil Conservation Service, United States Department of Agriculture, in their reports entitled "A Method of Estimating Water Requirements in Irrigated Areas from Climatological Data," dated December, 1947, and "Determining Water Requirements in Irrigated Areas From Climatological and Irrigation Data," dated August, 1950, was generally utilized for adjustment of available data on unit consumptive use by irrigated crops in other localities to correspond with conditions existing in Placer County. This method involved correlation of the data on the basis of variations in average monthly temperatures, monthly percentages of annual daytime hours, precipitation, and lengths of growing season. It disregarded certain generally unmeasured factors such as wind movement, humidity, etc.

Certain modifications were made in this procedure to meet the needs of the current investigation. Unit values of consumptive use and irrigation demand for rice in the Valley Unit were derived by independent analysis, utilizing data obtained during the investigation. Unit use of water factors applicable to urban and miscellaneous types of land use in the Foothill, American River, Bear River, and Yuba River Units were estimated, using values determined in connection with studies for the Survey of Mountainous Areas. The total amount of such use of water is small in comparison with agricultural requirements. Unit use of water factors for the Tahoe Unit was not estimated during the current investigation. Estimates of present and probable ultimate water requirements of the Tahoe Unit were obtained from the "Joint Report on the Use of Water in the Lake Tahoe Watershed," prepared by the State Engineers of Nevada and California, dated June, 1949. The procedures utilized for estimating unit values of consumptive use of water and unit values of consumptive use of applied water are outlined separately herein.

Consumptive Use of Water. The following is an outline of the procedure utilized for estimating unit values of consumptive use of water:

1. The unit value for each irrigated crop during its growing season was taken as the product of available heat and an appropriate coefficient of consumption, where: (a) the available heat was the sum of the products of average monthly temperatures and monthly per cent of daytime hours, and (b) the coefficient of consumption was one which has been selected as appropriate for California by Harry F. Blaney as a result of his studies for the Soil Conservation Service. Certain exceptions involved the use of coefficients estimated from consumptive use data available from other sources.
2. The unit value for each irrigated crop during its nongrowing season was taken as the amount of precipitation available, but not exceeding one to two inches of depth per month, depending upon the type of crop and cover crop.
3. The seasonal unit value for each irrigated crop was taken as the summation of values determined under items 1 and 2 for that type.
4. Unit seasonal values for rice were taken as 54 inches of depth of water per year, plus precipitation available during the nongrowing season up to but not exceeding one inch of depth per month.
5. Unit seasonal values for native annual grasses were taken as equal to the available precipitation up to but not exceeding two inches of depth per month.
6. Unit seasonal values for native vegetation other than annual grasses were estimated on the basis of available data on corresponding consumptive use in similar localities, due consideration being given to density and type of vegetation and depth to ground water.

Pump Irrigation of Rice West of Lincoln

Sprinkler Irrigation of Pasture West of Roseville
Water Supply Pumped From Underground

7. Unit seasonal values for free water surfaces were estimated from available records of evaporation.

8. Unit seasonal values for remaining miscellaneous types of land use were estimated on the basis of available data on corresponding consumptive use in similar localities.

Estimated unit seasonal values of consumptive use of water in the Valley Unit, including consumption of precipitation, are presented in Table 29. In view of the indicated water supply and climatological similarities of the mean and base periods, the estimated average unit seasonal values of consumptive use for the base period were considered to approximate corresponding values for the mean period.

TABLE 29

ESTIMATED UNIT VALUES OF SEASONAL CONSUMPTIVE USE OF WATER IN VALLEY UNIT OF PLACER COUNTY

(In feet of depth)

Class and type of land use	Average for 3-year base period, 1948-49 through 1950-51	1948-49	1949-50	1950-51
Irrigated lands				
Hops	2.9	3.0	2.9	2.9
Orchard	2.8	2.8	2.8	2.8
Pasture	3.7	3.7	3.7	3.7
Rice	5.0	4.9	5.0	5.0
Truck	2.2	2.2	2.2	2.3
Vineyard	2.3	2.3	2.3	2.2
Dry-farmed and fallow lands				
Fallow	0.7	0.6	0.7	0.8
Grain	1.3	1.2	1.4	1.2
Orchard	1.0	0.9	1.0	1.1
Rice, idle	0.7	0.6	0.8	0.8
Vineyard	1.0	0.9	1.0	1.1
Native vegetation				
Brush and trees	4.0	4.0	4.0	4.0
Native grass	1.2	1.1	1.2	1.3
Wasteland	0.7	0.6	0.7	0.8
Miscellaneous				
Airports	1.2	1.1	1.2	1.3
County and farm roads	1.0	1.0	1.0	1.0
Farm lots and urban	2.0	2.0	2.0	2.0
Highways and railroads	1.0	1.0	1.0	1.0

Consumptive Use of Applied Water. The consumptive use of applied water in the Valley Unit was computed as the difference between total seasonal consumptive use of water and that portion of the seasonal consumptive use met by precipitation. Estimated unit seasonal values of consumptive use of applied water in the Valley Unit of Placer County are presented in Table 30.

Little information is available regarding actual values of consumptive use of applied water by irrigated crops in mountain and foothill areas of California. Organized agencies distributing irrigation water are few, and such records as are available generally do not permit the determination of quantities of applied water consumed by irrigated lands. Validity of the described method for estimating unit consumptive use of applied water in such areas in Placer County was confirmed by the results of detailed inflow-outflow studies conducted on four small watersheds in the Foothill, American River, and Bear River Units. The watersheds are located in highly developed orchard areas, and include a portion of Eden Valley in the Bear River Unit, Penryn Valley and the upper portion of the Sailor Ravine watershed in the Foothill Unit, and the Mormon Creek watershed in the American River Unit. Areas of the watersheds vary from 360 to 6,025 acres, and the average elevations range from about 500 to about 2,300 feet above sea level. Locations of the watersheds are shown on Plate 13.

TABLE 30

ESTIMATED UNIT VALUES OF SEASONAL CONSUMPTIVE USE OF APPLIED WATER IN VALLEY UNIT OF PLACER COUNTY

(In feet of depth)

Class and type of land use	Average for 3-year base period, 1948-49 through 1950-51	1948-49	1949-50	1950-51
Irrigated lands				
Hops	1.7	1.8	1.7	1.6
Orchard	1.6	1.7	1.6	1.5
Pasture	2.6	2.7	2.7	2.5
Rice	4.3	4.3	4.3	4.1
Truck	1.5	1.6	1.5	1.5
Vineyard	1.2	1.3	1.2	1.1
Miscellaneous				
Farm lots and urban	2.0	2.0	2.0	2.0

Field surveys and studies were conducted on these watersheds throughout the irrigation season of 1950-51. The water supplies consisted of precipitation and diversions from canals of the Pacific Gas and Electric Company and Nevada Irrigation District. Records of inflow to and outflow from the watersheds were obtained from measurements. Precipitation data were obtained from United States Weather Bureau records at Auburn, Colfax, and Rocklin. Of a total irrigated area of about 5,400 acres in the four watersheds, approximately 3,300 acres are orchards, about 1,200 acres are water-loving native vegetation, and the remaining 900 acres are pasture and vineyard. The results of the studies are shown in Table 31, which also shows, for comparison, the values of unit consumptive use of applied water computed for 1950-51 culture and climatological conditions. Data obtained in connection with the watershed inflow-outflow studies are given in Appendix L.

Table 31 indicates that the computed 1950-51 unit values of consumptive use of applied water agree closely with values derived from the inflow-outflow studies in all watersheds except Eden Valley. In this

TABLE 31

ESTIMATED UNIT VALUES OF SEASONAL CONSUMPTIVE USE OF APPLIED WATER IN SELECTED WATERSHEDS OF PLACER COUNTY

Watershed	Irrigated area, in acres	Average elevation, in feet	Consumptive use of applied water, in inches of depth	
			1950-51 (from inflow-outflow studies)	1950-51 (computed)
Eden Valley	113	2,350	16	21
Penryn Valley	3,240	500	24	22
Sailor Ravine	209	1,500	23	22
Mormon Creek	687	1,050	20	19

watershed, the smallest of the four, the computed value is considerably higher than that from the inflow-outflow studies. In view of the close agreement of results from the three larger watersheds, subsequent estimates of present mean seasonal consumptive use of applied water in the Foothill, American River, and Bear River Units were derived by computing the unit values of seasonal consumptive use by the method described previously.

Estimated unit values of seasonal consumptive use of applied water in the Foothill, American River, and Bear River Units, together with average temperature and mean annual precipitation on the units, are presented in Table 32. In view of the indicated water supply and climatological similarities of the mean and base periods, the estimated average unit seasonal values of consumptive use of applied water for the base period were considered to approximate corresponding values for the mean period.

TABLE 32

ESTIMATED UNIT VALUES OF SEASONAL CONSUMPTIVE USE OF APPLIED WATER IN FOOTHILL, AMERICAN RIVER, AND YUBA RIVER UNITS

Unit	Average temperature, in degrees F.	Mean annual precipitation, in inches	Consumptive use of applied water	
			In inches	In feet
Foothill	62	27	22	1.8
American River	59	48	18	1.5
Bear River	61	24	22	1.8

Present Water Requirements

The total amount of the present water requirement in the Valley Unit of Placer County was estimated by multiplying the acreage of each type of land use by its respective unit value of consumptive use of water. The present requirements for water on irrigated, urban, and miscellaneous lands in the Foothill, American River, Bear River, and Yuba River Units were estimated by multiplying the respective present acreages by appropriate unit values of consumptive use of applied water. The total present requirement for water in the Tahoe Unit was derived from values reported in the "Joint Report on the Use of Water in the Lake Tahoe Watershed," prepared by the State Engineers of Nevada and California, dated June, 1949.

The results of the estimates of water requirements in the Valley Unit during the base period and the investigational seasons are presented in Table 33, summarized by general classes of land use. An estimate of the mean seasonal water requirement in the Valley Unit, as it would be with present land use but under mean conditions of water supply and climate, is also presented in Table 33. The estimate was based on the land use pattern determined by the 1950-51 survey, and on estimated average unit seasonal values of consumptive use of water for the three-year base period which were considered to approximate those for the mean period. The estimates in Table 33 include consumptive use of precipitation.

TABLE 33

ESTIMATED PRESENT MEAN SEASONAL CONSUMPTIVE USE OF WATER IN VALLEY UNIT AND USE DURING BASE PERIOD AND INVESTIGATIONAL SEASONS

(In acre-feet)

Class of land use	Average for 3-year base period, 1948-49 through 1950-51	1948-49	1949-50	1950-51	With present land use under mean conditions of water supply and climate
Irrigated lands	40,100	37,800	37,100	45,000	45,000
Dry-farmed and fallow lands	52,000	49,100	59,700	45,400	45,000
Native vegetation	61,600	54,500	60,400	70,700	65,900
Miscellaneous	5,300	5,300	5,300	5,400	5,400
TOTALS	159,100	147,700	162,500	166,500	161,300

In order to facilitate certain phases of the analysis of ground water hydrology, presented in Chapter II, and to permit derivation of irrigation efficiencies, it was desirable to estimate seasonal consumptive use of applied water from surface and ground water supplies in the Valley Unit of Placer County. To this end, appropriate unit seasonal values of consumptive use of applied water were multiplied by the acreages of each type of land use served by surface water and ground water during the respective periods. The estimates of consumptive use of surface water and ground water are summarized in Table 34 by general classes of land use.

The results of the estimates of present mean seasonal consumptive use of applied water in the Foot-

TABLE 34

ESTIMATED PRESENT MEAN SEASONAL CONSUMPTIVE USE OF APPLIED SURFACE AND GROUND WATER IN VALLEY UNIT AND USE DURING BASE PERIOD AND INVESTIGATIONAL SEASONS

(In acre-feet)

Class of land use	Average for 3-year base period, 1948-49 through 1950-51	1948-49	1949-50	1950-51	With present land use under mean conditions of water supply and climate
Surface water					
Irrigated lands	12,100	13,500	11,800	10,800	11,400
Miscellaneous	1,400	1,400	1,400	1,200	1,200
Subtotals	13,500	14,900	13,200	12,000	12,600
Ground water					
Irrigated lands	19,500	17,300	17,400	22,900	24,000
Miscellaneous	4,400	4,400	4,400	4,500	4,500
Subtotals	23,900	21,700	21,800	27,400	28,500
TOTALS	37,400	36,600	35,000	39,400	41,100

TABLE 35

ESTIMATED PRESENT MEAN SEASONAL CONSUMPTIVE USE OF APPLIED WATER IN FOOTHILL, AMERICAN RIVER, BEAR RIVER, YUBA RIVER, AND TAHOE UNITS

(In acre-feet)

Unit	Irrigated lands	Urban and miscellaneous	Totals
Foothill	44,500	3,200	47,700
American River	3,600	200	3,800
Bear River	2,600	0	2,600
Yuba River	0	100	100
Tahoe	0	400	400
Subtotals	50,700	3,900	54,600
National forests	0	900	900
TOTALS	50,700	4,800	55,500

hill, American River, Bear River, Yuba River, and Tahoe Units are presented in Table 35.

Although the results are not utilized in subsequent analyses in this bulletin, the total consumptive use of water in the Foothill Unit was estimated as a matter of interest. This was done for each of the investigational seasons by evaluating the difference between water supply and disposal. The method was the same as that used for the Valley Unit to evaluate the difference between subsurface inflow and outflow, as explained in Chapter II, except that total consumptive use of water was the unknown quantity. In the case of the Foothill Unit, values for pertinent items other than consumptive use of water, including surface inflow and outflow, and precipitation, were quantitatively measured or estimated. Table 36 sets forth the equation of hydrologic equilibrium for the Foothill Unit. The estimate of total consumptive use of water includes consumptive use of precipitation.

TABLE 36

ESTIMATED TOTAL SEASONAL CONSUMPTIVE USE OF WATER IN FOOTHILL UNIT DURING BASE PERIOD AND INVESTIGATIONAL SEASONS

(In acre-feet)

Item	1948-49	1949-50	1950-51	Average for 3-year base period, 1948-49 through 1950-51
Water supply				
Bear River Canal at Halsey Forebay	251,700	227,200	235,200	238,000
Gold Hill Canal below Combie Dam	25,700	30,700	24,000	26,800
Precipitation	251,700	250,500	375,300	292,500
TOTALS	529,100	508,400	634,500	557,300
Water disposal				
South Canal above spill	139,100	135,100	124,700	133,000
Coon Creek at U. S. Highway 99E	36,300	39,500	90,400	55,400
Auburn Ravine at U. S. Highway 99E	47,400	34,600	67,600	49,900
Linda Creek at Roseville	30,000	34,900	65,500	43,500
TOTALS	252,800	244,100	348,200	281,800
REMAINDER—TOTAL CONSUMPTIVE USE	276,300	264,300	286,300	275,500

Table 36 indicates that total consumptive use of water in the Foothill Unit during each of the three investigational seasons did not vary materially. During 1950-51, when rainfall was about 50 per cent greater than that during either 1948-49 or 1949-50, the amount of retained water increased by only about 10 per cent, and the additional rainfall was largely disposed of as runoff. The seasonal utilization of precipitation can be estimated by subtracting the consumptive use of applied water, presented in Table 35, from the total consumptive use. Based on this computation, it is indicated that the seasonal consumptive use of precipitation was about 229,000 acre-feet, 217,000 acre-feet, and 239,000 acre-feet in 1948-49, 1949-50, and 1950-51, respectively, which amounts to average depths of about 19 inches, 18 inches, and 20 inches, based on the gross area of 141,140 acres.

Probable Ultimate Water Requirements

The total water requirement in the Valley Unit was estimated as it would be with the probable ultimate pattern of land use and under mean conditions of water supply and climate. This was accomplished by multiplying acreages of land use types, derived in the forecast of the ultimate land use pattern, by corresponding average unit seasonal values of consumptive use of water for the base period. It was considered that unit consumptive use during the base period was equivalent to that under mean conditions of water supply and climate. The estimate of the probable ultimate water requirement in the Valley Unit is summarized in Table 37 by general land use classes. The estimate includes consumptive use of precipitation.

TABLE 37

PROBABLE ULTIMATE MEAN SEASONAL CONSUMPTIVE USE OF WATER IN VALLEY UNIT

Class of land use	Acre-feet
Irrigated lands	286,200
Dry-farmed and fallow lands	16,000
Native vegetation	12,200
Miscellaneous	27,900
TOTAL	342,300

The total seasonal consumptive use of applied water on irrigable, urban, and miscellaneous lands in the Foothill, American River, Bear River, Yuba River, and Tahoe Units was similarly estimated as it would be under probable ultimate conditions of land use and under mean conditions of water suply and climate. The estimates for the Tahoe Unit were based on those presented in the previously referred to joint report by the State Engineers of Nevada and California on use of water in the Lake Tahoe watershed. The estimates are summarized in Table 38.

TABLE 38

PROBABLE ULTIMATE MEAN SEASONAL CONSUMPTIVE USE OF APPLIED WATER IN FOOTHILL, AMERICAN RIVER, BEAR RIVER, YUBA RIVER, AND TAHOE UNITS

(In acre-feet)

Unit	Irrigated lands	Urban and miscellaneous	Totals
Foothill	118,100	14,800	132,900
American River	30,400	500	30,900
Bear River	10,800	200	11,000
Yuba River	0	200	200
Tahoe	0	2,000	2,000
Subtotals	159,300	17,700	177,000
National forests	0	3,400	3,400
TOTALS	159,300	21,100	180,400

Nonconsumptive Water Requirements

As has been stated, certain nonconsumptive requirements for water, such as those for hydroelectric power generation, flood control, recreation, and conservation of fish and wildlife, will be of significance in the design of works to meet consumptive requirements for water in Placer County. In most instances the magnitudes of the nonconsumptive requirements are relatively indeterminate and dependent upon allocations made during design of the works and after consideration of economic factors. Water requirements for hydroelectric power production, flood control, recreation, and conservation of fish and wildlife are discussed in general terms in this section, but not specifically evaluated.

Hydroelectric Power Production. The principal nonconsumptive requirement for water in Placer County is that which pertains to the generation of hydroelectric power. Although this requirement generally does not result in the consumption of water nor in the depletion of runoff, it is a fundamental consideration in the development and distribution of water. Revenues from the sale of hydroelectric power, generated in connection with possible new projects to meet supplemental consumptive water requirements of Placer County, will serve in many instances to make irrigation and other features of the projects financially and economically feasible.

In subsequent yield studies involving the operation of hydroelectric power plants included in new projects under consideration, the schedule of monthly requirements for water for generation of energy presented in Table 39 was utilized. The schedule represents the estimated monthly energy requirements to be realized in 1960 for northern California, and results from studies conducted by a group of engineers drawn from various state and federal agencies. These studies are presented in a publication entitled "Central Valley Project Studies, Problem 7," published in 1947 by the United States Department of the Interior.

TABLE 39

ESTIMATED MONTHLY REQUIREMENTS FOR WATER FOR GENERATION OF HYDROELECTRIC ENERGY

Month	Per cent of seasonal total	Month	Per cent of seasonal total
October	8.57	April	8.13
November	7.42	May	8.45
December	8.30	June	8.62
January	8.13	July	9.41
February	7.21	August	9.25
March	8.02	September	8.49
		TOTAL	100.00

Flood Control. Destruction and havoc caused by floods in California have frequently been accompanied by the economic anomaly of wastage of large amounts of water from areas of deficient water supply. Storage of such flood waters in upstream reservoirs would have accomplished the dual purpose of conservation of needed water and reduction of flood damages. Furthermore, results of the State-wide Water Resources Investigation to date indicate that if California is to attain growth and development commensurate with her manifold resources, nearly all of the potential reservoir storage capacity of the State must be constructed and dedicated to operation for water conservation purposes. This in itself will result in a substantial increase in downstream flood protection. However, any portion of the available reservoir storage capacity that is operated wholly or partially for solely flood control purposes will correspondingly reduce the capacity available for conservation.

Historical damages from floods of the American, Yuba, and Bear Rivers have been very large on the flat floor of the Sacramento Valley, and extensive channel improvements and levees have been built for protection of the valley lands. Folsom Reservoir, recently constructed by the Corps of Engineers, United States Army, will provide substantial flood protection for valley floor lands along the American River. Above the valley floor, historical flood damages have been generally limited to local washouts of roads and bridges, and minor erosion of agricultural lands.

The only lands in the Valley Unit subject to serious flood damage at the present time are located adjacent to the south bank of the Bear River as it emerges from the foothills. Although the channel of the Bear River in this reach is leveed to prevent damage from all but major floods, during the flood of November 20, 1950, the south levee failed, the washout occurring downstream from the U. S. Highway 99E bridge. Minor flood damages in the Foothill and Valley Units result from major rain floods. Heavy rain storms result in localized damage along streams in both units, and inundation of narrow strips of agricultural land adjacent to stream channels in the Valley Unit. Preliminary studies made in connection with the current State-wide Water Resources Investigation indicate that additional stream channel alignment and leveeing is desirable on Coon Creek, Markham Ravine, Auburn Ravine, Pleasant Grove Creek, and Linda Creek. Records and estimates obtained during the present investigation of peak flood flows on Auburn Ravine and Coon and Linda Creeks are included in Table 40.

Damages from floods occur in the Tahoe Unit around the shore line of Lake Tahoe and along the Truckee River from Lake Tahoe to Donner Creek.

TABLE 40

RECORDED AND ESTIMATED FLOOD FLOWS ON PRINCIPAL STREAMS IN VALLEY UNIT DURING INVESTIGATIONAL PERIOD

Stream	Location	Drainage area, in square miles	Date	Instantaneous discharge, in second-feet
Coon Creek	U. S. Highway 99E	84	11/20/50	5,200
Auburn Ravine	U. S. Highway 99E	32	1/15/52	*1,100
Linda Creek	at Roseville	85	1 12/52	*5,500

* Estimated.

Floods on the Truckee River also cause considerable damage downstream from Farad to Pyramid Lake in the State of Nevada, including the Cities of Reno and Sparks. Damages suffered as a result of floods in the Truckee River watershed differ appreciably for rain and snowmelt type of floods. A large rain flood on the Truckee River causes heavy damage to the City of Reno where high-value properties are concentrated, and damage to agricultural lands, roads, and railroads, and loss of livestock. In the case of a snowmelt flood, the Lake Tahoe area, which is not normally damaged during a rain flood, suffers major damage as a result of sustained lake stages above an elevation of 6,228 feet where damage to lake shore property begins. The damage around the lake is principally to resorts, summer residences, beaches, and piers.

In preliminary design of works to meet the supplemental water requirements of Placer County, no consideration was given to additional provisions for flood control and protection, although such might be desirable in certain instances. The provision of reservoirs for flood control and channel improvement for flood protection purposes was considered to be outside the scope of the current investigation.

Recreation and Fish and Wildlife. By virtue of its climatic advantages and wide variety of natural attractions, Placer County enjoys an outdoor recreational opportunity of great importance to her growth and economy, and of significant importance to the State as a whole. With anticipated continued growth in population, it is expected that the public demand for preservation and enhancement of recreational facilities will be sufficient to assure the provision of water supplies necessary for such purposes.

In the aggregate, the amount of water presently used for domestic and service facilities in recreational areas in Placer County is relatively small. As for waters employed for boating, sailing, swimming, and other water sports, most are available naturally or as a result of works constructed and operated for other purposes, and the nonconsumptive recreational use of the water is incidental to the other uses. Of considerable importance among the many uses of water for recreational purposes in Placer County are those associated with the preservation and propagation of fish and wildlife.

So far as is known, no artificial lakes in Placer County are utilized exclusively for fish life, such use being incidental to the primary purposes for which the reservoirs were constructed. However, the levels of a few small natural lakes at the headwaters of streams have been raised by the State Department of Fish and Game, and releases are made to maintain downstream flow conditions favorable to the preservation and propagation of fish life. It is considered probable that in the future more reservoir storage capacity will be allocated to this purpose, and that in some instances reservoirs will be constructed exclusively to augment naturally low summer and fall stream flows in the interest of fish life.

Water released down a stream to maintain the minimum flow required for fish life does not constitute a consumptive use of the water. The demands of fish life, however, are frequently incompatible with hydroelectric development and diversion and use of the water for other beneficial purposes. Nevertheless, it is believed than an improved and adequate stream fishery can be developed and maintained by the dedication of certain streams, and certain reaches of other streams, to recreation and fishing, and by the construction of upstream storage to improve low stream flow conditions. In addition, reservoirs constructed to regulate stream flow for other purposes will provide a greatly increased lake fishery.

In connection with most reservoir yield studies made for the Placer County Investigation, about three per cent of the yield of water was allocated to the interests of fish, wildlife, and recreation. Releases of water within this allocation generally would provide downstream flows in excess of the minimum requirements for fish life as determined by the State Department of Fish and Game and the United States Forest Service.

Demands for Water

The term "demands for water," as used in this bulletin, refers to those factors pertaining to rates, times, and places of delivery of water, losses of water, quality of water, etc., imposed by the control, development, and use of water for beneficial purposes. Irrigation practice in Placer County, as determined by rates of application, irrigation efficiencies, conveyance losses, gross diversions, monthly demands, return flow, and permissible deficiencies in application of water, must be given consideration in preliminary design of works to meet supplemental water requirements. These demand factors, which were not measured or considered in the foregoing estimates of water requirements, are discussed in the following sections.

Application of Water. During each of the three seasons of the investigation, measurements were made of the amount of water applied for irrigation of selected plots of principal crops grown in Placer County. Records of such application of water pumped from wells in Placer County were obtained for 9 plots during 1948-49, 26 plots during 1949-50, and 44 plots during 1950-51. The 1949-50 and 1950-51 studies included most of the irrigated land in the Valley Unit. In 1950-51, 36 additional studies were made in eastern Sutter County which were utilized in connection with the investigation. Records of application of water diverted from canals in the Foothill Unit were obtained for 11 plots in 1949-50. Results of the studies of water pumped from wells, which may be considered representative of prevailing ground water irrigation practice in the Valley Unit, are summarized in Table 41. Detailed results of the studies of plots using ground water are presented in Appendix L, and locations of the plots are indicated on Plate 13.

TABLE 41

MEASURED AVERAGE SEASONAL APPLICATION OF GROUND WATER ON REPRESENTATIVE PLOTS OF PRINCIPAL CROPS IN AND ADJACENT TO VALLEY UNIT

Crop	Number of plots				Weighted average application of water, in feet of depth			
	1948-49	1949-50	1950-51	Total	1948-49	1949-50	1950-51	1948-49 through 1950-51
Valley Unit								
Almond	3	1	1	5	0.9	1.4	0.9	1.0
Ladino	1	4	6	11	3.8	3.4	2.9	3.3
Pasture	0	7	13	20	---	4.0	3.5	3.6
Rice	3	14	24	41	5.1	4.9	5.2	5.1
Vineyard	2	0	0	2	0.3	---	---	----
TOTALS	9	26	44	79				
Adjacent to Valley Unit								
Pasture	--	--	14	--	--	--	3.8	----
Rice	--	--	22	--	--	--	6.3	----
TOTALS			36					

Results of the 1949-50 plot studies of water diverted from canals in the Foothill Unit are summarized in Table 42. Detailed results of the studies are presented in Appendix L, and locations of the plots are shown on Plate 13.

TABLE 42

MEASURED AVERAGE APPLICATION OF SURFACE WATER ON REPRESENTATIVE PLOTS OF PRINCIPAL CROPS IN FOOTHILL UNIT IN 1949-50

Crop	Number of plots	Weighted average application of water	
		Inches of depth	Feet of depth
Orchard	6	47	3.8
Orchard and cover crop	1	49	4.1
Pasture	3	52	4.3
Pears	1	30	2.5

In the Foothill, American River, and Bear River Units, water for irrigation is diverted from canals and conduits by means of miner's inch boxes. The diversion is made on a continuous flow basis for about 150 days, and the water is measured in miner's inches. The number of miner's inches per acre is generally used as a measure of duty of water. The general practice is to buy one-half miner's inch of water per acre of pasture, whether irrigated by sprinkler or flooding. This amounts to an application of about 45 inches depth of water during the season from May through September. On orchard land, irrigation practice is varied, with applications ranging from one miner's inch for six acres to one miner's inch per acre. Generally, less water is applied with furrow irrigation, because even a minimum rate of application results in a high rate of runoff. Irrigation practice and crop production are improved by use of sprinklers, which permit better control and application of greater amounts of water. The use of cover crops on orchard lands has also resulted in increased application of water to these lands.

Estimates were made of the total amount of irrigation water applied to lands in Placer County during the investigational seasons, utilizing results of the plot studies and other pertinent available information. The summary of these estimates is given in Table 43.

TABLE 43

ESTIMATED TOTAL SEASONAL APPLICATION OF IRRIGATION WATER IN UNITS OF PLACER COUNTY DURING INVESTIGATIONAL SEASONS

(In acre-feet)

Unit	1948-49	1949-50	1950-51
Valley			
Surface water	18,900	15,700	16,600
Ground water	21,500	21,500	29,300
Subtotals	40,400	37,200	45,900
Foothill	102,800	95,400	96,600
American River	9,900	9,200	9,400
Bear River	5,800	5,800	5,800
Subtotals	118,500	110,400	111,800
TOTALS	158,900	147,600	157,700

Irrigation and Water Service Area Efficiencies. Studies were made to determine irrigation efficiency realized from application of water in Placer County. Irrigation efficiency is defined as the ratio of consumptive use of applied water to the total amount of applied water, and is commonly expressed as a percentage.

It was estimated that the irrigation efficiency realized from application of ground water in the Valley Unit during 1948-49 and 1949-50 was about 81 per cent, and during 1950-51 about 78 per cent. It was further estimated that the irrigation efficiency realized from application of surface water in the Valley Unit during the three seasons was about 71 per cent, 75 per cent, and 65 per cent, respectively. The indicated irrigation efficiencies in the Valley Unit are unusually high when compared with those experienced in many other parts of California. This may be partly due to the relatively unbroken and extensive hardpan layer underlying the Valley Unit. The western edge of the hardpan layer is approximately along the western boundary of Placer County. The apparent effect of the hardpan layer in reducing application of water is indicated by a comparison of the values for application of water to pasture and rice in Placer County and in eastern Sutter County, as presented in Table 41.

There is little information available regarding irrigation efficiencies in Placer County other than in the Valley Unit. Water service area efficiencies, however, were calculated from data resulting from the four previously discussed watershed studies in the Foothill, American River, and Bear River Units. Water service area efficiency is defined as the ratio of consumptive use of applied water in a given service area to the gross amount of water delivered to the area, expressed as a percentage. The estimates of water service area efficiency realized in the four watersheds in 1950-51 are shown in Table 44.

TABLE 44

ESTIMATED WATER SERVICE AREA EFFICIENCY IN SELECTED WATERSHEDS IN PLACER COUNTY, 1950-51

(In per cent)

Watershed	Efficiency
Eden Valley	51
Penryn Valley	56
Sailor Ravine	55
Mormon Creek	55

It is considered that the foregoing estimates of irrigation and water service area efficiencies reflect present irrigation practices in Placer County. Even with increasing demands for water, efficiencies substantially higher than the high values now obtained in the Valley Unit are not anticipated in the future. However, some improvement in future irrigation practice may be expected in the Foothill, American River, and Bear River Units.

Conveyance Losses. No estimates were made of conveyance losses under present irrigation practices in Placer County. In addition to the main conduits conveying water, many distribution canals and ditches are concrete-lined in those places where large losses have occurred in the past. Study of records of measurements made at various locations on conduits of the Nevada Irrigation District indicate that conveyance losses are not excessive. Conveyance losses from conduits and canals are sometimes recovered in natural streams or by canals at lower elevations. More often, however, the water lost is consumed by native vegetation, especially where the irrigated lands occur as isolated parcels. In the Valley Unit a considerable portion of the seepage from unlined canals, together with most of the unconsumed portion of applied irrigation water, probably accrues to ground water and is subject to recovery by pumping. In the selection of sizes of conservation works to serve the Valley Unit, it was assumed that conveyance losses would approximate 25 per cent of the diverted water supply. In the Foothill, American River, and Bear River Units, where lined conduits or tunnels were generally specified, it was assumed that conveyance losses would approximate 10 per cent of the diverted supply.

Gross Diversion of Water. Total seasonal diversion of irrigation water to the four previously discussed watersheds in the Foothill, American River, and Bear River Units was measured during the investigation. The measured amounts so diverted in 1950-51, together with the computed unit values of gross diversion per acre of irrigated land, are given in Table 45.

TABLE 45

GROSS SEASONAL DIVERSION OF IRRIGATION WATER TO SELECTED WATERSHEDS OF PLACER COUNTY, 1950-51

Watershed	Irrigated land, in acres	Total diversion, in acre-feet	Unit diversion, in acre-feet per acre
Eden Valley	113	286	2.5
Penryn Valley	3,240	11,770	3.6
Sailor Ravine	209	740	3.5
Mormon Creek	687	2,020	3.0

Monthly Demands for Water. Because of differences in water utilization by various crops grown in Placer County, there is considerable variation in both rate and period of demand for irrigation water. On the average, the irrigation demand in the Valley Unit occurs during the months of April through November. In the Foothill, American River, and Bear River Units, irrigation demand occurs during May through September.

Based on analysis of measurements of application of ground water for irrigation made in 1949-50 in the Valley Unit, the estimated average monthly distribution of demand for irrigation water is as presented in Table 46.

Inspection of records of application of water in the four selected watersheds, discussed previously, indicates that the monthly diversion of surface water in 1950-51 to the three smaller watersheds was a nearly constant amount and was fixed by the maximum capacity of conduits to convey water. In Penryn Valley, however, a monthly variation in the amount of the total surface diversion was observed, as shown in Table 47. This table also presents demand

TABLE 46

ESTIMATED AVERAGE MONTHLY DISTRIBUTION OF DEMAND FOR IRRIGATION WATER IN VALLEY UNIT

Month	Per cent of seasonal total	Month	Per cent of seasonal total
April	1	September	12
May	14	October	3
June	21	November	1
July	25		
August	23	TOTAL	100

schedules of the Nevada and El Dorado Irrigation Districts based on records of canal discharge, together with the schedule of distribution of monthly demand of the Nevada Irrigation District during the irrigation season. The demand schedule of the Nevada Irrigation District was assumed to be representative of the distribution of demand for water in Placer County other than in the Valley Unit, and was so utilized in yield studies for the design of water conservation works.

TABLE 47

ESTIMATED AVERAGE MONTHLY DISTRIBUTION OF DEMANDS FOR WATER IN PLACER COUNTY

(In per cent of seasonal total)

Month	Irrigation demand		Total demand	
	In Penryn Valley	In Nevada Irrigation District	In Nevada Irrigation District	In El Dorado Irrigation District
January	0	0	2	1
February	0	0	1	1
March	0	0	1	2
April	0	0	3	2
May	15	15	12	14
June	20	20	16	19
July	22	24	20	21
August	23	23	19	19
September	20	18	15	13
October	0	0	7	5
November	0	0	2	2
December	0	0	2	1
TOTALS	100	100	100	100

Return Flow. In the previous discussion of water service area efficiency it was indicated that the average quantity of water delivered to irrigated lands in certain watersheds of the Foothill Unit was almost twice the quantity of water consumed by the irrigated crops. In the same manner it was shown that the amount of water applied to irrigated crops in the Valley Unit was also considerably greater than the water consumed by these crops. Most of the unconsumed water constitutes return flow which generally reaches surface streams or ground water basins and may be available for rediversion or for pumping. Return flow is an important source of water supply, and in many instances may be recovered and re-used within the water service area itself. Such return flow as cannot be recovered within the area where it originates accrues to downstream users as a source of water supply.

In the design of water conservation works to serve the Valley Unit it was assumed that the unconsumed portion of water applied to irrigation would percolate to the ground water basin and would be available for re-use, and that half of the conveyance losses would be available for re-use in a similar manner. No present attempt was made to evaluate the occurrence and use of return flow in connection with the design of water conservation works to serve the other units of Placer County.

Permissible Deficiencies in Application of Irrigation Water. Studies to determine deficiencies in the supply of irrigation water that might be endured without permanent injury to perennial crops were not made in connection with the Placer County Investigation. However, the results of past investigation and study of endurable deficiencies in the Sacramento River Basin are believed to be applicable to Placer County. In this respect, the following is quoted from Division of Water Resources Bulletin No. 26, "Sacramento River Basin," 1931.

"* * * A full irrigation supply furnished water not only for the consumptive use of the plant but also for evaporation from the surface during application and from the moist ground surface, and for water which is lost through percolation to depths beyond the reach of the plant roots. Less water can be used in years of deficiency in supply by careful application and by more thorough cultivation to conserve the ground moisture. In these ways the plant can be furnished its full consumptive use with much smaller amounts of water than those ordinarily applied and the yield will not be decreased. If the supply is too deficient to provide the full consumptive use, the plant can sustain life on smaller amounts but the crop yield will probably be less than normal.

"It is believed from a study of such data as are available that a maximum deficiency of 35 per cent of the full seasonal requirement can be endured, if the deficiency occurs only at relatively long intervals. It is also believed that small deficiencies occurring at relatively frequent intervals can be endured."

In the selection of sizes of conservation works for design purposes to serve Placer County, it was assumed that deficiencies in the amount of 35 per cent of the average seasonal requirement for irrigation water may be endured in seasons of critically deficient water supply, provided that such deficiencies do not occur frequently and in no case in consecutive seasons. It was further assumed that requirements for urban water and hydroelectric power would be met at all times without deficiency.

SUPPLEMENTAL WATER REQUIREMENTS

The previously presented data, estimates, and discussion regarding water supply and utilization in Placer County indicate that present and probable future water problems of the Foothill, American River, and Bear River Units of Placer County are largely limited to those connected with supply and distribution of surface water, and that their effects are related to irrigated agriculture and municipal use. These problems may be largely eliminated if adequate supplemental water supplies are developed and utilized on lands above the present service areas of the Nevada Irrigation District and the Pacific Gas and Electric Company. The present and probable future water problems of the Yuba River and Tahoe Units, as well as those of lands situated in the national forests, are of a minor nature since their present and future water needs are small and may be met with local small-scale conservation works. As for present and probable future water problems of the Valley Unit, it is indicated that they are largely limited to those connected with ground water, and that their effects are largely related to irrigated agriculture. The ground water problems in the Valley Unit, created by progressive lowering of water levels and low yield of wells, may be eliminated or prevented if adequate supplemental water supplies are developed and utilized in the unit. The estimated present and probable ultimate requirements for supplemental water in Placer County are discussed and evaluated in the following sections.

Present Supplemental Water Requirement

In the Foothill, American River, Bear River, and Yuba River Units, with the exception of the Foresthill Divide in the American River Unit, all presently developed lands are served or can be served by existing works of either the Nevada Irrigation District or the Pacific Gas and Electric Company. There is no apparent shortage of water in the service area of the Nevada Irrigation District, nor in the Wise service area of the Pacific Gas and Electric Company. However, in some localities above the foregoing service areas, on the Foresthill Divide, and in the Tahoe Unit, development is presently restricted because of limited water supplies and works. Such present deficiencies are not readily susceptible to evaluation and are believed to be small. For these reasons, present supplemental water requirements of the Foothill, American River, Bear River, Yuba River, and Tahoe Units were not estimated, but for purposes of the present studies were considered to be negligible.

The present requirement for supplemental water in the Valley Unit was evaluated as the difference between safe yield of the ground water basin and present consumptive use of ground water. It might be argued that this evaluation fails to give consideration to possible inadequacies in service of surface water to portions of the unit. However, in the equation of hydrologic equilibrium presented in Table 18, upon which the estimate of safe ground water yield was based, the unit consumptive use factors chosen assumed a full and sufficient application of water on all irrigated lands whether from surface sources or ground water. It follows that any possible present inadequacy in surface water service was taken into account and provided for in the estimate of safe ground water yield.

It was estimated in Chapter II that safe seasonal ground water yield in the Valley Unit amounted to 20,200 acre-feet. This was determined as the seasonal net extraction of water from the ground water basin that might be maintained, under mean conditions of water supply and climate, without further progressive lowering of the water table below average levels prevailing in 1950-51. Seasonal consumptive use of ground water, with present culture and under mean conditions of water supply and climate, was estimated to be about 28,500 acre-feet, as shown in Table 34. The estimated present requirement for supplemental water in the Valley Unit is, therefore, about 8,300 acre-feet per season.

Probable Ultimate Supplemental Water Requirement

The probable ultimate requirement for supplemental water in the Valley Unit was evaluated as the difference between present and probable ultimate consumptive use of water, plus the present requirement for supplemental water, since it was assumed that in this unit the conveyance and application losses would return to the ground water basin. Development and utilization of a supplemental water supply in the amount of this forecast would assure an adequate supply of water for lands presently irrigated in the Valley Unit, as well as for those irrigable lands not presently served with water. Furthermore, present problems in the Valley Unit, resulting from progressive and permanent lowering of water levels and low yield of wells, would be eliminated.

In other units the probable ultimate requirement for supplemental water was evaluated as the difference between present and probable ultimate consumptive use of applied water, and adjusted to account for estimated re-use of return flows and losses in conveyance and application. In the Foothill, American River, Bear River, Yuba River and Tahoe Units the requirement will be satisfied principally by stream diversions or reservoir releases. A part of the requirement may be satisfied, however, by recoverable return flows. In addition, a portion of the developed water supply will be lost in conveyance and application. Therefore, in these units the ultimate supplemental water requirement does not signify either required stream diversion or draft on a reservoir, which quantities can only be estimated with knowledge of physical features. Since the ultimate supplemental water requirement in these units will be affected by the location of project features, an accurate estimate can only be made when the basic framework of the water supply project is established. Nevertheless, preliminary estimates of ultimate supplemental water requirements are considerably more realistic and more useful for project planning purposes than are estimates of consumptive use of applied water. As a first step in deriving such estimates, it is assumed that, in connection with future water development, the demands for and the cost of water will be such that conveyance and application losses will be reduced to a minimum, and that every effort will be made to recover return flows. On this basis, it is considered reasonable to assume that average irrigation efficiencies of about 75 per cent will prevail, and that return flow will be recovered in quantities sufficient to balance the conveyance loss. Under these conditions, the probable ultimate supplemental water requirement in the Foothill, American River, Bear River, Yuba

TABLE 48

PROBABLE ULTIMATE MEAN SEASONAL SUPPLEMENTAL WATER REQUIREMENT IN UNITS OF PLACER COUNTY

(In acre-feet)

Unit	1	2	3	4	5	6
	Present consumptive use of water	Probable ultimate consumptive use of water	Probable increase in consumptive use of water (2 — 1)	Probable increase in water requirement (3 × 1.33)	Present supplemental water requirement	Probable ultimate supplemental water requirement (4 + 5)
Valley	161,300[a]	342,100[a]	180,800	180,800	8,300	189,100
Foothill	47,700[b]	132,900[b]	85,200	113,300	0	113,300
American River	3,800[b]	30,900[b]	27,100	36,000	0	36,000
Bear River	2,600[b]	11,000[b]	8,400	11,200	0	11,200
Yuba River	100[b]	200[b]	100	100	0	100
Tahoe	400[b]	2,000[b]	1,600	2,100	0	2,100
Subtotals	215,900	519,100	303,200	343,500	8,300	351,800
National Forests	900[b]	3,400[b]	2,500	3,300	0	3,300
TOTALS	216,800	522,500	305,700	346,800	8,300	355,100

[a] Includes consumptive use of precipitation.
[b] Consumptive use of applied water only.

River, and Tahoe Units will be equivalent to the probable increase in consumptive use of applied water plus 33 per cent. Such estimates computed on this basis, together with the estimate for the Valley Unit, are presented in Table 48.

With certain qualifications, the foregoing estimates can be used in project planning as a basis for determining probable stream diversions or drafts on reservoirs. Where appropriate, the possibility of recovering return flow from upstream areas should be considered as a means of satisfying a part of a service area water requirement, and thereby reducing the required stream diversion or draft on the reservoir. Moreover, the situation in any given water service area may be such that relatively large quantities of return flow originating within the area may be recovered and re-used. On the other hand, the conveyance loss between the service area and the proposed diversions or reservoirs constitutes an additional requirement for water. Under the most unfavorable conditions the stream diversion or draft on reservoir storage to satisfy the probable ultimate supplemental water requirement would be somewhat larger than the quantities given in Table 48 by the amount of water lost in transit between the diversion or reservoir and the service area. Under favorable conditions, where return flows from upstream areas can be used to satisfy a part of the water requirement, the diversion or draft on storage could be considerably less than the quantity listed in Table 48.

CHAPTER IV

PLANS FOR WATER DEVELOPMENT

It has been shown heretofore that present critical water problems of the Valley Unit in Placer County largely consist of progressive lowering of ground water levels, and low yield of wells in certain areas. In the Foothill, American River, Bear River, and Yuba River Units, where existing water service is generally adequate for current demands, desirable expansion of irrigated agriculture is impeded by the insufficiency of developed water supplies. Water supply is not at present a critical problem within the Tahoe Unit, but recreational property along the shore of Lake Tahoe is subject to flood damage at times of high water levels, and new water supplies will be needed in the future to meet anticipated growing demands for recreational and agricultural purposes. Elimination of present critical ground water problems in the Valley Unit, and provision of water for irrigable and potentially urban and recreational lands in Placer County not presently served with water, will require further conservation development of the available water resources. In the preceding chapter, estimates were presented as to the amount of supplemental water required for these purposes.

It has been shown that large surplus flows of water are presently available to Placer County from the watersheds of the Yuba, Bear, American, and Truckee Rivers and from many minor streams within the county. This surplus water is available during the snowmelt period of every season. Studies which are described in this chapter indicate that the surplus flows, if properly controlled and regulated, would more than meet the present and probable ultimate water requirements of Placer County. Furthermore, reduction of flooding around the shore of Lake Tahoe would be attained.

As was stated in Chapter I, the Division of Water Resources is presently conducting surveys and studies for the State-wide Water Resources Investigation, under direction of the State Water Resources Board. This investigation has as its objective the formulation of The California Water Plan, for full conservation, control, and utilization of the State's water resources, to meet present and future water needs for all beneficial purposes and uses in all parts of the State, insofar as practicable. Surveys and studies are also being conducted by the Division of Water Resources for the Survey of Mountainous Areas. This investigation, which is coordinated with the state-wide investigation, has as its primary objective the determination of probable ultimate water requirements of certain counties of the Sierra Nevada, and the formulation of plans for projects which will meet those requirements. Although these investigations are still in progress, they are sufficiently advanced to permit tentative description of certain major features of The California Water Plan which would provide supplemental water to meet the probable ultimate requirement of Placer County. The projects would also provide supplemental water supplies for other water-deficient areas of California. In addition, benefits from the projects would include hydroelectric power, flood and salinity control, mining debris storage, and benefits in the interests of recreation and preservation of fish and wildlife.

In general, the major features of The California Water Plan which were mentioned in the preceding paragraph would be large multipurpose projects requiring relatively large capital expenditures. Their scope, with regard to both location of the works and benefits derived from their operation, would not be limited to Placer County, but would embrace other portions of California as well, and in some instances, of Nevada. Additional study will be required to determine possible means of financing, constructing, and operating these large projects, and of coordinating them with other major features of The California Water Plan. In connection with the Placer County Investigation, therefore, surveys and studies were made in order to estimate costs of supplemental water supplies for Placer County under localized portions of the major projects, that might be suitable for current financing, construction, and operation by appropriate local public agencies. It was desirable that these plans for initial development be such that the works could be readily integrated into the future major projects. For this reason the purposes of the initial plans were not limited merely to conservation of new water sufficient to meet present water requirements of Placer County and provide for limited future growth. Rather, the works proposed for initial development would yield supplemental water to meet the probable ultimate requirements in many portions of Placer County, as well as furnish limited amounts of water and hydroelectric power for export from the county.

Major features of The California Water Plan which would be pertinent to full development of the water resources of Placer County are described in general terms in this chapter under the heading "The California Water Plan." These projects will be more specifically described in future reports of the State Water Resources Board. The several plans for possible initial local development of supplemental water supplies which were given consideration in connection with the Placer County Investigation are described in this chapter under the heading "Plans for Initial Local Development." All such plans considered would be subject to vested rights. Specific plans are presented for the more favorable local projects, together with estimates of capital and annual costs and unit costs of the developed supplemental water supplies. Locations of the principal features of the possible plans for both initial and future construction are shown on Plate 14, entitled "Plans for Water Development."

THE CALIFORNIA WATER PLAN

To enable orderly and logical presentation, tentative plans for major projects of The California Water Plan pertinent to full development of the water resources of Placer County are presented separately for the American, Bear and Upper Yuba, and Truckee River Basins. Locations of the works described are shown on Plate 14.

American River Basin

The California Water Plan as it relates to the American River Basin will be described in detail in a future publication of the State Water Resources Board. For present purposes, there follows a brief description of works on the Middle and North Forks of the American River which would not only provide supplemental water to meet the probable ultimate requirements of lands in Placer County, but which also would provide large amounts of regulated water for other beneficial purposes both inside and outside of Placer County.

Tentative plans for development of the Middle Fork of the American River contemplate the construction of a diversion dam at a site on the Upper Rubicon River immediately east of Rockbound Lake, and about eight miles southwest of Meeks Bay, and construction of a canal and tunnel to convey the diverted water via Rockbound and Buck Island Lakes, into an enlarged Loon Lake Reservoir. Water from a diversion on the Little South Fork of the Rubicon River would also be conveyed to the enlarged Loon Lake Reservoir by means of a conduit about 0.7 mile in length. Water released from Loon Lake Reservoir would flow westerly through a proposed tunnel for about two miles to the penstock of the Loon Lake Power Plant, to be located near the flow line at the upper end of Gerle Reservoir. This reservior would be created by construction of a dam on Gerle Creek, about 4.5 miles downstream from the existing Loon Lake Dam, owned by the Georgetown Divide Water Company. Releases of water would be made from Gerle Reservoir through a proposed tunnel, 2.7 miles in length, to the penstock of the Gerle Power House, to be located near the flow line at the upper end of the proposed Parsley Bar Reservoir, which would be created by construction of a dam at a site on the Rubicon River about five miles above its junction with the little South Fork of the Rubicon River.

The tentative plans also contemplate construction of a diversion dam on Duncan Creek and conveyance of the diverted water southeasterly in a tunnel for a distance of about 1.4 miles to French Meadows Reservoir, to be created by construction of a dam at a site on the Middle Fork of the American River approximately 18 miles upstream from its junction with the Rubicon River. The water thus conserved would be conveyed in a tunnel for a distance of about 2.8 miles to the French Meadows Power House, to be located near the flow line on the right bank of the proposed Lower Hell Hole Reservoir. Lower Hell Hole Reservoir would be created by construction of a dam at a site on the Rubicon River about one mile upstream from the previously mentioned Parsley Bar Reservoir.

Under the foregoing plans, all power releases from the upstream reservoirs would be re-regulated in Parsley Bar Reservoir. Water released from Parsley Bar Reservoir would be conveyed westerly in a proposed tunnel about 4.5 miles in length, and released into the natural channel of Long Canyon. Immediately downstream the water would be diverted, together with a portion of the natural runoff of Long Canyon, into a proposed canal which would extend along the south bank of Long Canyon below Ralston Ridge for a distance of about nine miles to the forebay and penstock of the proposed Ralston Power House. This power house would be located on the Rubicon River and near the flow line at the upper end of the proposed American Bar Reservoir, which would be created by construction of the American Bar Dam at a site on the Middle Fork of the American River about 1.5 miles below the junction with the Rubicon River. Water released from American Bar Reservoir would be conveyed in a tunnel in a westerly direction for a distance of about 2.7 miles to the penstock of the proposed American Bar Power House, on the left bank of the Middle Fork of the American River below Foresthill, and thence into the pool of the proposed Auburn Reservoir, which would be created by construction of a dam on the American River about two miles south of the City of Auburn. The proposed Auburn Power House would be located on the right bank of the American River about 0.5 mile downstream from Auburn Dam, and would be connected to the reservoir by means of a tunnel. Water discharged from the power plant would flow downstream to Folsom Dam and Reservoir, where it would be re-regulated and available for development of hydroelectric power and for other beneficial purposes at downstream points. Consideration is also being given to plans including construction of a tunnel from Auburn Reservoir to Auburn Ravine which would permit delivery of water to lands below Wise Power House.

Other tentative plans for development of the Middle Fork of the American River would provide water to meet the probable ultimate requirements of the Foresthill Divide. These plans include construction of facilities for diversion and conveyance of water from Secret Canyon, Black Canyon, El Dorado Creek, and Bullion Creek to a proposed Forbes Reservoir on Forbes Creek, and to an enlarged Big Reservoir located on a tributary of the same stream. Additional water, including spill from an enlarged Big Reservoir and Forbes Reservoir, would be conserved in the proposed Sugar Pine Reservoir, to be created by construction of a dam on North Shirttail Canyon. Water conserved in each of the three reservoirs would be released to and conveyed in canals to serve lands on the Foresthill Divide.

Tentative plans for development of the North Fork of the American River contemplate the dedication of this stream above Pickering Bar principally to the interests of fish, game, and recreation. Construction of a small dam and reservoir is proposed at The Cedars, about five miles south of Norden. This reservoir would insure a minimum stream flow of about seven second-feet in the North Fork below this point.

Bear and Upper Yuba River Basins

The California Water Plan as it relates to the Bear and Upper Yuba River Basins will be described in detail in a future publication of the State Water Resources Board. For present purposes, there follows a brief description of certain of the works which relate directly or indirectly to provision of supplemental water for Placer County.

In general, the tentative plans for development of the waters of the Bear and Upper Yuba Rivers involve works which would be integrated into, or operated in conjunction with, the existing systems of the Nevada Irrigation District and the Pacific Gas and Electric Company. The proposed works would supplement the foregoing systems and in some cases would result in the increase of capacities and yields of existing works. The plans contemplate the construction of a dam and reservoir at the Jackson Meadows site, located on the Middle Fork of the Yuba River about five miles northeast of Bowman Lake Reservoir and about two miles upstream from the existing Milton Diversion of the Nevada Irrigation District. Jackson Meadows Reservoir would conserve the runoff of its own watershed, plus water diverted from Haypress Creek which would be conveyed in a proposed tunnel for a distance of about three miles to the reservoir. The conserved waters of both the Middle Fork of the Yuba River and Haypress Creek, after release from Jackson Meadows Reservoir, would flow into Bowman Lake by way of the existing Milton-Bowman Tunnel, and thence through the existing Bowman-Spaulding Conduit and Spaulding Power House No. 3 into Lake Spaulding and the Drum System of the Pacific Gas and Electric Company.

The tentative plans also contemplate the construction of an enlarged dam and reservoir upstream from the site of the existing Lake Valley Dam owned by the Pacific Gas and Electric Company, which is located on the North Fork of the North Fork of the American River about three miles west of Cisco. Lake Valley Reservoir, thus created, would conserve the runoff of its own watershed, and would receive water from the existing Fordyce Lake, which presently discharges into Lake Spaulding, and from Rattlesnake Creek and the South Fork of the Yuba River. As an alternative to the Lake Valley Dam and Reservoir, consideration is also being given to construction of a dam and reservoir at a site near Cisco on the South Fork of the Yuba River. Water conserved in either the Lake Valley or Cisco Reservoirs would be discharged through conduits, 2.0 and 3.6 miles in length, respectively, into a power house on the flow line of Lake Spaulding. This and other water discharged from Lake Spaulding into the Drum System, and through the existing Drum and Dutch Flat Power Houses, would be conveyed from the afterbay of the latter plant in a new conduit, including about six miles of canal, to the proposed Chicago Park Power House. The Chicago Park Power House would be located 0.75 mile upstream from the flow line of the proposed Rollins Reservoir, which would be created by construction of a dam on the Bear River at a site about 2.5 miles north of Colfax and immediately above the intake of the existing Bear River Canal. Water conserved in Rollins Reservoir would be diverted into the Bear River Canal.

The plans under study for development of the Bear River also contemplate the construction of a dam and reservoir for conservation purposes at the Garden Bar site, about 10 miles east of Wheatland on the Bear River. In addition, plans have been made for an enlarged Camp Far West Dam and Reservoir at the site of the existing development, about six miles east of Wheatland on the Bear River.

Truckee River Basin

Features of The California Water Plan pertaining to Lake Tahoe and the Truckee River Basin will be more specifically described in a future publication of the State Water Resources Board. For present purposes, however, there follows a brief description of certain of the works which not only would provide supplemental water to meet the probable ultimate requirements of lands in Placer County, but which also would provide regulated water for other beneficial purposes both inside and outside of Placer County, and a large measure of flood control.

Tentative plans for the development of Lake Tahoe and the Truckee River contemplate the operation of

Lake Tahoe within the presently prescribed range of lake stage of 6.1 feet provided in the Truckee River Decree and the Truckee River Agreement, except that the upper water surface elevation would be reduced from 6,229.1 feet to 6,228 feet to alleviate flood damage. The Truckee River Decree, the so-called "1915 Decree," on record in the office of the United States Federal Court, San Francisco, provided that the natural outlet of Lake Tahoe, which is at an elevation of 6,223 feet, shall not be disturbed. The Truckee River Agreement of 1935, having as its parties the United States of America, Truckee-Carson Irrigation District, Washoe County Water Conservation District, and the Sierra Pacific Power Company, provided that the Lake Tahoe level shall not be permitted to rise above an elevation of 6,229.1 feet.

Water conserved in Lake Tahoe would be consumed around the lake, released to the Truckee River for support of fish life, or would be diverted at a point on the northeast edge of Lake Tahoe to the proposed Washoe Reservoir in Washoe Valley in Nevada by means of the Washoe Diversion Tunnel. The Washoe Diversion Tunnel would extend northeasterly for a distance of about 3.3 miles to Franktown Creek, and to the intake of a tunnel 0.35 mile in length leading to the penstock of the proposed Franktown Power House. This power house would be located near the flow line of the proposed Washoe Reservoir, which would be created by construction of an earthfill dam on Steamboat Creek at the north end of Washoe Valley. In addition to storage of water diverted from Lake Tahoe, the natural runoff to Washoe Reservoir would be augmented by intercepting the flow of Thomas, Whites, and Galena Creeks, which originate on the water-productive easterly slopes of Mount Rose, southwest of Reno.

Operation studies for Lake Tahoe conducted through the 53-year period from 1894-95 through 1946-47 indicate that under the foregoing plan the lake would not be drawn down below an elevation of 6,223 feet more than once during the period, and that such drawdown would have occurred after September 1st near the end of the summer recreation season. The absolute minimum level reached during the period would have been at an elevation of 6,222.1 feet, and the lake would have filled to above an elevation of 6,223 feet by the following May 1st.

Under the tentative plan of operation, Lake Tahoe would yield an estimated 62,000 acre-feet of water seasonally, with no deficiency during the 53-year period. It was estimated that about 2,000 acre-feet of this seasonal yield would ultimately be consumed around the lake largely for recreational and domestic purposes, and that an additional 5,000 acre-feet would be released down the Truckee River for the support of fish life. Under the plan, the remaining 55,000 acre-feet of dependable seasonal supply, together with a portion of the surplus water available during years of heavy runoff, would be diverted from Lake Tahoe to the Franktown Power House by means of the Washoe Diversion Tunnel. The water would be discharged from the plant for regulation and conservation in Washoe Reservoir, and released therefrom for beneficial uses in lower areas in Nevada.

Tentative plans of development of the Truckee River below Lake Tahoe include construction of the proposed Stampede Dam and Reservoir, at Stampede Valley about 10 miles north of Truckee on the Little Truckee River. The natural runoff to Stampede Reservoir would be augmented by intercepting the flow of Cold, Donner, Trout, Alder, and Prosser Creeks. It is anticipated that seepage from the unlined portions of the canal intercepting these streams, plus spill from these diversions, would serve in a large measure to replenish the water-bearing sediments underlying irrigable lands in the Prosser Creek-Little Truckee River area north of Truckee. Water conserved in Stampede Reservoir would be released through a pressure tunnel about 5.7 miles in length to the penstock of the proposed New Verdi Power House, located on the Truckee River two miles upstream from Verdi, Nevada, and would be available for beneficial uses in lower areas in Nevada.

PLANS FOR INITIAL LOCAL DEVELOPMENT

Possible plans for initial local development of supplemental water supplies for Placer County, together with cost estimates, are described in this section. Design of features of the plans was necessarily of a preliminary nature and primarily for cost estimating purposes. More detailed investigation, which would be required in order to prepare plans and specifications, might result in designs differing in detail from those presented in this report. However, it is believed that such changes would not result in significant modifications in estimated costs.

In connection with the ensuing discussion of surface water development works the following terms are used as indicated:

Safe Yield—The maximum sustained rate of draft from a reservoir that could have been maintained through a critically deficient water supply period to meet a given demand for water. For purposes of this bulletin, safe yield was determined on the basis of the critical period that occurred in the Sacramento Valley from 1920-21 through 1934-35.

New Safe Yield—That portion of the safe yield resulting from a proposed new water supply development and method of operation thereof, over and above the safe yield of existing works.

Irrigation Yield—The maximum sustained rate of draft from a reservoir that could have been maintained through a critically deficient water supply period to meet a given irrigation demand for water, with certain specified deficiencies. For purposes of this bulletin, irrigation yield was determined on the basis of the critical period that occurred in the Sacramento Valley from 1920-21 through 1934-35.

New Water—The seasonal yield of water resulting from a proposed new water supply development and method of operation thereof, that would have been wasted without the proposed works, including all conserved water, whether available on a safe yield, irrigation yield, or other basis.

Dependable Power Capacity—The minimum kilowatt capacity of the hydroelectric generating equipment when meeting an assumed load requirement. In this bulletin the load requirement for typical plants was assumed to have the characteristic of 5,550 kilowatt-hours per kilowatt of annual peak demand, approximately representative of the present northern California power market. In the case of plants located on a reservoir affording large afterbay capacity the load requirement was assumed to have the characteristic of 4,235 kilowatt-hours per kilowatt of annual peak demand, which approximately represents the energy production of a hydroelectric plant when operated to serve a portion of the peak demand of the present northern California power market under conditions of minimum hydroelectric production.

Installed Power Capacity—The kilowatt name plate rating of the hydroelectric generating equipment. In this bulletin, which deals only with high or constant head plants, the installed power capacity was determined as the optimum capacity which would develop the available water supply, and was taken as the capacity necessary to utilize twice the safe yield, equivalent to a minimum plant factor of 0.5.

Firm Energy Output—The energy in kilowatt-hours that would have an assured availability to the customer to meet his load requirements. For purposes of this bulletin, it was determined as the energy produced by discharge of the safe yield through the hydroelectric generating equipment.

Average Energy Output—The energy in kilowatt-hours generated by the hydroelectric generating equipment, with the available water supply, that would be usable under the assumed system load. For purposes of this bulletin, all of the energy output was assumed to be usable.

Capital costs of dams, reservoirs, diversion works, conduits, pumping plants, power plants, and appurtenances included in the considered works were estimated from preliminary designs based largely on data from surveys made during the current investigation. Approximate construction quantities were estimated from these preliminary designs. Unit prices of construction items were determined from recent bid data on projects similar to those in question, or from manufacturers' cost lists, and are considered representative of prices prevailing in April, 1953. The estimates of capital cost included costs of rights of way and construction, and interest during one-half of the estimated construction period at both 3 and 4 per cent per annum, plus 10 per cent for engineering and 15 per cent of construction costs for contingencies. Estimates of annual costs included interest on the capital investment at both 3 and 4 per cent, amortization over a 50-year period on both a 3 and 4 per cent sinking fund basis, and replacement, operation, and maintenance costs.

Estimates of revenue derived from proposed hydroelectric power plants were based on an annual value of $22.00 per kilowatt of dependable power capacity, plus 2.8 mills per kilowatt-hour of average energy output. A value of 2.8 mills per kilowatt-hour also was assigned in the cases where new energy was produced by existing power plants.

Because of geographical considerations and respective types of water service and water supplies in the several units of Placer County, possible plans for initial water development are presented separately for the Foothill, American River, and Bear River Units, and for the Valley Unit. As mentioned in the previous chapter, the present and future water needs of the Yuba River and Tahoe Units are small and may be met with local small-scale conservation works. For these reasons no plans for initial local development are presented in this bulletin for these units.

Foothill, American River, and Bear River Units

In Chapter III it was shown that the probable ultimate requirement for supplemental water in the Foothill, American River, and Bear River Units totals about 160,000 acre-feet per season. The principal areas of irrigable land in these units are in the valleys and foothills of the Foothill Unit, on the watershed divide between the American and Bear Rivers, and on the Foresthill Divide between the North and Middle Forks of the American River. In the following discussion four plans are presented to provide additional regulatory storage capacity on the Upper Middle Yuba River, on the South Fork of the Yuba River, and on the Bear River, and for conveyance of the conserved water and its discharge through the existing Milton-Bowman-Spaulding-Drum hydroelectric power system. The new water developed by these works would be made available for conveyance in existing Nevada Irrigation District and Pacific Gas and Electric Company conduits for use in the Foothill, American River, and Bear River Units, and, if not consumed above Wise Power House, would be available for use in the Valley Unit after discharge from this plant. These plans are hereinafter referred to as the "Jackson Meadows Project," "Lake Valley

Project," "Cisco Project" and "Rollins Project." The Lake Valley and Cisco Projects are alternative developments.

In addition, two alternative plans are presented involving conservation of water in the American River Basin. The first of these plans involves construction of dams and reservoirs on the Middle Fork of the American River, Pagge Creek, and North Shirttail Canyon. The water conserved under this plan would be discharged through two hydroelectric power plants, and conveyed to the Foresthill Divide in the American River Unit to meet the ultimate requirements of that area. The project would also provide a large amount of new water in the North Fork of the American River at Pickering Bar. This plan is hereinafter referred to as the "French Meadows Project." The second of the alternative plans would involve the construction of dams and reservoirs on Forbes Creek, a tributary of Forbes Creek, and North Shirttail Canyon, and conveyance of the conserved water to the Foresthill Divide to meet the ultimate requirements of that area. This plan is hereinafter referred to as the "Foresthill Divide Project."

Jackson Meadows Project. This project includes the diversion of water from Haypress Creek into the proposed Jackson Meadows Reservoir on the Middle Fork of the Yuba River, and conveyance to and discharge of the conserved waters through the existing Milton-Bowman-Spaulding-Drum hydroelectric power system. The project would provide a new safe yield of about 17,000 acre-feet per season, which could be made available in the existing Nevada Irrigation District and Pacific Gas and Electric Company conduits for use in the Valley, Foothill, American River, and Bear River Units. The project would also provide about 54,000,000 kilowatt-hours of new firm energy output seasonally if all of the new safe yield were discharged through all power plants of the existing Drum System. Smaller amounts of energy would be produced, dependent upon allocation of the new water to particular water service areas above Wise Power House. Principal features of the project are delineated on Plate 15, entitled "Jackson Meadows Project."

The proposed Jackson Meadows Dam would be located on the Middle Fork of the Yuba River about two miles upstream from the existing Milton Diversion, in Section 18, Township 19 North, Range 13 East, M. D. B. & M. The stream bed elevation at this point is 5,865 feet. Flows of Haypress Creek would be diverted at a stream bed elevation of 6,253 feet, in Section 32, Township 20 North, Range 13 East, M. D. B. & M., and conveyed by a tunnel to Jackson Meadows Reservoir. The waters of both Haypress Creek and the Middle Fork of the Yuba River would be released from Jackson Meadows Reservoir, and rediverted at the existing Milton Diversion into the Milton-Bowman Tunnel of the Nevada Irrigation District, from where they would flow into Bowman Lake. The waters would be discharged from Bowman Lake through the existing Bowman-Spaulding Conduit to Lake Spaulding. From Lake Spaulding the waters would be available for use in the Drum System of the Pacific Gas and Electric Company, and to meet municipal, domestic, and agricultural water requirements as they occur.

In subsequent descriptions of the Jackson Meadows, Lake Valley, and Cisco Projects, no specific allocations of new water are made to particular service areas. The amounts of water that may be made available to the Valley, Foothill, American River, and Bear River Units will depend upon the growth of water requirements and upon yield of the constructed works. It is considered probable, however, that in the case of water developed on the Upper Yuba River for use in Placer County the following general pattern of distribution would prevail: Such water as would be re-regulated in Lake Spaulding would be discharged either through Spaulding Power House No. 1 to the Drum Canal, or through Spaulding Power House No. 2 to the Boardman Canal by way of the South Yuba Canal. However, in order to develop the maximum amount of hydroelectric energy, water would be discharged to the Boardman Canal, the sole source of supply to lands on the Colfax Divide above the Bear River Canal and Halsey Forebay, only as the water requirements develop. The remaining water, after discharge into the Drum Canal, would be conveyed through the Drum and Dutch Flat Power Houses, and then diverted into the Bear River Canal, from which diversions would be made to serve scattered lands in the Bear River Unit as the water requirements develop. Remaining water in the Bear River Canal would be discharged through the Halsey Power House. From the Halsey Afterbay, from which location all lower lands in the Foothill and Valley Units can be served, a portion of the water would be diverted to the north and along the Bear River. The remaining water would be conveyed in the Wise Canal and through the Wise Power House, or diverted enroute to serve adjacent lands. Releases from the Wise Power House would be diverted downstream for use in service areas of the Nevada Irrigation District and Pacific Gas and Electric Company.

In Chapter III it was estimated that the ultimate seasonal requirement for supplemental water in the American River Unit will be about 36,000 acre-feet. The portion of this requirement for irrigable lands on the divide between the Bear and North Fork of the American Rivers, which could be served by the Jackson Meadows Project, probably will be about 11,300 acre-feet per season. Water could be served to these lands, and to all other irrigable lands in the Bear River, Foothill, and Valley Units, which have a probable ultimate seasonal supplemental water requirement totaling about 314,000 acre-feet, from the existing systems of the Nevada Irrigation District and Pacific Gas and Electric Company.

As a first step in determination of the size of the project, estimates were made of yield of the proposed works for various reservoir storage capacities. It was estimated that mean seasonal runoff from the approximately 38.4 square miles of watershed above the Jackson Meadows dam site is about 79,000 acre-feet. Estimated mean seasonal runoff of Haypress Creek, from the approximately 15.9 square miles of watershed above the proposed point of diversion, is about 28,700 acre-feet.

Based upon records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, monthly yield studies were made of five sizes of reservoir at the Jackson Meadows site. Demands on the reservoir were assumed to be constant, but with no diversions in August in order to permit maintenance. A summary of results of the yield studies is presented in Table 49.

TABLE 49

ESTIMATED SAFE SEASONAL YIELD OF JACKSON MEADOWS RESERVOIR WITH HAYPRESS DIVERSION, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Safe yield
22,500	33,200
32,500	39,100
45,000	45,100
52,500	47,100
62,500	49,900

After consideration of results of the yield studies, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 45,000 acre-foot storage capacity, with estimated safe seasonal yield of 45,100 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. A summary of the yield study for this size of reservoir is included in Appendix M.

Since Bowman Lake at present receives runoff from the Middle Fork of the Yuba River by means of the Milton Diversion, it was next necessary to operate the proposed Jackson Meadows Reservoir jointly with Bowman Lake in order to determine the new safe yield resulting from the Jackson Meadows Project. This method of operation indicated a new safe yield of about 17,000 acre-feet per season. It is estimated that the present capacity of 250 second-feet of the existing Bowman-Spaulding Conduit would be sufficient to carry the additional conserved water.

Topographic data required for the calculation of storage capacities and surface areas flooded at various water surface elevations of Jackson Meadows Reservoir were taken from an existing United States Bureau of Reclamation reservoir survey map, with scale of 1 inch equals 200 feet and with contour interval of 10 feet. Storage capacities of Jackson Meadows Reservoir at various stages of water surface elevation are given in Table 50.

TABLE 50

AREAS AND CAPACITIES OF JACKSON MEADOWS RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	5,865	0	0
35	5,900	15	400
55	5,920	80	1,250
75	5,940	240	4,500
95	5,960	450	11,500
115	5,980	605	22,000
135	6,000	825	36,500
145	6,010	890	45,000

Based upon preliminary geological reconnaissance, the Jackson Meadows dam site is considered suitable for an earthfill dam of any height up to about 200 feet. Bedrock in the vicinity consists chiefly of a metasedimentary formation which is generally hard and massive. This material is part of the Milton formation of Jurassic age. Bedding attitudes can still be determined despite the metamorphism, and the series apparently strikes slightly east of north. Jointing is prominent and in sets, but joint seams are tight and relatively unweathered. Rhyolitic lava flows outcrop in this vicinity and morainal deposits also occur nearby. In some cases the lavas overlie ancient stream gravels locally. Stripping from the abutments and from the channel section for the impervious section of an earth dam should not exceed three feet of jointed bedrock beneath a few feet of overburden.

Some impervious fill material is available from the meadows of the reservoir area, but considerable further exploration would be necessary to determine the extent and the suitability of such deposits. Borings would have to be made, and compaction and permeability tests run on samples of material thus obtained as a major part of this exploration program. Coarse gravels containing some fines are available in large quantities, also from within the reservoir area. These could be used as pervious fill, or, from selected small areas, as concrete aggregate. Suitable rock which could be quarried for use either in a blanket section or as riprap is also available locally in virtually unlimited quantities.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 145 feet in height from stream bed to spillway lip, and with a crest elevation of 6,024 feet, was selected to illustrate estimates of cost of the Jackson Meadows

Project. The dam would have a crest length of about 1,530 feet, a crest width of 30 feet, and 2.5:1 upstream and downstream slopes. The upstream face of the dam would be covered with coarse rock, and riprap would not be required. The dam would be constructed with a rolled earth impervious core having a 10-foot crest width and 0.7:1 side slopes. The total volume of fill would be an estimated 1,458,000 cubic yards.

The chute-type spillway would be located in the right abutment around the end of the structure. It would have a capacity of 19,000 second-feet, required for an assumed maximum discharge of 495 second-feet per square mile of drainage area, and would discharge into the Middle Fork of the Yuba River below the dam. The maximum depth of water above the spillway lip would be 10 feet, and an additional 4 feet of freeboard would be provided.

Outlet works would consist of a 60-inch diameter welded steel pipe, placed in a trench excavated in rock beneath the dam, and encased in concrete. Releases from the reservoir would be controlled at the upstream end of the outlet by two 48-inch diameter hydraulically controlled butterfly valves, located in a submerged inlet structure. Hydraulic control lines would extend up the face of the dam from the inlet structure to a control house located on the crest of the dam. The outlet would be controlled at the downstream end by a 60-inch diameter hollow jet valve, discharging directly into the natural channel of the river.

Several county roads and a United States Forest Service cabin would be inundated by the Jackson Meadows Reservoir. The quantity of merchantable timber within the reservoir area is estimated by the United States Forest Service to be approximately 25,000,000 board feet.

The proposed Haypress diversion structure would be located in Section 32, Township 20 North, Range 13 East, M. D. B. & M., at a site on Haypress Creek about 5.5 miles upstream from Sierra City. The site was examined and cross sections taken during the course of the investigation. The proposed weir would consist of a concrete gravity overpour section, with a crest 160 feet in length and 12 feet in height above stream bed. An opening at the left end of the weir would provide entrance to a side channel leading downstream about 75 feet to the headworks of the conduit. The side channel would have a concrete gravity parapet wall of the overpour type, and two 4- by 4-foot sluice gates would be provided for sand clearance. The headworks would consist of a concrete headwall across the end of the side channel, in which there would be two 5- by 5-foot slide headgates. The diversion conduit would consist of a tunnel, 3.0 miles in length, with a capacity of 350 second-feet. About 20 per cent of the length of the tunnel would be lined and would have a diameter of 7.0 feet. The unlined portion of the tunnel would have a diameter of 8.3 feet. The tunnel would discharge directly into Jackson Meadows Reservoir.

Pertinent data with respect to the general features of the Jackson Meadows Project, as designed for cost estimating purposes, are presented in Table 51.

TABLE 51

GENERAL FEATURES OF JACKSON MEADOWS PROJECT

Jackson Meadows Dam
- Type—earthfill
- Crest elevation—6,024 feet
- Crest length—1,530 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—145 feet
- Side slopes—2.5:1 upstream and downstream
- Freeboard, above spillway lip—14 feet
- Elevation of stream bed—5,865 feet
- Volume of fill—1,458,000 cubic yards

Jackson Meadows Reservoir
- Surface area at spillway lip—890 acres
- Storage capacity at spillway lip—45,000 acre-feet
- Drainage area, Middle Fork of Yuba River—38.4 square miles
- Estimated mean seasonal runoff, Middle Fork of Yuba River—79,000 acre-feet
- Drainage area, Haypress Creek—15.9 square miles
- Estimated mean seasonal runoff, Haypress Creek—28,700 acre-feet
- Estimated safe seasonal yield—45,100 acre-feet
- Estimated new safe seasonal yield—17,000 acre-feet
- Type of spillway—chute-type cut in right abutment
- Spillway discharge capacity—19,000 second-feet
- Type of outlet—60-inch diameter steel pipe beneath dam

Diversion Works
- Hypress Creek—concrete gravity weir with ogee overpour section, 160 feet in length, and 12 feet in height above stream bed elevation of 6,253 feet

Conduit
- Type—tunnel
- Length—3.0 miles
- Portion lined—20 per cent
- Diameter lined portion 7.0 feet
- Diameter unlined portion—8.3 feet
- Capacity—350 second-feet
- Inlet elevation—6,257 feet
- Discharge elevation—6,010 feet

The capital cost of the Jackson Meadows Project, on a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be about $5,644,000, and corresponding annual costs of the project were estimated to be about $250,000.

The resultant estimated average unit cost of the 17,000 acre-feet per season of new safe yield, excluding consideration of possible revenues from sale of power, was about $14.70 per acre-foot. On a 4 per cent interest basis the unit cost of the new safe yield per season was about $17.10 per acre-foot. If a value of 2.8 mills per kilowatt-hour is assigned to the estimated 54,000,000 kilowatt-hours of new firm energy output per season that would be produced from discharge of the new safe yield through the existing power plants of the Drum System, the revenue would amount to $151,000, thus reducing the unit costs of the new safe yield to about $5.80 and $8.20 at interest rates of 3 and 4 per cent, respectively.

Estimated capital and annual costs of the Jackson Meadows Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Jackson Meadows Dam and Reservoir	$2,792,000	$127,000
Haypress Diversion and Conduit	2,852,000	123,000
Totals	$5,644,000	$250,000

Lake Valley Project. This project includes construction of a dam and reservoir on the North Fork of the North Fork of the American River about 3 miles west of Cisco, and the diversion of waters from the South Fork of the Yuba River, and from Fordyce Lake and Rattlesnake Creek, to the proposed enlarged Lake Valley Reservoir. The conserved waters would be released from Lake Valley Reservoir through the proposed Lake Valley Power House located on the flow line of Lake Spaulding to the Drum hydroelectric power system of the Pacific Gas and Electric Company. The project would provide about 48,000 acre-feet of new safe seasonal yield, which could be made available in the existing Nevada Irrigation District and Pacific Gas and Electric Company conduits for use in the Valley, Foothill, American River, and Bear River Units. The project would provide about 69,000,000 kilowatt-hours of average energy output seasonally and 16,300 kilowatts of dependable power capacity from discharge of the new water through the proposed Lake Valley Power House. The project would also provide about 80,000,000 kilowatt-hours of new firm energy output seasonally if all of the new safe yield were discharged through all power plants of the existing Drum System. Principal features of the project are delineated on Plates 16 and 17, entitled "Lake Valley Project." and "Lake Valley Project, Plan and Profile."

The proposed Lake Valley Dam would be located some 2,000 feet upstream from the existing earthfill dam on the North Fork of the North Fork of the American River in Section 35, Township 17 North, Range 12 East, M. D. B. & M. The stream bed elevation at this point is about 5,720 feet. The existing earth dam, owned by the Pacific Gas and Electric Company, was constructed in 1911 and conserves water which upon release is conveyed westerly and discharged into the Drum Canal in the vicinity of Emigrant Gap. The existing dam is 74 feet in height, has a crest length of 940 feet, and creates a reservoir with a storage capacity of about 8,100 acre-feet.

Under the proposed project, water conserved in the existing Fordyce Lake, instead of being discharged in Lake Spaulding as at present, would be conveyed in a southerly direction to Rattlesnake Creek. From Rattlesnake Creek the combined flows would be conveyed to a junction with another conduit conveying water from a diversion on the South Fork of the Yuba River. From the junction the combined diverted flows of Fordyce Lake, Rattlesnake Creek, and the South Fork of the Yuba River would be further conveyed to Lake Valley Reservoir. From Lake Valley Reservoir the conserved water would be conveyed to a power house located on the flow line of Lake Spaulding at an elevation of 5,025 feet, developing an average static head of about 815 feet. From Lake Spaulding the water would be discharged through existing Spaulding Power House No. 1 and into the existing Drum Canal, where it would be available for use in the Drum System and to meet municipal, domestic, and agricultural water requirements as they occur.

In Chapter III it was estimated that the ultimate seasonal requirement for supplemental water in the American River Unit will be about 36,000 acre-feet. The portion of this requirement for irrigable lands on the divide between the Bear and North Fork of the American Rivers, which could be served by the Lake Valley Project, probably will be about 11,300 acre-feet per season. Water could be served to these lands and to all other irrigable lands in the Bear River, Foothill, and Valley Units, which have a probable ultimate seasonal supplemental water requirement totaling about 314,000 acre-feet, from the existing systems of the Nevada Irrigation District and the Pacific Gas and Electric Company.

As a first step in determination of the size of the project, estimates were made of the yield of proposed works for various storage capacities. It was estimated that mean seasonal runoff from the approximately 4.4 square miles of watershed above the Lake Valley dam site is about 10,000 acre-feet. Estimated mean seasonal runoff of Rattlesnake Creek from the approximately 6.6 square miles of watershed above the point of diversion is about 17,400 acre-feet. It was also assumed that a uniform flow of 4,500 acre-feet per month would be available from Fordyce Lake. The estimated mean seasonal runoff of the South Fork of the Yuba River above the diversion point is 82,000 acre-feet, of which an estimated 46,000 acre-feet would be diverted to Lake Valley Reservoir.

Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, monthly yield studies were made of three reservoir sizes at the Lake Valley site. Monthly demands on the reservoir were assumed to be proportional to the estimated distribution of hydroelectric power demands, as presented in Table 39. It was assumed that these demands would be met with no deficiencies. A summary of the results of the yield studies is presented in Table 52.

After consideration of results of the yield determinations, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 41,000 acre-foot storage capacity, with estimated safe seasonal yield of 104,000 acre-feet, was chosen for purposes of cost estimates to be presented in this bul-

TABLE 52

ESTIMATED SAFE SEASONAL YIELD OF LAKE VALLEY RESERVOIR, WITH FORDYCE LAKE, RATTLESNAKE CREEK, AND SOUTH FORK YUBA RIVER DIVERSIONS, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Safe yield
28,000	94,000
41,000	104,000
75,000	114,000

letin. A summary of the yield study for this size of reservoir is contained in Appendix M.

Since the foregoing estimated safe yield of the Lake Valley Project includes a portion of the present yield of Lake Spaulding and the yield of Fordyce Lake, it was necessary to make additional operation studies to determine the net effect of routing water conserved in Fordyce Lake to Lake Valley Reservoir instead of to Lake Spaulding, as at present. The present safe seasonal yield of Lake Spaulding was estimated to be 226,000 acre-feet, based on records of flow at the head of the Drum and South Yuba Canals during the critical season of 1931-32. Based on additional yield studies, the combined safe seasonal yield of Lake Spaulding and the Lake Valley Project was estimated to be 274,000 acre-feet. Thus, the new safe yield of the Lake Valley Project would be about 48,000 acre-feet per season.

Topographic data for determination of storage capacities of Lake Valley Reservoir at different water surface elevations, together with areas flooded, were taken from a Division of Water Resources map prepared in 1952 by photogrammetric means, at a scale of 1 inch equals 500 feet, and with a contour interval of 20 feet. Data for the preliminary design of the proposed dam were taken from the same map. Storage capacities of Lake Valley Reservoir and areas flooded at various stages of water surface elevation are given in Table 53.

TABLE 53

AREAS AND CAPACITIES OF LAKE VALLEY RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	5,720	0	0
30	5,750	40	1,000
100	5,820	480	20,000
120	5,840	560	28,000
140	5,860	630	39,000
143	5,863	640	41,000
160	5,880	690	49,000
180	5,900	750	62,000
200	5,920	800	76,000

Based upon preliminary geological reconnaissance, the Lake Valley dam site is considered suitable for an earthfill or rockfill dam up to about 350 feet in height. The maximum height is topographically limited by the crest of the ridge forming the right abutment. As indicated previously, the axis of the proposed dam is about 2,000 feet upstream from the present earthfill structure and, therefore, the channel section and lower abutments were not accessible during the field investigation since they lie beneath the water surface of the existing reservoir. The upper left abutment consists essentially of barren, hard, glacial-polished granitic rock. Soil occurs on the left abutment only in small pockets. The right abutment, however, consists entirely of morainal material derived from a granitic source and varying in particle size from clay grains to boulders 10 feet in diameter. Grouting of such material is not possible, although the material is generally extremely permeable. Large leakage losses may be expected at this site unless a cutoff to bedrock beneath the dam can be effected. Except for such a cutoff, stripping of only about 3 feet would be necessary beneath the foundation of an earthfill or rockfill dam at the right abutment at this site, this being necessary to eliminate the vegetative root zone. The depth of cutoff excavation which would be necessary cannot be estimated without exploratory data on the depth of morainal material overlying the right abutment. Only one foot of stripping would be necessary on the left abutment, and no more than 10 feet should be necessary in the channel section. It would probably be advantageous to utilize a spillway around the end of the dam across the left abutment, thereby avoiding the weak morainal deposits on the right abutment.

The great mass of glacial detritus that covers much of this area is unsuitable for construction use except possibly in a stability section. However, an adequate supply of impervious fill material is available in nearby areas, with an average haul distance of about one mile to the site.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 143 feet in height from stream bed to spillway lip, and with a crest elevation of 5,870 feet, was selected to illustrate estimates of cost of the Lake Valley Dam and Reservoir. The dam would have a crest length of about 2,470 feet and a crest width of 30 feet, with 2.5:1 slopes both upstream and downstream. The central impervious core would have a top width of 20 feet and slopes of 0.8:1 both upstream and downstream. The total volume of fill would be about 2,473,000 cubic yards.

The spillway would be a concrete weir of the side channel type, about 190 feet in width, across the left abutment. It would have a discharge capacity of 3,500 second-feet, required for an assumed maximum discharge of 430 second-feet per square mile of drainage area. The maximum depth of water above the spillway lip would be 3 feet, and an additional 4 feet of free-board would be provided. The spillway would discharge into the North Fork of the North Fork of the American River below the dam.

The outlet works would include a submerged inlet structure, trash racks, and 96-inch diameter steel pipe leading to a valve chamber, located beneath the crest of the dam and equipped with a 4- by 5-foot high-pressure slide gate. The steel pipe would be placed in a trench excavated in the right abutement beneath the dam, and would be encased in concrete. From the valve chamber a 60-inch diameter welded steel pipe, placed in a 10-foot diameter horseshoe tunnel about 420 feet in length, would discharge directly into the pipe line leading to the penstock of the proposed Lake Valley Power House. A 60-inch diameter butterfly valve would be installed in the discharge pipe outside the tunnel portal. A 24-inch diameter hollow jet valve would be installed in the steel outlet pipe just upstream from the butterfly valve, and would permit discharge directly into the stream channel below the dam.

About one-half of the new reservoir area that would be created is already inundated, and the remainder of the land is of relatively small value, with no improvements. Much clearing of land would be required, however, as approximately 50 per cent of the proposed reservoir is covered with medium to small trees with no appreciable salvage value.

The proposed conduit from Fordyce Lake to Rattlesnake Creek would consist of a metal flume 2.4 miles in length and a tunnel 1.1 miles in length, and would have a capacity of 100 second-feet. The flume would have an inlet elevation of 6,361 feet. The unlined tunnel would be 8.3 feet in diameter, with an inlet elevation of 6,326 feet, and would discharge into Rattlesnake Creek at an elevation of 6,300 feet.

The diversion works on Rattlesnake Creek would be located at a stream bed elevation of 5,930 feet. Location of the diversion site and design of the diversion works were based on a map study and were checked in the field. The proposed diversion weir would consist of a concrete gravity overpour section and apron, 5 feet in height above stream bed and some 120 feet in length. An opening at the left end of the weir, with a trash rack, would provide entrance to a side channel leading downstream about 30 feet to the headworks of the conduit to Lake Valley Reservoir. The side channel would have a concrete parapet wall of the overpour type, and a 2- by 2-foot sluice gate would be provided for sand clearance. The headworks would consist of a concrete headwall across the end of the side channel in which there would be a 3.5- by 3.5-foot slide gate. The conduit, with a capacity of 100 second-feet and an inlet elevation of 5,930 feet, would consist of 1.5 miles of metal flume and 0.4 mile of inverted siphon to its junction at an elevation of 5,900 feet with the conduit conveying water from the diversion on the South Fork of the Yuba River.

The diversion works on the South Fork of the Yuba River would be located about 4 miles east of Cisco at a stream bed elevation of 5,945 feet. Location of the diversion site and design of the diversion works were based on a map study and were checked in the field. The proposed diversion weir would consist of a concrete gravity overpour section and apron, 10 feet in height above stream bed and some 100 feet in length. An opening at the left end of the weir, with a trash rack, would provide entrance to a side channel leading downstream about 60 feet to the headworks of the conduit to Lake Valley Reservoir. The side channel would have a concrete parapet wall of the overpour type, and a 3- by 3-foot sluice gate would be provided for sand clearance. The headworks would consist of a concrete headwall across the end of the side channel in which there would be a 5- by 5-foot slide gate. The conduit with an inlet elevation of 5,950 feet, and consisting of 3.7 miles of metal flume with a capacity of 200 second-feet, would extend in a westerly direction along the left bank of the Yuba River to its junction with the conduit from Rattlesnake Creek at an elevation of 5,900 feet.

From the junction of the two conduits the water would be conveyed westerly in a metal flume for a distance of 1.8 miles, and then southerly through the watershed divide between the South Fork of the Yuba River and the North Fork of the American River in a tunnel about 1.0 mile in length. The tunnel would discharge at an elevation of 5,875 feet into Lake Valley Reservoir. The metal flume would have a capacity of 300 second-feet. The unlined tunnel, with a capacity of 300 second-feet, would have a diameter of 8.7 feet.

The conduit from the outlet of Lake Valley Reservoir to the penstock of the proposed Lake Valley Power House would consist of a pipe line, 2.0 miles in length and 5.5 feet in diameter, with a capacity of 200 second-feet. The pipe line would discharge at an elevation of 5,700 feet directly into a steel penstock leading to the power house. The penstock would have a 5.0- to 4.5-foot variable diameter, and would be about 3,600 feet in length. The proposed pipe line and penstock would develop an average static head of about 815 feet at the Lake Valley Power House. The power house would be located on the flow line of Lake Spaulding at an elevation of 5,025 feet and would have an installed power capacity of 17,500 kilowatts.

Pertinent data with respect to general features of the Lake Valley Project, as designed for cost estimating purposes, are presented in Table 54.

The capital costs of the Lake Valley Project, on both a 3 and 4 per cent interest basis and based on

TABLE 54

GENERAL FEATURES OF LAKE VALLEY PROJECT

Lake Valley Dam
Type of dam—earthfill
Crest elevation—5,870 feet
Crest length—2,470 feet
Crest width—30 feet
Height, spillway lip above stream bed—143 feet
Side slopes—2.5:1 upstream and downstream
Freeboard above spillway lip—7 feet
Elevation of stream bed—5,720 feet
Volume of fill—2,473,000 cubic yards

Lake Valley Reservoir
Surface area at spillway lip—640 acres
Storage capacity at spillway lip—41,000 acre-feet
Drainage area
Lake Valley—4.4 square miles
Rattlesnake Creek above diversion—6.6 square miles
South Fork Yuba River above diversion—31.1 square miles

Lake Valley Reservoir—Continued
Estimated mean seasonal runoff
Lake Valley—10,000 acre-feet
Rattlesnake Creek above diversion—17,400 acre-feet
South Fork Yuba River above diversion—82,000 acre-feet
Estimated safe seasonal yield—104,000 acre-feet
Estimated new safe seasonal yield—48,000 acre-feet
Type of spillway—side channel
Spillway discharge capacity—3,500 second-feet
Type of outlet—60-inch diameter steel pipe beneath dam

Diversion Works
Rattlesnake Creek—concrete gravity dam, 5 feet high and 120 feet long
South Fork Yuba River—concrete gravity dam, 10 feet high and 100 feet long

Conduits

Item	Fordyce Diversion		Rattlesnake Creek Diversion		South Fork Yuba Diversion			Lake Valley Pipeline and Penstock	
Type	Metal flume	Tunnel	Metal flume	Inverted siphon	Metal flume	Metal flume	Tunnel	Pipeline	Penstock
Length, in miles	2.8	1.1	1.5	0.4	4.7	0.8	1.0	2.0	0.7
Diameter, in feet	----	8.3	----	4.0	---	----	8.7	5.5	5.0 to 4.5
Capacity, in second-feet	100	100	100	100	200	300	300	200	200
Inlet elevation, in feet	6,361	6,326	5,930	5,910	5,950	5,900	5,890	5,750	5,700
Outlet elevation, in feet	6,326	6,300	5,910	5,900	5,900	5,890	5,875	5,700	5,025

Lake Valley Power House
Average static head—815 feet
Installed power capacity—17,500 kilowatts
Dependable power capacity—16,300 kilowatts

prices prevailing in April, 1953, were estimated to be about $10,110,000 and $10,172,000, respectively. Corresponding annual costs of the project were estimated to be about $654,000 and $733,000. If an annual value of $22.00 per kilowatt of dependable power capacity is assigned to the proposed Lake Valley Power House, and a value of 2.8 mills per kilowatt-hour is assigned to the estimated 69,000,000 kilowatt-hours of average energy output that would be developed, the annual power revenue would amount to $552,000, thus reducing the estimated average unit cost of the new safe yield to about $2.10 and $3.80 per acre-foot for interest rates of 3 and 4 per cent, respectively. Additional revenues from discharge of the new safe yield through the existing downstream power houses would result in net annual revenues for the project of about $182,000 and $103,000, respectively, with interest rates of 3 and 4 per cent. The resultant estimated average unit costs of the 48,000 acre-feet of new safe seasonal yield, excluding consideration of possible revenues from power and costs of power facilities, were about $9.80 and $11.10 per acre-foot, for interest rates of 3 and 4 per cent, respectively.

Estimated capital and annual costs of the Lake Valley Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Enlarged Lake Valley Dam and Reservoir	$4,187,000	$245,000
Fordyce Diversion Conduit	1,200,000	58,000
Rattlesnake Creek Diversion Conduit	444,000	30,000
South Fork Yuba Diversion Conduit	1,616,000	102,000
Lake Valley Pipe Line	537,000	33,000
Lake Valley Power House	2,090,000	186,000
Totals	$10,110,000	$654,000

Cisco Project. This project, which is presented as an alternative to the Lake Valley Project, includes the construction of a dam and reservoir on the South Fork of the Yuba River about 1.5 miles northwest of Cisco, and the diversion of waters from the existing Fordyce Lake and from Rattlesnake Creek to Cisco Reservoir through the proposed Cisco Power House No. 1. The conserved waters would be released from Cisco Reservoir through the proposed Cisco Power House No. 2, located on the flow line of Lake Spaulding, to the Drum hydroelectric power system of the Pacific Gas and Electric Company. The project would provide about 71,000 acre-feet of new safe yield per season, which could be made available in the existing Nevada Irrigation District and Pacific Gas and Electric Company conduits for use in the Valley, Foothill, American River, and Bear River Units. The project would also provide about 130,000,000 kilowatt-hours of average energy output seasonally and 26,600 kilowatts of dependable power capacity from water discharged through the Cisco Power Houses Nos. 1 and 2. The project would also provide about 159,000,000 kilowatt-hours of new firm energy output seasonally if all of the new safe yield were discharged through existing downstream installations. Principal features of the project are delineated on Plate 18, entitled "Cisco Project."

The proposed Cisco Dam would be located on the Middle Fork of the Yuba River about 4 miles upstream from Spaulding Dam, in Sections 19 and 30, Township 17 North, Range 13 East, M. D. B. & M. The stream bed elevation at this point is 5,590 feet. The regulated flow of about 75 second-feet from Fordyce Lake and the flow of Rattlesnake Creek would be diverted and conveyed in a conduit to Cisco Reservoir, discharging through the Cisco Power House No. 1, which would be located on the right bank of Rattlesnake Creek where it enters the reservoir. From Cisco Reservoir the conserved water would be conveyed to Cisco Power House No. 2, located on the flow line of Lake Spaulding at an elevation of 5,025 feet. From Lake Spaulding the water would be discharged through existing Spaulding Power House No. 1 and into the existing Drum Canal, where it would be available for use in the Drum System and to meet municipal, domestic, and agricultural water requirements as they occur.

In Chapter III it was estimated that the ultimate seasonal requirement for supplemental water in the American River Unit will be about 36,000 acre-feet. The portion of this requirement for irrigable lands on the divide between the Bear and North Fork of the American Rivers, which could be served by the Cisco Project, probably will be about 11,300 acre-feet per season. Water could be served to these lands and to all other irrigable lands in the Bear River, Foothill, and Valley Units, which have a probable ultimate seasonal supplemental water requirement totaling about 314,000 acre-feet, from the existing systems of the Nevada Irrigation District and Pacific Gas and Electric Company.

As a first step in determination of the size of the project, estimates were made of the yield of the proposed works for various reservoir storage capacities. It was estimated that mean seasonal runoff from the approximately 51 square miles of watershed above the Cisco dam site is about 134,500 acre-feet. Estimated mean seasonal runoff of Rattlesnake Creek from the approximately 6.6 square miles of watershed above the point of diversion is about 17,400 acre-feet. It was also assumed that a uniform flow of 4,500 acre-feet per month would be available from Fordyce Lake.

Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, monthly yield studies were made of four sizes of reservoir at the Cisco site. Monthly demands on the reservoir were assumed to be proportional to the estimated distribution of hydroelectric power demands, as presented in Table 39. It was assumed that these demands would be met with no deficiencies. A summary of the results of the yield studies is presented in Table 55.

TABLE 55

ESTIMATED SAFE SEASONAL YIELD OF CISCO RESERVOIR, WITH FORDYCE LAKE AND RATTLESNAKE CREEK DIVERSIONS, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Safe yield
42,000	105,000
62,000	123,000
82,000	134,000
100,000	146,000

After consideration of results of the yield determinations, together with the topography of the dam site and cost analyses hereinafter discussed, a reservoir of 100,000 acre-foot storage capacity, with estimated safe seasonal yield of 146,000 acre-feet, was chosen for the purpose of cost estimates to be presented in this bulletin. A summary of the yield study for this size of reservoir is contained in Appendix M.

Since the foregoing estimated safe yield of the Cisco Project consists of a portion of the present yield of Lake Spaulding, including the yield of Fordyce Lake, it was necessary to make operation studies to determine the present safe yield of Lake Spaulding and the safe yield of Lake Spaulding with Cisco Reservoir. The present safe seasonal yield of Lake Spaulding was estimated to be about 226,000 acre-feet, based on records of flow at the head of the Drum and South Yuba Canals during the critical season of 1931-32. Based on additional yield studies, the combined safe seasonal yield of Lake Spaulding and Cisco Reservoir was estimated to be about 297,000 acre-feet. Thus, the new safe yield of the Cisco Project would be about 71,000 acre-feet per season.

Topographic data for determination of storage capacities of Cisco Reservoir at different elevations, together with area flooded, were taken from an existing United States Bureau of Reclamation survey map of the reservoir site, at a scale of 1 inch equals 200 feet, and with contour interval of 20 feet. Data for preliminary design of the proposed Cisco Dam were taken from the same map. Storage capacities of Cisco Reservoir and areas flooded at various stages of water surface elevation are given in Table 56.

TABLE 56

AREAS AND CAPACITIES OF CISCO RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	5,590	0	0
20	5,610	50	500
40	5,630	150	2,000
60	5,650	225	5,000
80	5,670	290	10,000
100	5,690	345	16,000
120	5,710	395	24,000
140	5,730	465	33,000
160	5,750	555	43,000
180	5,770	650	55,000
200	5,790	740	68,500
220	5,810	835	84,000
238	5,828	920	100,000
250	5,840	940	112,000
260	5,850	1,015	121,000

Based upon a preliminary geological reconnaissance, the Cisco site is considered to be suitable for a rockfill dam of any height up to about 300 feet. Three saddles occur in the abutments at varying heights above stream bed level, any of which could be used for a spillway location. The height of dam would be limited by the saddles. Bedrock consists primarily of a meta-volcanic rock, which is often schistose although relatively hard and massive. The rock was probably originally a basalt. Metamorphic variations locally include schist, phyllite, quartzite, and an undifferentiated rock having a slaty cleavage. Fine-grained granitic rock occurs in place high on the right abutment. Some morainal detritus and a number of glacial erratics were also noted in the area. Quartz veining and limonite staining is common throughout the bedrock. A few tight shears, recognizable only by slickensides, are also found at this site. All of the various rock types are strongly jointed, with the joints being widely spaced but weathered to a considerable depth. Stripping under the foundation of a rockfill dam should not exceed an average of two feet of overburden, consisting chiefly of loose morainal detritus and talus blocks.

Either the granite or the metamorphic rock occurring locally could be quarried for use as rockfill. Aggregates would either have to be crushed locally or imported to the area by rail or truck. There is not an adequate supply of earth in the vicinity of the site to provide for an impervious section in a dam of the height desired.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, a rockfill dam 238 feet in height from stream bed to spillway lip, and with a crest elevation of 5,840 feet, was selected to illustrate estimates of cost of the Cisco Project. The dam would have a crest length of about 1,450 feet, a crest width of 20 feet, and 1.4 : 1 upstream and 1.5 : 1 downstream slopes. To form the impervious upstream face of the dam, a concrete slab with thickness varying from 1 to 3 feet would be poured upon a layer of placed rock. The thickness of the placed rock layer would vary from 10 feet to 20 feet. The total volume of fill of the dam would be about 2,574,000 cubic yards.

The spillway would be a concrete weir about 175 feet in length across a saddle on the right abutment. It would have a capacity of 16,000 second-feet, required for an assumed maximum discharge of 300 second-feet per square mile of drainage area. The maximum depth of water above the spillway lip would be 8 feet, and an additional 4 feet of freeboard would be provided. The spillway would discharge into the South Fork of the Yuba River below the dam.

The outlet works would include an outlet tower, trash racks, and a circular pressure tunnel 9 feet in diameter through the left abutment of the dam, leading to a valve chamber located about 150 feet downstream from the axis of the dam, and equipped with a 4- by 4-foot high-pressure slide gate. From the valve chamber a 60-inch diameter welded steel pipe, placed in a 10-foot diameter horseshoe tunnel about 825 feet in length, would discharge into an open cut excavated in rock. This discharge would be controlled by a 48-inch diameter hollow jet valve. About 475 feet downstream from the valve chamber a turnout with a 4- by 4-foot high-pressure slide gate would permit discharge of water into the tunnel leading to Cisco Power House No. 2.

The main line tracks of the Southern Pacific Railroad traverse the left abutment of the Cisco dam site at a height about 290 feet above stream level, but would not have to be relocated with a dam of the height studied. The axis of the dam crosses U. S. Highway 40, and the highway would have to be relocated for several miles. The reservoir would inundate extensive commercial and resort developments. Construction of the dam and reservoir would also make necessary the relocation of about 3 miles of underground toll cable, 3 miles of surface telephone lines, and 7 miles of power transmission lines.

The proposed conduit from Fordyce Lake to Rattlesnake Creek would consist of a metal flume 2.8 miles in length and a tunnel 1.14 miles in length, and would have a capacity of 100 second-feet. The flume would have an inlet elevation of 6,361 feet. The unlined tunnel would be 8.3 feet in diameter, with an inlet elevation of 6,326 feet, and would discharge into Rattlesnake Creek at an elevation of approximately 6,300 feet.

Woodchuck Flat Dam and Reservoir, the proposed diversion structure on Rattlesnake Creek, which would also serve as a forebay for Cisco Power House No. 1, would be a low rockfill dam, located at stream bed elevation of 6,240 feet in Section 21, Township 17 North, Range 13 East, M. D. B. & M. The dam would be 50 feet in height from stream bed to spillway lip, with a crest elevation of 6,300 feet, and would create a reservoir with a capacity of 1,475 acre-feet. The dam would have a crest length of 830 feet, a crest width of 20 feet, and 1:1 upstream and 1.5:1 downstream slopes. To form the impervious upstream face of the dam, a 12-inch concrete slab would be poured upon a layer of placed rock. The thickness of the placed rock layer would vary from 5 feet to 10 feet. The total volume of fill of the dam would be about 47,000 cubic yards.

The spillway would be a concrete ogee weir about 120 feet in length, located on the right abutment. It would have a capacity of 6,200 second-feet, required for an assumed discharge of 950 second-feet per square mile of drainage area. The maximum depth of water above the spillway lip would be 6 feet, and an additional 4 feet of freeboard would be provided. The spillway would discharge into Rattlesnake Creek below the dam.

The outlet works would include a 48-inch diameter steel pipe 180 feet in length, placed in a trench excavated in the right abutment and encased in concrete. Discharges would be controlled at the upstream end by a 48-inch diameter circular slide gate, set in the inlet structure and covered with a trash rack. The outlet pipe would end in a stilling box and transition to the Rattlesnake Creek Diversion Conduit. Diverted water would discharge at an elevation of 6,253 feet into a metal flume, 8.9 feet in diameter and 1.0 mile in length, with a capacity of 160 second-feet. The flume would discharge into the steel penstock of Cisco Power House No. 1 through a transition structure. The penstock would have a 5- to 4.75-foot variable diameter, and would be 1,400 feet in length. It would develop an average static head of 419 feet at the power house. The power house would be located at the flow line of Cisco Reservoir at an elevation of 5,828 feet, and would have an installed power capacity of 4,600 kilowatts.

The conduit leading from Cisco Reservoir to the penstock of Cisco Power House No. 2 would consist of a pressure tunnel 3.6 miles in length, 7.0 feet in diameter for the lined portion and 8.3 feet in diameter

TABLE 57

GENERAL FEATURES OF CISCO PROJECT

Cisco Dam
- Type of dam—rockfill
- Crest elevation—5,840 feet
- Crest length—1,440 feet
- Crest width—20 feet
- Height, spillway lip above stream bed—238 feet
- Side slopes—1.5:1 downstream
  1.4:1 upstream
- Freeboard above spillway lip—12 feet
- Elevation of stream bed—5,590 feet
- Volume of fill—2,574,000 cubic yards

Cisco Reservoir
- Surface area at spillway lip—920 acres
- Storage capacity at spillway lip—100,000 acre-feet
- Drainage area of South Fork Yuba River—51 square miles
- Estimated mean seasonal runoff of South Fork Yuba River—134,500 acre-feet
- Estimated mean seasonal diversion from Rattlesnake Creek—14,000 acre-feet
- Estimated mean seasonal diversion from Fordyce Lake—54,000 acre-feet

Cisco Reservoir—Continued
- Estimated safe seasonal yield, with Fordyce and Rattlesnake diversions—145,800 acre-feet
- Estimated new safe seasonal yield—53,000 acre-feet
- Type of spillway—concrete weir
- Spillway discharge capacity—16,000 second-feet
- Type of outlet—9-foot diameter pressure tunnel

Diversion Works—Woodchuck Flat Dam
- Type of dam—rockfill
- Crest elevation—6,300 feet
- Crest length—830 feet
- Crest width—20 feet
- Height, spillway lip above stream bed—50 feet
- Side slopes—1:1 upstream
  1.5:1 downstream
- Freeboard above spillway lip—10 feet
- Elevation of stream bed—6,240 feet
- Volume of fill—46,700 cubic yards
- Reservoir storage capacity—1,475 acre-feet

Conduits

Item	Fordyce Diversion		Rattlesnake Creek Diversion		Cisco Reservoir Tunnel and Penstock		
					Pressure tunnel		
Type	Metal flume	Unlined tunnel	Metal flume	Penstock	Lined	Unlined	Penstock
Length, in miles	2.8	1.14	1.0	0.27	0.4	3.2	0.6
Diameter, in feet	6.4	8.3	8.9	5.0 to 4.75	7.0	8.3	6.3 to 5.5
Capacity, in second-feet	100	100	160	160	300	300	300
Inlet elevation, in feet	6,361	6,326	6,253	6,248	5,610	5,610	5,531
Outlet elevation, in feet	6,326	6,300	6,248	5,829	5,531	5,531	5,025

Power Houses

Item	Cisco Power House No. 1	Cisco Power House No. 2
Average static head, in feet	419	755
Installed power capacity, in kilowatts	4,600	28,000
Dependable power capacity, in kilowatts	4,600	22,000

for the unlined portion. It would have a capacity of 300 second-feet and would discharge into a varying diameter penstock 0.6 mile in length. This conduit would develop an average static head of 755 feet at Cisco Power House No. 2, and the installed power capacity of the power house would be 28,000 kilowatts.

Pertinent data with respect to general features of the Cisco Project, as designed for cost estimating purposes, are presented in Table 57.

The capital costs of the Cisco Project, on both a 3 and 4 per cent interest basis and based on prices prevailing in April, 1953, were estimated to be about $23,303,000 and $23,457,000, respectively. Corresponding annual costs were estimated to be about $1,212,000 and $1,409,000. The resultant estimated average unit costs of the 71,000 acre-feet of new safe seasonal yield, excluding consideration of possible revenues from power and costs of power facilities, were about $9.90 and $11.80 per acre-foot for interest rates of 3 and 4 per cent, respectively.

If an annual value of $22.00 per kilowatt of dependable power capacity is assigned to the Cisco Power Houses Nos. 1 and 2 and a value of 2.8 mills per kilowatt-hour is assigned to the estimated 130,000,000 kilowatt-hours of average energy output per season that would be produced by these plants, the annual power revenue would amount to about $949,000, thus reducing the estimated average unit cost of the new safe yield to about $3.70 and $6.50 per acre-foot, with interest rates of 3 and 4 per cent, respectively. Additional revenues from discharge of the new safe yield through the existing downstream power houses would result in an estimated annual net revenue for the project of about $163,000 with an interest rate of 3 per cent, or would reduce the estimated average unit cost of the new safe yield to about $0.20 per acre-foot with an interest rate of 4 per cent.

Estimated capital and annual costs of the Cisco Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Cisco Dam and Reservoir	$14,120,000	$616,000
Fordyce Diversion Conduit	1,200,000	58,000
Woodchuck Flat Dam	524,000	23,000
Rattlesnake Diversion Conduit	104,000	6,000
Cisco Power House No. 1	952,000	88,000
Cisco Reservoir Tunnel	2,683,000	114,000
Cisco Power House No. 2	3,720,000	307,000
Totals	$23,303,000	$1,212,000

The above costs include relocation of the existing U. S. Highway 40. In the event that this highway is replaced, as proposed, by a 4-lane highway before construction of Cisco Dam and Reservoir, the additional cost of relocating the new highway would further increase the costs of the Cisco Project. On a 3 per cent interest basis, the capital and annual costs would then be $31,239,000 and $1,519,000, respectively.

Comparison of Lake Valley and Cisco Projects. Both the Lake Valley and Cisco Projects conserve a portion of the flow of the South Fork of the Yuba River and make possible the development of a substantial power drop into Spaulding Reservoir. Also, both projects involve use of the regulated flow from Fordyce Lake. Table 58 presents comparable data for the two projects.

TABLE 58

COMPARISON OF LAKE VALLEY AND CISCO PROJECTS

Item	Lake Valley Project	Cisco Project	
		With relocation of existing highway	With relocation of 4-lane highway
Reservoir storage capacity, in acre-feet	41,000		100,000
Safe seasonal yield, in acre-feet	104,000		146,000
New safe seasonal yield, in acre-feet	48,000		71,000
Installed power capacity, in kilowatts	17,500		33,000
Dependable power capacity, in kilowatts	16,300		25,500
Average seasonal energy output, in kilowatt-hours	69,000,000		130,000,000
Firm seasonal energy output, in kilowatt-hours	69,000,000		112,000,000
Capital costs			
With 3% interest rate	$10,110,000	$23,303,000	$31,239,000
With 4% interest rate	$10,172,000	$23,457,000	$31,445,000
Annual costs			
With 3% interest rate	$654,000	$1,212,000	$1,519,000
With 4% interest rate	$733,000	$1,409,000	$1,780,000
Cost per acre-foot of new safe seasonal yield at Spaulding Reservoir			
With 3% interest rate	$2.10	$3.70	$8.00
With 4% interest rate	$3.80	$6.50	$11.70
Annual net revenue at Wise Power House			
With 3% interest rate	$182,000	$163,000	
With 4% interest rate	$103,000		
Cost per acre-foot of new safe seasonal yield at Wise Power House			
With 3% interest rate			$1.75
With 4% interest rate		$0.20	$5.40

Rollins Project. This project includes the construction of a dam and reservoir on the Bear River at the site of the existing Bear River Canal intake, a power house immediately upstream from the reservoir created by the dam, and a diversion works with a conveyance canal which would divert the flow of the Bear River below the existing Dutch Flat Power House and convey it to the penstock of the proposed power house. The project would provide a new irrigation yield of about 182,000 acre-feet, which could be made available in existing and proposed conduits of the Nevada Irrigation District and Pacific Gas and Electric Company, for use in the Valley, Foothill, and Bear River Units of Placer County and to lands in Nevada County below about 2,000 feet in elevation. The project would also provide about 88,000,000 kilowatt-hours of average energy output seasonally and 20,700 kilowatts of dependable power capacity from discharge of flow of the existing Drum System through

Rollins Dam Site and Bear River Canal Intake the proposed Chicago Park Power House. Principal features of the project are delineated on Plate 18a, entitled "Rollins Project."

The proposed Rollins Dam would be located on the Bear River about one-half mile upstream from the crossing of the highway connecting Colfax and Grass Valley, and in Section 22, Township 15 North, Range 9 East, M. D. B. & M. The stream bed elevation at this point is about 1,950 feet. Inflow to the reservoir would include natural flow in the Bear River plus the regulated flow of the Drum System. These waters would be diverted from the Bear River immediately below the Dutch Flat Power House tailrace and would be conveyed along the north bank of the Bear River in a lined canal and bench flume and returned to the Bear River by discharge through the proposed Chicago Park Power House, which would be located about three-fourths of a mile upstream from the flow line of the proposed Rollins Reservoir.

In subsequent descriptions of the Rollins Project no specific allocation of new water is made to particular service areas. The amounts of water that may be made available to the Valley, Foothill, and Bear River Units and to adjacent service areas in Nevada County will depend upon the growth of water requirements and upon yield of the constructed works. It is considered probable, however, that the following general pattern of distribution would prevail during the irrigation season: Such water as would be conserved or regulated in Rollins Reservoir would be discharged into the existing Bear River Canal. A portion of the water would be released therefrom to the Bear River to Combie Reservoir or a proposed conduit to Nevada County. Remaining water in the Bear River Canal would serve lands in the Bear River Unit or would be discharged through the existing Halsey Power House. From the Halsey Afterbay a portion of the water could be diverted to lower lands adjacent to the Bear River. The major portion would be conveyed, as at present, in the existing Wise Canal to Rock Creek Reservoir. From Rock Creek Reservoir further diversions could be made to the Foothill Unit. The remaining water would continue in the Wise Canal and be discharged through the Wise Power House or diverted enroute to serve adjacent lands. Releases from Wise Power House would be diverted downstream for use in service areas of the Nevada Irrigation District and the Pacific Gas and Electric Company. Releases made to the proposed conduit to Nevada County would be on an irrigation schedule. The water would be available to lands below the 2,000-foot contour and would be served as the demand develops. During the nonirrigation season the major portion of the release from Rollins Reservoir would be available below Wise Power House for storage in foothill reservoirs. Releases made to the Bear River would insure the filling of Lake Combie to meet the requirements of lands which are more readily served from that existing reservoir.

In Chapter III it was estimated that the ultimate seasonal requirement for supplemental water in the Bear River, Foothill, and Valley Units will be about 314,000 acre-feet. Water from Rollins Reservoir could be served to these lands from the existing systems of the Nevada Irrigation District and the Pacific Gas and Electric Company and to the previously mentioned lands in Nevada County which have an ultimate supplemental water requirement of about 44,000 acre-feet.

As a first step in determination of the size of the project, estimates were made of the yield of proposed works for various storage capacities. It was estimated that mean seasonal runoff from the approximately 104 square miles of watershed above the Rollins dam site is about 184,000 acre-feet. Additional inflow to the reservoir was determined from records of the Drum System of the Pacific Gas and Electric Company.

Based upon records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, monthly yield studies were made of four sizes of reservoir at the Rollins site. Demands on the reservoir assumed use of the existing Bear River Canal to full capacity during the months of maximum irrigation demand and on a constant flow basis during the remaining months of the year. The chosen demand schedule represents a compromise between hydroelectric and irrigation demands and was selected after inspection of records of flow in the Drum System under present operating criteria. The schedule would furnish an approximately uniform discharge to Wise Power House. In each yield study 5,000 acre-feet of reservoir space was allocated to storage of debris.

A summary of the results of the yield studies is presented in Table 59.

TABLE 59

ESTIMATED SEASONAL IRRIGATION YIELD OF ROLLINS RESERVOIR BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Irrigation yield
60,000	239,000
70,000	272,000
75,000	275,000
90,000	278,000

After consideration of results of the yield studies together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 70,000 acre-foot storage capacity, with estimated irrigation yield of 272,000 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. A summary of the yield study for this size of reservoir is included in Appendix M.

Additional yield studies were made to determine the safe seasonal yield and the new safe seasonal yield of the Rollins Project. Since the flow in the Bear River at the dam site includes regulated discharge from Lake Spaulding and other upstream reservoirs, it was necessary to determine the new safe yield of the Rollins Project as the difference between the present safe yield of the Drum System at this point and the safe yield of the system with Rollins Reservoir in operation. The present safe yield of the Drum System at this point was taken as the minimum sum of the diversion to Bear River Canal and the flow of Combie Ophir-Gold Hill Canal and was determined to be 90,000 acre-feet. The safe seasonal yield of the Rollins Project with a reservoir of 70,000 acre-foot storage capacity was determined to be about 225,000 acre-feet. Thus the new safe seasonal yield of the project would be about 135,000 acre-feet. It is estimated that the existing Bear River Canal, with capacity in excess of 450 second-feet, could convey the additional conserved water.

Topographic data for determination of storage capacities of Rollins Reservoir at different water surface elevations, together with areas flooded, were taken from a United States Bureau of Reclamation reservoir survay map, with scale of 1 inch equals 800 feet and with contour interval of 10 feet, and from the Chicago Park quadrangle map with a scale of 1 inch equals 2,000 feet and with contour interval of 40 feet. Storage capacities of Rollins Reservoir and areas flooded at various stages of water surface elevation are given in Table 60.

Based upon preliminary geological reconnaissance, the Rollins dam site is considered suitable for a concrete gravity, earthfill, or rockfill dam of any height up to approximately 300 feet. Bedrock at the Rollins site consists essentially of a highly variable greenstone, probably a meta-andesite, which occurs over the entire right and most of the left abutment. This rock is green in color, very hard where fresh, relatively resistant to weathering, and slightly porphyritic with a fine-grained matrix. Foliation or flow planes are generally obscure but may possibly dip steeply downstream into the right abutment. Jointing, which is of moderate importance on the surface, can be expected to tighten rapidly with depth. A major fault of the region probably underlies the gully which crosses the abandoned railroad right of way about 300 yards northeast of the trestle. Stripping from the abutments for the impervious section of an earth dam should not exceed 3 feet of bedrock beneath a few feet of overburden. In the channel section an estimated 30 feet of river gravels would be stripped for the impervious section of an earthen dam but the underlying bedrock need only be shaped. Impervious fill material is available from flats about 1 mile northwest of the dam site. These flats are partly cultivated at the present time. Large quantities of stream gravels with admixed sand are available locally for the pervious section or concrete aggregate. Suitable rock which could be quarried or salvaged from a spillway cut for use either in a blanket section or as riprap is also available locally in virtually unlimited quantities.

As a result of yield studies, geologic reconnaissance, and preliminary economic analysis, an earthfill dam 220 feet in height from stream bed to spillway lip, and with a crest elevation of 2,185 feet, was selected to illustrate estimates of cost of the Rollins Project. The dam would have a crest length of about 1,100 feet, a crest width of 30 feet, and 3:1 upstream and 2.5:1 downstream slopes. The upstream slope of the dam would be faced with riprap. The dam would be constructed with a rolled earth impervious core having a 10-foot crest width and 1:1 side slopes. The total volume of fill would be an estimated 2,789,000 cubic yards.

The chute-type spillway would be located on the right abutment around the end of the dam. It would have a capacity of 35,000 second-feet, required for an assumed maximum discharge of 340 second-feet per square mile of drainage area, and would discharge into the Bear River below the dam. The maximum depth of water above the spillway lip would be 8.75 feet and an additional 6.25 feet of freeboard would be provided. The outlet works would include a horseshoe-type tunnel, 10 feet in diameter and 1,400 feet in length, excavated through the left abutment and concrete-lined. The tunnel would be used to divert flow of the Bear River during the construction period. After completion of the dam a concrete plug would be placed in the tunnel at a point inside the inlet portal where the rock overburden is approximately 50 feet. Immediately upstream from the concrete plug

TABLE 60

AREAS AND CAPACITIES OF ROLLINS RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	1,950	0	0
25	1,975	25	100
50	2,000	80	1,500
75	2,025	150	4,700
100	2,050	235	9,500
125	2,075	310	16,500
150	2,100	410	26,000
175	2,125	545	38,400
200	2,150	710	54,200
220	2,170	900	70,000
225	2,175	905	74,800
250	2,200	1,125	100,000
275	2,225	1,395	130,600
300	2,250	1,700	169,500
325	2,275	2,090	217,000
330	2,280	2,190	228,000

a vertical shaft 7 feet in diameter would be cut to ground surface at an approximate elevation of 2,015 feet. This vertical shaft would contain the outlet conduit, a 60-inch steel pipe encased in concrete, which would have an inlet elevation of 2,025 feet and would extend through the concrete plug into the tunnel and terminate at the Bear River Canal intake. Releases would be controlled at the upstream end by a 60-inch butterfly valve operated from within the tunnel and at the downstream end by a 48-inch hollow jet valve.

The reservoir area consists of about 900 acres, of which 400 acres are streambed or bare slopes. The remaining 500 acres would require clearing. Existing improvements within the reservoir area include about one-fourth mile of existing Highway 40 which will be realigned out of the reservoir area under an adopted freeway program. There are also 18 cabins within the reservoir area and an estimated 1 mile each of steel tower and wood pole power transmission lines.

The proposed diversion works for the Chicago Park Power House on the Bear River would be located in Section 27, Township 16 North, Range 10 East, M. D. B. & M., at stream bed elevation of 2,700 feet and about 400 feet downstream from the existing Dutch Flat Power House. The diversion weir would consist of a gravity concrete overpour section and apron. The crest of the overpour would be 15 feet in height above stream bed and some 175 feet in length. Two radial gates, each 20 feet in length and 7 feet in height, would be installed in the dam near the right abutment to permit sluicing of an approach to a side channel overpour section. The side channel overpour section would consist of a weir with a crest elevation of 2,718 feet and 200 feet in length, extending upstream from the dam along the right bank of the river. Water diverted over the weir would enter a side channel 20 feet in width, 8 feet in depth below the overpour crest, and 450 feet in length, extending from the upstream end of the overpour weir to a point about 250 feet downstream from the right abutment of the dam. The side channel downstream from the dam would be provided with a wasteway to the Bear River for flows in excess of about 700 second-feet, two 5- by 5-foot slide gates at the lower end for sluicing, and a submerged right side wall to retain silt in the main side channel while allowing desilted water to spill to the right over into the headworks of a concrete canal. The canal, with a capacity of 700 second-feet, would be of concrete construction, rectangular in section, with a bottom width of 15.3 feet, a depth of 7.65 feet, and a freeboard of 1.0 foot, and would extend along the right bank of the Bear River for a distance of 5.75 miles to the inlet of the penstock of the proposed Chicago Park Power House.

The steel penstock with a diameter of 7.0 feet would have its inlet in Section 6, Township 15 North, Range 10 East, M. D. B. & M., at an elevation of 2,691 feet, and would extend a distance of 2,020 feet to the proposed Chicago Park Power House.

The power house would be located at elevation 2,220 feet on the right bank of the Bear River just upstream from Steep Hollow Creek in Section 6, Township 15 North, Range 10 East, M. D. B. & M., and would have an installed capacity of 25,000 kilowatts.

Forebay storage, if desirable, could be obtained by extending the conduit by siphon, canal, and tunnel for a distance of about 3.5 miles to Poorman Creek. Under such arrangement the power house would be located on the right bank of the reservoir in Section

TABLE 61

GENERAL FEATURES OF ROLLINS PROJECT

Rollins Dam
- Type of dam—earthfill
- Crest elevation—2,185 feet
- Crest length—1,100 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—220 feet
- Side slopes, upstream—3.0:1
  downstream—2.5:1
- Freeboard above spillway lip—15 feet
- Elevation of stream bed—1,950 feet
- Volume of fill—2,789,000 cubic yards

Rollins Reservoir
- Surface area at spillway lip—900 acres
- Storage capacity at spillway lip—70,000 acre-feet
- Drainage area of Bear River at Rollins dam site—104 square miles
- Estimated mean seasonal natural runoff of Bear River at Rollins dam site—184,000 acre-feet
- Estimated seasonal irrigation yield—272,000 acre-feet
- Estimated safe seasonal yield—225,000 acre-feet
- Estimated new safe seasonal yield—135,000 acre-feet
- Type of spillway—concrete weir with chute-type channel
- Spillway discharge capacity—35,000 second-feet
- Type of outlet—60-inch diameter steel pipe supported in a 10-foot diameter tunnel, and extending through a concrete tunnel plug to a vertical intake

Diversion Works
- Type of dam—concrete weir with gated sluiceway and overpour weir to side channel
- Crest elevation—2,720 feet
- Crest length—175 feet
- Crest width—6 feet
- Height, crest above stream bed—15 feet
- Side slopes, upstream—vertical
  downstream—0.7:1
- Elevation of stream bed—2,705 feet
- Volume of fill—1,010 cubic yards
- Elevation of crest of weir to side channel—2,718 feet
- Length of weir crest—250 feet

Conduits

Item	Chicago Park Canal	Chicago Park Power House penstock
Type	Rectangular section bench flume	steel pipe
Length, in miles	5.75	0.38
Width, in feet	15.3	--
Depth, in feet	7.65	--
Diameter, in feet	--	7.0
Capacity, in second-feet	700	700
Inlet elevation, in feet	2,707	2,691
Outlet elevation, in feet	2,691	2,220

Chicago Park Power House
- Average static head—477 feet
- Installed power capacity—25,000 kilowatts
- Dependable power capacity—20,700 kilowatts

12, Township 15 North, Range 9 East, M. D. B. & M. The additional facilities, although not included in the described plan, would have a capital cost of about $2,300,000 and would make available an increased productive head of about 50 feet from fluctuating reservoir levels.

Pertinent data with respect to general features of the Rollins Project, as designed for cost estimating purposes, are presented in Table 61.

The capital costs of the Rollins Project, on both a 3 and 4 per cent interest basis and based on prices prevailing in April, 1953, were estimated to be about $9,437,000 and $9,506,000, respectively. Corresponding annual costs were estimated to be about $562,400 and $688,300. The resultant estimated average unit costs of the 182,000 acre-feet of new irrigation seasonal yield, excluding consideration of possible revenues from power and costs of power facilities, were about $1.10 and $1.60 per acre-foot for interest rates of 3 and 4 per cent, respectively.

If an annual value of $22.00 per kilowatt of dependable power capacity is assigned to the Chicago Park Power House and a value of 2.8 mills per kilowatt-hour is assigned to the estimated 88,000,000 kilowatt-hours of average energy output per season that would be produced by this plant, the average power revenue would amount to about $701,000, resulting in net annual revenues for the project of about $138,600 and $12,700, respectively, with interest rates of 3 and 4 per cent. Additional revenues from discharge of the new safe yield through the existing downstream power houses would amount to about $260,000.

Estimated capital and annual costs of the Rollins Project on a 3 per cent basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Rollins Dam and Reservoir	$4,582,000	$205,500
Chicago Park Diversion	240,000	12,700
Chicago Park Canal	1,641,000	102,200
Chicago Park Power House	2,974,000	242,000
Totals	$9,437,000	$562,400

French Meadows Project. This project contemplates the construction of a reservoir on the Middle Fork of the American River and conveyance of the conserved water in a westerly direction in a conduit, consisting generally of tunnel, which would intercept and divert water from various streams enroute and would terminate in a proposed reservoir on Pagge Creek. The project, which would include construction of one other reservoir and two hydroelectric power plants, would provide water in the amount of about 25,000 acre-feet per season, largely on a safe yield basis, to meet the probable ultimate requirements of the Foresthill Divide. It would produce about 250,000,000 kilowatt-hours of average energy output seasonally, plus 39,900 kilowatts of dependable power capacity, and about 90,000 acre-feet of safe yield per season, delivered on a power demand schedule to the North Fork of the American River at Pickering Bar. It would also provide sustained minimum flows for the enhancement of fish life, wildlife, and recreation. Principal features of the project are delineated on Plates 19 and 20, entitled "French Meadows Project, Plan, Profile, and Project Area," and "French Meadows Project, Dams," respectively.

The proposed French Meadows Dam would be constructed on the Middle Fork of the American River 0.5 mile downstream from the lower end of French Meadows. A diversion structure and conduit would divert runoff from Duncan Creek southerly to French Meadows Reservoir. From the reservoir a conduit would extend westerly to the proposed Deep Canyon Power House, located at the junction of Deep and Antone Canyons. From the afterbay of the power house a conduit consisting largely of tunnel would extend in a general westerly direction to Bullion Creek, intercepting flows from Lost Canyon, Secret Canyon, El Dorado Creek, and Bullion Creek enroute. On Bullion Creek the combined flows would be diverted into the reconditioned Breece-Wheeler Ditch, in which they would be conveyed southerly and then into a tunnel, from which they would discharge into Sugar Pine Canyon. In Sugar Pine Canyon a turnout would divert a portion of the water into the proposed Foresthill Canal, which would extend southerly to serve lands on the Foresthill Divide south of Shirttail Canyon. The remaining water would be conveyed northwesterly in the proposed Sugar Pine Canal and through a tunnel to the proposed Pagge Reservoir.

Pagge Dam would be constructed on Pagge Creek about 7 miles north of the town of Foresthill. The proposed Sugar Pine Dam would be constructed adjacent to and north of Pagge Reservoir at a site in North Shirttail Canyon below the mouth of Sugar Pine Creek. Additional water conserved in the existing Big Reservoir would be released to flow into Sugar Pine Reservoir. The spill from Sugar Pine Reservoir would flow into Pagge Reservoir through a cut made in a saddle on the ridge between the two reservoirs. Downstream releases of water would be made from Sugar Pine Reservoir to the proposed Iowa Hill Canal, which would extend southwesterly to provide water to serve lands north of Shirttail Canyon and below an elevation of about 3,400 feet. Higher lands north of Shirttail Canyon would be served from Sugar Pine Reservoir by pumping.

Water discharged from Pagge Reservoir would be conveyed northwesterly in a pipe conduit, and into a pressure tunnel to the penstock of the proposed Pickering Bar Power House. Sugar Pine Reservoir would also be connected with the pressure tunnel by means of a pipe conduit. The power house would be located on the left bank of the North Fork of the American River at Pickering Bar.

In Chapter III it was estimated that the probable ultimate requirement for supplemental water in the American River Unit will be about 27,000 acre-feet per season. The estimated portion of this requirement for lands on the Foresthill Divide will be about 18,500 acre-feet per season. In design of the French Meadows Project it was considered desirable to plan to meet this supplemental requirement fully.

As a first step in determination of the size of the French Meadows Project, estimates were made of yield of the proposed works for various reservoir storage capacities. To accomplish this, estimates were made of mean seasonal runoff of watersheds above the various dam sites and diversion points. These estimates are shown in Table 62.

TABLE 62

ESTIMATED MEAN SEASONAL RUNOFF AT DAM SITES AND DIVERSION POINTS OF FRENCH MEADOWS PROJECT

Stream	Location	Mean seasonal runoff, in acre-feet	Drainage area, in square miles
Duncan Creek	at diversion	24,000	9.2
Middle Fork of American River	at French Meadows dam site	112,000	47.5
Deep Canyon	at diversion	51,000	24.9
Lost Canyon	at diversion		
Secret Canyon	at diversion	16,000	8.7
El Dorado Creek	at diversion	9,100	5.5
Bullion Creek	at diversion		
Pagge Creek	at Pagge dam site	8,400	5.0
North Shirttail Canyon	at Sugar Pine dam site	13,000	7.8
Tributary to Forbes Creek	at Big Reservoir	2,500	1.5

Based on estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, monthly yield studies were made of the French Meadows Project with two sizes of reservoir at French Meadows. Monthly water demands for the Deep Canyon and Pickering Bar Power Houses were assumed to be proportional to estimated distribution of hydroelectric power demands, as presented in Table 39. Monthly demands for water from the Foresthill Canal, and from Sugar Pine and Big Reservoirs, were assumed to be proportional to the estimated monthly distribution of demand of the Nevada Irrigation District, as presented in Table 47. A summary of the results of the yield studies is presented in Table 63.

After consideration of the results of the yield studies, together with topography of the dam sites and

TABLE 63

ESTIMATED SEASONAL YIELD OF FRENCH MEADOWS PROJECT, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Yield	Storage capacity, French Meadows Reservoir*	
	50,000	74,000
Safe seasonal yield		
From French Meadows—Pagge Conduit		
To Deep Canyon Power House	54,000	64,000
To Foresthill Canal	17,500	17,500
From Pagge Reservoir		
To Pickering Bar Power House	78,000	89,000
Seasonal irrigation yield		
From Sugar Pine Reservoir**		
To Iowa Hill Canal	3,400	3,400
To Iowa Hill Pumping Plant and Pipe Line	3,800	3,800
To Pickering Bar Power House	5,800	5,800

* Other reservoirs of the French Meadows Project would have capacities as follows: Pagge Reservoir, 69,000 acre-feet; Sugar Pine Reservoir, 10,000 acre-feet; Big Reservoir, 2,200 acre-feet.
** Includes 1,500 acre-feet per season attributable to Big Reservoir.

cost analyses hereinafter discussed, a reservoir of 74,000 acre-foot storage capacity at French Meadows, operated in conjunction with Pagge Reservoir with a capacity of 69,000 acre-feet, Sugar Pine Reservoir with a capacity of 10,000 acre-feet, and existing Big Reservoir with a capacity of 2,200 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. A summary of the project yield study for these sizes of reservoirs is included in Appendix M.

It was assumed that return flow from the application of irrigation waters would be recovered in quantities sufficient to equal the conveyance losses, and that an average irrigation efficiency of 75 per cent would prevail. From this, it was estimated that 25 per cent of the seasonal irrigation supply of 24,700 acre-feet per season, or about 6,200 acre-feet, would be irrecoverably lost. The remaining 18,500 acre-feet per season of water for irrigation would be available to

TABLE 64

ESTIMATED MONTHLY DISTRIBUTION OF DEMANDS FOR WATER FROM FRENCH MEADOWS PROJECT

(In acre-feet)

Month	Power generation, Deep Canyon Power House	Irrigation, Foresthill Divide	Power generation, Pickering Bar Power House
October	5,500	1,700	7,700
November	4,800	600	6,700
December	5,300	500	7,500
January	5,200	500	7,300
February	4,600	200	6,500
March	5,200	200	7,200
April	5,200	700	7,300
May	5,400	3,000	7,600
June	5,500	4,000	7,800
July	6,000	4,900	8,500
August	5,900	4,700	8,300
September	5,400	3,700	7,600
TOTALS	64,000	24,700	90,000

meet the probable ultimate requirements of some 13,100 net irrigable acres on the Foresthill Divide. These lands are presently unirrigated and lie within the service area shown on Plate 18. Based on the foregoing assumptions and estimates, monthly demands on the French Meadows Project would be as shown in Table 64.

The various features of the French Meadows Project are described in some detail in the following sections.

(1) *French Meadows Dam and Reservoir.* The proposed French Meadows Dam would be located in Section 36, Township 15 North, Range 13 East, M. D. B. & M., at a site on the Middle Fork of the American River at a stream bed elevation of 5,010 feet, about 20 miles east of Foresthill and about 0.5 mile downstream from the lower end of French Meadows. A topographic map of the dam and reservoir sites, at a scale of 1 inch equals 800 feet, and with contour interval of 10 feet, was furnished by the United States Bureau of Reclamation. Storage capacities of French Meadows Reservoir at various stages of water surface elevation are given in Table 65.

TABLE 65

AREAS AND CAPACITIES OF FRENCH MEADOWS RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	5,010	0	0
30	5,040	1	20
50	5,060	10	300
70	5,080	50	1,200
90	5,100	200	3,600
110	5,120	370	8,000
130	5,140	540	17,500
150	5,160	700	30,600
170	5,180	850	46,000
190	5,200	980	64,000
200	5,210	1,050	74,000

Based upon preliminary geological reconnaissance, the French Meadows dam site is considered suitable for a concrete gravity or rockfill dam up to a maximum height in excess of 500 feet. Foundation rock at the site is a granite which is basic in composition and which has been jointed into great, massive blocks. These joints apparently extend to considerable depth. Spalling in thick and extensive sheets is common. There is a tendency for talus piles to accumulate at the base of steep slopes. Glacial till occurs in scattered patches on both abutments. The abutment slopes are inconsistent, being disrupted by several old bench levels, and average only between 15 and 30 per cent. The channel width is approximately 100 feet. Stripping of about 3 feet of soil, till, and loose rock from the channel section would be necessary to prepare a suitable foundation for a rockfill dam. About 8 feet of stripping on the abutments, and 6 feet in the channel section would be necessary to prepare the same foundation for a concrete gravity dam.

The flats of French Meadows are covered almost entirely by old and slightly silty gravels. Glaciers have stripped the soil cover from the surrounding hills in comparatively recent geologic times, and there is now no supply of earth suitable for impervious fill construction in the vicinity. The granitic rock could be quarried locally for use as riprap, and possibly also in some selected locations for use in a rockfill section. Gravel and sand from the reservoir area flats could be used in a pervious fill, or for aggregate after washing. There are no low saddles in the reservoir area. The spillway, therefore, would either have to be of an overpour type, or placed around the end of the structure across either abutment. With a side-channel spillway, only light lining would be necessary in the spillway channel where cut into the hard granitic bedrock.

As a result of yield studies, geologic reconnaissance, and preliminary economic analysis, a rockfill dam 200 feet in height from stream bed to spillway lip, and with a crest elevation of 5,220 feet, was selected to illustrate estimates of cost of the French Meadows Dam and Reservoir. The dam would have a crest length of 1,500 feet, a crest width of 20 feet, and 1.4:1 upstream and 1.5:1 downstream slopes. The upstream impervious face of the dam would be formed by a 12-inch to 24-inch blanket of concrete. The dam would be constructed of rock obtained from a quarry adjacent to the dam site, and would have an estimated volume of fill of 1,165,000 cubic yards.

The concrete weir spillway would be excavated in rock through the left abutment of the dam. It would have a capacity of 17,400 second-feet, determined from a flood routing study assuming a once-in-1,000-year flood, with a discharge of 500 second-feet per square mile of drainage area, and would discharge into the Middle Fork of the American River below the dam. The maximum depth of water above the spillway lip would be 6 feet, and an additional 4 feet of freeboard would be provided.

The outlet works would include a horseshoe-type tunnel, 8 feet in diameter and 700 feet in length, excavated through the right abutment and concrete-lined. The tunnel would be used to divert flow of the Middle Fork of the American River during the construction period. After completion of the dam a concrete plug would be placed in the tunnel at a point just upstream from the concrete facing of the dam, and a 5.5- by 5.5-foot, high-pressure slide gate would be installed to control releases from the reservoir. A 66-inch diameter steel pipe would convey the water through the tunnel, and would terminate in a 60-inch diameter butterfly valve at the tunnel portal. This valve would control discharges into the French

Meadows-Deep Canyon Conduit. A 48-inch diameter hollow jet valve also would be installed in the steel outlet pipe at the tunnel portal, and would permit discharge directly into the Middle Fork of the American River.

Within the area inundated by French Meadows Reservoir are located a Forest Service cabin and garage, two small campgrounds, and a private cabin. A portion of the Georgetown-Soda Springs road would also be inundated and would require relocation. This probably could best be accomplished by constructing a new road which would cross the Middle Fork of the American River on the crest of the proposed dam and would extend about 2 miles along the north shore of the proposed reservoir. This realignment would connect with the existing road near the east quarter corner of Section 29, T. 15 N., R. 14 E., M. D. B. & M. The United States Forest Service estimates the quantity of merchantable timber within the proposed reservoir to be approximately 35,000,000 board feet. Access to this timber could be had by extending an existing logging road which extends from Foresthill to within 1 mile of the proposed dam.

(2) *Duncan Creek Diversion and Conduit.* The proposed diversion works on Duncan Creek would be located in Section 24, Township 15 North, Range 13 East, M. D. B. & M., at a stream bed elevation of 5,390 feet. The diversion weir would consist of a concrete gravity overpour section and apron, 25 feet in height above stream bed and some 30 feet in length. An opening at the left end of the weir would provide entrance to a side channel leading downstream about 75 feet to the headworks of the conduit. The side channel would have a concrete gravity parapet wall of the overpour type, and two 2- by 2-foot sluice gates would be provided for sand clearance. The headworks would consist of a concrete headwall across the end of the side channel, with two 4- by 4-foot slide gates and a trash rack.

The conduit, with a capacity of 100 second-feet, would include about 2.4 miles of shotcrete-lined, trapezoidal section canal, with 3-foot bottom width, 0.5:1 side slopes, and water depth of 4 feet. It would also include about 0.4 mile of unlined tunnel, with a diameter of 8.3 feet. The conduit would discharge at an elevation of 5,210 feet into French Meadows Reservoir.

(3) *French Meadows-Deep Canyon Conduit.* Water from French Meadows Reservoir would be discharged directly into the proposed French Meadows-Deep Canyon Conduit. With a capacity of 200 second-feet, this conduit would consist of 5.6 miles of pressure tunnel, with diameters of 8.3 feet and 7.0 feet for the unlined and lined portions, respectively, and 0.42 mile of steel pipe siphon with diameter of 7.0 feet. It was estimated that about 20 per cent of the tunnel would be concrete-lined. This conduit would discharge into the penstock of Deep Canyon Power House.

(4) *Deep Canyon Power House.* The steel penstock of this power house would have a steel surge tower at its inlet. The penstock, with an inlet elevation of 4,910 feet, would have a diameter varying from 7.2 to 6.0 feet, a capacity of 200 second-feet, and would be 2,450 feet in length. The power house would be located on the right bank of Deep Canyon, at the junction of Deep and Antone Canyons, in Section 25, Township 15 North, Range 12 East, M. D. B. & M., at an elevation of 4,020 feet. The plant would operate under an average static head of about 1,150 feet, and would have an installed power capacity of 15,000 kilowatts.

(5) *Deep Canyon Diversion and Conduit.* Water discharged from Deep Canyon Power House would be rediverted from Deep Canyon immediately downstream, together with water from Deep Canyon and Antone Creek. The diversion works would create the afterbay of the power house, and would be located at a stream bed elevation of 4,000 feet, immediately below the junction of Deep Canyon and Antone Creek. The proposed diversion weir would consist of a concrete gravity overpour section and apron, 20 feet in height above stream bed and some 65 feet in length. An opening at the right end of the weir would provide entrance to a side channel leading downstream about 75 feet to the headworks of the conduit. The side channel would have a concrete gravity parapet wall of the overpour type, and two 2- by 2-foot sluice gates would be provided for sand clearance. The headworks would consist of a concrete headwall across the end of the side channel, equipped with two 5- by 5-foot slide gates and a trash rack. The conduit, with capacity of 400 second-feet, would consist of a 7-foot diameter steel pipe line for the first 0.1 mile. Water from the pipe line would discharge into a tunnel, 0.7 mile in length, and thence into Lost Canyon at a stream bed elevation of 3,983 feet. It was estimated that about 20 per cent of the tunnel would be lined. Diameter of the lined section would be 7.5 feet, and of the unlined section, 9.0 feet.

(6) *Lost Canyon Diversion and Tunnel.* Water discharged from Deep Canyon Tunnel into the natural channel of Lost Canyon would be rediverted immediately downstream, together with flow from Lost Canyon, and would be conveyed in the Lost Canyon Tunnel to Secret Canyon. The diversion works on Lost Canyon would be located at a stream bed elevation of 3,960 feet. The proposed diversion weir would be located in Section 23, Township 15 North, Range 12 East, M. D. B. & M., and would consist of a concrete gravity overpour section and apron, 20 feet in height above stream bed and some 30 feet in length. Remaining features of the weir and side channel would be similar to those described for Deep Canyon.

The conduit would consist entirely of tunnel, with a capacity of 400 second-feet, and would be about 1.3 miles in length. Its inlet elevation would be 3,970 feet, and it would discharge into Secret Canyon at a stream bed elevation of 3,955 feet. An estimated 10 per cent of the tunnel would be concrete-lined. The lined section would have a diameter of 7.5 feet, and the unlined section, 9.0 feet.

(7) *Secret Canyon Diversion and Tunnel.* Water discharged from Lost Canyon Tunnel into the natural channel of Secret Canyon would be rediverted immediately downstream, together with flow from Secret Canyon, and would be conveyed in the Secret Canyon Tunnel to El Dorado Creek. The diversion works on Secret Canyon would be located at a stream bed elevation of 3,935 feet. The proposed diversion weir would consist of a concrete gravity overpour section and apron, 20 feet in height above stream bed and some 90 feet in length. Remaining features of the weir and side channel would be similar to those described for Deep Canyon.

The conduit would consist entirely of tunnel, with a capacity of 450 second-feet, and would be about 2.8 miles in length. Its inlet elevation would be 3,945 feet, and it would discharge into El Dorado Creek at a stream bed elevation of 3,900 feet. An estimated 10 per cent of the tunnel would be concrete-lined. The lined section would have a diameter of 7.9 feet, and the unlined section, 9.4 feet.

(8) *El Dorado Creek Diversion and Tunnel.* Water discharged from Secret Canyon Tunnel into the natural channel of El Dorado Creek would be rediverted immediately downstream, together with flow from El Dorado Creek, and would be conveyed in the El Dorado Creek Tunnel to Bullion Creek. The diversion works on El Dorado Creek would be located at a stream bed elevation of 3,860 feet. The proposed diversion weir would consist of a concrete gravity overpour section and apron, 30 feet in height above stream bed and some 30 feet in length. Remaining features of the weir and side channel would be similar to those described for Deep Canyon.

The conduit would consist entirely of tunnel, with a capacity of 500 second-feet, and would be about 1.8 miles in length. Its inlet elevation would be 3,880 feet, and it would discharge into Bullion Creek at a stream bed elevation of 3,832 feet. An estimated 10 per cent of the tunnel would be concrete-lined. The lined section would have a diameter of 8.5 feet, and the unlined section, 10.0 feet.

(9) *Bullion Creek Diversion and Conduit.* Water discharged from the El Dorado Creek Tunnel into the natural channel of Bullion Creek would be rediverted immediately downstream, together with flow from Bullion Creek, into the Bullion Creek Conduit. The water would be conveyed in the conduit for a distance of about 4.2 miles, where a portion would be diverted for use on the Foresthill Divide, while the remainder would be discharged into Sugar Pine Canyon. The diversion works on Bullion Creek would be located at a stream bed elevation of 3,818 feet at the site of the diversion of the abandoned Breece-Wheeler Ditch. The proposed diversion weir would consist of a concrete gravity overpour section and apron, 20 feet in height above stream bed and some 30 feet in length. Remaining features of the weir and side channel would be similar to those described for Deep Canyon.

For the first 1.6 miles the conduit, with a capacity of 500 second-feet, would consist of concrete-lined canal and flume following the alignment of the Breece-Wheeler Ditch. This canal would discharge into the Bullion Creek Tunnel at an inlet elevation of 3,790 feet. The tunnel, with a capacity of 500 second-feet, would be about 2.6 miles in length, and would discharge into Sugar Pine Canyon at an elevation of 3,660 feet. An estimated 10 per cent of the tunnel would be concrete-lined. The lined section would have a diameter of 8.5 feet, and the unlined section, 10.0 feet.

(10) *Foresthill Canal.* About 17,500 acre-feet of the water discharged seasonally from the Bullion Creek Tunnel into Sugar Pine Canyon would be diverted into the Foresthill Canal to serve about 9,300 acres of irrigable land on the Foresthill Divide south of Shirttail Canyon. The Foresthill Canal would be about 7.6 miles in length, shotcrete-lined, and of trapezoidal section, with 1:1 side slopes. At the intake it would have a bottom width of 3.0 feet, depth of 2.4 feet, and freeboard of 1.0 foot. Its slope would be approximately 13.5 feet per mile, its velocity about 6.0 feet per second, and at the intake its capacity would be about 75 second-feet. The canal would terminate in Section 18, Township 14 North, Range 11 East, M. D.B. & M. Releases of water for use on the Foresthill Divide would be made along the canal and at its terminus. Detailed design of works for distribution of the water was considered to be outside the scope of the current investigation.

(11) *Sugar Pine Canal.* Water discharged from the Bullion Creek Tunnel into Sugar Pine Canyon would be diverted into the Foresthill Canal, or conveyed in the Sugar Pine Canal to be discharged through Pagge Reservoir Tunnel into Pagge Reservoir. The Sugar Pine Canal would have a length of 0.7 mile, a capacity of 500 second-feet, and would be shotcrete-lined. It would be of trapezoidal section, with a bottom width of 7 feet, 1:1 side slopes, depth of 6.4 feet, and freeboard of 1.0 foot.

(12) *Pagge Reservoir Tunnel.* Pagge Reservoir Tunnel, with a capacity of 500 second-feet, would be 0.8 mile in length, and would discharge into Pagge Reservoir at an elevation of 3,640 feet. The tunnel inlet elevation would be 3,657 feet. An estimated 10 per cent of the tunnel would be concrete-lined. The

lined section would have a diameter of 8.5 feet, and the unlined section, 10.0 feet.

(13) *Pagge Dam and Reservoir.* The proposed Pagge Dam would be located in Section 25, Township 15 North, Range 10 East, M. D. B. & M., at a site on Pagge Creek at a stream bed elevation of 3,360 feet, about 7 miles north of Foresthill. An auxiliary dam would be required across a low saddle about 2,500 feet upstream from the left abutment. A topographic map of the Pagge dam and reservoir sites, at a scale of 1 inch equals 500 feet and with contour interval of 10 feet, was prepared in 1952 by the Division of Water Resources by photogrammetric methods. Storage capacities of Pagge Reservoir at various stages of water surface elevation are given in Table 66.

TABLE 66

AREAS AND CAPACITIES OF PAGGE RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	3,360	0	0
20	3,380	3	200
60	3,420	21	500
100	3,460	90	2,800
140	3,500	210	8,600
180	3,540	350	19,800
220	3,580	460	36,200
260	3,620	570	57,000
280	3,640	630	69,000

Based upon preliminary geological reconnaissance, the Pagge dam site is considered suitable for an earthfill, rockfill, or concrete gravity dam up to a height of about 280 feet, where the reservoir would spill over the south rim into Snail Canyon. Foundation rock in the vicinity of the site consists of a dark-colored, fine-grained, hard amphibolite schist. No serpentine was noted at the axis, although a contact with a large serpentine zone occurs just upstream therefrom, and serpentine outcrops widely throughout most of the reservoir area. At least two prominent joint sets occur here. However, the joint seams are relatively tight, and no faults or shears of consequence have been found. Quartz veining occurs along many of the planes of schistosity. The abutment slopes average 60 to 80 per cent. Stripping of an average of 3 feet of soil and loose rock, and 6 feet of jointed bedrock from the abutments; and 3 feet of gravel and boulders, and 4 feet of jointed bedrock from the channel section would be necessary beneath an impervious section of a fill-type dam.

Earthfill occurs locally in sufficient quantity for use in construction of an impervious fill at this site, but the material is far from being of best quality. The local bedrock is suitable for quarrying for any ordinary construction use. Local supplies of aggregate are thin and laden with detritus, so crushing or importation to the vicinity from outside sources might prove desirable.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, a rockfill dam 280 feet in height from stream bed to spillway lip, and with a crest elevation of 3,650 feet, was selected to illustrate estimates of cost of Pagge Dam and Reservoir. The dam would have a crest length of about 950 feet, a crest width of 30 feet, and 2:1 upstream and downstream slopes. The impervious section would have a crest width of 10 feet and 0.8:1 side slopes. The dam would have an estimated volume fill of 2,791,000 cubic yards.

The auxiliary dam would be an impervious earthfill structure, with maximum height of about 40 feet. Its crest length would be about 770 feet, its crest width 20 feet, and its side slopes 2:1. The auxiliary dam would have an estimated volume of fill of 41,400 cubic yards.

The concrete weir spillway would be located in an open cut through the ridge adjacent to the auxiliary dam above the left abutment. It would have a capacity of 6,800 second-feet, determined from a flood routing study assuming a once-in-1,000-year flood with a discharge of 690 second-feet per square mile of the combined drainage areas above Pagge, Sugar Pine, and Big Reservoirs, and would discharge into Snail Canyon. The maximum depth of water above the spillway lip would be 6 feet, and an additional 4 feet of freeboard would be provided.

The outlet works would consist of a 72-inch diameter welded steel pipe, placed in a trench excavated in rock beneath the right abutment of the dam and encased in concrete, and would discharge directly into the Pagge-Pickering Bar Conduit. Releases from the reservoir would be controlled at the downstream end by a 4- by 4-foot hydraulically controlled high-pressure slide gate. A 48-inch diameter hollow jet valve at the downstream end of the outlet pipe would permit discharge directly into Pagge Creek.

The proposed reservoir would inundate the Finning Mill Road and the Marall Chrome Mine.

(14) *Sugar Pine Dam and Reservoir.* The proposed Sugar Pine Dam would be located in Section 24, Township 15 North, Range 10 East, M. D. B. & M., at a site on North Shirttail Canyon at a stream bed elevation of 3,510 feet and adjacent to the proposed Pagge Dam and Reservoir, previously described. A topographic map of the Sugar Pine dam and reservoir sites, at a scale of 1 inch equals 500 feet and with contour interval of 10 feet, was prepared in 1952 by the Division of Water Resources by photogrammetric methods. Storage capacities of Sugar Pine Reservoir at various stages of water surface elevation are given in Table 67.

Based upon preliminary geological reconnaissance, the Sugar Pine dam site is considered suitable for an earthfill or rockfill dam up to a height of about 150

TABLE 67

AREAS AND CAPACITIES OF SUGAR PINE RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	3,510	0	0
10	3,520	3	30
30	3,540	12	180
50	3,560	35	660
70	3,580	85	1,900
90	3,600	120	3,600
110	3,620	154	6,300
130	3,640	197	9,800
131	3,641	202	10,000
150	3,660	247	14,300
160	3,670	272	17,000
170	3,680	300	18,800

feet, where the reservoir would spill over the rim to the south into the proposed Pagge Reservoir. Two additional saddle dams, however, would permit an increase in the height up to about 170 feet. Foundation rock at the site consists of a lightly metamorphosed ultrabasic igneous rock. Flow structures are still in evidence throughout the mass, with phenocrysts of hornblende orientated along the flow planes. The latter closely resemble bedding planes. They stand nearly vertical, and strike across the channel and slightly upstream on the left abutment. Serpentine does not appear to be as closely associated with the ultrabasic rock here as elsewhere in the vicinity. Minor separation occurs along surficially opened joints, but these probably tighten rapidly with depth. Stripping of about 6 feet of soil and 2 feet of bedrock from under an impervious section would be necessary on the abutments. About 3 feet of silt and 1 foot of bedrock would have to be removed from the channel section. The spillway could be placed through the aforementioned saddle into Pagge Reservoir, which, in turn, would spill over another saddle farther south into Snail Canyon. Much of the exposed bedrock in the reservoir area is serpentinous, although none was noted at the dam site.

There is a large quantity of red clayey soil within the reservoir area which could probably be used in construction of an impervious fill. This soil may contain a high percentage of fines and probably is of light density, but nevertheless should be usable to some degree with or without blending. Local bedrock could be quarried for rockfill or riprap or for crushing to aggregates if needed.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 131 feet in height from stream bed to spillway lip, and with a crest elevation of 3,650 feet, was selected to illustrate estimates of cost of Sugar Pine Dam and Reservoir. The dam would have a crest length of about 620 feet, a crest width of 30 feet, and 3:1 upstream and 2:1 downstream slopes. The upstream face of the dam would be protected by a 3-foot blanket of riprap. The dam would have an estimated volume of fill of 656,000 cubic yards.

The unlined earth cut spillway would be located in a saddle 1.3 miles upstream from the main dam on the left bank. It would have a capacity of 4,700 second-feet, required for an assumed maximum discharge of 600 second-feet per square mile of drainage area, and would discharge into Pagge Reservoir. The maximum depth of water above the spillway lip would be 5 feet, and an additional 4 feet of freeboard would be provided.

Outlet works would consist of a 72-inch diameter steel pipe, placed in a trench excavated beneath the right abutment of the dam and encased in concrete. The outlet would be controlled at the downstream end by a 4- by 4-foot high-pressure slide gate, and would discharge at an elevation of 3,515 feet directly into the Sugar Pine-Pickering Bar Conduit. A 48-inch diameter hollow jet valve at the downstream end of the outlet pipe would also permit discharge directly into North Shirttail Canyon for downstream diversion into the Iowa Hill Canal.

Sugar Pine Reservoir would inundate the dirt road and bridge over Shirttail Creek and the campground downstream from the bridge. The reservoir area has a light to moderate forest cover, although there are few salvageable trees since the area has generally either been logged out in the past or burned over.

(15) *Big Reservoir.* Big Reservoir is created by the Morning Star Dam, which was constructed in 1870 and is owned by the McGeachin Placer Gold Mining Company. The dam is a hydraulic fill structure about 39 feet in height from stream bed to spillway lip, and is located at a stream bed elevation of 4,026 feet on a tributary of Forbes Creek, in Section 17, Township 15 North, Range 11 East, M. D. B. & M., some 8 miles northeast of Foresthill. The dam has a crest length of 835 feet, a crest width of 18 feet, and 2:1 upstream and downstream slopes. The reservoir has a capacity of 2,200 acre-feet. There is a concrete-lined spillway placed in the right abutment of the dam. The outlet works include a 3.5- by 6.0-foot unlined tunnel, and hand-operated lift gates. The outlet tunnel discharges directly into the stream channel below the dam. Runoff from its own watershed conserved in Big Reservoir would be released to flow downstream for a distance of about 3 miles to the proposed Sugar Pine Reservoir, where the water would be re-regulated and released for beneficial use.

(16) *Iowa Hill Canal.* About 3,400 acre-feet of the water released seasonally from Sugar Pine Reservoir would be diverted into the natural channel of North Shirttail Canyon at a point immediately downstream from the dam. The water would be conveyed in the channel for a distance of about 0.5 mile, where it would be diverted into the Iowa Hill Canal. The diver-

sion works on North Shirttail Canyon would be located at a stream bed elevation of 3,440 feet. The proposed diversion weir would consist of a concrete gate structure about 30 feet in width, with flashboards. A diversion box at the right end of the structure would provide entrance to the conduit. The diversion box would have a 4- by 5-foot slide gate.

The Iowa Hill Canal would serve about 1,760 acres of irrigable land on the Foresthill Divide north of Shirttail Canyon and below an elevation of about 3,400 feet. The canal would be about 6.8 miles in length, shotcrete-lined, and would have a capacity of about 15 second-feet at its intake. It would be of trapezoidal section, with 1.5:1 side slopes, and at its intake would have a bottom width of 2 feet, depth of 1.4 feet, and freeboard of 1.0 foot. Its slope would be approximately 5 feet per mile, and its velocity about 2.6 feet per second. Detailed design of works for distribution of the water was considered to be outside the scope of the current investigation.

(17) *Iowa Hill Pumping Plant and Pipe Line.* About 3,800 acre-feet of the water released seasonally from Sugar Pine Reservoir would be pumped in a series of three lifts to serve about 2,000 acres of irrigable land on the Foresthill Divide between elevations of about 3,400 feet and 4,000 feet. The site for the diversion and the first pumping plant, as selected for cost estimating purposes, is at a point immediately downstream from Sugar Pine Dam. The first pump would divert directly from the Sugar Pine-Pickering Bar Conduit, at an elevation of 3,515 feet, and would lift the water 85 feet to a sump. A portion of the water would be diverted from the sump for gravity conveyance and distribution to adjacent lower lands. Two additional pumps would lift the remaining water to sumps at elevations of 3,800 and 4,000 feet, respectively, for diversion, conveyance, and distribution to other adjacent lands. Detailed design of works for conveyance and distribution of the water was considered to be outside the scope of the current investigation.

(18) *Pagge-Pickering Bar Conduit.* Water conserved in Pagge Reservoir would be discharged into the Pagge-Pickering Bar Conduit and conveyed to the Pickering Bar Tunnel. The conduit, with an inlet

TABLE 68

GENERAL FEATURES OF FRENCH MEADOWS PROJECT

French Meadows Dam
- Type—rockfill
- Crest elevation—5,220 feet
- Crest length—1,500 feet
- Crest width—20 feet
- Height, spillway lip above stream bed—200 feet
- Side slopes—1.4:1 upstream
  1.5:1 downstream
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—5,010 feet
- Volume of fill—1,165,000 cubic yards

French Meadows Reservoir
- Surface area at spillway lip—1,010 acres
- Storage capacity at spillway lip—74,000 acre-feet
- Drainage area, Middle Fork of American River—47.5 square miles
- Estimated mean seasonal runoff, Middle Fork of American River—112,000 acre-feet
- Estimated mean seasonal diversion from Duncan Creek—16,000 acre-feet
- Estimated safe seasonal yield—64,000 acre-feet
- Type of spillway—chute behind left abutment, with concrete weir control and unlined channel
- Spillway discharge capacity—17,400 second-feet
- Type of outlet—8 foot diameter pressure tunnel and 66-inch diameter steel pipe, through right abutment

Pagge Dam
- Type—rockfill
- Crest elevation—3,650 feet
- Crest length—950 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—280 feet
- Side slopes—pervious 2:1
  impervious 0.8:1
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—3,363 feet
- Volume of fill—2,791,000 cubic yards
- Auxiliary earthfill dam
  - Crest length—770 feet
  - Crest width—20 feet
  - Side slopes—2:1
  - Maximum height—40 feet
  - Volume of fill—41,000 cubic yards

Pagge Reservoir
- Surface area at spillway lip—600 acres
- Storage capacity at spillway lip—69,000 acre-feet
- Drainage area, Pagge Creek—5 square miles

Pagge Reservoir—continued
- Estimated mean seasonal runoff, Pagge Creek—6,200 acre-feet
- Estimated safe seasonal yield from Pagge Creek, plus water imported in conduit from French Meadows Conduit—84,000 acre-feet
- Type of spillway—concrete weir in open cut
- Spillway discharge capacity—6,800 second-feet
- Type of outlet—72-inch diameter steel pipe beneath dam

Sugar Pine Dam
- Type—earthfill
- Crest elevation—3,650 feet
- Crest length—620 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—131 feet
- Side slopes—3:1 upstream
  2:1 downstream
- Freeboard, above spillway lip—9 feet
- Elevation of stream bed—3,510 feet
- Volume of fill—656,000 cubic yards

Sugar Pine Reservoir
- Surface area at spillway lip—202 acres
- Storage capacity at spillway lip—10,000 acre-feet
- Drainage area, North Shirttail Canyon—7.8 square miles
- Estimated mean seasonal runoff, North Shirttail Canyon—13,000 acre-feet
- Estimated safe seasonal yield—9,500 acre-feet
- Type of spillway—earth cut
- Spillway discharge capacity—4,700 second-feet
- Type of outlet—6-foot diameter steel pipe beneath dam

Existing Morning Star Dam and Big Reservoir
- Type—hydraulic fill
- Crest elevation—4,070 feet
- Crest length—835 feet
- Crest width—18 feet
- Height, spillway lip above stream bed—39 feet
- Side slopes—2:1
- Elevation of stream bed—4,026 feet
- Storage capacity at spillway lip—2,200 acre-feet
- Drainage area above reservoir—1.5 square miles
- Estimated mean seasonal runoff above reservoir—2,500 acre-feet
- Estimated safe seasonal yield—1,500 acre-feet
- Type of spillway—concrete-lined
- Type of outlet—3.5- by 6.0-foot unlined tunnel with hand-operated lift gates

TABLE 68—Continued

GENERAL FEATURES OF FRENCH MEADOWS PROJECT

Conduits

Name	Type	Length, in miles	Capacity, in second-feet	Diameter, in feet: Concrete-lined and supported	Diameter, in feet: Unlined	Percentage lined	Inlet elevation, in feet	Outlet elevation, in feet
Duncan Creek Conduit	shotcrete-lined canal	2.4	100	----	----	---	5,400	----
	tunnel	0.4	100	-	8.3	0	----	5,210
French Meadows-Deep Canyon Conduit	tunnel	5.6	200	7.0	8.3	20	5,035	---
	steel siphon	0.42	200	7.0	----	--	----	4,910
Deep Canyon Conduit	steel pipe line	0.17	400	7.0	..	----	4,010	----
	tunnel	0.7	400	7.5	9.0	20	----	3,983
Lost Canyon Tunnel	tunnel	1.3	400	7.5	9.0	10	3,970	3,955
Secret Canyon Tunnel	tunnel	2.8	450	7.9	9.4	10	3,945	3,900
El Dorado Creek Tunnel	tunnel	1.8	500	8.5	10.0	10	3,880	3,832
Bullion Creek Conduit	shotcrete-lined canal	0.9	500	----	----	100	3,818	----
	concrete flume	0.7	500	----	----	----	----	3,790
	tunnel	2.6	500	8.5	10.0	10	3,790	3,660
Pagge Reservoir Tunnel	tunnel	0.8	500	8.5	10.0	10	3,657	3,640
Pagge-Pickering Bar Conduit	steel pipe line	0.83	300	6.0	----		3,400	3,390
Sugar Pine-Pickering Bar Conduit	steel pipe line	0.34	300	6.0	----	----	3,515	3,390
Pickering Bar Tunnel	tunnel	1.7	300	7.0	----	100	3,390	3,366

Name	Type	Length, in miles	Capacity, in second-feet	Side slopes	Bottom width, in feet	Depth, in feet	Free-board, in feet	Slope, in feet per mile	Velocity, in feet per second	Inlet elevation, in feet	Outlet elevation, in feet
Foresthill Canal	trapezoidal shotcrete-lined section	7.6	75	1:1	3.0	2.4	1.0	13.2	6.0	3,660	----
Sugar Pine Canal	trapezoidal shotcrete-lined section	0.7	500	1:1	7.0	6.4	1.0	3.7	6.0	3,660	3,657
Iowa Hill Canal	trapezoidal shotcrete-lined section	6.8	15	1.5:1	2.0	1.4	1.0	5.0	1.6	3,440	----

Sugar Pine Pumping Plant and Pipe Line
- Pumps
  - First stage—double suction, centrifugal type, 16 second-foot capacity
  - Second stage—double suction, centrifugal type, 10 second-foot capacity
  - Third stage—double suction, centrifugal type, 3 second-foot capacity
- Intake elevation, first stage—3,515 feet
- Discharge elevation, third stage—4,000 feet
- Pumping lifts
  - First stage—85 feet
  - Second stage—200 feet
  - Third stage—200 feet

Sugar Pine Pumping Plant and Pipe Line—Continued
- Motors
  - First stage—300 horsepower
  - Second stage—300 horsepower
  - Third stage—125 horsepower
- Estimated gross seasonal diversion—4,800 acre-feet
- Discharge lines—12-inch diameter for first and second stages, 6-inch diameter for third stage, welded steel, placed in trench

Power Houses

Name	Inlet elevation of penstock, in feet	Tailrace elevation, in feet	Average static head, in feet	Installed power capacity, in kilowatts	Dependable power capacity, in kilowatts
Deep Canyon Power House	4,910	4,020	1,150	15,000	11,300
Pickering Bar Power House	3,366	1,486	2,100	37,000	28,600

elevation of 3,400 feet, would consist of a steel pipe, 6 feet in diameter, 0.83 mile in length, and with a capacity of 300 second-feet. It would discharge at an elevation of 3,390 feet into the Pickering Bar Tunnel.

(19) *Sugar Pine-Pickering Bar Conduit.* Water would be released from Sugar Pine Reservoir directly into the Sugar Pine-Pickering Bar Conduit. With an inlet elevation of 3,515 feet, the conduit would consist of a steel pipe, 0.34 mile in length, 6 feet in diameter, and with a capacity of 300 second-feet. It would discharge at an elevation of 3,390 feet directly into the Pickering Bar Tunnel.

(20) *Pickering Bar Tunnel.* Water released from Pagge and Sugar Pine Reservoirs for discharge through the Pickering Bar Power House would be conveyed in the Pickering Bar Tunnel to the penstock of the power house. The conduit, with an inlet elevation of 3,390 feet, would be a pressure tunnel about 1.7 miles in length. It would be concrete-lined throughout, and would have a diameter of 7.0 feet. The tunnel would have a capacity of about 300 second-feet, and would discharge at an elevation of 3,366 feet directly into the penstock of the Pickering Bar Power House.

(21) *Pickering Bar Power House.* The steel penstock of the Pickering Bar Power House would have a steel surge tower at its inlet. The penstock, with an inlet elevation of 3,366 feet, would have a 6.5- to 5.0-foot variable diameter, a capacity of 300 second-feet, and would be 4,800 feet in length. The power house would be located on the left bank of the North Fork of the American River at an elevation of 1,486 feet, in Section 15, Township 15 North, Range 10 East, M. D. B. & M. The plant would operate under an average static head of about 2,100 feet, and would have an installed power capacity of 28,600 kilowatts.

Pertinent data with respect to the various features of the French Meadows Project, as designed for cost estimating purposes, are presented in Table 68.

The capital cost of the French Meadows Project, at a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be about $48,718,000, and corresponding annual costs were estimated to be about $2,432,000. If an annual value of $22.00 per kilowatt of dependable power capacity is assigned to the Deep Canyon and Pickering Bar hydroelectric generating plants, and a value of 2.8 mills per kilowatt-hour is assigned to the estimated 250,000,000 kilowatt-hours of average energy output per season that would be produced by these plants, the seasonal power revenue would amount to about $1,628,000, thus reducing the estimated average unit cost of the 119,000 acre-feet of safe seasonal yield to about $6.80 and $10.00 per acre-foot for interest rates of 3 and 4 per cent, respectively. The estimated unit costs of the 119,000 acre-feet per season of safe yield of the project, excluding consideration of possible revenues from power and costs of power facilities, were about $14.00 and $16.40 per acre-foot for interest rates of 3 and 4 per cent, respectively.

Estimated capital and annual costs of the French Meadows Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Duncan Creek Diversion and Conduit	$663,000	$29,000
French Meadows Dam and Reservoir	6,863,000	303,000
French Meadows-Deep Canyon Conduit	5,619,000	240,000
Deep Canyon Power House	3,619,000	252,000
Deep Canyon Diversion and Conduit	927,000	40,000
Lost Canyon Diversion and Tunnel	1,424,000	62,000
Secret Canyon Diversion and Tunnel	2,944,000	128,000
El Dorado Creek Diversion and Tunnel	2,151,000	94,000
Bullion Creek Diversion and Conduit	3,352,000	152,000
Foresthill Canal	273,000	14,000
Sugar Pine Canal	148,000	8,000
Pagge Reservoir Tunnel	895,000	38,000
Pagge Dam and Reservoir	7,622,000	335,000
Sugar Pine Dam and Reservoir	1,571,000	67,000
Iowa Hill Canal	231,000	12,000
Iowa Hill Pumping Plant and Pipe Line	36,000	20,000
Pagge-Pickering Bar Conduit	440,000	24,000
Sugar Pine-Pickering Bar Conduit	199,000	11,000
Pickering Bar Tunnel	2,014,000	86,000
Pickering Bar Power House	7,725,000	517,000
TOTALS	$48,716,000	$2,432,000

Foresthill Divide Project. This project is presented as an alternative to the French Meadows Project. The project is susceptible to staged development, and when completed through the final stages would conserve the runoff of Secret Canyon, Black Canyon, El Dorado Creek, and Bullion Creek in reservoirs on Forbes Creek, on North Shirttail Canyon, and in an enlarged Big Reservoir on a tributary to Forbes Creek. The project would also include construction of facilities for conveyance and distribution of the water conserved in the three reservoirs to serve irrigable lands on the Foresthill Divide. Principal features of the projects are delineated on Plates 21 and 22, entitled "Foresthill Divide Project," and "Foresthill Divide Project, Dams."

Under the project, waters of Secret Canyon, Black Canyon, El Dorado Creek, and Bullion Creek would be diverted and conveyed in a general westerly direction, in an unlined canal about 39 miles in length, to the proposed Forbes Reservoir, into which a portion of the conserved water would be discharged. The remaining water would be conveyed for an additional distance of about 1 mile, and discharged into a proposed enlarged Big Reservoir on a tributary to Forbes Creek. Water discharged from the conduit into Big Reservoir in excess of the capacity of this reservoir would be spilled and conserved downstream in the proposed Sugar Pine Reservoir on North Shirttail Canyon. Water conserved in Forbes Reservoir and in Sugar Pine Reservoir would be released to lined canals to serve irrigable lands on the Foresthill Divide south of Shirttail Canyon, while the water conserved in Big Reservoir would be released to a lined canal to serve such lands on the Foresthill Divide in the vicinity of Iowa Hill and generally west of North Shirttail Canyon. The project would provide sufficient water to meet the ultimate requirements of the Foresthill Divide. Furthermore, it could be constructed in a succession of stages to provide water as the requirements develop. The order in which the various features would be constructed would depend upon the growth of water requirements in various portions of the area and upon the yield of the constructed works. It is considered probable, however, that the following general pattern of development would prevail.

As an initial feature, to serve irrigable lands south of Shirttail Canyon, the Forbes Dam and Reservoir together with the canal from Bullion Creek would be constructed. Water conserved in the reservoir would be released and conveyed to a point about 5 miles northeast of Foresthill, from which point the water would be distributed to lower lands by means of a canal and ditch system. As an initial feature, to serve remaining irrigable lands on the Foresthill Divide, which lie generally west of North Shirttail Canyon, the existing Big Reservoir would be enlarged, and additional water would be obtained by extending the diversion canal discharging into Forbes Reservoir. The water thus conserved would be released to a canal and conveyed to a point about 4 miles northeast of Iowa Hill, from which point the water would be distributed to lower lands by means of a canal and ditch system.

As a second step, to provide additional water to the two reservoirs, the canal from Bullion Creek would be extended up to El Dorado Creek, to Black Canyon, and then to Secret Canyon, in stages as the requirements develop. At this point in the project development, the estimated yield of the enlarged Big Reservoir would be sufficient to meet the probable ultimate requirement of its service area, while the yield of Forbes Reservoir would be sufficient to meet only about 40 per cent of the ultimate requirement of its service area. However, construction of a canal about 2 miles in length would permit transfer of water discharged from Big Reservoir to supplement the yield of Forbes Reservoir. This feature is not further described because it would serve only as a temporary measure, pending completion of the final project units.

As a final step, Sugar Pine Dam and Reservoir would be constructed and would conserve tributary runoff together with water spilled from Big Reservoir. The water thus conserved would be released to and conveyed in a canal which would extend in a general southerly direction for a distance of about 17 miles to a point about 1 mile northeast of Foresthill, from which point it would be available in a canal and ditch system to serve lower lands.

If it should become necessary to provide water above that furnished by the described project, a program of additional canal lining could be undertaken. In this respect, allowance was made in the yield studies for percolation losses from the unlined canals. Concrete, shotcrete, or clay lining would reduce the percolation losses and increase the usable yield of the project. Additional water could also be obtained by extending the canal above Secret Ravine, or by constructing a canal from Humbug Creek to Big Reservoir.

In Chapter III it was estimated that the probable ultimate requirement for supplemental water in the American River Unit will be about 27,000 acre-feet per season. The estimated portion of this requirement for lands on the Foresthill Divide is about 18,500 acre-feet per season. In design of the Foresthill Divide Project it was considered desirable that the project with all features constructed should meet this requirement.

As a first step in determination of the size of units of the Foresthill Divide Project, estimates were made of yield of the works for various reservoir storage capacities. To accomplish this, estimates were made of mean seasonal runoff of watersheds above the various dam sites and diversion points. Where considered feasible, portions of the drainage area tributary to main diversion canals were also included as contributing runoff to the project. These estimates are shown in Table 69.

Based on estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, monthly yield studies were

TABLE 69

ESTIMATED MEAN SEASONAL RUNOFF AT DAM SITES AND DIVERSION POINTS, AND TRIBUTARY TO CANALS OF FORESTHILL DIVIDE PROJECT

Stream	Location	Mean seasonal runoff, in acre-feet	Drainage area, in square miles
Forbes Creek	at Forbes dam site	3,700	2.2
Tributary to Forbes Creek	at Big Reservoir Dam	2,500	1.5
North Shirttail Canyon	at Sugar Pine dam site	13,200	7.8
Secret Canyon	at diversion point	10,200	5.0
Black Canyon	at diversion point	4,300	2.1
El Dorado Creek	at diversion point	5,300	3.1
Bullion Creek	at diversion point	1,700	1.0
Secret Canyon and El Dorado Creek	above Black Canyon Canal	10,200	5.1
El Dorado and Bullion Creeks	above El Dorado Creek Canal	4,100	2.4
Volcano Creek	above Bullion Creek Canal	1,000	0.6
Brimstone Creek	above Bullion Creek Canal	3,400	2.0

Young Apple Trees on Foresthill Divide

Big Reservoir

made of the various reservoirs of the Foresthill Divide Project to aid in determining the proper sizes. Monthly water demands were assumed to be proportional to the estimated monthly distribution of demand of the Nevada Irrigation District, as presented in Table 47. It was further assumed that losses from the earthen diversion canals would be of the order of 1 per cent of the gross diversion per mile of canal. A summary of the results of the yield studies of the selected sizes of reservoirs is presented in Table 70.

TABLE 70

ESTIMATED SEASONAL IRRIGATION YIELD OF RESERVOIRS OF FORESTHILLL DIVIDE PROJECT, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Feature	Reservoir storage capacity	Irrigation yield
Forbes Reservoir	5,300	2,500
Forbes Reservoir with Bullion Creek diversion	5,300	5,100
Forbes Reservoir with Bullion and El Dorado Creek and Black and Secret Canyon diversions less diversion to Big Reservoir	5,300	7,100
Big Reservoir (existing)	2,200	1,500
Enlarged Big Reservoir	6,500	1,800
Enlarged Big Reservoir with Bullion Creek diversion	6,500	7,200
Sugar Pine Reservoir	17,000	10,400

It was stated in Chapter III that seasonal irrigation deficiencies in the amount of 35 per cent may occasionally be endured. In the case of the initial units of the Foresthill Divide Project, Forbes and enlarged Big Reservoirs, maximum seasonal deficiencies of 27 per cent are indicated. Yield studies of Sugar Pine Reservior, the final unit of the project, indicate that the maximum seasonal irrigation deficiency would be about 41 per cent. This would be of serious consequence only if the ultimate water requirement were actually realized. Even in this event, it is probable that the predominant orchard crops would endure the deficiency better than most other crops.

After consideration of the results of the yield studies, together with topography of the dam sites and cost analyses hereinafter discussed, reservoirs with the above indicated capacities were chosen for purposes of cost estimates to be presented in this bulletin. A summary of the yield studies for these sizes of reservoirs is included in Appendix M.

It was assumed that the canals from the reservoirs would be shotcrete-lined, that within the service areas return flow from the application of irrigation water would be recovered in quantities sufficient to balance the conveyance losses, and that an average irrigation efficiency of 75 per cent would prevail. From this, it was estimated that 25 per cent of the irrigation yield of 24,700 acre-feet per season, or 6,200 acre-feet, would be irrecoverably lost. The remaining 18,500 acre-feet per season would be available to meet the probable ultimate requirements of some 13,100 net irrigable acres on the Foresthill Divide. These lands are presently unirrigated and lie within the service area shown on Plate 21.

Based on the monthly distribution of demands for water in the Nevada Irrigation District, as shown in Table 47, monthly demands on the three reservoirs of the Foresthill Divide Project are given in Table 71.

TABLE 71

ESTIMATED MONTHLY DISTRIBUTION OF DEMANDS FOR WATER FROM RESERVOIRS OF FORESTHILL DIVIDE PROJECT

(In acre-feet)

Month	Forbes Reservoir	Big Reservoir	Sugar Pine Reservoir
October	500	500	700
November	200	200	200
December	100	100	200
January	100	100	200
February	100	100	100
March	100	100	100
April	200	200	300
May	900	900	1,200
June	1,100	1,100	1,700
July	1,400	1,400	2,100
August	1,300	1,400	2,000
September	1,100	1,100	1,600
TOTALS	7,100	7,200	10,400

The various features of the Foresthill Divide Project as designed for cost estimating purposes are described in some detail in the following sections:

(1) *Secret Canyon Diversion and Canal.* The proposed diversion works on Secret Canyon would be located in Section 11, Township 15 North, Range 12 East, M. D. B. & M., at a stream bed elevation of 4,430 feet. The diversion works would consist of a concrete gravity overpour weir and apron, 15 feet in height above stream bed and some 50 feet in length. An opening at the right end of the weir would provide entrance to a side channel leading downstream about 25 feet to the headworks of the Secret Canyon Canal. The side channel would have a concrete gravity parapet wall of the overpour type, and a 3- by 3-foot sluice gate would be provided for sand clearance. The headworks would consist of a concrete headwall across the end of the side channel, equipped with a 3- by 3-foot slide gate and trash rack.

The proposed Secret Canyon Canal, with a capacity of 75 second-feet, would be about 0.5 mile in length, unlined, and of trapezoidal section with 1:1 side slopes. It would have a bottom width of 3.0 feet, depth of 3.8 feet, and freeboard of 1.0 foot. Its slope would be approximately 8.0 feet per mile, and its velocity about 3 feet per second. The canal would discharge at an elevation of 4,425 feet into Black Canyon.

(2) *Black Canyon Diversion and Canal.* The proposed diversion works on Black Canyon would be located in Section 10, Township 15 North, Range 12 East, M. D. B. & M., at a stream bed elevation of 4,415 feet. The diversion works would consist of a concrete gravity overpour weir and apron, 10 feet in height above stream bed and some 50 feet in length. Remaining features would be similar to those described for Secret Canyon.

The proposed Black Canyon Canal, with a capacity of 125 second-feet, would be about 17.0 miles in length, unlined, and of trapezoidal section with 1:1 side slopes. It would have a bottom width of 5.0 feet, depth of 4.5 feet, and freeboard of 1.0 foot. Its slope would be approximately 6.5 feet per mile, and its velocity about 3 feet per second. The canal would convey the combined diverted flows of Secret and Black Canyons, would intercept the runoff from about 5.1 square miles of drainage area tributary to Secret Canyon and El Dorado Creek above the canal, and would discharge at an elevation of 4,300 feet into El Dorado Creek.

(3) *El Dorado Creek Diversion and Canal.* The proposed diversion works on El Dorado Creek would be located in Section 17, Township 15 North, Range 12 East, M. D. B. & M., at a stream bed elevation of 4,290 feet. The diversion works would be similar to those described for Secret Canyon.

The proposed El Dorado Creek Canal, with a capacity of 125 second-feet, would be about 8.5 miles in length, unlined, and of trapezoidal section with 1:1 side slopes. It would have a bottom width of 5.0 feet, depth of 4.5 feet, and freeboard of 1.0 foot. Its slope would be approximately 6.5 feet per mile, and its velocity about 3 feet per second. The canal would convey the combined diverted flows of Secret Canyon, Black Canyon, and El Dorado Creek, would intercept the runoff from about 2.4 square miles of drainage area tributary to El Dorado and Bullion Creeks above the canal, and would discharge at an elevation of 4,230 feet into Bullion Creek.

(4) *Bullion Creek Diversion and Canal.* The proposed diversion works on Bullion Creek would be located in Section 23, Township 15 North, Range 11 East, M. D. B. & M., at a stream bed elevation of 4,220 feet. The diversion works would consist of a concrete gravity overpour weir and apron, 10 feet in height above stream bed and some 25 feet in length. Remaining features would be similar to those described for Secret Canyon.

The proposed Bullion Creek Canal, with a capacity of 150 second-feet, would be about 14.0 miles in length, unlined, and of trapezoidal section with 1:1 side slopes. For the first 13.0 miles it would have a bottom width of 5.0 feet, depth of 5.0 feet, and freeboard of 1.0 foot. Its slope would be approximately 5.5 feet per mile, and its velocity about 3 feet per second. The canal would convey the combined diverted flows of Secret Canyon, Black Canyon, El Dorado Creek, and Bullion Creek, and would also intercept the runoff from about 2.6 square miles of drainage area tributary to Volcano and Brimstone Creeks above the canal. A portion of the flow would be discharged at an elevation of 4,142 feet into the proposed Forbes Reservoir. Beyond this point the canal would continue in a northerly direction for a distance of about 1.0 mile, and would discharge at an elevation of 4,137 feet into Big Reservoir.

(5) *Forbes Dam and Reservoir, and Forbes Reservoir Canal.* The proposed Forbes Dam would be located in Section 20, Township 15 North, Range 11 East, M. D. B. & M., at a site on Forbes Creek some 8 miles northeast of Foresthill. The stream bed elevation at this location is 3,875 feet. A topographic map of the Forbes dam and reservoir sites, at a scale of 1 inch equals 500 feet, with contour interval of 10 feet, was prepared in 1953 by the Division of Water Resources by photogrammetric methods. Storage capacities of Forbes Reservoir at various stages of water surface elevation are given in Table 72.

TABLE 72

AREAS AND CAPACITIES OF FORBES RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	3,875	0	0
45	3,920	10	100
55	3,930	20	300
65	3,940	30	500
85	3,960	62	1,400
105	3,980	97	3,000
125	4,000	138	5,300
135	4,010	159	6,800

Based upon preliminary geological reconnaissance, the Forbes dam site is considered suitable for either an earthfill or an earthfill and rockfill dam up to a maximum height of about 170 feet. The foundation bedrock consists of metamorphic rock for the most part. This is a quartzitic and schistose sandstone, containing many quartz veins which occur especially along the old bedding planes. The rock is hard and resistant where unweathered, as in the channel section, and probably is not seriously affected by joints or shears at depth. Volcanic rocks, including some tuff and much fragmental obsidian, occur at an undetermined height on the right abutment at the site. However, these rocks are probably located high enough on the abutment so as not to affect the feasibility of constructing a dam at this site. Other volcanics occur throughout much of the proposed reservoir area. Stripping from under the impervious section of a dam here, normal to the surface, should not xceed an average of 6 feet from the abutments and 3 feet from the narrow channel section. Only the oose overburden, averaging 4 feet in depth, would nave to be removed to prepare the abutment foundaions for the pervious sections of a zoned dam.

The spillway could be located in either of two saddle reas upstream from the left abutment, or around the eft end of the main dam. It would seem advisable to void the right end of the dam for a spillway location ntil more is known concerning the nature and extent of the volcanic rocks mentioned previously which outrop in that area. Earth suitable for use in an impervious fill section could be obtained from the top of the narrow ridge lying between Forbes Creek and Big Reservoir to the northeast. Depth of soil at any one point on this ridge would not be great, but even considering this, the average haul for impervious fill at this site should not exceed 1 mile downhill. The ocal bedrock would serve as a source for pervious fill naterial, or for rockfill or riprap, as the occasion lemanded.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 125 feet in height from stream bed to spillway lip, and vith a crest elevation of 4,010 feet, was selected to llustrate estimates of cost of the Forbes Dam and Reservoir. The dam would have a crest length of about 1,160 feet, a crest width of 30 feet, and 2.25:1 upstream and downstream slopes. The central impervious core would have a top width of 10 feet and 0.8:1 slopes. A saddle dike on the left side of the reservoir would have a crest length of about 620 feet, a crest width of 20 feet, a maximum height of 16 feet, and 2:1 upstream and downstream slopes. The dam and saddle dike would have an estimated volume of fill of 656,000 cubic yards.

The concrete weir and chute spillway would be ocated adjacent to the saddle dam, and about 1,000 feet upstream from the left abutment. The spillway vould have a capacity of 2,400 second-feet, required for an assumed maximum discharge of 1,000 secondfeet per square mile of drainage area, and would discharge into Pagge Creek. The maximum depth of water above the spillway lip would be 6 feet, and an additional 4 feet of freeboard would be provided.

Outlet works would consist of an 18-inch diameter steel pipe, placed in a trench excavated in the left abutment of the dam and encased in concrete. Releases from the reservoir would be controlled at a submerged concrete box inlet structure by two 12-inch diameter hydraulically controlled butterfly valves operated from a control house on the crest of the dam. The outlet would be controlled at the downstream end by a 12-inch diameter hollow jet valve discharging into a concrete-lined stilling basin, from which water vould enter the Forbes Reservoir Canal at an elevaion of 3,920 feet. A 2.0- by 2.5-foot slide gate would permit discharge from the stilling basin into the natural stream channel below the dam.

The Forbes Reservoir Canal would be shotcretelined and of trapezoidal section, with 1:1 side slopes, bottom width of 2.0 feet, depth of 1.8 feet, and freeboard of 1.0 foot. Its slope would be about 12 feet per mile, its velocity about 4.5 feet per second, and its capacity at the inlet would be 30 second-feet. It would convey the water in a southerly direction for a distance of 9.0 miles to a point about 5 miles northeast of Foresthill, where the elevation is about 3,800 feet. The conserved water would be diverted enroute and distributed by means of an unlined canal and ditch system. Detailed design of the distribution system was considered to be outside the scope of the current investigation.

(6) *Enlarged Morning Star Dam and Big Reservoir, and Big Reservoir Canal.* The proposed enlarged dam would be an earthfill structure at the site of the existing Morning Star Dam, which was described in the earlier section on the French Meadows Project, and which is located on a tributary of Forbes Creek in Section 17, Township 15 North, Range 11 East, M. D. B. & M., some 8 miles northeast of Foresthill. The stream bed elevation at this point is 4,026 feet. The existing dam, about 39 feet in height from stream bed to spillway lip, creates a reservoir with a storage capacity of 2,200 acre-feet and a water surface elevation of 4,065 feet. A topographic map of the dam and reservoir site, above this elevation, and at a scale of 1 inch equals 500 feet, with contour interval of 10 feet, was prepared in 1953 by the Division of Water Resources by photogrammetric methods. Storage capacities of enlarged Big Reservoir at various stages of water surface elevation are given in Table 73.

TABLE 73

AREAS AND CAPACITIES OF ENLARGED BIG RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	4,026	0	0
14	4,040	30	500
39	4,065	65	2,200
44	4,070	78	2,600
54	4,080	90	3,400
64	4,090	103	4,400
74	4,100	120	5,500
82	4,108	140	6,500
84	4,110	144	6,800
92	4,118	160	8,000

Based upon preliminary geological reconnaissance, the dam site is considered suitable for an earthfill or rockfill dam with a height in excess of 100 feet. Considerable leakage occurs through the existing structure, possibly through the foundation, and in the cost estimate it was therefore assumed that all of the existing dam would be razed and stockpiled in order to properly investigate and eliminate this leakage. The earth from the old hydraulic fill dam could probably then be used in the construction of an impervious section for the new dam at the same site. An alternative and topographically similar axis occurs within the present reservoir area, utilizing essentially the same left abutment but with the right abutment moved slightly upstream.

Bedrock at either axis consists of a very hard metasandstone on the left abutment and of a softer ultrabasic rock on the right abutment. The contact between the two formations trends approximately at right angles to the axis of the existing dam and crosses the line of the dam in the saddle area north of the channel knob around which the present dam was built. The leakage observed through the dam may be, at least in part, associated with this contact. Much jointing was noted in the bedrock where exposed to weathering, but this probably does not continue at depth. A heavy soil cover overlies most of the right abutment, and the average depth of this soil is estimated to be about 10 feet. Stripping on the left abutment and in the channel section at either axis would be less than on the right abutment.

The spillway cut, if placed in a saddle 2,000 feet upstream from the left abutment, would be partly in soil and partly in hard bedrock. Lining would be necessary in a short control section. Ample quantities of suitable impervious fill material are located within a mile of this site, chiefly in the north abutment area, and the local bedrock could be quarried for use in rockfill sections of the dam. Metamorphic rock from the south side of the reservoir area should prove better material for this use than the ultrabasic rock outcropping generally on the north side of the reservoir.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 92 feet in height from stream bed to spillway lip, and with a crest elevation of 4,118 feet, was selected to illustrate estimates of cost of the enlarged Big Reservoir. The dam would have a crest length of about 1,470 feet, a crest width of 20 feet, and 3.5:1 upstream and 3:1 downstream slopes. It would have an estimated volume of fill of about 831,000 cubic yards.

The concrete weir, control section, and unlined spillway would be located in a saddle 2,000 feet upstream from the left abutment. The spillway would have a capacity of 1,800 second-feet, required for an assumed maximum discharge of 1,200 second-feet per square mile of drainage area, and would discharge into a tributary of Forbes Creek below the proposed Forbes Dam. The maximum depth of water above the spillway lip would be 5 feet, and an additional 5 feet of freeboard would be provided.

Outlet works would consist of an 18-inch diameter steel pipe, placed in a trench excavated in the left abutment of the dam and encased in concrete. Releases from the reservoir would be controlled at a submerged concrete box inlet structure by two 12-inch diameter hydraulically controlled butterfly valves operated from a control house on the crest of the dam. The outlet would be controlled at the downstream end by a 12-inch diameter hollow jet valve discharging into a concrete-lined stilling basin, from which water would enter the Big Reservoir Canal at an elevation of 4,040 feet. A 2.0- by 2.0-foot slide gate would permit discharge from the stilling basin into the natural stream channel below the dam.

The Big Reservoir Canal, with a capacity of 25 second-feet, would be shotcrete-lined and of trapezoidal section, with 1:1 side slopes, bottom width of 2.0 feet, depth of 1.6 feet, and freeboard of 1.0 foot. Its slope would be about 13 feet per mile and its velocity about 4.5 feet per second. It would convey water in a westerly direction for a distance of 5.2 miles to a point about 4 miles northeast of Iowa Hill, where the elevation is about 3,900 feet. The conserved water would be diverted enroute and distributed by means of an unlined canal and ditch system. Detailed design of the distribution system was considered to be outside the scope of the current investigation.

(7) *Sugar Pine Dam and Reservoir, and Sugar Pine Reservoir Canal.* The proposed Sugar Pine Dam would be located in Section 24, Township 15 North, Range 10 East, M. D. B. & M., at a site on North Shirttail Canyon some 2 miles west of Big Reservoir. The site was described in detail in an earlier section on the French Meadows Project.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill and rockfill dam 160 feet in height from stream bed to spillway lip, and with a crest elevation of 3,680 feet, was selected to illustrate estimates of cost of Sugar Pine Dam and Reservoir. The dam would have a crest length of about 790 feet, and a crest width of 30 feet. The impervious earthfill section would have 3:1 upstream and 1:1 downstream slopes. The rockfill section, placed on the downstream face of the impervious section, would have a 2:1 downstream slope. The upstream face of the dam would be protected above an elevation of about 3,570 feet by a 3-foot blanket of riprap. A saddle dike on the left side of the reservoir would have a crest length of about 1,200 feet, a crest width of 20 feet, a maximum height of 25 feet, and 2:1 upstream and downstream slopes. The dam and saddle dike would have an estimated volume of fill of 1,334,600 cubic yards.

The concrete weir and chute spillway would be located adjacent to the saddle dam, and about 1,000 feet upstream from the left abutment. The spillway would have a capacity of 4,700 second-feet, required for an assumed maximum discharge of 600 second-feet per square mile of drainage area, and would discharge into a tributary of North Shirttail Canyon. The maximum depth of water above the spillway lip would be 6 feet, and an additional 4 feet of freeboard would be provided.

Outlet works would consist of a 36-inch diameter steel pipe, placed in a trench excavated in the left abutment of the dam and encased in concrete. Releases from the reservoir would be controlled at a submerged concrete box inlet structure by two 30-inch diameter hydraulically controlled butterfly valves operated from a control house on the left bank of the reservoir. The outlet would be controlled at the downstream end by a 36-inch diameter needle valve discharging into a concrete-lined stilling basin, from which water would enter the Sugar Pine Reservoir Canal at an elevation of 3,510 feet. Two 2.5- by 3-foot slide gates would permit discharge from the stilling basin into North Shirttail Canyon.

The Sugar Pine Reservoir Canal would be shotcrete-lined and of trapezoidal section, with 1:1 side slopes, bottom width of 2.0 feet, depth of 1.8 feet, and freeboard of 1.0 foot. Its slope would be about 12 feet per mile, its velocity about 4.5 feet per second, and its capacity at the inlet would be 30 second-feet. It would convey water in a southerly direction a distance of about 17 miles to a point approximately one mile northeast of Foresthill, where the elevation is about 3,300 feet. The conserved water would be

TABLE 74

GENERAL FEATURES OF FORESTHILL DIVIDE PROJECT

Forbes Dam
- Type—earthfill
- Crest elevation—4,010 feet
- Crest length—1,160 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—125 feet
- Side slopes—2.25:1 upstream and downstream
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—3,875 feet
- Volume of fill—656,000 cubic yards

Forbes Reservoir
- Surface area at spillway lip—138 acres
- Storage capacity at spillway lip—5,300 acre-feet
- Drainage area, Forbes Creek—2.2 square miles
- Estimated mean seasonal runoff, Forbes Creek—3,700 acre-feet
- Estimated safe seasonal yield from Forbes Creek, plus water imported in canal from Bullion Creek—7,100 acre-feet
- Type of spillway—concrete weir with chute
- Spillway discharge capacity—2,400 second-feet
- Type of outlet—18-inch diameter steel pipe beneath dam

Enlarged Morning Star Dam
- Type—earthfill
- Crest elevation—4,118 feet
- Crest length—1,470 feet
- Crest width—20 feet
- Height, spillway lip above stream bed—82 feet
- Side slopes—3.5:1 upstream; 3:1 downstream
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—4,026 feet
- Volume of fill—831,000 cubic yards

Enlarged Big Reservoir
- Surface area at spillway lip—140 acres
- Storage capacity at spillway lip—6,500 acre-feet
- Drainage area above dam—1.5 square miles
- Estimated mean seasonal runoff, above dam—2,500 acre-feet
- Estimated safe seasonal yield including water imported in canal from Bullion Creek—7,200 acre-feet
- Type of spillway—concrete weir and control section with unlined spillway
- Spillway discharge capacity—1,800 second-feet
- Type of outlet—18-inch diameter steel pipe beneath dam

Sugar Pine Dam
- Type—earthfill and rockfill
- Crest elevation—3,680 feet
- Crest length—790 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—160 feet
- Side slopes—3:1 upstream; 2:1 downstream
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—3,510 feet
- Volume of fill—1,334,600 cubic yards

Sugar Pine Reservoir
- Surface area at spillway lip—272 acres
- Storage capacity at spillway lip—17,000 acre-feet
- Drainage area, North Shirttail Canyon—7.8 square miles
- Estimated mean seasonal runoff, North Shirttail Canyon—13,200 acre-feet
- Estimated safe seasonal yield—10,400 acre-feet
- Type of spillway—concrete weir with chute
- Spillway discharge capacity—4,700 second-feet
- Type of outlet—36-inch diameter steel pipe beneath dam

Conduits

Name	Type	Length, in miles	Capacity, in second-feet	Side slopes	Bottom width, in feet	Depth, in feet	Free-board, in feet	Slope, in feet per mile	Velocity, in feet per second	Inlet elevation, in feet	Elevation of terminus, in feet
Secret Canyon Canal	Trapezoidal, unlined section	0.5	75	1:1	3.0	3.8	1.0	8.0	3.0	4,430	4,425
Black Canyon Canal	Trapezoidal, unlined section	17.0	125	1:1	5.0	4.5	1.0	6.5	3.0	4,410	4,300
El Dorado Creek Canal	Trapezoidal, unlined section	8.5	125	1:1	5.0	4.5	1.0	6.5	3.0	4,285	4,230
Bullion Creek Canal	Trapezoidal, unlined section	14.0	150	1:1	5.0	5.0	1.0	5.5	3.0	4,215	4,137
Forbes Reservoir Canal	Trapezoidal, shotcrete-lined section	9.0	30	1:1	2.0	1.8	1.0	12.0	4.5	3,920	3,816
Big Reservoir Canal	Trapezoidal, shotcrete-lined section and 2 siphons	5.2	25	1:1	2.0	1.6	1.0	13.0	4.5	4,035	3,919
Sugar Pine Reservoir Canal	Trapezoidal, shotcrete-lined section and 8 siphons	17.0	30	1:1	2.0	1.8	1.0	12.0	4.5	3,520	3,256

diverted enroute and distributed by means of an unlined canal and ditch system. Detailed design of the distribution system was considered to be outside the scope of the current investigation.

Pertinent data with respect to the various features of the Foresthill Divide Project, as designed for cost estimating purposes, are presented in Table 74.

The capital cost of the Foresthill Divide Project, at a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be about $6,081,000, and the corresponding annual cost was estimated to be about $317,000. The resultant estimated unit cost of the 24,700 acre-feet of irrigation yield per season was about $12.80 per acre-foot. On a 4 per cent interest basis the estimated unit cost was about $14.50 per acre-foot.

Estimated capital and annual costs of the Foresthill Divide Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Forbes Dam and Reservoir	$855,000	$38,000
Enlarged Morning Star Dam and Big Reservoir	1,067,000	47,000
Sugar Pine Dam and Reservoir	2,061,000	92,000
Canals	1,704,000	97,000
Distribution System	394,000	43,000
TOTALS	$6,081,000	$317,000

The capital cost, on a 3 per cent interest basis, of an initial project including Forbes Dam and Reservoir, the enlarged Morning Star Dam and Big Reservoir, the diversion canal from Secret Ravine, the Forbes Reservoir Canal, the Big Reservoir Canal, and a distribution system to serve 10,000 acres, was estimated to be about $3,314,000, and the corresponding annual cost was about $178,000. The resultant estimated unit cost of the 16,000 acre-feet of irrigation yield per season conserved by the initial units would be about $11.10 per acre-foot. On a 4 per cent interest basis, the estimated unit cost would be about $12.80 per acre-foot.

Valley Unit

In Chapter III it was shown that the present requirement for supplemental water in the Valley Unit is about 8,300 acre-feet per season, measured in terms of consumptive use of applied water. However, in the design of projects for initial local development to meet this requirement, it was considered desirable to provide some capacity for future growth in water demand which would occur through development of irrigable lands not presently irrigated.

Earlier in this chapter it was pointed out that a part of the new water conserved in the drainage basins of the Upper Yuba and Bear Rivers by the Jackson Meadows and the alternative Lake Valley and Cisco Projects and the Rollins Project would be available, if discharged into existing works of the Nevada Irrigation District and the Pacific Gas and Electric Company, to serve lands in Placer County including the Valley Unit. Under these projects, the amount of supplemental water available for use in the Valley Unit would depend on the yield of works constructed, and upon use of the new water in upstream service areas. In addition to the Jackson Meadows, Lake Valley, Cisco and Rollins Projects, seven other possible projects for initial construction to provide supplemental water to the Valley Unit were considered. An eighth project, while not a water conservation project, presents, as an example, a plan to develop hydroelectric energy from water discharged from Wise Power House.

The first of the seven projects would include the construction of a larger dam and reservoir on the Bear River at the site of the existing Camp Far West Dam and Reservoir, and facilities for conveyance of the conserved water to and its distribution in Placer County and in Sutter and Yuba Counties. This plan is hereinafter referred to as the "Camp Far West Project," and its principal features are delineated on Plate 23, "Camp Far West Project."

The second of the projects would include the construction of a dam and reservoir on Coon Creek, at a site approximately 7 miles northeast of Lincoln, utilization of existing diversion works and ditch to convey flood flows of the Bear River to the reservoir, reconstruction of existing abandoned facilities for diversion of conserved waters from Coon Creek below the dam, and construction of facilities for conveyance of the waters to and their distribution in Placer and Sutter Counties. This plan is hereinafter referred to as the "Coon Creek Project," and its principal features are delineated on Plate 24, "Coon Creek Project."

The third project would include the construction of a dam and reservoir some 4.3 miles east of Lincoln on Doty Ravine, a tributary of Coon Creek, utilization of existing diversion works and a canal to convey winter flows of the Drum System of the Pacific Gas and Electric Company to the reservoir, and facilities for conveyance of the conserved water to and its distribution in Placer and Sutter Counties. This plan is hereinafter referred to as the "Doty Ravine Project," and its principal features are delineated on Plate 25, "Doty Ravine Project."

The fourth project would include construction of a dam and reservoir some 5.5 miles north of Lincoln on Coon Creek, utilization of existing diversion works and a canal to convey winter flows of the Drum System of the Pacific Gas and Electric Company to the reservoir, and facilities for conveyance of the conserved water to and its distribution in Placer and Sutter Counties. The plan is hereinafter referred to as the "Lincoln Project," and its principal features are delineated on Plate 25a, "Lincoln Project."

The fifth project considered would include the construction of a dam and reservoir some 8 miles east of Lincoln on Auburn Ravine, utilization of existing diversion works and ditches to convey winter flows of the Drum System to the reservoir, and facilities for conveyance of the conserved water to and its distribution in Placer and Sutter Counties. This plan is hereinafter referred to as the "Auburn Ravine Project," and its principal features are delineated on Plate 26, "Auburn Ravine Project."

The sixth project would include the construction of a dam and reservoir at the Whitney Ranch site on Pleasant Grove Creek, some 4 miles north of Roseville, facilities for diversion of winter flows of the Drum System to the reservoir, and facilities for conveyance of the conserved water to and its distribution in Placer and Sutter Counties. This plan is hereinafter referred to as the "Whitney Ranch Project," and its principal features are delineated on Plate 27, "Whitney Ranch Project."

The seventh project considered would include the construction of a dam and reservoir about 1 mile north of Rocklin on Clover Creek, facilities for diversion of winter flows of the Drum System to the reservoir, and facilities for conveyance of the conserved water to and its distribution in Placer County. This plan is hereinafter referred to as the "Clover Valley Project," and its principal features are delineated on Plate 27a, "Clover Valley Project."

Under each of the foregoing plans, use of the new surface water supplies would prevent progressive and permanent lowering of ground water levels in the Valley Unit and adjacent areas. Each plan would provide water to meet the present supplemental water requirement of the Valley Unit of Placer County, and for growth in water utilization for a number of years in the future. Each project, and the general area that most logically would be served with water, is described in a subsequent section. Selection of design sizes of features was for cost estimating purposes, and project planning studies might result in selection of somewhat different sizes, and in adjustment of areas to be served from the various projects. However, it is believed the projects described herein and the estimated costs thereof are indicative of the cost of supplemental water that may be developed and served in the Valley Unit of Placer County.

The eighth project considered would include the construction of a power house on Auburn Ravine immediately downstream from the proposed Auburn Ravine Dam, and facilities for diversion of water from the South Canal and its conveyance to a forebay above the proposed power house. This plan is hereinafter referred to as the "Auburn Ravine Power Development Project," and its principal features are delineated on Plate 28, "Auburn Ravine Power Development Project." This project could be constructed and operated separately or in conjunction with the Doty Ravine, Lincoln, Auburn Ravine, Whitney Ranch, or Clover Valley Projects.

Camp Far West Project. The proposed Camp Far West Dam would be located on the Bear River in Section 21, Township 14 North, Range 6 East, M. D. B. & M., some 16 miles upstream from the confluence with the Feather River, and 6.6 miles upstream from U. S. Highway 99E. Stream bed elevation at the site is 145 feet. The dam would be superimposed upon an existing curved concrete gravity dam, 62 feet in height from stream bed to dam crest, which creates a reservoir of about 5,000 acre-foot capacity, and is owned by the Camp Far West Irrigation District. Flood waters of the Bear River conserved by the enlarged reservoir would be released to canals servicing portions of Placer, Sutter, and Yuba Counties.

In State Water Resources Board Bulletin No. 6, "Sutter-Yuba Counties Investigation," it was estimated that the present requirement for supplemental water in the portion of Sutter County south of the Bear River is about 28,000 acre-feet per season, and in the portion of Yuba County between the Yuba and Bear Rivers and west of the foothills it is an additional 28,000 acre-feet, or a total of about 56,000 acre-feet per season. In design of the Camp Far West Project in connection with the current investigation, it was considered necessary to furnish sufficient supplemental water to meet these requirements, plus the 8,300 acre-feet of supplemental water per season required in the Valley Unit. It was also necessary to provide about 10,000 acre-feet of water per season for the Camp Far West Irrigation District to replace yield of the existing reservoir. Based upon the area of lands irrigated by this district, this estimate is believed to be adequate. It was also considered desirable to provide some capacity for future growth in water requirements, which would occur through development of irrigable lands not presently irrigated.

As a first step in determination of size of the project, estimates were made of yield of the proposed works for various reservoir storage capacities. It was estimated that mean seasonal runoff of the Bear River, from the approximately 280 square miles above the dam site, is about 347,000 acre-feet. Based upon records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, yield studies were made for three sizes of reservoir at the Camp Far West site. It was assumed that a seasonal irrigation deficiency up to 35 per cent could be endured in one season of the period. A summary of results of the yield studies is presented in Table 75.

After consideration of the results of the yield studies, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 104,000 acre-foot storage capacity, with estimated seasonal irrigation yield of 90,000 acre-feet, was chosen

TABLE 75

ESTIMATED SEASONAL IRRIGATION YIELD OF CAMP FAR WEST RESERVOIR, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Irrigation yield
55,000	55,000
104,000	90,000
151,000	122,000

for purposes of cost estimates to be presented in this bulletin. The yield study for this size of reservoir is included in Appendix M.

The foregoing estimates of yield of Camp Far West Reservoir are based on records and estimates of actual flow of the Bear River near Wheatland. In the event the subsequently described Rollins Project were built and operated in conjunction with the existing Drum hydroelectric system, the flow in the Bear River at Wheatland would be considerably impaired, with a resultant decreased yield of Camp Far West Reservoir. In this event, it would be both feasible and advantageous to return a portion of the discharge of the Drum System which occurs during the nonirrigation season to Camp Far West Reservoir by way of a foothill canal extending southerly from Auburn Ravine. Under such a scheme the yield of Camp Far West Reservoir would be enhanced. Other studies also indicate that under plans for offstream storage of the Yuba River, Camp Far West Reservoir would be favorably situated to furnish terminal or regulatory storage in conjunction with the proposed Waldo Project, as discussed in State Water Resources Board Bulletin No. 6, "Sutter-Yuba Counties Investigation."

For cost estimating purposes, a tentative distribution of yield of the proposed Camp Far West Reservoir was made. Of the estimated 90,000 acre-feet of seasonal irrigation yield, 10,000 acre-feet per season were assigned to the Camp Far West Irrigation District to replace the yield of the existing reservoir. The remaining yield was divided equally between service areas north and south of the Bear River, as shown on Plate 23. In the cited Bulletin No. 6 it was estimated that the present supplemental requirement of lands in Sutter County south of the Bear River is about 28,000 acre-feet per season, or some 12,000 acre-feet less than the 40,000 acre-feet assigned. The 12,000 acre-feet per season of indicated surplus yield is greater than the present requirement for supplemental water of 8,300 acre-feet per season in the Valley Unit of Placer County, and if utilized on lands in the Valley Unit would prevent progressive and permanent lowering of ground water levels and provide for some growth in water utilization.

It was assumed that canal and ditch losses, plus the unconsumed portion of the supplemental water applied to irrigation, would be effective in preventing progressive and permanent lowering of ground water levels. It was estimated that losses in conveyance and distribution of the 40,000 acre-feet of seasonal irrigation yield assigned to lands south of the Bear River would be about 25 per cent, leaving some 30,000 acre-feet per season for application to irrigation. It was also assumed that the average seasonal application of the supplemental water would be 3.5 acre-feet per acre. On this basis it was estimated that the supplemental water would be applied to some 8,500 acres in a service area lying generally adjacent to Coon Creek and Auburn Ravine and easterly of the boundaries of Reclamation Districts 1000 and 1001. Elevation of this service area ranges from about 150 feet along the eastern boundary to about 50 feet on the west. Of the lands which would be served with the supplemental supply, about 6,900 acres are presently irrigated by ground water, and 1,800 acres are irrigable lands presently not irrigated.

An estimate of the monthly distribution of demand for irrigation water in Sutter and Yuba Counties was presented in State Water Resources Board Bulletin No. 6, "Sutter-Yuba Counties Investigation." Based on these data, monthly demands on the Camp Far West Project would be as shown in Table 76.

TABLE 76

ESTIMATED MONTHLY DISTRIBUTION OF DEMAND FOR WATER FROM CAMP FAR WEST PROJECT

Month	Per cent of seasonal total	Gross release to Camp Far West Irrigation District, in acre-feet	Gross release to lands north of the Bear River in Yuba County, in acre-feet	Gross release to lands south of the Bear River in Placer and Sutter Counties, in acre-feet
April	10	1,000	4,000	4,000
May	16	1,600	6,400	6,400
June	17	1,700	6,800	6,800
July	22	2,200	8,800	8,800
August	17	1,700	6,800	6,800
September	11	1,100	4,400	4,400
October	5	500	2,000	2,000
November	2	200	800	800
TOTALS	100	10,000	40,000	40,000

A topographic survey of the Camp Far West reservoir site up to an elevation of 225 feet was made by the Camp Far West Irrigation District in 1922. This survey was extended to an elevation of 320 feet by the Division of Water Resources in 1930, and a map was drawn from both surveys at a scale of 1 inch equals 500 feet, with a contour interval of 10 feet. Storage capacities of the Camp Far West Reservoir at various stages of water surface elevation are given in Table 77.

TABLE 77

AREAS AND CAPACITIES OF CAMP FAR WEST RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	145	0	0
25	170	100	1,400
45	190	180	4,200
65	210	380	9,800
85	230	600	19,400
105	250	890	34,200
125	270	1,260	55,500
145	290	1,750	85,600
155	300	2,020	104,400
165	310	2,330	126,100
175	320	2,620	151,000

Based upon preliminary geological reconnaissance, the Camp Far West dam site is considered suitable for an earthfill dam of any height up to a maximum of about 180 feet. Bedrock at the site consists of a slightly porphyritic, compact and massive dark greenstone with gradations into coarse-grained plutonic rock. A complex joint system exists in this vicinity with joint cracks opened a few inches on the surface by weathering. The joints probably do not persist to appreciable depths other than as hairline cracks in the rock. However, some moderate grouting would be necessary. Shears are not abundant in the bedrock, and no serpentine was found locally. While slopes up to an elevation of about 100 feet above stream bed on both abutments consist essentially of barren bedrock with scattered patches of overlying soil, the abutment slopes above 100 feet show only occasional bedrock outcrops with a much heavier mantle of overburden. Stripping under the impervious section of an earthfill dam at this site should not exceed 4 feet of depth of loose material up to 100 feet above stream bed on both abutments, and 8 feet of depth above 100 feet on the abutments. Topographic considerations indicate that the spillway should be located across the ridge forming the right abutment of the dam, utilizing a natural saddle and drainage channel.

The material stripped from the foundation and abutments and excavated from the spillway should prove largely recoverable for construction use as pervious fill, rockfill, or riprap. Deposits of dredger tailings about 2 miles downstream from the dam, as well as sands and gravels accumulated in the existing reservoir, could be used as pervious fill material for the proposed dam. Soil suitable for use in the construction of an impervious embankment is available in limited quantities within a radius of about 3 miles from the dam. Although the depth of this material is probably not great, it is believed that enough could be obtained from several sources to provide for a minimum impervious earth section.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam, 155 feet in height from stream bed to spillway lip, and with a crest elevation of 311 feet, was selected to illustrate estimates of costs of the Camp Far West Project. The dam would have a crest length of about 2,980 feet, a crest width of 30 feet, and 3 : 1 upstream and 2.5 : 1 downstream slopes. The central impervious core would have a top width of 10 feet and 0.8 : 1 slopes. The outer pervious zones of the dam would consist of stream bed gravels, dredger tailings, and salvaged material from stripping and excavation. A 3-foot blanket of gravel riprap would protect the upstream face of the dam. The volume of the fill would be an estimated 2,070,000 cubic yards.

The spillway would be of the chute type, located across the ridge forming the right abutment, and concrete-lined. The maximum depth of water above the spillway lip would be 7 feet, and an additional 4 feet of freeboard would be provided. The spillway would have a capacity of 60,000 second-feet, required for an assumed discharge of 215 second-feet per square mile of drainage area. The spillway would discharge into a draw that joins the Bear River about 900 feet downstream from the toe of the dam. Camp Far West Reservoir would inundate a 220 kilovolt steel tower transmission line, which would require relocation since the reservoir would be too wide to span at the present location. The reservoir would also inundate the county road which crosses the Bear River at McCourtney Crossing. Most of the reservoir area, however, is hillside brush and unimproved grazing land.

The outlet works would include a horseshoe-type tunnel, 10 feet in diameter and 880 feet in length, excavated through the left abutment and concrete-lined. The tunnel would be used to divert flow of the Bear River during the construction period. After completion of the dam a concrete plug would be placed in the tunnel at the axis of the dam, and a 5- by 5-foot high-pressure slide gate would be installed to control releases from the reservoir. A 66-inch diameter steel pipe, with capacity of 440 second-feet, would convey the water through the tunnel and terminate in a 60-inch diameter needle valve at a location about 250 feet downstream from the tunnel portal. This needle valve would discharge into a concrete-lined stilling basin, from which water would enter a concrete-lined canal at an elevation of 187 feet. Another needle valve, of 36-inch diameter, would be installed in the steel outlet pipe just outside of the tunnel portal, and would discharge directly into the Bear River.

The canal from the stilling basin would be of trapezoidal section with 1 : 1 side slopes, bottom width of 7.0 feet, depth of 6.0 feet, and freeboard of 1.0 foot. Its slope would be about 2.5 feet per mile, its velocity about 5.1 feet per second, and its capacity 400 second-feet. The canal would extend along the left bank of the Bear River a distance of about 8,000 feet, terminating in a concrete division box at an elevation of 183 feet. From this structure a steel pipe siphon, 66 inches in diameter and about 800 feet in length, with capacity of 200 second-feet, would convey water across the Bear River, discharging into a canal to serve lands north of the Bear River in Yuba County. The division box would also contain an outlet to a canal to serve lands south of the Bear River in Sutter and Placer Counties, and another outlet to a wasteway emptying into the Bear River.

The canals to serve lands both north and south of the Bear River would have capacities at their intakes of 200 second-feet. The canal to serve lands north of the Bear River would extend from the siphon outlet in a northwesterly direction a distance of approximately 3.6 miles, where about one-half of the water would be discharged into the channel of Dry Creek for downstream rediversion. The remaining water would be carried an additional distance of about 0.8 mile and discharged into the channel of Best Slough.

The canal to serve lands south of the Bear River would extend from the division box in a southerly direction a distance of approximately 10.0 miles to Coon Creek, where about one-half of the flow would be discharged for rediversion by downstream users. The remaining water would be carried in a canal, with capacity reduced to 100 second-feet, a distance of about 5.5 miles in a general southerly direction, where it would be discharged into and conveyed in the natural channel of Markham Ravine for a distance of about 1.1 miles. The conserved water would be diverted from Markham Ravine by a flashboard dam, and conveyed in a canal for a distance of about 1.2 miles and discharged into Auburn Ravine for rediversion by downstream users. For an initial distance of about 1.0 mile from the division box, the canal would be shotcrete-lined and of trapezoidal section, with 1 : 1 side slopes, bottom width of 6.0 feet, depth of 4.5 feet, and freeboard of 1.0 foot. The slope would be about 2.5 feet per mile, and the velocity about 4.3 feet per second. For the remainder of the distance to Coon Creek the canal would be unlined, of trapezoidal section, with 2 : 1 side slopes, bottom width of 8.0 feet, depth of 5.0 feet, and freeboard of 1.0 foot. Its slope would be about 2.5 feet per mile, and its velocity about 2.2 feet per second. From Coon Creek to Auburn Ravine the canal would be unlined and of trapezoidal section, with 2 : 1 side slopes, bottom width of 7.0 feet, depth of 3.7 feet, and freeboard of 1.0 foot. Its slope would be about 2.5 feet per mile, and its velocity about 1.9 feet per second.

The cost estimate for the canals was based on designs utilizing data obtained by field location surveys. Detailed design of the distribution system was considered to be outside the scope of the current investigation. The cost estimate for the distribution system was based on known costs of similar irrigation works elsewhere in California, adjusted to correspond with conditions prevailing in Placer County.

Pertinent data with respect to general features of the Camp Far West Project, as designed for cost estimating purposes, are presented in Table 78.

TABLE 78

GENERAL FEATURES OF CAMP FAR WEST PROJECT

Camp Far West Dam
- Type—earthfill
- Crest elevation—311 feet
- Crest length—2,980 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—155 feet
- Side slopes—3:1 upstream
  2.5:1 downstream
- Freeboard, above spillway lip—11 feet
- Elevation of stream bed—145 feet
- Volume of fill—2,070,000 cubic yards

Camp Far West Reservoir
- Surface area at spillway lip—2,020 acres
- Storage capacity at spillway lip—104,000 acre-feet
- Drainage area—280 square miles
- Estimated mean seasonal runoff—347,000 acre-feet
- Estimated seasonal irrigation yield—90,000 acre-feet
- Type of spillway—chute, concrete-lined
- Spillway discharge capacity—60,000 second-feet
- Type of outlet—10-foot diameter pressure tunnel and 66-inch diameter steel pipe through left abutment

Conduits

Item	Outlet	Bear River Canal	Bear River Siphon	Canal to lands north of Bear River			Canal to lands south of Bear River		
Type	66-inch diameter steel pipe	Trapezoidal, concrete lined	66-inch diameter steel pipe	Trapezoidal lined section	Unlined section		Trapezoidal lined section	Unlined section	
Length in miles	0.21	1.5	0.15	.07	2.9	0.8	1.0	10.0	6.7
Side slopes	---	1:1	---	1:1	1:1	1:1	1:1	1:1	1:1
Bottom width, in feet	---	7.0	---	6.0	8.0	7.0	6.0	8.0	7.0
Depth, in feet	---	6.0	---	4.5	5.0	3.7	4.5	5.0	3.7
Freeboard, in feet	---	1.0	---	1.0	1.0	1.0	1.0	1.0	1.0
Slope, in feet per mile	---	2.5	---	2.5	2.5	2.5	2.5	2.5	2.5
Velocity, in feet per second	18.5	5.1	8.4	4.3	2.2	1.9	4.3	2.2	1.9
Capacity, in second-feet	440	400	200	200	200	100	200	200	100

The capital cost of the Camp Far West Project on a 3 per cent interest basis and based on prices prevailing in April, 1952, was estimated to be about $5,340,000, and the corresponding annual cost was estimated to be about $305,000. The resultant estimated unit cost of the 80,000 acre-feet per season of net irrigation yield was about $3.80 per acre-foot. The estimated unit cost of water applied to lands north of the Bear River was about $4.70 per acre-foot, and the estimate for water applied for irrigation to lands south of the Bear River was about $5.40 per acre-foot. On a 4 per cent interest basis these unit costs were about $4.30, $5.30, and $6.10, respectively.

Estimated capital and annual costs of the Camp Far West Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Camp Far West Dam and Reservoir	$3,726,000	$172,000
Bear River Canal	233,000	13,000
Siphon and canal to lands north of Bear River	287,000	16,000
Canal to lands south of Bear River	668,000	38,000
Distribution system, lands north of Bear River	213,000	33,000
Distribution system, lands south of Bear River	213,000	33,000
TOTALS	$5,340,000	$305,000

Coon Creek Project. The proposed Coon Creek Dam would be located in Sections 8 and 17, Township 13 North, Range 6 East, M. D. B. & M., at a site on Coon Creek some 7.5 miles northeast of Lincoln and 8.3 miles upstream from U. S. Highway 99E. Stream bed elevation at the site is 345 feet. For cost estimating purposes, it was assumed that flood waters of the Bear River would be diverted by existing works, conveyed in the existing Upper Gold Hill and Combie-Ophir Canals, and discharged into a tributary of Coon Creek above the reservoir. These diversion works and the canals belong to the Nevada Irrigation District. The conserved waters of both Coon Creek and Bear River, after release from the reservoir, would flow down Coon Creek and be diverted to canals servicing portions of Placer and Sutter Counties.

In State Water Resources Board Bulletin No. 6, "Sutter-Yuba Counties Investigation," it was assumed that the present requirement for supplemental water in the portion of Sutter County south of Bear River is about 28,000 acre-feet per season. In the design of the Coon Creek Project in connection with the current investigation, it was considered necessary to provide sufficient water to meet this requirement, plus the 8,300 acre-feet per season of supplemental water required in the Valley Unit. It was also considered necessary to provide some capacity for future growth in water requirements, which would occur through development of irrigable lands not presently irrigated.

As a first step in determination of the size of the Coon Creek Project, estimates were made of yield of the proposed works for various reservoir storage capacities. It was estimated that mean seasonal runoff of Coon Creek, from the approximately 40 square miles of watershed above the dam site, is about 32,800 acre-feet. Of the Bear River waters, studies indicated that flood flows in an estimated mean seasonal amount of about 35,700 acre-feet could be diverted to Coon Creek Reservoir, through the existing Combie-Ophir Canal of about 106 second-foot capacity, during the months of November through April.

Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, yield studies were made of two sizes of reservoir at the Coon Creek site. It was assumed that a seasonal irrigation deficiency up to 35 per cent could be endured in one season of the period. Monthly demands on the reservoir were assumed to be proportional to the estimated distribution of irrigation demands in the Valley Unit of Placer County, as presented in Table 46, except for modification in April and May to permit greater irrigation of rice. A summary of the results of the yield studies is presented in Table 79.

TABLE 79

ESTIMATED SEASONAL IRRIGATION YIELD OF COON CREEK RESERVOIR WITH BEAR RIVER DIVERSION, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Irrigation yield
25,500	34,000
59,000	56,000

After consideration of the results of the yield studies, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 59,000 acre-foot capacity, with estimated seasonal irrigation yield of 56,000 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. The yield study for this size of reservoir is included in Appendix M.

It was assumed that canal and ditch losses, plus the unconsumed portion of the supplemental water applied to irrigation, would be effective in preventing progressive and permanent lowering of ground water levels in the area served in the Valley Unit and in adjacent areas in Sutter County. It was estimated that seasonal losses in conveyance and distribution of the 56,000 acre-feet of seasonal irrigation yield would be about 25 per cent, or 14,000 acre-feet, leaving some 42,000 acre-feet for application to irrigation. It was assumed that the average seasonal application of water would be 3.5 acre-feet per acre. On this basis it was estimated that the imported supply would be applied to some 12,000 acres, in a service area lying generally adjacent to Coon Creek and Auburn Ravine, and easterly of the boundaries of Reclamation Districts 1000 and 1001, as shown on Plate 24. Elevation of this service area ranges from about 125 feet along the eastern boundary to about 50 feet on the west. Of the lands which would be served with the supplemental water, about 3,300 acres are presently irrigated by ground water, and 8,700 acres are irrigable lands presently not irrigated.

Coon Creek Dam Site

An estimate of the monthly distribution of demand for irrigation water in the Valley Unit of Placer County was presented in Table 46. Based on these data, with modification to permit greater irrigation of rice, monthly demands on the Coon Creek Project would be as shown in Table 80.

TABLE 80

ESTIMATED MONTHLY DISTRIBUTION OF DEMAND FOR WATER FROM COON CREEK PROJECT

Month	Per cent of seasonal total	Gross release, in acre-feet
April	10	5,600
May	16	9,000
June	17	9,500
July	22	12,300
August	17	9,500
September	11	6,200
October	5	2,800
November	2	1,100
TOTALS	100	56,000

A topographic map of the Coon Creek dam and reservoir sites, at a scale of 1 inch equals 425 feet, with contour interval of 20 feet, was made by the Division of Water Resources in 1951, using photogrammetric methods. Topography of the dam site was shown on the map up to an elevation of 580 feet, while topography of the reservoir site was shown up to an elevation of 500 feet. Reservoir topography above that elevation was estimated. Storage capacities of Coon Creek Reservoir at various stages of water surface elevation are given in Table 81.

TABLE 81

AREAS AND CAPACITIES OF COON CREEK RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	345	0	0
15	360	5	50
35	380	25	300
55	400	65	1,200
75	420	110	3,000
95	440	180	5,800
115	460	260	10,300
135	480	360	16,600
155	500	500	25,500
175	520	610	37,600
195	540	740	51,000
205	550	810	58,000
207	552	820	59,000
215	560	880	65,000

Based upon preliminary geological reconnaissance, the Coon Creek dam site is considered suitable for an earthfill dam of any height up to a maximum of about 220 feet. Foundation rock at the site consists essentially of amphibolite schist. In the vicinity of the site the rock varies between schistose and massive material, striking across the channel and dipping vertically. The foundation bedrock as a whole is relatively hard and unweathered where exposed in outcrops. Joints are prominently developed in several sets, with a horizontal joint set predominating. Some faulting and shearing serves to further complicate the structural picture. The rock is locally porphyritic and contains many phenocrysts of hornblende.

The stream has cut a narrow, steep-walled gorge through the relatively resistant rock at this site. Saddles exist on either side of the main dam which would necessitate the use of auxiliary dikes. One of these saddles could readily be adapted for use as a spillway location.

It is probable that stripping under the impervious section of an earthfill dam at the Coon Creek site would be relatively heavy, due to the jointed blocky nature of the rock. Required stripping is estimated at 2 feet of overburden and 15 feet of weathered rock from the abutments, and 4 feet of boulders and 5 feet of jointed bedrock from the channel section. In addition, removal of about 12 feet of talus which occurs in a cone over the lower 60 feet of the right abutment would be necessary. Soil suitable for use in the construction of an impervious core is available at this site only in limited quantities. Deposits of residual clayey soil are scattered and thin in the the vicinity. However, based on a preliminary sampling program, sufficient material is believed to be available within 2 to 3 miles of the dam site to provide for a minimum impervious earth section. Materials for the pervious sections of the dam could be obtained from salvage from stripping, and from stream bed gravels of Coon Creek and the Bear River.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 207 feet in height from stream bed to spillway lip, and with a crest elevation of 560 feet, was selected to illustrate estimates of cost of the Coon Creek Project. The dam would consist of three earthfill structures, a main dam across Coon Creek and two auxiliary saddle dams. The main dam would have a crest length of about 1,420 feet, a crest width of 30 feet, and 3:1 upstream and 2.5:1 downstream slopes. The south saddle dam would have a crest length of about 1,450 feet and a maximum height of about 64 feet. The north saddle dam would have a crest length of about 550 feet and a maximum height of about 39 feet. Both saddle dams would have crest widths of 20 feet, and 2.5:1 upstream and downstream slopes. The central impervious cores of all dams would have top widths of 10 feet and 0.8:1 slopes, and would be blanketed with sand and gravel filters. The outer pervious zones of the dams would consist of stream bed gravels and materials salvaged from stripping and excavation. The upstream face of the main dam would be protected by a 3-foot blanket of riprap, and similar blankets 2 feet thick would protect the upstream faces of the saddle dams. The main dam would have an estimated volume of fill of 2,201,000 cubic yards, and the estimated volume of fill of the two saddle dams would be 449,000 cubic yards.

The concrete spillway would be of the ogee weir type, located in a saddle between the main dam and the north saddle dam. It would have a capacity of 14,000 second-feet, required for an assumed discharge of 350 second-feet per square mile of drainage area, and would discharge into a tributary of Coon Creek. The maximum depth of water above the spillway lip would be 4 feet, and an additional 4 feet of freeboard would be provided.

Outlet works would consist of a 48-inch diameter steel pipe placed in a trench excavated in rock beneath the dam and encased in concrete. Releases from the reservoir would be controlled at the upstream end by two 30-inch hydraulically controlled high-pressure slide gates, located at a submerged inlet upstream from the dam, and operated by hydraulic controls from a house on the left abutment. The outlet would be controlled at the downstream end by a hollow jet valve.

Coon Creek Reservoir would inundate the present county road which crosses the lower end of the reservoir area. The reservoir would also inundate a small amount of irrigated pasture. However, most of the reservoir area is unimproved grazing land.

The proposed diversion works on Coon Creek would incorporate remaining features of an abandoned diversion structure at a site approximately 3.3 miles upstream from U. S. Highway 99E. The site was examined and surveyed during the course of the investigation. The existing works consist of a concrete gate structure with concrete abutments. An earthen dike which formerly completed stream closure of the left abutment has been destroyed. Stream bed elevation at the site is 140 feet, and the gate structure is 17 feet in height above stream bed. The gate opening is 35 feet in width, and contains 7 bays to hold flashboards, each with an opening 4 feet in width.

For cost estimating purposes, it was planned to utilize the old concrete gate structure by installing removable flashboards to a height of 7 feet above stream bed elevation. The earthen dike would be replaced from the left abutment of the gate structure to the natural bank of Coon Creek, a distance of about 100 feet, to complete the stream closure. This embankment would be approximately 10 feet in height, with 2:1 side slopes and a crest elevation of 150 feet. A similar dike with crest elevation of 155 feet, portions of which are already in place, would extend upstream along the low left bank of Coon Creek for a distance of approximately 1,000 feet. At a point about 50 feet upstream from the main axis of the diversion structure, a concrete headwall would be placed in the left side embankment, containing a 4- by 4-foot slide gate to control releases into a proposed canal. It was estimated that spillway capacity of the existing gate structure, after removal of the flashboards, would be in excess of 2,000 second-feet. It was considered that infrequent flood flows in Coon Creek in excess of this amount would wash out the closing earth embankment, and that the embankment would have to be replaced after such floods.

The proposed canal, with a capacity of 100 second-feet, would extend from the headgate in a general southerly direction a distance of approximately 5.5 miles to Markham Ravine. The conserved water would then be conveyed in the natural channel of Markham Ravine for a distance of about 1.1 miles, where it would be diverted by a flashboard dam and conveyed in a canal for a distance of about 1.2 miles and discharged into Auburn Ravine. For an initial distance of about 0.5 mile from the headgate, the canal would be shotcrete-lined and of trapezoidal section, with 1:1 side slopes, bottom width of 4.0 feet, depth of 4.0 feet, and freeboard of 1.0 foot. Its slope would be approximately 2.5 feet per mile, and the velocity would be about 3.5 feet per second. The remaining portion of the constructed canal would be of an unlined trapezoidal section, with 2:1 side slopes, bottom width of 7.0 feet, depth of 3.7 feet, and freeboard of 1.0 foot. Its slope would be approximately 2.5 feet per mile, and the velocity would be about 1.9 feet per second. At a distance of about 1.3 miles before reaching Markham Ravine, the conduit would cross U. S. Highway 99E and the Southern Pacific Railroad. The structure to carry the water underneath the highway and railroad tracks would be a steel pipe 48 inches in diameter.

Cost estimates for the canal were based on designs utilizing data obtained by a reconnaissance field location survey. Detailed design of the distribution system, however, was considered to be outside the scope of the current investigation. Cost estimates for the system were based on known costs of similar irrigation works elsewhere in California, adjusted to correspond with conditions prevailing in Placer County.

Pertinent data with respect to general features of the Coon Creek Project, as designed for cost estimating purposes, are presented in Table 82.

The capital cost of the Coon Creek Project, on a 3 per cent interest basis and based on prices prevailing in April, 1952, was estimated to be about $5,575,000, and the corresponding annual cost was estimated to be about $283,000. The resultant estimated average unit cost of the 56,000 acre-feet per season of irrigation yield was about $5.00 per acre-foot. The estimated unit cost of the 42,000 acre-feet of supplemental water per season applied for irrigation in the service area considered was about $6.70 per acre-foot. On a 4 per cent interest basis these unit costs were $5.80 per acre-foot and $7.70 per acre-foot, respectively. These estimates of cost do not include possible charges for use of the existing diversion works on the

TABLE 82

GENERAL FEATURES OF COON CREEK PROJECT

Coon Creek Dam
- Type—earthfill
- Crest elevation—560 feet
- Crest length—1,420 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—207 feet
- Side slopes—3:1 upstream
  2.5:1 downstream
- Freeboard, above spillway lip—8 feet
- Elevation of stream bed—345 feet
- Volume of fill—2,201,000 cubic yards

Auxiliary Dams
- Type—earthfill
- South saddle dam
  - Crest length—1,450 feet
  - Crest width—20 feet
  - Side slopes—2.5:1
  - Maximum height—64 feet
- North saddle dam
  - Crest length—550 feet
  - Crest width—20 feet
  - Side slopes—2.5:1
  - Maximum height—39 feet
- Volume of fill, both dams—449,000 cubic yards

Coon Creek Reservoir
- Surface area at spillway lip—820 acres
- Storage capacity at spillway lip—59,000 acre-feet
- Drainage area, Coon Creek—40 square miles
- Estimated mean seasonal runoff, Coon Creek—32,800 acre-feet
- Estimated seasonal diversion of Bear River water through Combie-Ophir Canal—35,700 acre-feet
- Estimated seasonal irrigation yield—56,000 acre-feet
- Type of spillway—ogee weir, concrete-lined
- Spillway discharge capacity—14,000 second-feet
- Type of outlet—48-inch diameter steel pipe beneath dam

Diversion Works
- Bear River.........Existing concrete gravity weir, with overpour section, approximately 300 feet in length, and approximately 15 feet high above stream bed elevation of about 1,500 feet; side channel diversion box, with overpour parapet wall and sluice gate; headgates in concrete headwall.
- Coon Creek.........Existing concrete diversion structure for flashboard control, with opening 35 feet in width and 17 feet in height above stream bed elevation of 140 feet; to be rehabilitated by installation of flashboards to height of 7 feet, construction of auxiliary earthen dikes, and installation of concrete headwall and 4- by 4-foot slide headgate.

Conduits
- Bear River Diversion..Existing conduit with estimated capacity of 106 second-feet, 2.4 miles in length, comprised of concrete-lined and unlined canal sections, wooden flume, and steel pipe siphons.
- Coon Creek Diversion

Type	Trapezoidal, shotcrete-lined canal	Trapezoidal, unlined canal
Length in miles	0.5	5.0
Side slopes	1:1	2:1
Bottom width, in feet	4.0	7.0
Depth, in feet	4.0	3.7
Freeboard, in feet	1.0	1.0
Slope, in feet per mile	2.5	2.5
Velocity, in feet per second	3.5	1.9
Capacity, in second-feet	100	100

Bear River and the canals of the Nevada Irrigation District. They do, however, include estimated costs for acquiring the existing abandoned diversion structure on Coon Creek below the dam.

Estimated capital and annual costs of the Coon Creek Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Coon Creek Dam and Reservoir	$5,045,000	$224,000
Coon Creek Diversion and Conduit	230,000	13,000
Distribution system	300,000	46,000
TOTALS	$5,575,000	$283,000

Doty Ravine Project. The proposed Doty Ravine Dam would be located in Sections 30 and 31, Township 13 North, Range 7 East, M. D. B. & M., at a site on Doty Ravine, a tributary of Coon Creek, some 4.3 miles northeast of Lincoln and 6.2 miles upstream from U. S. Highway 99E. Stream bed elevation at this site is 225 feet. For cost estimating purposes it was assumed that Doty Ravine Reservoir would conserve the runoff of its own watershed, as well as water discharged from the Wise Power House of the Pacific Gas and Electric Company during the winter. This latter flow would be available in Auburn Ravine for diversion to and conveyance in the existing Auburn Ravine Canal of the Nevada Irrigation District. The water would be released into the Doty Ravine watershed at a point some 4 miles above the dam site. The conserved waters, after release from the reservoir, would flow down the channels of Doty Ravine and Coon Creek for downstream diversion and use.

In Chapter III it was estimated that the present requirement for supplemental water in the Valley Unit is about 8,300 acre-feet per season. However, in design of the Doty Ravine Project, it was considered desirable to provide some capacity for future growth in water requirements. As a first step in determination of the size of the Doty Ravine Project, estimates were made of yields of the proposed works for various reservoir storage capacities.

In studies of the Doty Ravine, Lincoln, Auburn Ravine, Whitney Ranch, and Clover Valley Projects, subsequently described, it was considered that the natural runoff of the watersheds above the proposed reservoirs would be supplemented by water discharged from Wise Power House, located on Auburn Ravine, during the six winter months from November through April. Records of spill from Wise Power House to the American River, measured as flow of the South Canal below Tunnel 16, southeast of Newcastle, indicate that during the period from 1932-33 through 1949-50 the minimum flow during these six months was 52,000 acre-feet, which occurred in 1945-46. In yield studies made for the five projects, therefore, it was assumed that this amount of water could have been diverted each season during the six winter months from the South Canal into Auburn Ravine at Wise Power House, for downstream storage or rediversion to off-stream storage. Allowance was made for an estimated conveyance loss of 15 per cent, or about 8,000 acre-feet per season, and the remaining 44,000 acre-feet of water per season was assumed to be available to supplement the natural runoff. Tentative allocations of water were made to the five projects, as shown in Table 83. It will be noted that the sum of the allocations to the projects exceeds the amount of water presently available since it was assumed that all projects would not be constructed.

TABLE 83

POSSIBLE SEASONAL SUPPLY OF WINTER RELEASES OF WATER FROM WISE POWER HOUSE TO PROPOSED RESERVOIRS IN PLACER COUNTY

Reservoir	Distribution, in acre-feet
Doty Ravine	23,000
Lincoln	9,000
Auburn Ravine	10,000
Whitney Ranch	11,000
Clover Valley	22,000

In yield studies for the Doty Ravine Project, it was estimated that mean seasonal runoff of Doty Ravine, from the approximately 18.3 square miles of watershed above the dam site, is about 10,800 acre-feet. As previously mentioned, it was assumed that an additional 23,000 acre-feet of water per season, discharged from Wise Power House, would be imported to the Doty Ravine watershed by means of the Auburn Ravine Canal. Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, yield studies were made of three sizes of reservoir at the Doty Ravine site. It was indicated that Doty Ravine Reservoir could be operated with only small irrigation deficiencies during the critical period. Monthly demands on the reservoir were assumed to be proportional to the estimated distribution of irrigation demands in the Valley Unit, as presented in Table 46, except for modification in April and May to permit greater irrigation of rice. A summary of the results of the yield studies is presented in Table 84.

Any releases that might be made to Doty Ravine Reservoir from the Wise Power House after the end of April and during the irrigation season would result in corresponding increases in yield.

TABLE 84

ESTIMATED SEASONAL IRRIGATION YIELD OF DOTY RAVINE RESERVOIR, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Irrigation yield
9,800	10,000
32,000	28,000
42,400	29,000

After consideration of the results of the yield studies, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 32,000 acre-foot capacity, with estimated seasonal irrigation yield of 28,000 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. The yield study for this size of reservoir is included in Appendix M.

It was assumed that conveyance losses, plus the unconsumed portion of the supplemental water supply applied to irrigation, would be effective in preventing progressive and permanent lowering of ground water levels in the area served and adjacent areas. It was estimated that seasonal losses in conveyance and distribution of the 28,000 acre-feet of seasonal irrigation yield would be about 25 per cent, or 7,000 acre-feet, leaving some 21,000 acre-feet per season for surface application to irrigation. It was also assumed that the average seasonal application of water would be 3.5 acre-feet per acre. On this basis it was estimated that the supplemental water would be applied to some 6,000 acres of irrigable land presently not irrigated. The lands are in a service area lying generally adjacent to Doty Ravine and Coon Creek, and east of Reclamation District 1001, and are shown on Plate 25.

An estimate of the monthly distribution demand for irrigation water in the Valley Unit was presented in Table 46. Based on these data, with modification to permit greater irrigation of rice, monthly demands on the Doty Ravine Project would be as shown in Table 85.

TABLE 85

ESTIMATED MONTHLY DISTRIBUTION OF DEMAND FOR WATER FROM DOTY RAVINE PROJECT

Month	Per cent of seasonal total	Gross release, in acre-feet
April	6	1,700
May	14	3,900
June	20	5,600
July	23	6,400
August	22	6,200
September	11	3,100
October	3	800
November	1	300
TOTALS	100	28,000

A topographic map of the Doty Ravine dam and reservoir sites, at a scale of 1 inch equals 440 feet, and with a contour interval of 20 feet, was made by the Division of Water Resources in 1952, using photogrammetric methods. Storage capacities of Doty Ravine Reservoir at various stages of water surface elevation are given in Table 86.

Based upon preliminary geologic reconnaissance, the Doty Ravine dam site is considered suitable for an earthfill dam of the moderate heights considered.

TABLE 86

AREAS AND CAPACITIES OF DOTY RAVINE RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	225	0	0
15	240	6	100
35	260	72	800
55	280	210	3,600
75	300	418	9,800
95	320	792	22,000
105	330	1,026	32,000
115	340	1,296	42,400

Foundation rock of the site consists essentially of a decomposed granitic rock. Outcrops occur in limited areas, chiefly in the upstream half of the reservoir area. Weathering of the rock is quite pronounced, often exceeding 15 to 20 feet where exposed in road cuts. When weathered the rock has a typical, light red ferruginous color, and is very friable. Large crystals of feldspar are common; biotite is present in variable amounts; and crystals of hornblende are moderately common. In exposed sections, random jointing is common and quite pronounced. Generally the rock appears to be a light-colored granodiorite, although variations from this frequently occur. Stripping beneath the impervious section would not be great, averaging 4 feet of earth and weathered rock, including the root zone. Stripping in the spillway section may average slightly greater across the crest of the ridge.

Investigation of potential borrow sources disclosed considerable amounts of earth located within the reservoir area. Material suitable for the impervious section of an earthfill dam exists within a 1-mile haul, and similar additional material is located still farther upstream. This material has the appearance of a dark brown clay and is located in the flat pasture lands bordering Doty Ravine.

Material suitable for the pervious section is available from tailings which are located northwest of the dam site but which would probably require some processing. In addition, decomposed granite is available in abundant quantity in the reservoir area and this could also be utilized for the pervious section. Riprap could be obtained by opening quarry pits and utilizing the hard granitic rock occurring in places within the reservoir area.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 105 feet in height from stream bed to spillway lip, and with a crest elevation of 340 feet, was selected to illustrate estimates of cost of the Doty Ravine Project. The dam would consist of 8 earthfill structures, a main dam across Doty Ravine and 7 auxiliary saddle dams. The main dam would have a crest length of about 6,590 feet, a crest width of 30 feet, and 2.5:1 upstream and downstream slopes. The saddle dams would vary in length from about 130 feet to 600 feet, and would vary in height from about 5 feet to 60 feet. The saddle dams would have crest widths of 30 feet to accommodate a roadway, and 2.5:1 upstream and downstream slopes. The central impervious core of the main dam would have a top width of 10 feet, and 1:1 slopes. The outer pervious zones of the main dam would consist of stream bed gravels, dredger tailings, and other gravel materials. The upstream face of the main dam would be protected by a 3-foot blanket of riprap, and a similar blanket 2 feet thick would protect the downstream face. The total estimated volume of fill of the main dams and the saddle dams would be 1,926,000 cubic yards.

The concrete spillway would be of the ogee weir type with a concrete-lined open chute, and would be located on the left abutment of the dam. The maximum depth of water above the spillway lip would be 6 feet, and an additional 4 feet of freeboard would be provided. The spillway would have a capacity of 10,800 second-feet, required for an assumed maximum discharge of 590 second-feet per square mile of drainage area, and would discharge into a stilling basin in a draw that joins Doty Ravine downstream from the toe of the dam.

The outlet works would consist of a 48-inch diameter welded steel pipe, placed in a trench excavated in rock beneath the dam and encased in concrete. Releases from the reservoir would be controlled at a submerged concrete box inlet structure by two 36-inch diameter hydraulically controlled butterfly valves, operated from a house on the crest of the dam. The outlet would be controlled at the downstream end by a 36-inch diameter hollow jet valve, discharging on the right bank of Doty Ravine downstream from the toe of the dam. The conserved water would be conveyed in the natural channels of Doty Ravine and Coon Creek for diversion by downstream users.

Within the reservoir are several miles of county road, a few small farm houses and buildings, and the Mount Pleasant Grange Hall. Most of the land is native grass and brush, with about 75 acres of irrigated pasture.

Detailed design of the distribution system required to serve water to users was considered to be outside the scope of the current investigation. Cost estimates for the system were based on known costs of similar irrigation works elsewhere in California, adjusted to correspond with conditions prevailing in Placer County.

Pertinent data with respect to general features of the Doty Ravine Project, as designed for cost estimating purposes, are presented in Table 87.

The capital cost of the Doty Ravine Project, on a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be about $3,352,000, and the corresponding annual cost was estimated

TABLE 87

GENERAL FEATURES OF DOTY RAVINE PROJECT

Doty Ravine Dam
- Type—earthfill
- Crest elevation—340 feet
- Crest length—6,590 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—105 feet
- Side slopes—2.5:1
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—225 feet
- Volume of fill—1,786,000 cubic yards

Auxiliary Dams
- Type—earthfill
- Total crest length, seven dams—2,310 feet
- Crest width—30 feet
- Side slopes—2.5:1
- Total volume of fill, seven dams—140,000 cubic yards

Doty Ravine Reservoir
- Surface area at spillway lip—1,026 acres
- Storage capacity at spillway lip—32,000 acre-feet
- Drainage area, Doty Ravine—18.3 square miles
- Estimated mean seasonal runoff, Doty Ravine—10,800 acre-feet
- Estimated maximum seasonal diversion of water from Wise Power House through Auburn Ravine Canal—23,000 acre-feet
- Estimated seasonal irrigation yield—28,000 acre-feet
- Type of spillway—circular ogee weir, concrete-lined open chute
- Spillway discharge capacity—10,800 second-feet
- Type of outlet—48-inch diameter welded steel pipe beneath dam

to be about $170,000. The resultant estimated average unit cost of the 28,000 acre-feet of irrigation yield per season conserved by Doty Ravine Reservoir was about $6.10 per acre-foot. The estimated unit cost of the 21,000 acre-feet of supplemental water per season supplied for irrigation in the service area considered was about $8.10 per acre-foot. On a 4 per cent interest basis these unit costs were $6.90 per acre-foot and $9.30 per acre-foot, respectively. These estimates of cost do not include possible charges for use of the Auburn Ravine Canal and the existing diversion works on Auburn Ravine, or the cost of water at Wise Power House.

Estimated capital and annual costs of the Doty Ravine Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Doty Ravine Dam and Reservoir	$3,202,000	$143,000
Distribution system	150,000	27,000
TOTALS	$3,352,000	$170,000

Lincoln Project. The proposed Lincoln Dam would be located in Sections 14 and 15, Township 13 North, Range 6 East, M. D. B. & M., at a site on Coon Creek, some 5.5 miles north of Lincoln and 5.0 miles upstream from U. S. Highway 99E. Stream bed elevation at this site is 175 feet. The Lincoln Dam would conserve the runoff of its own watershed, or, in the event Coon Creek Dam were constructed as heretofore described, it would conserve the runoff of the Coon Creek watershed between the two dams. It was assumed that, in either case, the natural runoff would be supplemented with water discharged from the Wise Power House of the Pacific Gas and Electric Company, as discussed in connection with the Doty Ravine Project. This latter flow would be available in Auburn Ravine for diversion to and conveyance in the existing Auburn Ravine Canal of the Nevada Irrigation District. The diverted water would be released from the Auburn Ravine Canal into the Doty Ravine watershed at a point some 4 miles above the Doty Ravine dam site, then rediverted downstream, from Doty Ravine by a diversion structure and conveyed in a canal to Coon Creek. The conserved waters, after release from the reservoir, would flow down the natural channel of Coon Creek for downstream diversion and use.

In Chapter III it was estimated that the present requirement for supplemental water in the Valley Unit is about 8,300 acre-feet per season. However, in design of the Lincoln Project, it was considered desirable to provide some capacity for future growth in water requirement which would occur through development of irrigable lands not presently irrigated. As a first step in determination of the yield of the Lincoln Project, estimates were made of the yield of a 15,000 acre-foot reservoir under various conditions of water supply. It was estimated that the mean seasonal runoff of Coon Creek, from the approximately 53 square miles of watershed above the dam site, is about 38,200 acre-feet, and that the runoff from the approximately 13 square miles of watershed between the Coon Creek and Lincoln dam sites is about 5,400 acre-feet. It was assumed that an additional supply up to 17,500 acre-feet of water per season discharged from Wise Power House, could be imported to the Coon Creek watershed by means of the Auburn Ravine Canal, enlarged and extended. Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, yield studies were made of a 15,000 acre-foot reservoir, under three possible conditions of runoff or diversion into the reservoir. It was indicated that in each case Lincoln Reservoir could be operated with only minor deficiencies during the critical period. Monthly demands on the reservoir were assumed to be propor-

TABLE 88

ESTIMATED SEASONAL IRRIGATION YIELD OF LINCOLN RESERVOIR WITH 15,000 ACRE-FOOT CAPACITY, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Inflow	Irrigation yield
Full natural flow of Coon Creek	14,000
Full natural flow of Coon Creek, plus 9,000 acre-foot diversion from Auburn Ravine	17,500
Natural runoff between Coon Creek Dam and Lincoln Dam plus 17,500 acre-foot diversion from Auburn Ravine	17,500

tional to the estimated average monthly distribution of irrigation demands in the Valley Unit, as presented in Table 46, except for modification in April and May to permit greater irrigation of rice. A summary of the results of the yield studies is presented in Table 88.

Releases to the Lincoln Project from Wise Power House after the end of April and during the irrigation season would result in corresponding increases in yield.

After consideration of topography of the dam site, yield studies, and cost analyses hereinafter discussed, a reservoir of 15,000 acre-foot storage capacity, with a 9,000 acre-foot diversion from Auburn Ravine and with an estimated seasonal irrigation yield of 17,000 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. The yield study for this size of reservoir is included in Appendix M.

It was assumed that conveyance losses, plus the unconsumed portion of the supplemental water supply applied to irrigation, would be effective in preventing progressive and permanent lowering of ground water levels in the area served and adjacent areas. It was estimated that seasonal losses in conveyance and distribution of the 17,500 acre-feet of seasonal irrigation yield would be about 25 per cent, or 4,400 acre-feet, leaving some 13,100 acre-feet per season for surface application to irrigation. It was also assumed that the average seasonal application of water would be 3.5 acre-feet per acre. On this basis it was estimated that the supplemental water would be applied to some 3,700 acres of irrigable land not presently irrigated. The lands are in a service area lying generally adjacent to Coon Creek, and east of Reclamation District 1001, and are shown on Plate 25a.

An estimate of the monthly distribution demand for irrigation water in the Valley Unit was presented in Table 46. Based on these data, with modification to permit greater irrigation of rice, the monthly demands on the Lincoln Project would be as shown in Table 89.

A topographic map of the Lincoln dam and reservoir sites, at a scale of 1 inch equals 425 feet, and with a contour interval of 10 feet, was made by the Division of Water Resources in 1952, using photogrammetric methods. Storage capacities of Lincoln Reservoir at various stages of water surface elevation are given in Table 90.

TABLE 89

ESTIMATED MONTHLY DISTRIBUTION OF DEMAND FOR WATER FROM LINCOLN PROJECT

Month	Per cent of seasonal total	Gross release, in acre-feet
April	6	1,100
May	14	2,400
June	20	3,500
July	23	4,100
August	22	3,800
September	11	1,900
October	3	500
November	1	200
TOTALS	100	17,500

TABLE 90

AREAS AND CAPACITIES OF LINCOLN RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	175	0	0
10	185	32	200
20	195	100	850
30	205	217	2,500
40	215	330	5,200
50	225	485	9,250
60	235	675	15,000
65	240	800	18,780
70	245	930	22,400

Based upon preliminary geologic reconnaissance, the Lincoln dam site is considered suitable for an earthfill dam of the moderate heights considered. Slopes at this site are very gentle. Both abutments appear to be granite rock ridges with an estimated moderately heavy mantle of Pliocene deposits. Granite rock is also exposed in a borrow pit located at the edge of the road immediately north of the stream about a quarter of a mile upstream from the site. This rock is badly decomposed at the surface and is high in chlorite, probably an alteration product of hornblende. Stripping for the impervious section would consist of 3 feet of earth and gravel on the right abutment, 4 to 5 feet of earth and gravel on the left abutment, and in the channel section a minimum stripping of 10 feet near the bases of the abutments to 30 feet in the active channel. This material would consist of gravel and fines. Material for the impervious core is readily available within easy hauling distance and consists of decomposed granite and fines. Dredger tailings are available for the pervious section. Due to the gravelly structure of the dam site foundation and reservoir area, leakage may be a problem if not properly countered. A side channel spillway could be cut in the left abutment at about 60 feet above the stream bed.

The abutments and reservoir area have a light brush cover with scattered oak and cottonwood trees. The land is presently used for cattle grazing.

As a result of yield studies, geologic reconnaissance, and consideration of topography and preliminary cost estimates, an earthfill dam 60 feet in height from stream bed to spillway lip, and with a crest elevation of 245 feet, was selected to illustrate estimates of cost of the Lincoln Project. The dam would consist of three earthfill structures, a main dam across Coon Creek and two small auxiliary dikes in saddles at either end of the main dam. The main dam would have a crest length of about 3,400 feet, a crest width of 30 feet, and 2.5:1 upstream and downstream slopes. The two saddle dikes would have an over-all length of about 1,500 feet, and would be about 7 feet in height with 2.5:1 side slopes. The 30-foot crest width would accommodate a roadway to replace that portion of the county road which would be inundated by the reservoir. The central impervious core of the main dam would have a top width of 10 feet and 1:1 slopes. The outer pervious zones of the main dam would consist of stream bed gravels, dredger tailings, and other gravel materials. The upstream face of the main dam would be protected by a 3-foot blanket of riprap. The downstream slope would have pervious fill of the heavier grades on the surface. The total estimated volume of fill of the main dam and the two saddle dikes would be about 920,000 cubic yards.

The concrete spillway would be of the ogee weir type with a concrete-lined open chute, and would be located between the main dam and a saddle dike on the left abutment. The maximum depth of water above the spillway lip would be 5 feet, and an additional 5 feet of freeboard would be provided. The spillway would have a capacity of 18,500 second-feet, required for an assumed maximum discharge of 350 second-feet per square mile of drainage area, and would discharge into a draw that joins Coon Creek downstream from the toe of the dam.

The outlet works would consist of a 42-inch diameter welded steel pipe, placed in a trench excavated in rock beneath the dam and encased in concrete. Releases from the reservoir would be controlled by two 36-inch high-pressure slide gates operated manually from the crest of the dam. The conserved water would be conveyed in the natural channel of Coon Creek for diversion by downstream users.

Within the reservoir are 2 miles of meandering county road, most of which could be replaced by using the dam crest as a roadway. Lands within the reservoir area have little use except for grazing.

The proposed diversion works on Doty Ravine would be located at an elevation of about 280 feet, about 1 mile upstream from the proposed Doty Ravine Dam. A concrete and flashboard dam, 6 feet in height from stream bed and 25 feet in length, would be constructed to divert flows to the inlet of a canal. The canal, with a capacity of 60 second-feet and 8 miles in length, would be unlined. It would have a trapezoidal section, 3-foot bottom width, 1.5:1 side slopes, and a water depth of 3.2 feet. The canal would discharge into Coon Creek approximately 1,000 feet upstream from the Lincoln dam site.

Detailed design of the distribution system required to serve water to users was considered to be outside the scope of the current investigation. Cost estimates were based on known costs of similar irrigation works elsewhere in California, adjusted to correspond with conditions prevailing in Placer County.

Pertinent data with respect to general features of the Lincoln Project, as designed for cost estimating purposes, are presented in Table 91.

TABLE 91

GENERAL FEATURES OF LINCOLN PROJECT

Lincoln Dam
- Type—earthfill
- Crest elevation—245 feet
- Crest length—3,400 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—60 feet
- Side slopes—2.5:1
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—175 feet
- Volume of fill—895,000 cubic yards

Auxiliary Dikes
- Type—earthfill
- Total crest length, two dikes—1,500 feet
- Crest width—30 feet
- Side slopes—2.5:1
- Total volume of fill, two dikes—25,000 cubic yards

Reservoir
- Surface area at spillway lip—675 acres
- Storage capacity at spillway lip—15,000 acre-feet
- Drainage area, Coon Creek—53 square miles
- Estimated mean seasonal runoff, Coon Creek—38,200 acre-feet
- Estimated maximum seasonal diversion of water from Wise Power House through enlarged and extended Auburn Ravine Canal—9,000 acre-feet
- Estimated seasonal irrigation yield—17,500 acre-feet
- Type of spillway—straight ogee weir, concrete-lined open chute
- Spillway discharge capacity—18,500 second-feet
- Type of outlet—42-inch diameter welded steel pipe beneath dam

Diversion Works
- Flashboard dam with concrete abutments, wingwalls and apron, approximately 25 feet in length and 6 feet high above the stream bed elevation of 280 feet

Conduit
- Type—trapezoidal, unlined
- Length, in miles—8.0
- Side slopes—1.5:1
- Bottom width, in feet—3.0
- Depth, in feet—3.2
- Freeboard, in feet—1.0
- Slope, in feet per mile—4.2
- Velocity, in feet per second—2.3
- Capacity, in second-feet—60

The capital cost of the Lincoln Project, on a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be $1,321,000 and the corresponding annual cost was estimated to be about $66,000. The resultant estimated average unit cost of the 17,500 acre-feet of irrigation yield per season was about $3.80 per acre-foot. The estimated unit cost of the 13,100 acre-feet of supplemental water per season applied for irrigation in the service area considered was about $5.00 per acre-foot. On a 4 per cent basis these unit costs were about $4.30 per acre-foot and $5.80 per acre-foot, respectively. These estimates of cost do not include the cost of water at Wise Power House.

Estimated capital and annual costs of the Lincoln Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

Doty Ravine Dam Site

Auburn Ravine Dam Site

	Estimated Costs Capital	Annual
Lincoln Dam and Reservoir	$1,190,000	$50,000
Doty Ravine diversion and canal	38,000	2,000
Distribution system	93,000	14,000
	$1,321,000	$66,000

Auburn Ravine Project. Preliminary investigations were made of two dam sites on Auburn Ravine, a lower and an upper site, referred to as the Gold Hill and Ophir sites, respectively. Topographic considerations limit the Gold Hill site to a dam with a maximum height of 45 feet from stream bed to spillway lip. Capacity of the reservoir with such a dam would be only about 1,700 acre-feet, and the estimated seasonal irrigation yield would be only about 1,650 acre-feet. Preliminary cost estimates indicated that capital and annual costs of dam and reservoir at the Gold Hill site would be excessive, as would be the resultant unit cost of conserved water. Because of limited yield and high unit cost of water at this site, it was given no further present consideration.

The proposed Auburn Ravine Dam would be located in Sections 11 and 14, Township 12 North, Range 7 East, M. D. B. & M., at the Ophir site on Auburn Ravine some 2 miles west of the town of Ophir and some 8 miles east of Lincoln. Stream bed elevation at this site is 465 feet. For cost estimating purposes, it was assumed that Auburn Ravine Reservoir would conserve the runoff of its own watershed, plus additional water in the amount of 10,000 acre-feet per season from Wise Power House, as discussed in connection with the Doty Ravine Project. During the irrigation season the conserved waters, after release from the reservoir, would flow down Auburn Ravine and be available in the natural channel for downstream diversion and use.

In Chapter III it was estimated that the present requirement for supplemental water in the Valley Unit is about 8,300 acre-feet per season. However, in design of the Auburn Ravine Project, it was considered desirable to provide some capacity for future growth in water requirement which would occur through development of irrigable lands not presently irrigated.

As a first step in determination of the size of the Auburn Ravine Project, estimates were made of yield of the proposed works for various reservoir storage capacities. It was estimated that the mean seasonal runoff of Auburn Ravine, from the approximately 14.2 square miles of watershed above the dam site, is about 15,800 acre-feet. As mentioned above, it was assumed that runoff of Auburn Ravine would be supplemented by additional water in the amount of 10,000 acre-feet per season released into Auburn Ravine from Wise Power House.

Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, yield studies were made of two sizes of reservoir at the Ophir site. The limited number of sizes for which yield studies were made was largely determined by topographic considerations. It was indicated that the proposed Auburn Ravine Reservoir could be operated with only negligible irrigation deficiency during the critical period. Monthly demands on the reservoir were assumed to be proportional to the estimated distribution of irrigation demands in the Valley Unit, as presented in Table 46, except for modification in April and May to permit greater irrigation of rice. A summary of the results of the yield studies is presented in Table 92.

TABLE 92

ESTIMATED SEASONAL IRRIGATION YIELD OF AUBURN RAVINE RESERVOIR, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Irrigation yield
7,300	8,000
11,700	13,000

Releases to the Auburn Ravine Project from Wise Power House after the end of April and during the irrigation season would result in corresponding increases in yield.

After consideration of the results of the yield studies, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 11,700 acre-foot storage capacity, with estimated seasonal irrigation yield of 13,000 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. The yield study for this size of reservoir is included in Appendix M.

It was assumed that conveyance losses, plus the unconsumed portion of the supplemental water supply applied to irrigation, would be effective in preventing progressive and permanent lowering of ground water levels in the area served and in adjacent areas. It was estimated that seasonal losses of water in conveyance and distribution of the 13,000 acre-feet of seasonal irrigation yield would be about 25 per cent, or 3,300 acre-feet, leaving some 9,700 acre-feet per season for surface application to irrigation. It was also assumed that the average seasonal application of water would be 3.5 acre-feet per acre. On this basis it was estimated that the supplemental water would be applied to some 2,800 acres, including 700 acres presently served with ground water, and 2,100 acres of irrigable land presently not irrigated. These lands are in a service area lying generally adjacent to Auburn Ravine and easterly from Reclamation District 1001, and are shown on Plate 26.

An estimate of the monthly distribution of demand for irrigation water in the Valley Unit was presented in Table 46. Based on these data, with modification to permit greater irrigation of rice, monthly demands on the Auburn Ravine Project would be as shown in Table 93.

TABLE 93

ESTIMATED MONTHLY DISTRIBUTION OF DEMAND FOR WATER FROM AUBURN RAVINE PROJECT

Month	Per cent of seasonal total	Gross release, in acre-feet
April	6	800
May	14	1,800
June	20	2,600
July	23	3,000
August	22	2,900
September	11	1,400
October	3	400
November	1	100
TOTALS	100	13,000

Topographic maps of the Auburn Ravine dam and reservoir sites, at scales of 1 inch equals 200 feet and 1 inch equals 425 feet, respectively, with contour intervals of 20 feet, were made by the Division of Water Resources in 1952, using photogrammetric methods. Storage capacities of Auburn Ravine Reservoir at various stages of water surface elevation are given in Table 94.

TABLE 94

AREAS AND CAPACITIES OF AUBURN RAVINE RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	465	0	0
35	500	4	50
55	520	12	200
75	540	27	600
95	560	49	1,350
115	580	76	2,650
135	600	114	4,500
155	620	173	7,300
175	640	260	11,700

Based upon preliminary geological reconnaissance, the Auburn Ravine dam site is considered suitable for a concrete gravity dam or for an earthen or rockfill structure. Any height of dam up to nearly 200 feet would be feasible at the site, with the maximum height being topographically limited by a broad saddle a few hundred feet north of the crest of the right abutment. The axis of the proposed earthfill dam chosen for cost estimating purposes was located a short distance downstream from the best topographic location, in order to assure that the impervious section of the structure would not lie on the granitic-metamorphic contact hereinafter described. This chosen location provides a foundation of granitic rock for the most part. The granitic rock is a very slightly metamorphosed, hornblende-rich material which is quite hard and fresh where exposed in channel outcrop. Relatively unweathered rock extends from the stream bed to heights of about 25 feet on either abutment. Jointing is of minor importance, except in the area of the contact described in the following paragraph.

The contact, between granitic rock downstream and a schistose amphibolite upstream, crosses the stream a short distance above the chosen axial location, and would extend only beneath the pervious section of the dam. The contact strikes northwesterly across the channel and trends downstream into the right abutment. It closely follows a clearly defined gully, which is tributary to the main stream course at an acute angle downstream. This feature, coupled with the pronounced schistosity, and with the several sheared zones noted in the contact area, leads to the supposition that the concealed contact may actually be one of a fault nature.

The spillway could well be cut through the top of the hill forming the right abutment. An auxiliary dike of low height would have to be provided in the saddle occurring north of the spillway. Stripping under the impervious section of an earthfill dam at this site should not exceed 6 feet of soil mantle and loose rock on the right abutment and about 3 feet in the channel section on the left abutment. Bedrock in the vicinity of the site is hard, and could readily be quarried for use as rockfill, riprap, or crushing for aggregates. No stream gravels suitable for use either as concrete aggregates or as pervious fill occur in the area locally. Although further exploration and testing of potential earthfill sources and materials would be required, it seems likely that by stripping a thin cover of residual soils from a nearby large hilly area, it would be possible to obtain the required quantities of suitable impervious fill material. Pervious fill might also be obtained from a similar source, or, in lieu of this, quarried rock could be used for this purpose.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, and earthfill dam 175 feet in height from stream bed to spillway lip, and with a crest elevation of 650 feet, was selected to illustrate estimates of cost of the Auburn Ravine Project. The dam would consist of two earthfill structures, a main dam across Auburn Ravine and an auxiliary dam in a low saddle north of the right abutment. The main dam would have a crest length of about 620 feet, a crest width of 30 feet, and 3.25 : 1 upstream and 3 : 1 downstream slopes. The central impervious core of the main dam would have a top width of 10 feet, and 1 : 1 slopes. The outer pervious zones of the main dam would consist of decomposed granite, and a 3-foot blanket of gravel riprap would protect the upstream face. The saddle dam would be constructed of impervious material, and would have a crest length of about 415 feet, crest width of 20 feet, a maximum height of about 26 feet, and 2:1 upstream and downstream slopes. The main dam would have an estimated volume of fill of 1,631,000 cubic yards, and the estimated volume of fill of the saddle dam would be 14,400 cubic yards.

The concrete spillway would be of the ogee weir type with a concrete-lined open chute, and would be located between the main dam and the auxiliary dam. It would have a capacity of 9,400 second-feet, required for an assumed maximum discharge of 660 second-feet per square mile of drainage area, and would discharge into Auburn Ravine some 1,000 feet downstream from the dam. The maximum depth of water above the spillway lip would be 6 feet, and an additional 4 feet of freeboard would be provided.

Outlet works would consist of a 48-inch diameter steel pipe, placed in a trench excavated beneath the right abutment of the main dam and encased in concrete. Releases from the reservoir would be controlled at the upstream end by two 30-inch diameter butterfly valves, enclosed in a concrete inlet structure and protected by a trash rack, and operated by hydraulic controls from a house on the right abutment. The outlet conduit would terminate in a 36-inch diameter needle valve. This needle valve would discharge into a concrete-lined stilling basin, from which water would enter the existing Auburn Ravine Canal to supply present users, to be conveyed to Doty Ravine, or to be spilled into Auburn Ravine for downstream diversion.

Auburn Ravine Reservoir would inundate the existing Auburn Ravine Canal diversion and about 25 acres of pear orchard. Most of the reservoir area, however, is hillside brush land. Construction of the dam and reservoir would make necessary the relocation of somewhat more than 1 mile of underground toll cable.

Detailed design of the distribution system was considered to be outside the scope of the current investigation. Cost estimates for the system were based on known costs of similar irrigation works elsewhere in California, adjusted to correspond with conditions prevailing in Placer County.

Pertinent data with respect to general features of the Auburn Ravine Project, as designed for cost estimating purposes, are presented in Table 95.

The capital cost of the Auburn Ravine Project, on a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be about $3,170,000, and the corresponding annual cost was estimated to be about $147,000. The resultant estimated average unit cost of the 13,000 acre-feet per season of irrigation yield was about $11.30 per acre-foot. The estimated unit cost of the 9,700 acre-feet of supplemental water per season applied for irrigation in the service area considered was about $15.20 per acre-foot. On a 4 per cent interest basis these unit costs were about $12.20 per acre-foot and $16.40 per acre-foot, respectively. These estimates of cost do not include the cost of water at Wise Power House.

TABLE 95

GENERAL FEATURES OF AUBURN RAVINE PROJECT

Auburn Ravine Dam
- Type—earthfill
- Crest elevation—650 feet
- Crest length—620 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—175 feet
- Side slopes—3.25:1 upstream
  3:1 downstream
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—465 feet
- Volume of fill—1,631,000 cubic yards

Auxiliary Saddle Dam
- Type—earthfill
- Crest length—415 feet
- Crest width—20 feet
- Side slopes—2:1
- Maximum height—26 feet
- Volume of fill—14,400 cubic yards

Reservoir
- Surface area at spillway lip—260 acres
- Storage capacity at spillway lip—11,700 acre-feet
- Drainage area, Auburn Ravine—14.2 square miles
- Estimated mean seasonal runoff, Auburn Ravine—15,800 acre-feet
- Estimated maximum seasonal diversion of water from Wise Power House—10,000 acre-feet
- Estimated seasonal irrigation yield—13,000 acre-feet
- Type of spillway—circular ogee weir, concrete-lined open chute
- Spillway discharge capacity—9,400 second-feet
- Type of outlet—48-inch diameter welded steel pipe beneath dam

Estimated capital and annual costs of the Auburn Ravine Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Auburn Ravine Dam and Reservoir	$3,100,000	$135,000
Distribution system	70,000	12,000
TOTALS	$3,170,000	$147,000

Whitney Ranch Project. The proposed Whitney Ranch Dam and Reservoir would be located on Pleasant Grove Creek, in Section 11, Township 11 North, Range 6 East, M. D. B. & M., at a site some 4 miles north of Roseville and 1.5 miles upstream from U. S. Highway 99E. Stream bed elevation at the site is 128 feet. For cost estimating purposes it was assumed that Whitney Ranch Reservoir would conserve the runoff of its own watershed, plus additional water in the amount of 11,000 acre-feet per season from Wise Power House. Winter flows from Wise Power House would be spilled into Auburn Ravine and conveyed in the natural channel for a distance of about 7.5 miles to a point on that stream at an elevation of approximately 250 feet. At this point the water would be diverted and conveyed southwesterly in a canal for a distance of about 12 miles, discharging into Whitney Ranch Reservoir. The conserved water would be released from the reservoir to Pleasant Grove Creek, and would be available for downstream diversion and use.

In Chapter III it was estimated that the present requirement for supplemental water in the Valley Unit is about 8,300 acre-feet per season. However, in design of the Whitney Ranch Project it was considered desirable to provide some capacity for future growth in water requirement which would occur through development of irrigable lands not presently irrigated.

As a first step in determination of the size of the Whitney Ranch Project, estimates were made of yield of the proposed works. It was estimated that mean seasonal runoff of Pleasant Grove Creek, from the approximately 4.8 square miles of watershed above the dam site, is about 2,600 acre-feet. As previously discussed, it was assumed that an additional 11,000 acre-feet of water per season would be conveyed to Whitney Ranch Reservoir from Wise Power House on Auburn Ravine.

Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, yield studies were made of two sizes of reservoir at the Whitney Ranch site. It was indicated that the Whitney Ranch Reservoir could be operated with only negligible deficiency through the critical period. Monthly demands on the reservoir were assumed to be proportional to the estimated distribution of irrigation demands in the Valley Unit, as presented in Table 46, except for modification in April and May to permit greater irrigation of rice. A summary of the results of the yield studies is presented in Table 96.

TABLE 96

ESTIMATED SEASONAL IRRIGATION YIELD OF WHITNEY RANCH RESERVOIR, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Irrigation yield
4,000	2,800
10,300	9,500

Releases to the Whitney Ranch Project from Wise Power House after the end of April and during the irrigation season would result in corresponding increases in yield.

After consideration of the yield studies, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 10,300 acre-foot capacity, with estimated seasonal irrigation yield of 9,500 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. The yield study for this size of reservoir is included in Appendix M.

It was assumed that conveyance losses, plus the unconsumed portion of the supplemental water supply applied to irrigation, would be effective in preventing progressive and permanent lowering of ground water levels in the area served and in adjacent areas. It was estimated that seasonal losses of water in conveyance and distribution of the 9,500 acre-feet of seasonal irrigation yield would be about 25 per cent, or 2,400 acre-feet, leaving some 7,100 acre-feet per season for surface application to irrigation. It was also assumed that the average seasonal application would be 3.5 acre-feet per acre. On this basis it was estimated that the supplemental water would be applied to some 2,000 acres, including 1,500 acres presently served with ground water and 500 acres of irrigable land presently not irrigated. These lands are in a service area lying generally adjacent to Pleasant Grove and Curry Creeks, and easterly of the boundary of Reclamation District 1000, as shown on Plate 27.

An estimate of the monthly distribution of demand for irrigation water in the Valley Unit was presented in Table 46. Based on these data, with modification to permit greater irrigation of rice, monthly demands on the Whitney Ranch Project would be as shown in Table 97.

TABLE 97

ESTIMATED MONTHLY DISTRIBUTION OF DEMAND FOR WATER FROM WHITNEY RANCH PROJECT

Month	Per cent of seasonal total	Gross release, in acre-feet
April	6	600
May	14	1,300
June	20	1,900
July	23	2,200
August	22	2,100
September	11	1,000
October	3	300
November	1	100
TOTALS	100	9,500

A topographic map of the Whitney Ranch dam site at a scale of 1 inch equals 200 feet, with contour interval of 10 feet, was made by the Division of Water Resources in 1951, using photogrammetric methods. Topography of the reservoir site is shown on the Markham Ravine Quadrangle of the Corps of Engineers, United States Army, at a scale of 1:62,500, with contour interval of 5 feet. Storage capacities of Whitney Ranch Reservoir at various stages of water surface elevation are given in Table 98.

The Whitney Ranch dam site is topographically limited to a low dam. The site is suitable, from both the topographic and geologic viewpoints, only for an earthfill dam. Preliminary geologic reconnaissance indicates that the bedrock locally consists of a series of reworked volcanics of Tertiary age, interbedded with

TABLE 98

AREAS AND CAPACITIES OF WHITNEY RANCH RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	128	0	0
12	140	30	300
22	150	105	700
32	160	260	1,600
42	170	430	3,300
45	173	470	4,000
52	180	565	5,800
62	190	780	9,200
65	193	840	10,300
72	200	975	13,500

occasional sedimentary strata. The volcanics are chiefly fine-grained, tight rocks of low to medium density. Overlying this series is a layer of partially cemented gravels varying up to 4 feet in thickness. The latter occurs chiefly on the upper abutment slopes, and gives way to silt lower on the abutments and in the channel section. Throughout the vicinity the topsoil is tight, as evidenced by ponding water following heavy rains. Required stripping from the abutments would be about 3 feet of overburden and 2 feet of weathered bedrock, and from the channel section about 2 feet of fill and 2 feet of weathered bedrock. The best location for a spillway would be through a saddle occuring southeast of the dam site. The spillway section would have to be lined due to the moderately soft rocks which underlie shallow overburden in the saddle.

The foundation material described above probably is not suitable, due chiefly to low density, for use in construction of an impervious fill at this site. It may also be too clayey for use as pervious fill. However, a supply of both impervious and pervious fill material probably can be obtained within a haul distance of less than 3 miles. Harder rock, quarriable for use as riprap, can be obtained approximately 2 miles upstream from the axis location.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 65 feet in height from stream bed to spillway lip, and with a crest elevation of 200 feet, was selected to illustrate estimates of cost of the Whitney Ranch Project. The dam would have a crest length of about 2,320 feet, a crest width of 30 feet, and 3:1 upstream and 2.5:1 downstream slopes. The impervious core would have a top width of 20 feet, and 3:1 upstream and 1:1 downstream slopes. The upstream slope would be protected by a 3-foot blanket of riprap. The downstream pervious zone would consist of stream bed gravels and materials salvaged from stripping and excavation. The volume of fill would be an estimated 673,600 cubic yards.

The concrete spillway would be of the ogee weir type, located in a saddle south of the left abutment, and the spillway channel would be lined. The maximum depth of water above the spillway would be 3 feet and an additional 4 feet of freeboard would be provided. The spillway would have a capacity of 4,400 second-feet, required for an assumed maximum discharge of 920 second-feet per square mile of drainage area, and would discharge into a tributary of Pleasant Grove Creek.

The outlet works would consist of a 24-inch diameter welded steel pipe, placed in a trench excavated in rock beneath the dam and encased in concrete. Releases from the reservoir would be controlled at a submerged concrete box inlet structure by a 24-inch diameter hydraulically controlled gate valve, operated from a control house on the crest of the dam. The outlet would be controlled at the downstream end by an 18-inch diameter hollow jet valve, discharging into a stilling basin and into Pleasant Grove Creek downstream from the toe of the dam. The conserved water would be conveyed in the natural channel of Pleasant Grove Creek for diversion by downstream users.

The land within the reservoir area is almost entirely native pasture. The Whitney Ranch Reservoir would inundate the ranch headquarters of the Spring Valley Ranch.

The proposed diversion works on Auburn Ravine would be located at the previously mentioned Gold Hill site about 4 miles east of Lincoln. A topographic map of the Gold Hill site, at a scale of 1 inch equals 425 feet, with a contour interval of 10 feet, was made by the Division of Water Resources in 1951, using photogrammetric methods. The diversion works would consist of a concrete gravity overpour weir with a crest elevation of 252 feet. The weir would be 7 feet in height above stream bed and some 150 feet in length. An opening at the left end of the weir would provide entrance to a side channel and the headworks of the diversion canal. The side channel would have a concrete gravity parapet wall of the overpour type, and a 4- by 4-foot sluice gate would be provided for sand flushing. The headworks would consist of a concrete headwall across the end of the side channel, in which there would be trash racks and a 4- by 4-foot slide gate.

The proposed diversion canal would be about 12 miles in length, extending in a southwesterly direction and discharging into Pleasant Grove Creek. Location of the canal was based on a map study, and was checked in the field. The canal chosen for cost estimating purposes would have a capacity of 50 second-feet. It would be unlined and of trapezoidal section, with 2:1 side slopes, bottom width of 5 feet, depth of 2.5 feet, freeboard of 1 foot, and a slope of approximately 3.5 feet per mile. The velocity would be about 2 feet per second.

Detailed design of the distribution system was considered to be outside the scope of the current investigation. Cost estimates for the system were based on known costs of similar irrigation works elsewhere in California, adjusted to correspond with conditions prevailing in Placer County.

Pertinent data with respect to general features of the Whitney Ranch Project, as designed for cost estimating purposes, are presented in Table 99.

TABLE 99

GENERAL FEATURES OF WHITNEY RANCH PROJECT

Whitney Ranch Dam
- Type—earthfill
- Crest elevation—200 feet
- Crest length—2,320 feet
- Crest width—30 feet
- Height, spillway lip above stream bed—65 feet
- Side slopes—3:1 upstream
  2.5:1 downstream
- Freeboard, above spillway lip—7 feet
- Elevation of stream bed—128 feet
- Volume of fill—673,600 cubic yards

Reservoir
- Surface area at spillway lip—840 acres
- Storage capacity at spillway lip—10,300 acre-feet
- Drainage area, Pleasant Grove Creek—4.8 square miles
- Estimated mean seasonal runoff, Pleasant Grove Creek—2,600 acre-feet
- Estimated maximum seasonal diversion of water from Wise Power House—11,000 acre-feet
- Estimated seasonal irrigation yield—9,500 acre-feet
- Type of spillway—ogee weir
- Spillway discharge capacity—4,400 second-feet
- Type of outlet—24-inch diameter welded steel pipe beneath dam

Diversion Works—concrete gravity weir with ogee overpour section, 150 feet in length, and 7 feet in height above stream bed elevation of 245 feet; side channel diversion box with overpour parapet wall, and 4- by 4-foot slide sluice gate; 4- by 4-foot slide headgate in concrete headwall.

Conduit
- Type—trapezoidal, unlined canal
- Length, in miles—12
- Side slopes—2:1
- Bottom width, in feet—5.0
- Depth, in feet—2.5
- Freeboard, in feet—1.0
- Slope, in feet per mile—3.6
- Velocity, in feet per second—2.0
- Capacity, in second-feet—50

The capital cost of the Whitney Ranch Project, on a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be $1,313,000, and the corresponding annual cost was estimated to be about $66,000. The resultant estimated average unit cost of the 9,500 acre-feet of irrigation yield per season was about $6.90 per acre-foot. The estimated unit cost of the 7,100 acre-feet of supplemental water per season applied for irrigation in the service area considered was about $9.30 per acre-foot. On a 4 per cent interest basis these unit costs were about $8.00 per acre-foot and $10.70 per acre-foot, respectively. These estimates of cost do not include the cost of water at Wise Power House.

Estimated capital and annual costs of the Whitney Ranch Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Whitney Ranch Dam and Reservoir	$1,200,000	$54,000
Auburn Ravine diversion works and canal	63,000	3,000
Distribution system	50,000	9,000
TOTALS	$1,313,000	$66,000

Clover Valley Project. The proposed Clover Valley Dam and Reservoir would be located on Clover Creek, in Section 18, Township 11 North, Range 7 East, M. D. B. & M., at a site about 1 mile north of Rocklin. Stream bed elevation at the site is 260 feet. For cost estimating purposes it was assumed that Clover Valley Reservoir would conserve the runoff of its own watershed, plus additional water in the amount of 22,000 acre-feet per season from Wise Power House. Winter flows spilled from Wise Power House would be diverted from Auburn Ravine and conveyed in the existing Auburn Ravine Canal of the Nevada Irrigation District for a distance of about 1.1 miles. At this point the water would be diverted from the canal and conveyed southerly in a siphon across Auburn Ravine and thence southwesterly in a canal for a distance of about 14 miles, discharging through a tunnel about 0.35 mile in length into Clover Creek about 0.8 mile above the flow line of the proposed Clover Valley Reservoir. The conserved water would be released from the reservoir to Clover Creek, and would be available for downstream diversion and use.

In Chapter III it was estimated that the present requirement for supplemental water in the Valley Unit is about 8,300 acre-feet per season. However, in design of the Clover Valley Project it was considered desirable to provide some capacity for future growth in water requirement which would occur through development of irrigable lands not presently irrigated.

As a first step in determination of the size of the Clover Valley Project, estimates were made of yield of the proposed works. It was estimated that mean seasonal runoff of Clover Creek, from the approximately 3.3 square miles of watershed above the dam site, is about 2,000 acre-feet. As previously discussed, it was assumed that an additional 22,000 acre-feet of water per season would be conveyed to Clover Valley Reservoir from Wise Power House on Auburn Ravine.

Based on records and estimates of runoff during the critical dry period which occurred in the Sacramento Valley from 1920-21 through 1934-35, a yield study was made of a 21,600 acre-foot reservoir at the Clover Valley site. It was indicated that the Clover Valley Reservoir could be operated with only negligible deficiency through the critical period. Monthly demands on the reservoir were assumed to be proportional to the estimated distribution of irrigation demands in the Valley Unit, as presented in Table 46, except for modification in April and May to permit greater irrigation of rice. The result of the yield study is presented in Table 100.

TABLE 100

ESTIMATED SEASONAL IRRIGATION YIELD OF CLOVER VALLEY RESERVOIR WITH AUBURN RAVINE DIVERSION, BASED ON CRITICAL DRY PERIOD FROM 1920-21 THROUGH 1934-35

(In acre-feet)

Reservoir storage capacity	Irrigation yield
21,600	22,000

Releases to Clover Valley Reservoir from Wise Power House after the end of April and during the irrigation season would result in corresponding increases in yield.

After consideration of the yield study, together with topography of the dam site and cost analyses hereinafter discussed, a reservoir of 21,600 acre-foot capacity, with estimated seasonal irrigation yield of 22,000 acre-feet, was chosen for purposes of cost estimates to be presented in this bulletin. The yield study is included in Appendix M.

It was assumed that conveyance losses, plus the unconsumed portion of the supplemental water supply applied to irrigation, would be effective in preventing progressive and permanent lowering of ground water levels in the area served and in adjacent areas. It was estimated that seasonal losses of water in conveyance and distribution of the 22,000 acre-feet of seasonal irrigation yield would be about 25 per cent, or 5,500 acre-feet, leaving some 16,500 acre-feet per season for surface application to irrigation. It was also assumed that the average seasonal application would be 3.5 acre-feet per acre. On this basis it was estimated that the supplemental water would be applied to some 4,700 acres of irrigable land presently not irrigated. These lands are in a service area lying generally adjacent to Clover and Linda Creeks and easterly of the boundary of Reclamation District 1000, as shown on Plate 27a.

TABLE 101

ESTIMATED MONTHLY DISTRIBUTION OF DEMAND FOR WATER FROM CLOVER VALLEY PROJECT

Month	Per cent of seasonal total	Gross release, in acre-feet
April	6	1,300
May	14	3,100
June	20	4,400
July	23	5,100
August	22	4,800
September	11	2,400
October	3	700
November	1	200
TOTALS	100	22,000

An estimate of the monthly distribution of demand for irrigation water in the Valley Unit was presented in Table 46. Based on these data, with modification to permit greater irrigation of rice, monthly demands on the Clover Valley Project would be as shown in Table 101.

A topographic map of the Clover Valley dam and reservoir area at a scale of 1 inch equals 500 feet, with contour interval of 10 feet, was made by the Division of Water Resources in 1951, using plane table methods. Topography of the dam and reservoir site is also shown on the Rocklin quadrangle of the United States Geological Survey, at a scale of 1:24,000, with contour interval of 20 feet. Storage capacities of Clover Valley Reservoir at various stages of water surface elevation are given in Table 102.

TABLE 102

AREAS AND CAPACITIES OF CLOVER VALLEY RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	260	0	0
20	280	38	250
40	300	90	1,520
60	320	170	4,150
80	340	250	8,380
100	360	330	14,200
120	380	410	21,600
130	390	450	25,700
140	400	490	30,700

The Clover Valley dam site is topographically limited to a dam about 150 feet in height. The site is suitable, from both the topographic and geologic viewpoints, only for an earthfill dam. Preliminary geologic reconnaissance indicates that the bedrock locally consists of a variety of materials. The broad bottom of the valley is probably underlain by granitic rock, although exploration would be needed to establish this fact. Overlying the hard granite, and forming most of the abutments, are mixed sediments of the Ione formation. These include lagunal sandstones, conglomerates, and siltstones, all of which are poorly consolidated. High on the abutments, capping the interfluvial ridges, are found andesitic flow rocks which are hard but strongly and blockily jointed.

Slopes of both abutments are very even. Required stripping from the abutments would consist of about 3 feet of overburden and 4 feet of rock, and about 8 feet of fill and 2 feet of rock from the channel section.

The best location for a spillway would be through a saddle to the northwest of and about 750 feet upstream from the right abutment of the dam. Elevation of the saddle is about 415 feet. Excavation of the spillway would require stripping of about 5 feet of overburden consisting mostly of loose lava blocks.

An adequate supply of material for the impervious section of the dam is available within a distance of about one and one-half miles. However, much of the material would need to be sorted from gravels and tests would be required since the material is somewhat sandy. There is abundant local material for the pervious section, including layers of stream bed gravels and salvage of stripping from the abutments and spillway. In addition, the local volcanics could be quarried readily for use as riprap.

The land within the broad, flat valley of the reservoir area is almost entirely native grazing land with scattered oaks. There are no major roads within the reservoir area. Construction of the dam and reservoir would make necesary the relocation of about 3 miles of underground toll cable which traverses most of the length of the reservoir.

As a result of yield studies, geologic reconnaissance, and preliminary cost estimates, an earthfill dam 120 feet in height from stream bed to spillway lip, and with a crest elevation of 390 feet, was selected to illustrate estimates of cost of the Clover Valley Project. The dam would have a crest length of about 1,910 feet, a crest width of 30 feet, and 2.5:1 upstream and downstream slopes. The impervious core would have a top width of 10 feet, and 1:1 upstream and downstream slopes. The pervious zone would consist of stream bed gravels and materials salvaged from stripping and excavation. The upstream slope would be protected by a 3-foot blanket of riprap. The volume of fill would be an estimated 2,770,000 cubic yards.

The concrete spillway would be of the ogee weir type, located in a saddle north of the right abutment, and the spillway channel would be lined. The maximum depth of water above the spillway would be 5 feet and an additional 5 feet of freeboard would be provided. The spillway would have a capacity of 3,100 second-feet, required for an assumed maximum discharge of 940 second-feet per square mile of drainage area, and would discharge into a tributary of Pleasant Grove Creek.

The outlet works would consist of a 42-inch diameter welded steel pipe, placed in a trench excavated in rock beneath the right abutment of the dam and encased in concrete. Releases from the reservoir would be controlled at a submerged concrete box inlet structure by a 36-inch diameter hydraulically controlled butterfly valve, operated from a control house on the crest of the dam. The outlet would be controlled at the downstream end by a 42-inch diameter hollow jet valve, discharging into a stilling basin and into Clover Creek downstream from the dam. The conserved water would be conveyed in the natural channel of Clover Creek for diversion by downstream users.

The proposed diversion works on the Auburn Ravine Canal would be located at an elevation of about 490 feet, about 1.2 miles downstream from the existing diversion structure. A headwall with two 4- by 4-foot slide gates would be constructed across the Auburn Ravine Canal. A side channel delivery gate in the left bank of the canal would provide entrance to the siphon crossing Auburn Ravine. The siphon, consisting of welded steel pipe with a diameter of 3.5 feet and a length of about 1,500 feet, would cross Auburn Ravine in a southwesterly direction and would discharge into a canal. The canal, with a capacity of 75 second-feet and a length of about 14.1 miles, would be unlined. It would have a trapezoidal section, 3.0-foot bottom width, 1.5:1 side slopes, and a water depth of 3.4 feet. The canal would discharge through a tunnel about 0.35 mile in length into Clover Valley about 0.8 mile above the flow line of the proposed Clover Valley Reservoir. The tunnel would be concrete lined and would have a diameter of 6.0 feet.

Detailed design of the distribution system was considered to be outside the scope of the current investigation. Cost estimates for the system were based on known costs of similar irrigation works elsewhere in California, adjusted to correspond with conditions prevailing in Placer County.

Pertinent data with respect to general features of the Clover Valley Project, as designed for cost estimating purposes, are presented in Table 103.

TABLE 103

GENERAL FEATURES OF CLOVER VALLEY PROJECT

Clover Valley Dam
- Type—earthfill
- Crest elevation—390 feet
- Crest length—1,910 feet
- Crest width—30 feet
- Height, spillway lip above stream bed 120 feet
- Side slopes—2.5:1
- Freeboard, above spillway lip—10 feet
- Elevation of stream bed—260 feet
- Volume of fill—2,770,000 cubic yards

Reservoir
- Surface area at spillway lip—410 acres
- Storage capacity at spillway lip—21,600 acre-feet
- Drainage area, Clover Creek—3.3 square miles
- Estimated mean seasonal runoff, Clover Creek—2,000 acre-feet
- Estimated maximum, seasonal diversion of water from Wise Power House—22,000 acre-feet
- Estimated seasonal irrigation yield—22,000 acre-feet
- Type of spillway—ogee weir
- Spillway discharge capacity—3,100 second-feet
- Type of outlet—42-inch diameter welded steel pipe beneath dam

Diversion Works—side channel delivery gate; two 4- by 4-foot slide headgates in concrete headwall

Conduits
- Siphon—welded steel pipe, 3.5 feet in diameter with capacity of 75 second-feet, and 1,500 feet in length
- Canal

Type—trapezoidal, unlined	Freeboard, in feet—1.0
Length, in miles—14.1	Slope, in feet per mile—4.2
Side slopes—1.5:1	Velocity, in feet per second—2.5
Bottom width, in feet—3.0	Capacity, in second-feet—75
Depth, in feet—3.4	

- Tunnel—lined, horseshoe tunnel, 6.0 feet in diameter and 0.35 mile in length

The capital cost of the Clover Valley Project, on a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be $3,896,000, and the corresponding annual cost was estimated to be about $183,000. The resultant estimated average unit cost of the 22,000 acre-feet of irrigation yield per season was about $8.30 per acre-foot. The estimated unit cost of the 16,500 acre-feet of supplemental water per season applied for irrigation in the service area considered was about $11.10 per acre-foot. On a 4 per cent interest basis these unit costs were about $9.70 per acre-foot and $13.00 per acre-foot, respectively. These estimates of cost do not include the cost of water at Wise Power House.

Estimated capital and annual costs of the Clover Valley Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Clover Valley Dam and Reservoir	$3,204,000	$132,000
Clover Valley diversion and conduit	574,000	30,000
Distribution system	118,000	21,000
TOTALS	$3,896,000	$183,000

Auburn Ravine Power Development Project. Wise Power House, owned by the Pacific Gas and Electric Company and located on Auburn Ravine about 2 miles west of Auburn, discharges in excess of 200,000 acre-feet of water per season into the South Canal. During the irrigation season water is diverted from the South Canal into Auburn Ravine for downstream diversion and use. Portions of the remaining water in the canal are diverted into the Dutch Ravine and Boardman Canals, the Greeley Ditch, and the Monte Rio Pipe Line for irrigation, domestic, and municipal use in the service areas below these canals. The water not so diverted from the South Canal spills into the American River. The average seasonal spill to the American River during the period from 1932-33 through 1949-50 was about 130,000 acre-feet.

The hydroelectric power potentiality of the water discharged from Wise Power House could be realized by its discharge through a new power house which could be constructed either at a site on the American River or at a site on Auburn Ravine. As an example, a project involving a new power house on Auburn Ravine is described in this section. This project is subsequently referred to as the "Auburn Ravine Power Development Project," and its principal features are delineated on Plate 28, "Auburn Ravine Power Development Project."

Studies indicate that it would be feasible to divert from the South Canal the entire amount of water otherwise spilled to the American River, and to discharge this water, together with water presently diverted to Auburn Ravine, through the new power house.

The proposed project would involve diversion of water from the South Canal at the entrance portal of Tunnel 11 about 2 miles below Wise Power House, and conveyance of the diverted water to the forebay of the proposed Auburn Power House. This power house would be located on Auburn Ravine at a site immediately downstream from the proposed Auburn Ravine Dam, described in a previous section as some 2 miles west of Ophir and some 8 miles east of Lincoln. The water, after discharge from the power house, would be released to the natural channel of Auburn Ravine for downstream diversions to off-stream storage or for irrigation. Surplus water would discharge into the Natomas Cross Canal and the Sacramento River.

Records of discharge of water available from Wise Power House, measured as the sum of the diversion to Gold Hill from South Canal at Wise Power House, the diversion to Gold Hill from South Canal at Tunnel 11, and the flow of South Canal below Tunnel 16, indicate that during the 12-year period from 1940-41 through 1951-52, the average seasonal flow was 165,800 acre-feet, the minimum seasonal flow was 123,700 acre-feet, which occurred in 1945-46, and the maximum seasonal flow was 189,000 acre-feet, which occurred in 1951-52. In the studies it was assumed that 123,700 acre-feet, the amount of the minimum recorded seasonal flow, would be available each season for discharge through the Auburn Power House.

The diversion works on South Canal would be located at the entrance portal of Tunnel 11. The existing headgates and spillway which permit discharge into Auburn Ravine would be retained. A headwall with three 5- by 6-foot slide gates would be constructed across the South Canal just upstream from the entrance portal to Tunnel 11. An opening cut in the right bank upstream from the foregoing headwall would provide entrance to a side channel leading downstream about 10 feet to a second headwall with three 5- by 6-foot slide gates serving the proposed canal. The canal, with a capacity of 400 second-feet and a length of about 2.6 miles, would be shotcrete-lined. It would have a trapezoidal section, 6.0-foot bottom width, 1 : 1 side slopes, and water depth of 5.8 feet. The canal would discharge into a forebay of 200 acre-foot storage capacity above the power house. The forebay, with a water surface elevation of about 875 feet, would discharge into a steel penstock about 4,600 feet in length and with a 5.5-foot to 4.5-foot variable diameter. The power house would be located on the left bank of Auburn Ravine, in Section 14, Township 12 North, Range 7 East, M. D. B. & M., at an elevation of 420 feet, at a site immediately downstream from the previously described Auburn Ravine Dam. The major generating unit of the plant would

South Canal at Tunnel II

Halsey Power House

operate under an average static head of 455 feet and would have an installed power capacity of 10,000 kilowatts. A second generator with installed power capacity of 1,000 kilowatts would be driven by water discharged from Auburn Ravine Reservoir.

Pertinent data with respect to general features of the Auburn Ravine Power Development Project, as designed for cost estimating purposes, are presented in Table 104.

TABLE 104

GENERAL FEATURES OF AUBURN RAVINE POWER DEVELOPMENT PROJECT

South Canal Diversion — cut in right bank of existing channel section at entrance portal of Tunnel 11; side channel with three 5- by 6-foot slide gates in concrete headwall

Canal
- Type—trapezoidal, shotcrete-lined
- Length—2.6 miles
- Bottom width—6.0 feet
- Depth—5.8 feet
- Freeboard—1.0 foot
- Slope—4.5 feet per mile
- Velocity—6.0 feet per second
- Capacity—400 second-feet

Forebay
- Average elevation of water surface—875 feet
- Storage capacity—200 acre-feet

Auburn Power House
- Average static head
  - Main generating unit—455 feet
  - Additional generator—185 feet
- Installed power capacity—11,000 kilowatts
- Dependable power capacity—8,000 kilowatts
- Average annual energy output—62,000,000 kilowatt-hours

The capital cost of the Auburn Ravine Power Development Project, on a 3 per cent interest basis and based on prices prevailing in April, 1953, was estimated to be about $2,769,000. The corresponding annual cost of the project was estimated to be about $206,000. On a 4 per cent interest basis the annual cost would be about $228,000. If an annual value of $22.00 per kilowatt of dependable power capacity is assigned to the Auburn Power House, and a value of 2.8 mills per kilowatt-hour is assigned to the estimated 62,000,000 kilowatt-hours of average energy output per season that would be produced by this plant, the seasonal power revenue would amount to $350,000, with resultant estimated annual net incomes of $144,000 and $122,000 at 3 and 4 per cent interest rates, respectively.

Estimated capital and annual costs of the Auburn Ravine Power Development Project on a 3 per cent interest basis are summarized in the following tabulation. Detailed cost estimates are presented in Appendix N.

	Estimated Costs	
	Capital	*Annual*
Power house	$1,742,000	$151,000
Penstock	470,000	27,000
Forebay	356,000	17,000
Canal	199,000	11,000
TOTALS	$2,769,000	$206,000

Discussion of Plans for Water Supply Development. The several plans for initial development of supplemental water supplies for Placer County which were given consideration in the current investigation have been described in some detail in the preceding sections. Four of the projects, Jackson Meadows, Lake Valley, the alternative to Lake Valley, Cisco, and the Rollins Project would provide additional conservation facilities for waters of the Yuba and Bear Rivers, and would also provide considerable amounts of hydroelectric energy by discharge of the conserved water through new and existing power houses. Water developed by these projects could be utilized in any of the units of Placer County except that portion of the American River Unit referred to as the Foresthill Divide. Sufficient water would be developed to meet present supplemental requirements, and to provide for substantial future growth in water demand which would occur through development of irrigable lands not presently irrigated.

Two alternative plans have been presented to provide supplemental water for lands on the Foresthill Divide. The first, the French Meadows Project, would provide for conservation of runoff of the Middle Fork of the American River and its conveyance to irrigable lands on the Foresthill Divide. It would also result in the release of a considerable amount of regulated water in the North Fork of the American River and the generation of a substantial quantity of hydroelectric energy. The second plan, the Foresthill Divide Project, would also provide water for irrigable lands on the Foresthill Divide, but under a more localized plan of development and without generation of hydroelectric energy. Construction of either of these projects would meet the probable ultimate supplemental water requirement of the Foresthill Divide.

Seven other projects for Placer County have been described, each involving the construction of a reservoir in the lower foothills of the Sierra Nevada. These projects, Camp Far West, Coon Creek, Doty Ravine, Lincoln, Auburn Ravine, Whitney Ranch, and Clover Valley would each conserve water which could be utilized on lower lands. Any or all of these seven projects, if constructed, would provide water to meet the present supplemental water requirement in the Valley Unit of Placer County, as well as in portions of adjacent counties. They would also provide for substantial future growth in water demand which would occur through development of irrigable lands not presently irrigated.

The final project described in this bulletin is a plan to develop hydroelectric energy from water presently discharged from Wise Power House. This project could be operated separately or in conjunction with the Doty Ravine, Lincoln, Auburn Ravine, Whitney Ranch, or Clover Valley Projects.

In addition to the foregoing, water in sufficient amount to meet the ultimate requirements of Placer

TABLE 105

ECONOMIC COMPARISON OF POTENTIAL WATER DEVELOPMENT PROJECTS FOR PLACER COUNTY

Project	Reservoir storage capacity, in acre-feet	Seasonal yield, in acre-feet	Capital cost		Annual cost at 3 per cent interest		Annual power revenue	Annual excess of power revenue over cost	Net return on capital investment from sale of power, in per cent
			Total	Per acre-foot of seasonal yield	Total	Per acre-foot of seasonal yield			
Yuba River Developments									
Jackson Meadows	45,000	[a]17,000	$5,644,000	$332	$250,000	$14.70	$151,000	------	0
Lake Valley	41,000	[a]48,000	10,110,000	211	654,000	13.60 [c]9.80	836,000	$182,000	1.80
Cisco	100,000	[a]71,000	23,303,000	328	1,212,000	3.70 [c]9.90	1,375,000	163,000	0.70
Rollins	70,000	[a]135,000	9,437,000	70	562,000	4.20 [c]1.10	961,000	399,000	4.23
American River Developments									
French Meadows	155,000	[a]119,000	48,716,000	409	2,432,000	20.40	1,628,000	-------	----
Foresthill Divide	28,800	[b]24,700	5,924,000	240	310,000	[d]12.60	0	-----	----
Valley Developments									
Camp Far West	104,000	[b]80,000	5,340,000	59	305,000	[d]3.80	0	-------	-
Coon Creek	59,000	[b]56,000	5,574,000	100	283,000	[d]5.10	0	-------	---
Doty Ravine	32,000	[b]28,000	3,352,000	120	170,000	[d]6.10	0	-------	---
Lincoln	15,000	[b]17,500	1,321,000	76	66,000	[d]3.80	0	-------	---
Auburn Ravine	11,700	[b]13,000	3,170,000	244	147,000	[d]11.30	0	-------	---
Whitney Ranch	10,300	[b]9,500	1,313,000	138	66,000	[d]6.90	0	-------	---
Clover Valley	21,600	[b]22,000	3,869,000	176	183,000	[d]8.30	0	---	---
Auburn Ravine Power Development	------	0	2,769,000	----	206,000	----	350,000	144,000	5.20

[a] New safe yield.
[b] Irrigation yield.
[c] Excluding cost of power facilities.
[d] Includes cost of distribution system.

County would be available from future major units of The California Water Plan, including works on the Yuba, Bear, and American Rivers. The major units will be described in a future publication of the State Water Resources Board.

Table 105 presents an economic comparison of the various projects for initial development of supplemental water supplies for Placer County.

As shown in Table 105, the Jackson Meadows and Lake Valley Projects, the latter's alternative, the Cisco Project, and the Rollins Project would provide about 17,000 acre-feet, 48,000 acre-feet, 71,000 acre-feet, and 135,000 acre-feet, respectively, of new safe seasonal yield of water, with estimated capital costs ranging from about $5,600,000 to $23,000,000, or roughly in proportion to the new safe yields. Annual costs of the water would range from about $4.00 to $15.00 per acre-foot for the respective projects, excluding consideration of possible revenues from the sale of hydroelectric power. Power revenues from certain projects would exceed annual costs, excluding consideration of additional possible revenues from sale of water.

From a local point of view, the Foresthill Divide Project probably would be more desirable than the French Meadows Project. This is true because it would require a capital investment of only about $6,000,000, rather than the $49,000,000 estimated for the latter project. Furthermore, only a small portion of the yield of the larger project could be utilized on the Foresthill Divide, and unit cost of the developed water would be excessive until such time as the major portion of the yield could be put to beneficial use elsewhere. However, revenues from the sale of hydroelectric power would reduce the estimated annual unit cost of the safe seasonal yield to about $6.80 per acre-foot if all of the yield of water were marketed.

The seven Valley Unit developments, the Camp Far West, Coon Creek, Doty Ravine, Lincoln, Auburn Ravine, Whitney Ranch, and Clover Valley Projects, would provide supplemental water in amounts ranging from 80,000 acre-feet to 9,500 acre-feet per season, and at estimated capital costs ranging from about $5,600,000 to $1,300,000, or very roughly in proportion to yield from the developments. Annual unit costs of the seasonal irrigation yield would vary from about $4.00 to about $11.00 per acre-foot. Of the seven projects, it would appear that the Camp Far West Project, with an estimated capital cost of about $5,300,000 and annual unit cost of seasonal irrigation yield of about $4.00 per acre-foot, is the most favorable. This is emphasized by the fact that seasonal irrigation yield of the Camp Far West Project would be about 80,000 acre-feet—considerably larger than that for any of the other Valley development plans considered.

CHAPTER V

SUMMARY OF CONCLUSIONS, AND RECOMMENDATIONS

As a result of field investigation and analysis of available data on the water resources and water problems of Placer County, and on the basis of the estimates and assumptions discussed hereinbefore, the following conclusions and recommendations are made.

SUMMARY OF CONCLUSIONS

1. The present basic water problem in the Foothill, American River, and Bear River Units of Placer County is the limitation on desirable expansion of irrigated agriculture imposed by the insufficiency of developed water supplies. In the Tahoe Unit the present basic water problem is flood damage to recreational property along the shore of Lake Tahoe which occurs at times of high lake levels. The present basic water problems in the Valley Unit are largely confined to progressive lowering of ground water levels and to low yields of wells in certain areas.

2. Elimination of the foregoing problems, prevention of their recurrence in the future, and provision of water for lands not now served will require further development of water supplies available to Placer County.

3. Direct precipitation, and runoff from the highly productive tributary watersheds of the Sierra Nevada, constitute ample sources of water supply for present and future water service areas in Placer County. Mean seasonal depths of precipitation over the Valley and Foothill Units are about 18.9 inches and 24.5 inches, respectively. Direct precipitation contributes water in a mean seasonal amount of about 172,000 acre-feet to the Valley Unit, and about 288,000 acre-feet to the Foothill Unit. Mean seasonal natural runoff of the American River at Fair Oaks is slightly in excess of 2,770,000 acre-feet.

4. The ground water basin underlying the Valley Unit of Placer County functions as a natural regulatory reservoir, and at the present time about two-thirds of the irrigated valley floor lands of the unit are irrigated with water pumped from this reservoir. Storage capacity of the ground water basin is about 1,022,000 acre-feet between the levels of 20 and 200 feet below the ground surface, and its safe seasonal yield, with average maintenance of ground water levels prevailing in 1950-51, is about 20,000 acre-feet.

5. The gross extraction of ground water in the Valley Unit during 1950-51 was about 29,000 acre-feet, about 9,000 acre-feet in excess of the safe yield. Average ground water levels fell about 7.8 feet from the fall of 1948 to the fall of 1952, coincident with rapid development and increased use of ground water. This lowering, which continued to the fall of 1954, has resulted in increased agricultural production costs.

6. Satisfactory wells with yields sufficient for irrigation purposes may be obtained in all but certain small areas in the Valley Unit.

7. The surface water supplies of Placer County are of excellent mineral quality. The ground water supplies of the Valley Unit are generally of excellent to good mineral quality. However, in scattered wells along the eastern edge of the valley floor, ground water of poor mineral quality has been found.

8. At the present time there are approximately 39,000 acres of irrigated land in Placer County, distributed as follows: Valley Unit, 10,700 acres; Foothill Unit, 24,500 acres; American River Unit, 2,400 acres; Bear River Unit, 1,400 acres; Yuba River Unit, 0 acres; and Tahoe Unit, 0 acres.

9. The probable ultimate land use pattern of Placer County will include about 160,000 acres of irrigated land, distributed as follows: Valley Unit, 68,300 acres; Foothill Unit, 65,600 acres; American River Unit, 20,200 acres; Bear River Unit, 6,000 acres; Yuba River Unit, 0 acres; and Tahoe Unit, 0 acres.

10. The present mean seasonal water requirement in Placer County, measured in terms of consumptive use of applied water, is about 96,600 acre-feet, distributed among the units as follows: Valley Unit, 41,100 acre-feet; Foothill Unit, 47,700 acre-feet; American River Unit, 3,800 acre-feet; Bear River Unit, 2,600 acre-feet; Yuba River Unit, 100 acre-feet; Tahoe Unit, 400 acre-feet; and an additional 900 acre-feet for national forests which overlap several of the units. Of the total amount of water including rainfall now consumptively used in the Valley Unit, approximately 30 per cent is consumed in the production of irrigated crops. Dry-farmed and fallow lands, native vegetation, and lands devoted to miscellaneous uses including urban areas, consume the remaining 70 per cent.

11. Under conditions of ultimate development in Placer County the mean seasonal requirement for water, measured in terms of consumptive use of applied water, will probably increase to about 406,000 acre-feet, distributed among the several units as follows: Valley Unit, 225,000 acre-feet; Foothill Unit, 133,000 acre-feet; American River Unit, 31,000 acre-feet; Bear River Unit, 11,000 acre-feet; Yuba River Unit, 200 acre-feet; Tahoe Unit, 2,000 acre-feet; and an additional 3,400 acre-feet for national forest lands.

12. The present mean seasonal requirement for supplemental water in the Valley Unit, in order to prevent progressive lowering of ground water levels, is about 8,300 acre-feet. While agricultural growth in remaining units of Placer County has been limited to some extent by the available developed water supplies, such present supplemental water requirements as may exist in these units are small and not readily susceptible to evaluation.

13. Under ultimate conditions of development the mean seasonal requirement for supplemental water in Placer County probably will be about 355,000 acre-feet, distributed among the units as follows: Valley Unit, 189,000 acre-feet; Foothill Unit, 113,000 acre-feet; American River Unit, 36,000 acre-feet; Bear River Unit, 11,000 acre-feet; Yuba River Unit, 100 acre-feet; Tahoe Unit, 2,100 acre-feet; and an additional 3,300 acre-feet for national forest lands.

14. Major features of The California Water Plan, which is presently being formulated under direction of the State Water Resources Board, will provide supplemental water to meet the probable ultimate requirements of Placer County. It is feasible, from an engineering standpoint, to so regulate and conserve the relatively large flood flows of the Yuba, Bear, American, and Truckee Rivers as to yield firm water supplies considerably in excess of the probable ultimate supplemental water requirements of the county.

15. An immediate source of supplemental water is available to Placer County in the surface water presently wasting from the area, the salvage of which will require the construction of water storage, conveyance, and distribution facilities. The estimated capital costs of considered water development projects for the county vary from about $1,300,000 to $49,000,000, and the estimated average annual unit costs of new water made available by these developments vary from about $1 to $20 per acre-foot. In the case of certain of the projects these unit costs would be reduced by the sale of hydroelectric power.

16. New water sufficient to meet the present and a portion of the probable ultimate supplemental requirements of the Valley, Foothill, American River, Bear River, and Yuba River Units could be made available by construction of the Jackson Meadows or Lake Valley Projects, or the latter's alternative, the Cisco Project, or the Rollins Project. The capital costs of these projects were estimated to be about $5,644,000, $10,110,000, $23,303,000, and $9,437,000, respectively. Excluding consideration of revenues from the sale of power, average unit costs of the 17,000 acre-feet, 48,000 acre-feet, 71,000 acre-feet, and 135,000 acre-feet of new safe seasonal yield developed by the respective projects would be about $15, $10, $10, and $1, on a 3 per cent interest basis. Power revenues, however, would exceed annual costs in the case of all but the Jackson Meadows Project, and would result in returns on the capital investments of about 1.8 per cent, 0.7 per cent, and 4.2 per cent, respectively, excluding consideration of possible revenues from the sale of water.

The four projects are engineeringly feasible, and selection of the most desirable project for initial construction would depend upon such factors as present local capacity to finance, the rate at which the project yield could be sold and put to beneficial use, and future growth in water demands.

17. New water sufficient to meet the probable ultimate supplemental requirement of the Foresthill Divide could be made available by construction of the French Meadows or Foresthill Divide Projects, the capital costs of which were estimated to be about $48,716,000, and $5,924,000, respectively. The average unit costs of the 119,000 acre-feet of safe seasonal yield and 25,000 acre-feet of seasonal irrigation yield developed by the respective projects would be about $20 and $13, on a 3 per cent interest basis. Revenues from the sale of hydroelectric power would reduce the estimated annual unit cost of yield of the French Meadows Project to about $7 per acre-foot if all the yield were marketed.

Although both projects are engineeringly feasible, the Foresthill Divide Project probably would be more desirable than the French Meadows Project from a local point of view, because of its much lower capital cost. The indicated capital cost of the latter project is probably greater than present local capacity to finance, and unit cost of the water developed would be excessive until such time as the major portion of the yield could be sold and exported for beneficial use elsewhere than on the Foresthill Divide.

18. New water sufficient to meet the present and a portion of the probable ultimate supplemental requirements of the Valley Unit could be made available by construction of one or more of the Camp Far West, Coon Creek, Doty Ravine, Lincoln, Auburn Ravine, Whitney Ranch, and Clover Valley Projects. The estimated capital costs of these projects range from about $1,300,000 to $5,600,000, and the projects would provide supplemental water in amounts ranging from 9,500 acre-feet to 80,000 acre-feet per season. The average unit costs of the irrigation yield of water developed by the various projects would range from about $4 to about $11 per acre-foot, on a 3 per cent interest basis.

All of the projects are feasible of construction from the engineering standpoint. Of the seven projects, the Camp Far West Project probably would be the most favorable for initial development, because it would have the lowest annual unit cost of water and a seasonal irrigation yield considerably larger than any of the others. Capital costs of any of the seven projects are probably within the present local capacity to finance.

19. Construction of the Auburn Ravine Power Development Project would result in production of a

considerable amount of hydroelectric energy from discharge of water released from Wise Power House through a new power house that would be located on Auburn Ravine. The capital cost of the Auburn Ravine Power Development Project was estimated to be about $2,770,000. The estimated annual net revenue from such a project, on a 3 per cent interest basis, would be about $144,000, or about 5 per cent on the capital investment.

20. The estimated unit costs of new water for Placer County, as given in the foregoing paragraphs, are based on current prices of construction, and are illustrative of the costs that may be expected in the development of new water for the various units of the County. Certain of the estimated costs are comparable with those of surface and ground water presently served within Placer County. In this connection, as a basis for comparison, the Pacific Gas and Electric Company presently sells agricultural water in its service area in Placer County at a rate corresponding to about $7 per acre-foot, with service at canalside.

RECOMMENDATIONS

It is recommended that:

1. Public districts endowed with appropriate powers be created for the purpose of proceeding with further study of the local water problems and with financing, construction, and operation of projects if found financially feasible.

2. Local development of water resources be accomplished by an orderly progression of phases of development and in accordance with The California Water Plan. The proposed plans should be developed in successive steps, starting with those projects of indicated lowest capital and unit cost of water, and thence proceeding in order of expense to phases of greater unit cost.

3. Stream gaging stations be constructed and continuous records of stream flow be obtained at strategic points on those streams for which future construction of water conservation works is probable, in order to permit more reliable determination of yield of the projects and their most economic design and construction.

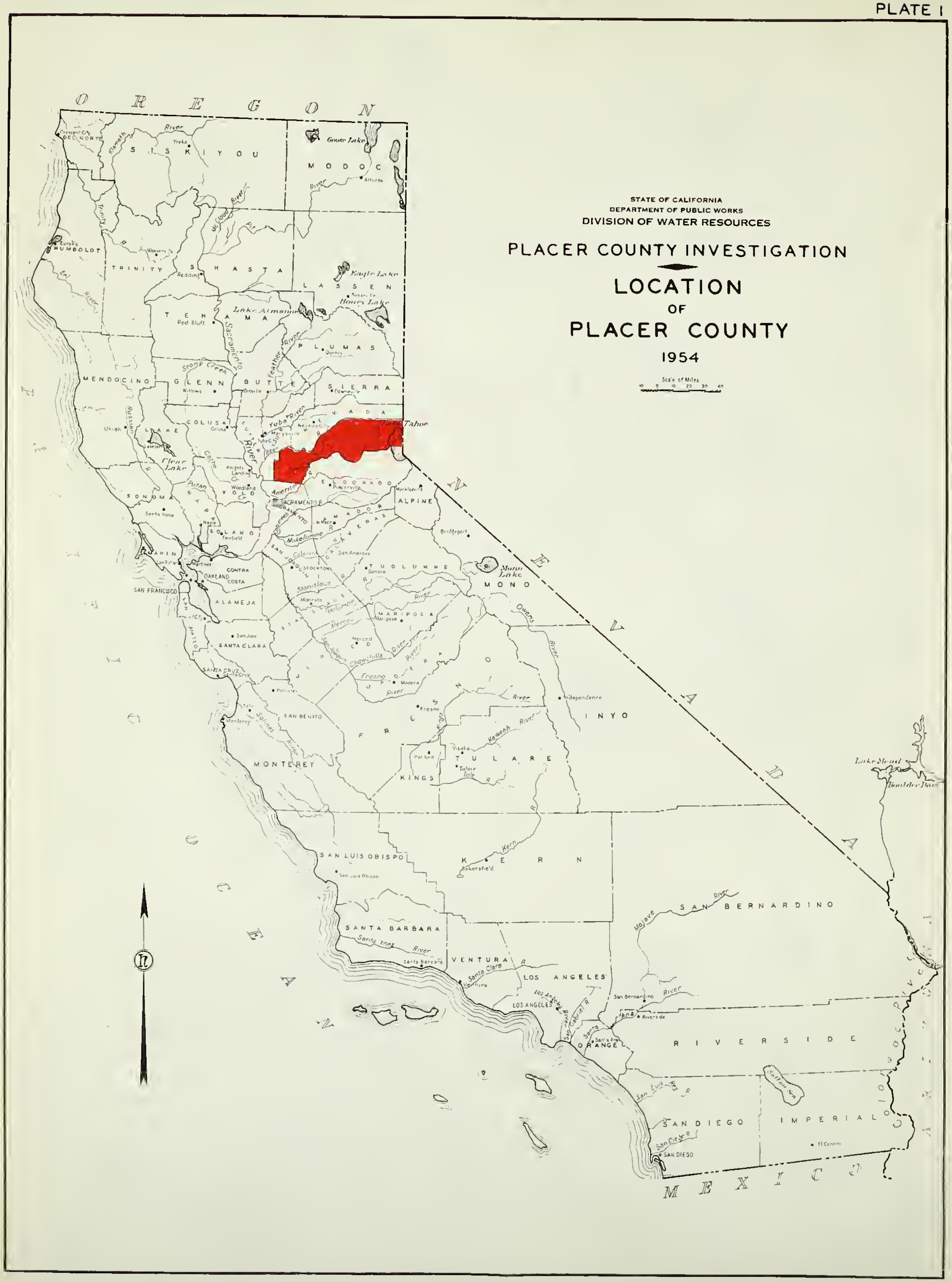
4. Regular periodic observations of ground water levels and sampling of ground water for quality determinations in the Valley Unit be made, and records maintained, in order to permit more reliable determination of safe ground water yield and future ground water conditions.

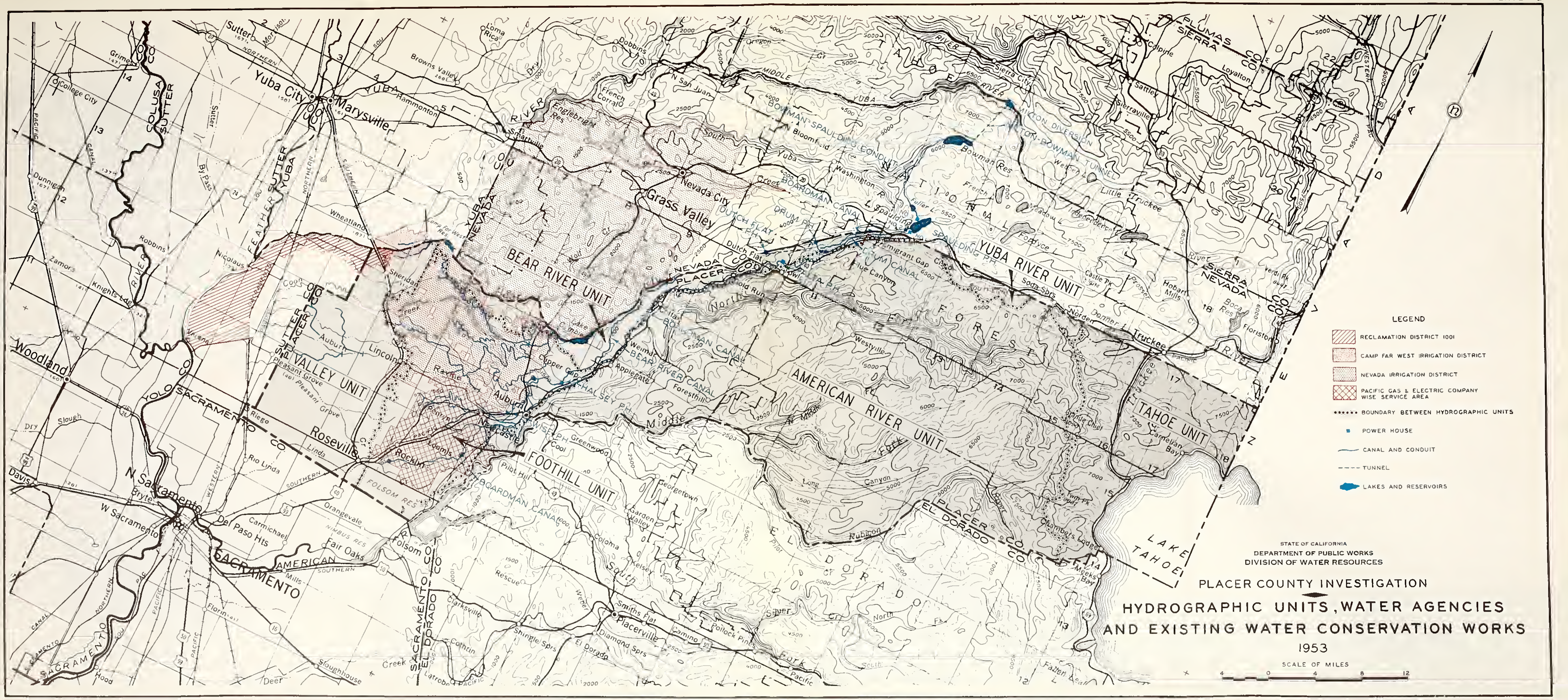
5. Periodic surveys be made of land use and water application as they relate to water utilization, in order to permit evaluation of future water demands and orderly development of water conservation works.

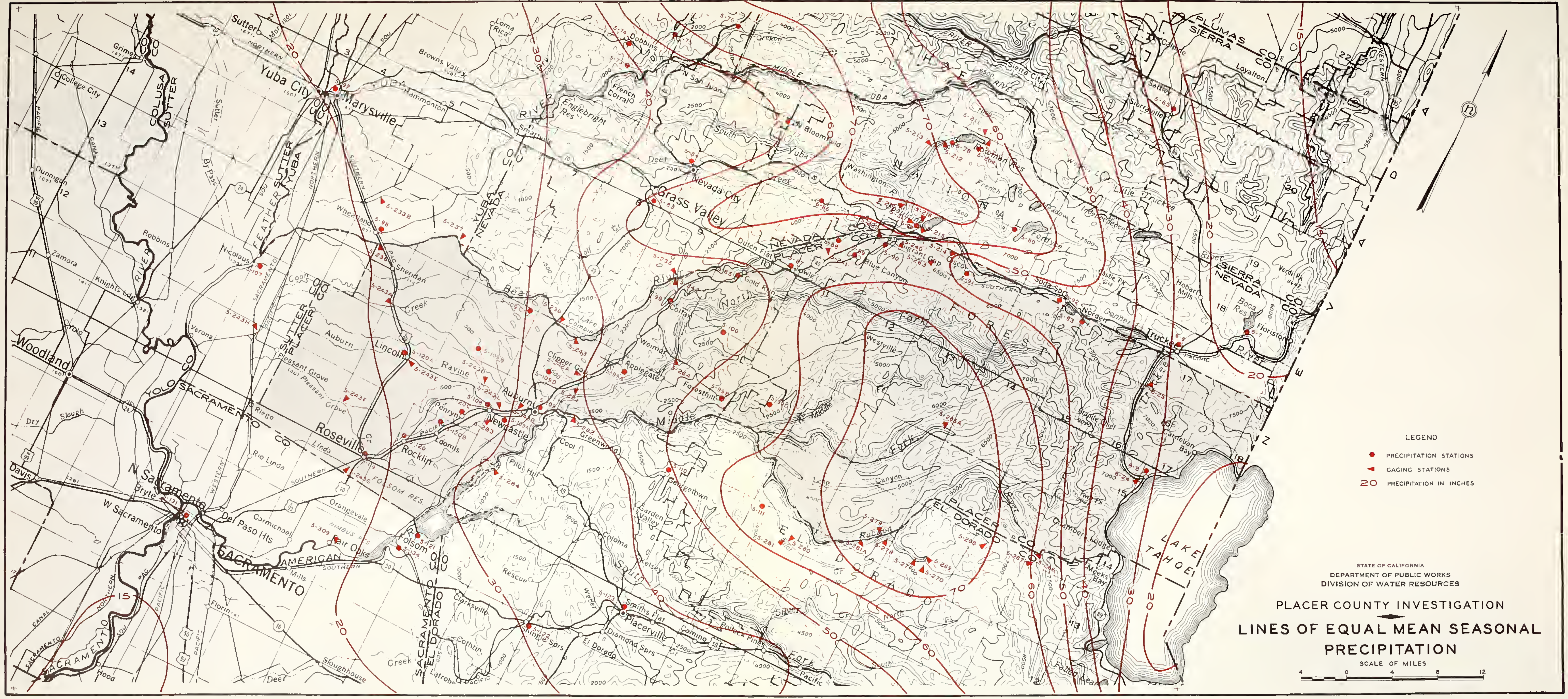
6. A program be initiated for the acquisition of lands, easements, and rights of way necessary for construction of required water conservation works.

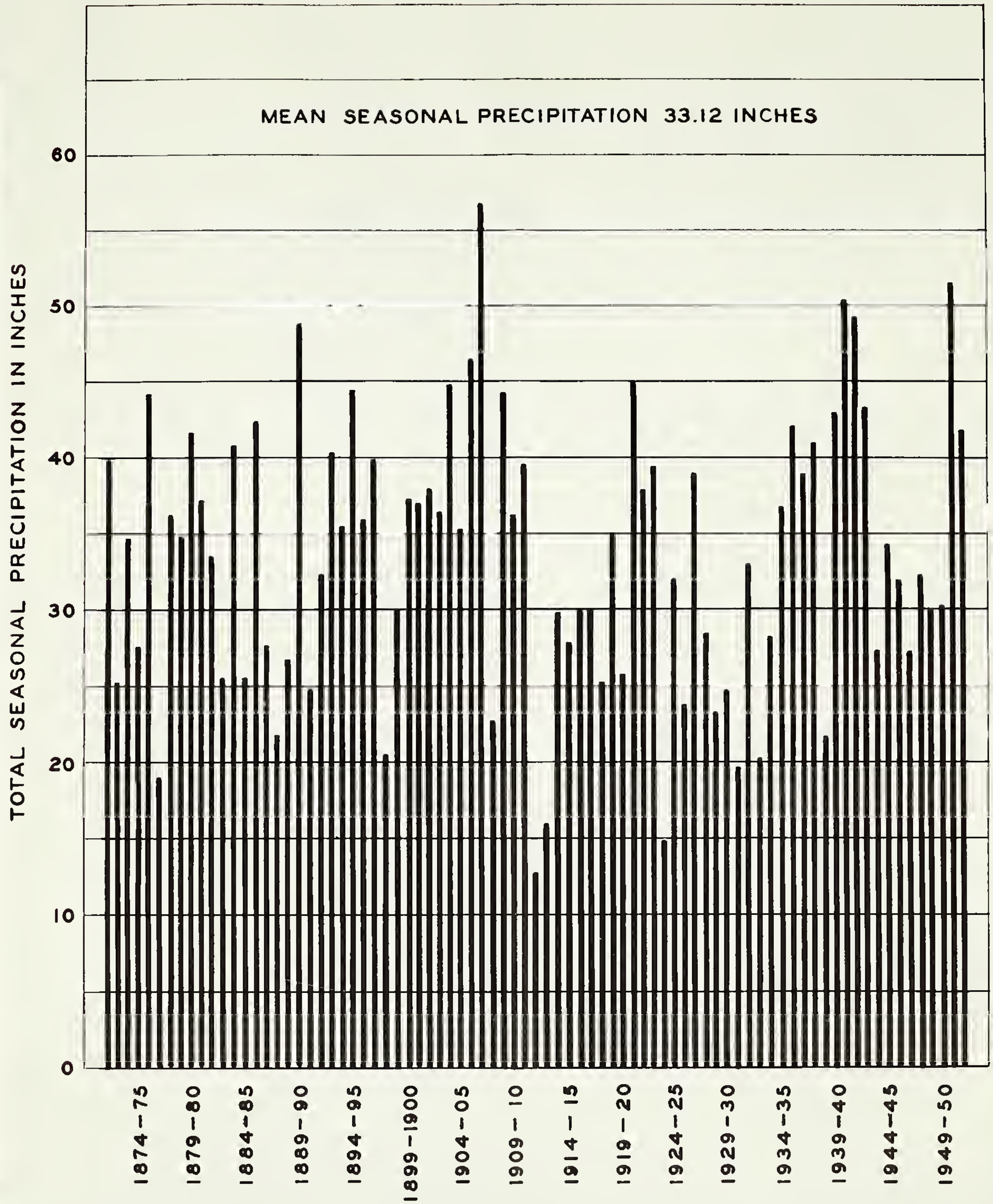
7. Continuing support be given to the investigation and study of major multipurpose development under The California Water Plan, including those on the Yuba, Bear, American, and Truckee River systems.

PLATE I

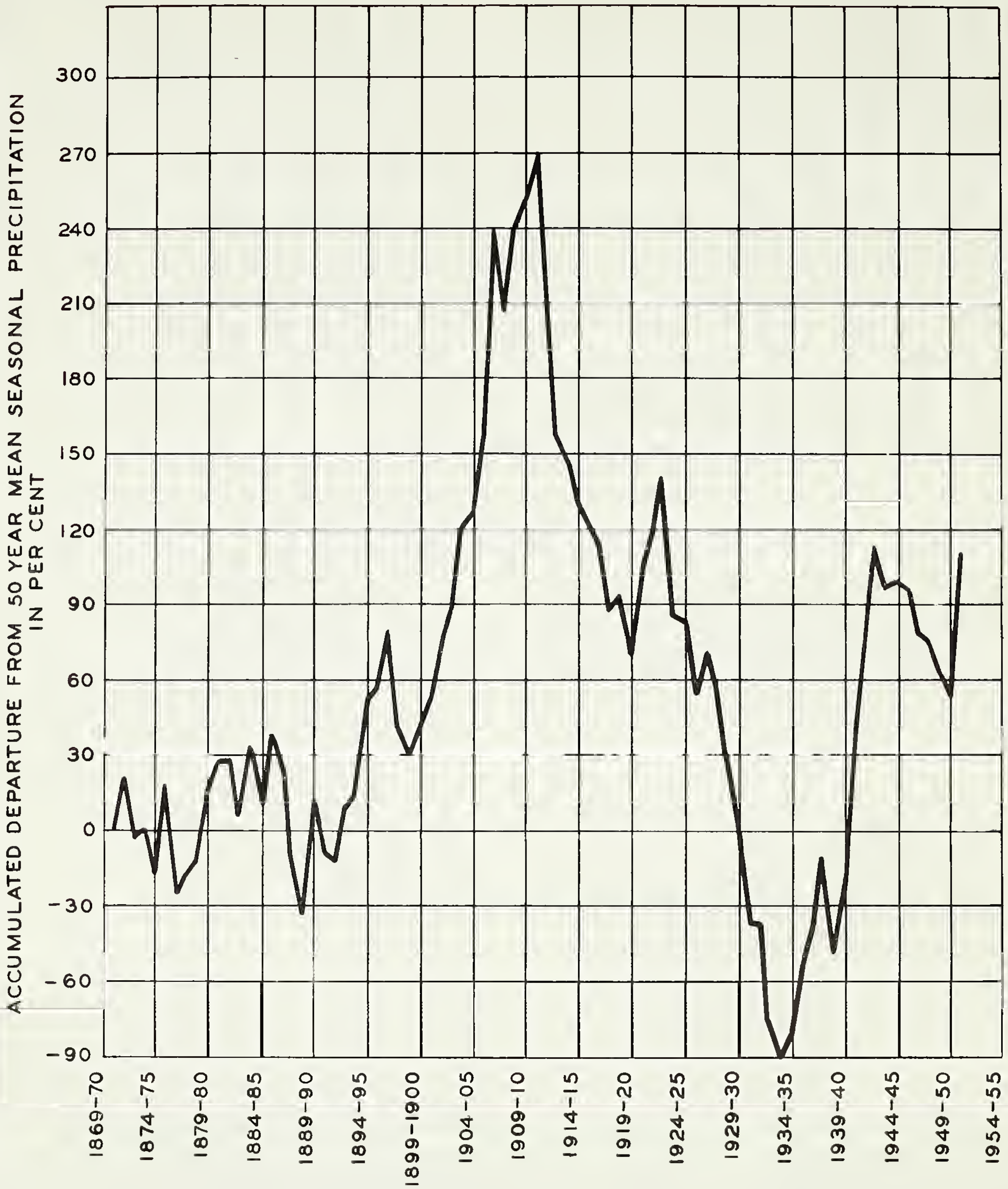

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
LOCATION
OF
PLACER COUNTY
1954
Scale of Miles
O R E G O N
N E V A D A
M E X I C O
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
COLUSA
LAKE
SONOMA
YOLO
SOLANO
EL DORADO
ALPINE
AMADOR
CALAVERAS
TUOLUMNE
MONO
ALAMEDA
SANTA CLARA
MARIPOSA
INYO
SAN BENITO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL
SAN FRANCISCO
OAKLAND
SACRAMENTO
STOCKTON
Clear Lake
Mono Lake
Lake Almanor
Eagle Lake
Goose Lake
Lake Mead
Boulder Dam


LEGEND
RECLAMATION DISTRICT 1001
CAMP FAR WEST IRRIGATION DISTRICT
NEVADA IRRIGATION DISTRICT
PACIFIC GAS & ELECTRIC COMPANY WISE SERVICE AREA
BOUNDARY BETWEEN HYDROGRAPHIC UNITS
POWER HOUSE
CANAL AND CONDUIT
TUNNEL
LAKES AND RESERVOIRS
BEAR RIVER UNIT
YUBA RIVER UNIT
VALLEY UNIT
AMERICAN RIVER UNIT
FOOTHILL UNIT
TAHOE UNIT
LAKE TAHOE
SACRAMENTO
Roseville
Auburn
Grass Valley
Nevada City
Marysville
Yuba City
Placerville
Truckee
Woodland
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
HYDROGRAPHIC UNITS, WATER AGENCIES
AND EXISTING WATER CONSERVATION WORKS
1953
SCALE OF MILES
4 0 4 8 12

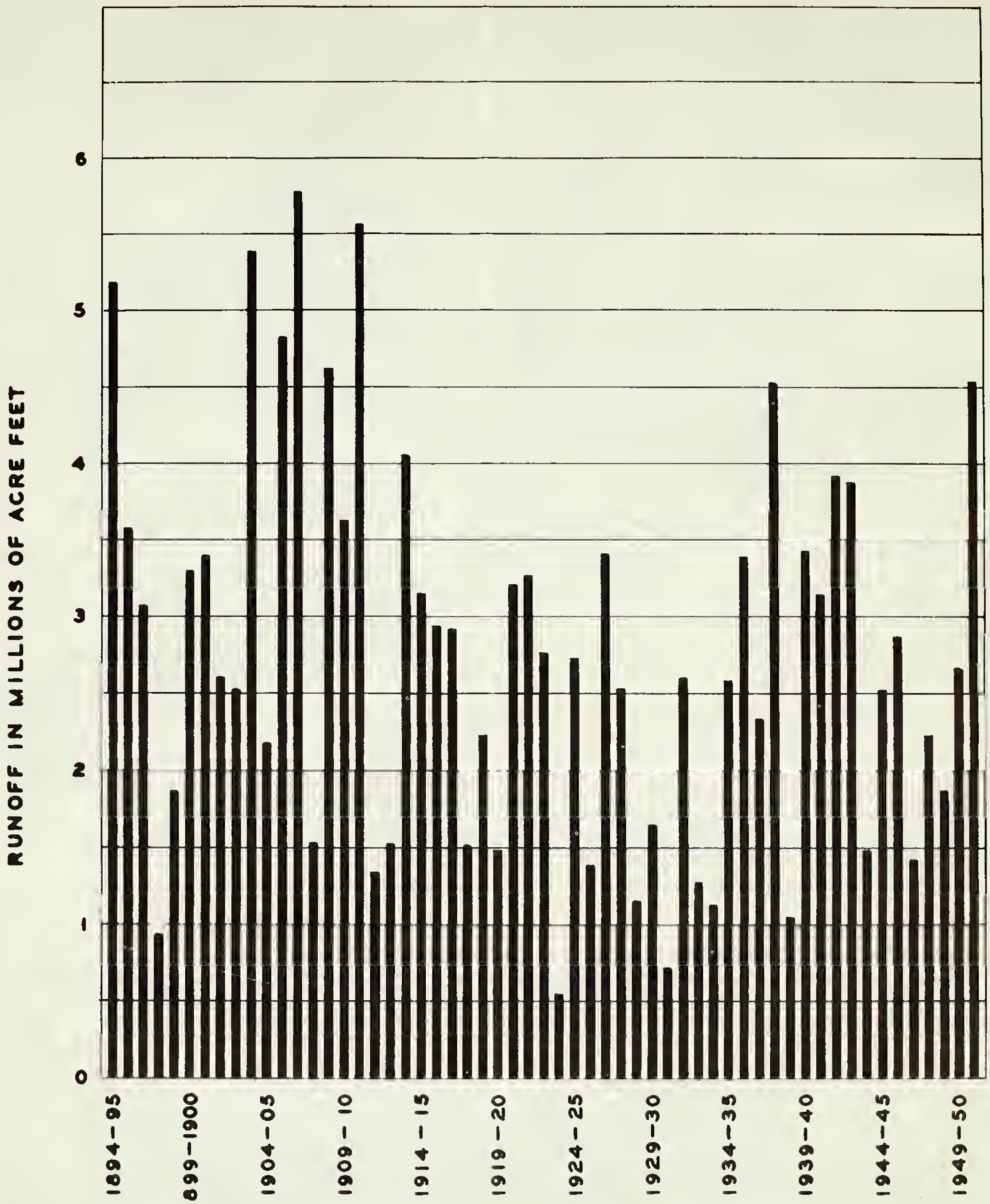

LEGEND
PRECIPITATION STATIONS
GAGING STATIONS
20 PRECIPITATION IN INCHES
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
LINES OF EQUAL MEAN SEASONAL PRECIPITATION
SCALE OF MILES
4 0 4 8 12



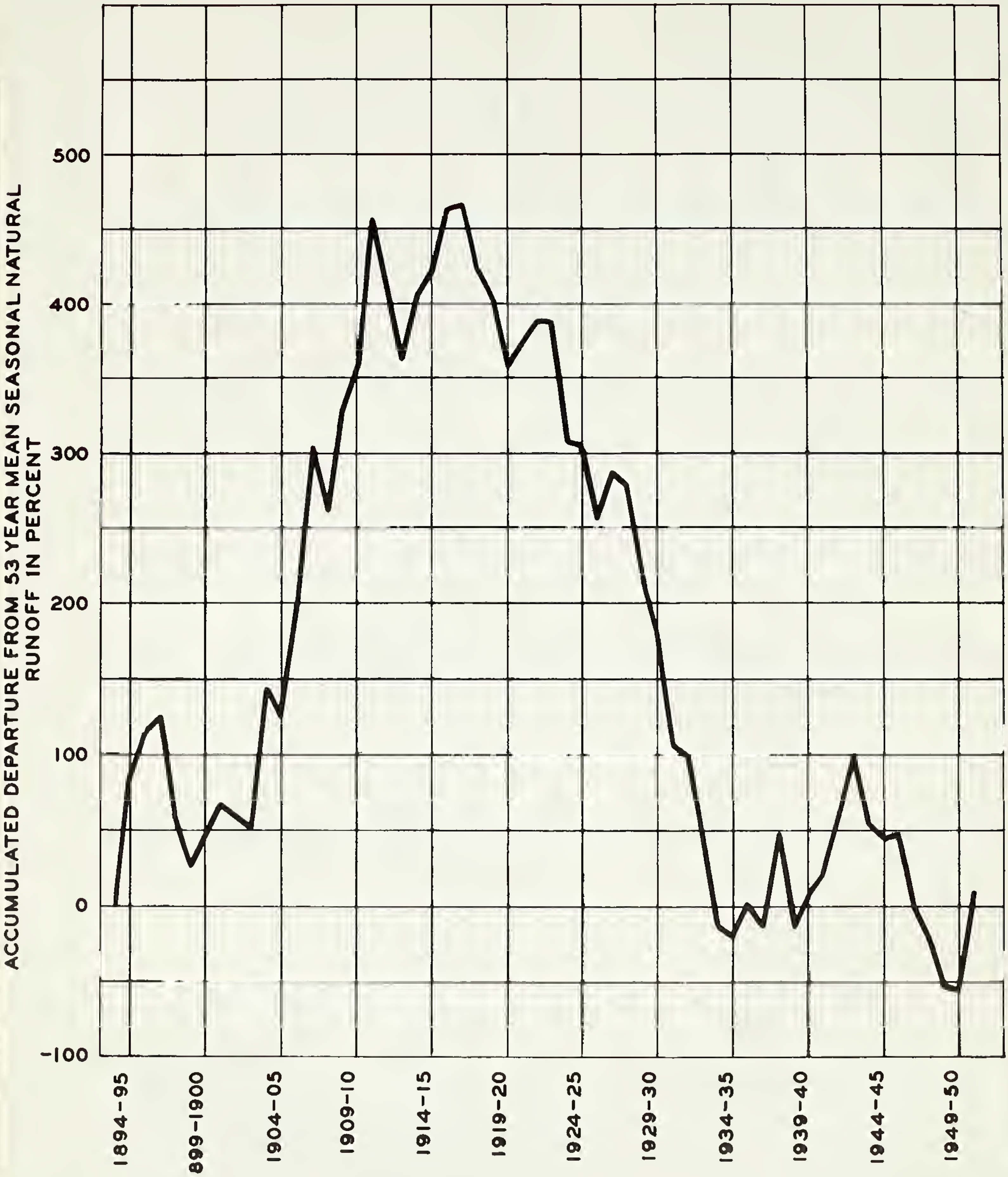
RECORDED SEASONAL PRECIPITATION AT AUBURN



ACCUMULATED DEPARTURE FROM
MEAN SEASONAL PRECIPITATION
AT AUBURN



ESTIMATED SEASONAL NATURAL RUNOFF OF AMERICAN RIVER
AT
FAIR OAKS

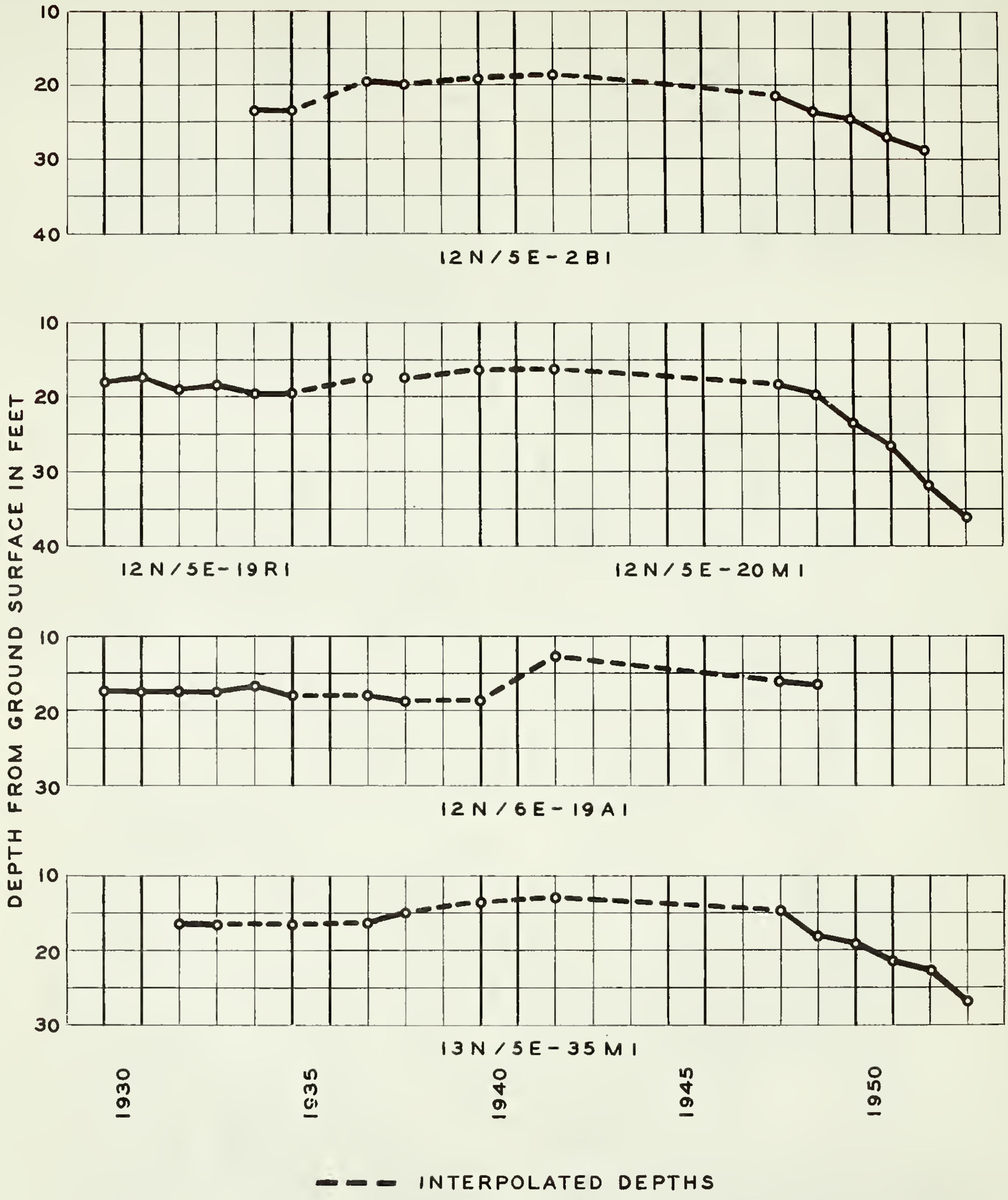


ACCUMULATED DEPARTURE FROM
MEAN SEASONAL NATURAL RUNOFF
OF
AMERICAN RIVER AT FAIR OAKS

PLATE 8


LEGEND
20 LINES OF EQUAL DEPTH TO GROUND WATER IN FEET
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
LINES OF EQUAL DEPTH
TO
GROUND WATER
VALLEY UNIT
FALL OF 1952
SCALE OF MILES
0
2
4
LINCOLN
SHERIDAN
AUBURN
ROSEVILLE
ROCKLIN
LOOMIS
PENRYN
NEWCASTLE
COLFAX
WEIMAR
APPLEGATE
WHEATLAND
EAST NICOLAUS
NICOLAUS
PLEASANT GROVE
VERONA
CHICAGO PARK
IOWA HILL
SUTTER
YOLO
SACRAMENTO
PLACER
NEVADA
YUBA
EL DORADO

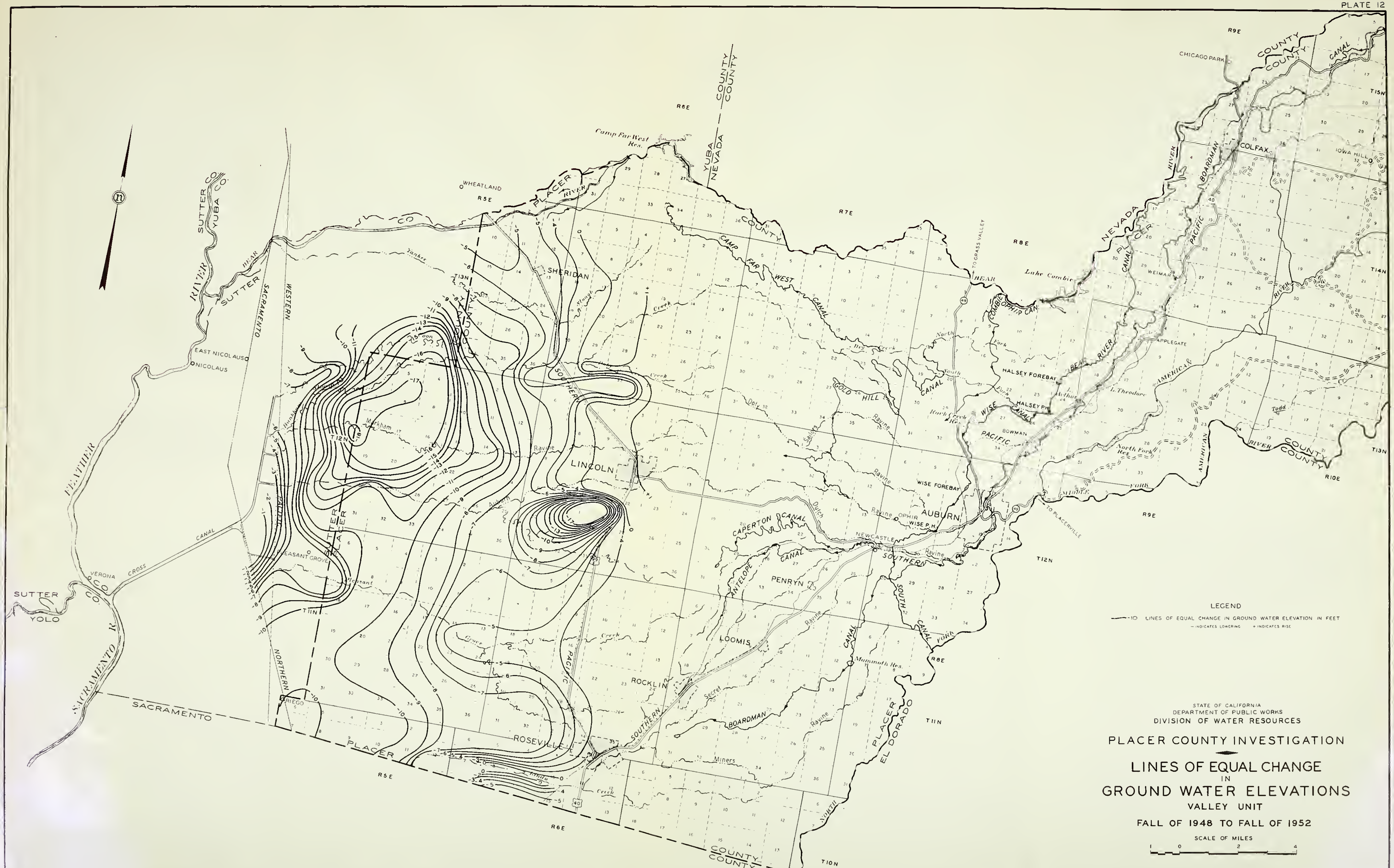
LEGEND
20 LINES OF EQUAL ELEVATION OF GROUND WATER IN FEET
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
LINES OF EQUAL ELEVATION
OF
GROUND WATER
VALLEY UNIT
FALL OF 1952
SCALE OF MILES
SHERIDAN
LINCOLN
AUBURN
ROSEVILLE
ROCKLIN
LOOMIS
PENRYN
NEWCASTLE
COLFAX
WHEATLAND
NICOLAUS
EAST NICOLAUS
VERONA
PLEASANT GROVE
RIEGO
APPLEGATE
WEIMAR
BOWMAN
CHICAGO PARK
IOWA HILL
SUTTER
YOLO
PLACER
NEVADA
YUBA
EL DORADO
SACRAMENTO



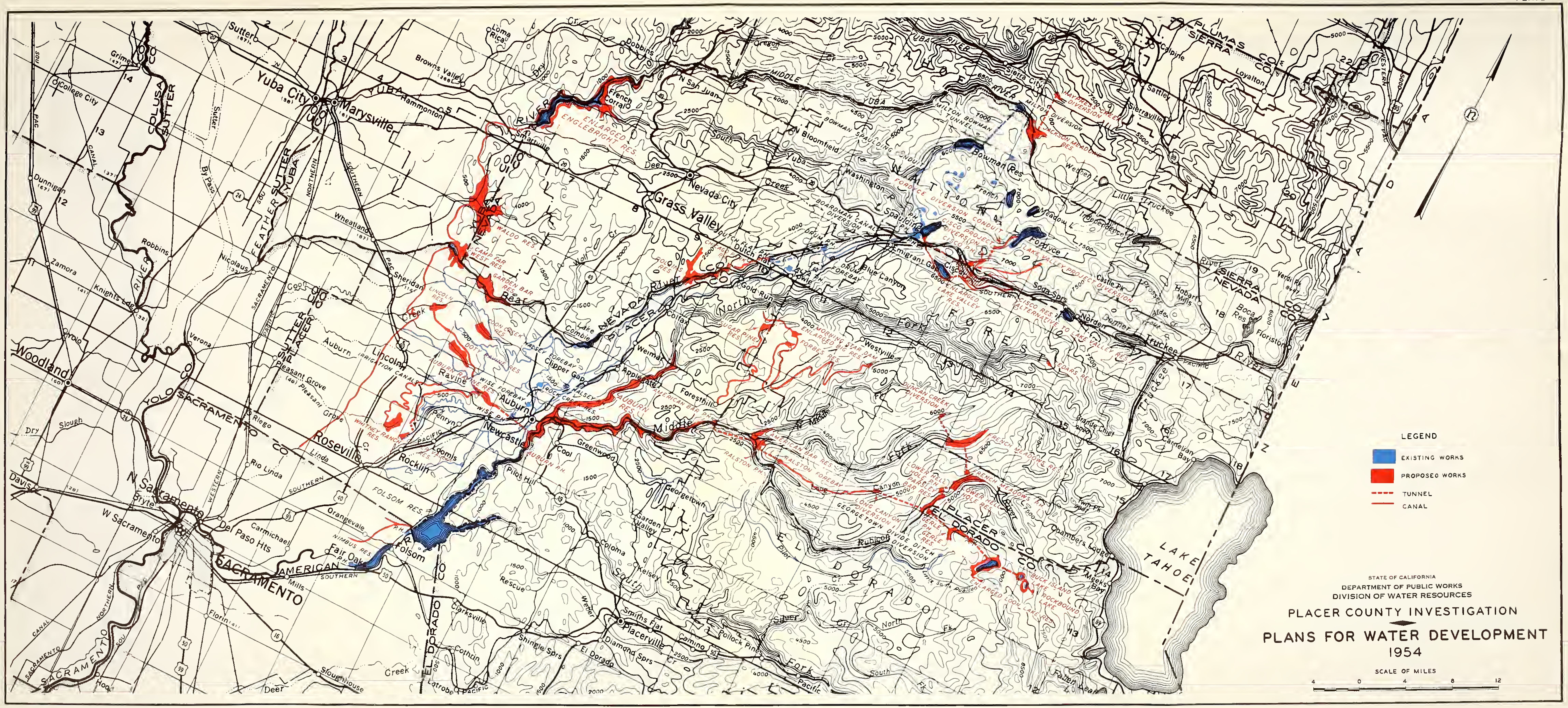
MEASURED FALL DEPTHS TO GROUND WATER
AT
REPRESENTATIVE WELLS
VALLEY UNIT

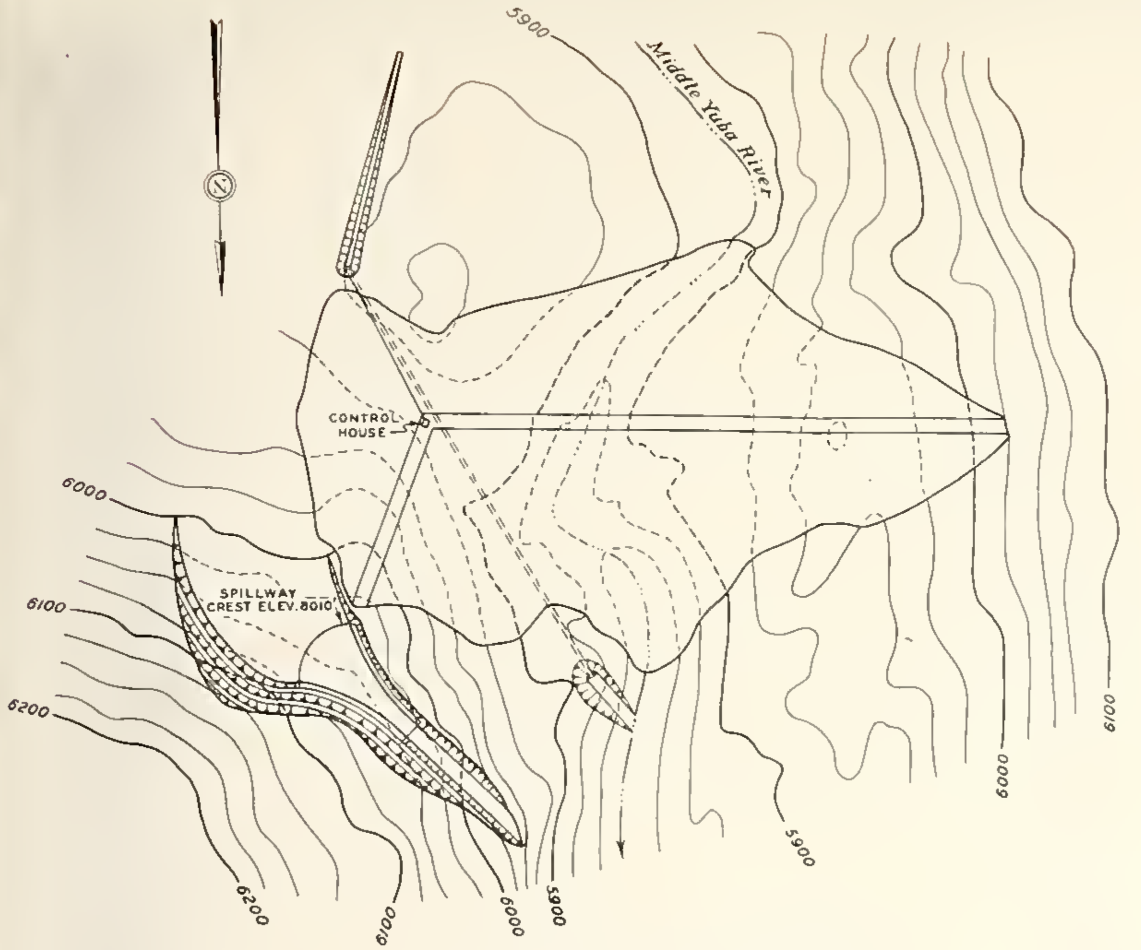
AVERAGE FALL DEPTH TO GROUND WATER

VALLEY UNIT


LEGEND
-10 LINES OF EQUAL CHANGE IN GROUND WATER ELEVATION IN FEET
- INDICATES LOWERING + INDICATES RISE
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
LINES OF EQUAL CHANGE
IN
GROUND WATER ELEVATIONS
VALLEY UNIT
FALL OF 1948 TO FALL OF 1952
SCALE OF MILES
1 0 2 4
SHERIDAN
LINCOLN
AUBURN
NEWCASTLE
PENRYN
LOOMIS
ROCKLIN
ROSEVILLE
COLFAX
WHEATLAND
EAST NICOLAUS
NICOLAUS
PLEASANT GROVE
VERONA
RIEGO
CHICAGO PARK
WEIMAR
APPLEGATE
IOWA HILL
SUTTER
YOLO
SACRAMENTO
PLACER
NEVADA
YUBA
EL DORADO
FEATHER
BEAR RIVER
AMERICAN
CAMP FAR WEST CANAL
GOLD HILL
CAPERTON CANAL
ANTELOPE CANAL
BOARDMAN
WISE FOREBAY
HALSEY FOREBAY
T13N
T12N
T11N
T10N
T14N
T15N
R5E
R6E
R7E
R8E
R9E
R10E


LEGEND
IRRIGATED LANDS
IRRIGABLE LANDS
LOCATION OF USE OF WATER STUDIES
LOCATION OF WATERSHED USE OF WATER STUDIES
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
IRRIGATED AND IRRIGABLE LANDS
1951
SCALE OF MILES
SUTTER
YOLO
SACRAMENTO
LINCOLN
ROSEVILLE
AUBURN
PLACER
EL DORADO
NEVADA
TRUCKEE
LAKE TAHOE

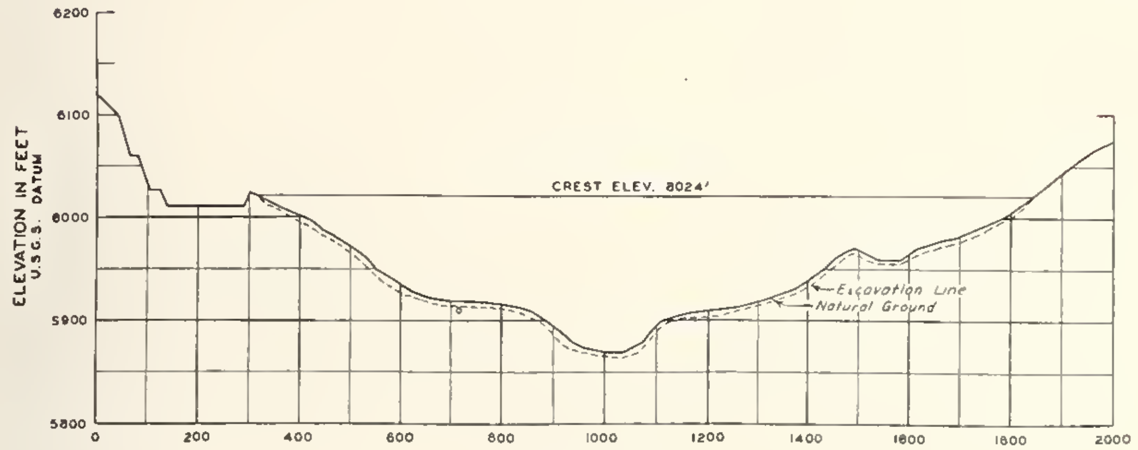

LEGEND
EXISTING WORKS
PROPOSED WORKS
TUNNEL
CANAL
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
PLANS FOR WATER DEVELOPMENT
1954
SCALE OF MILES
4 0 4 8 12



JACKSON MEADOWS DAM

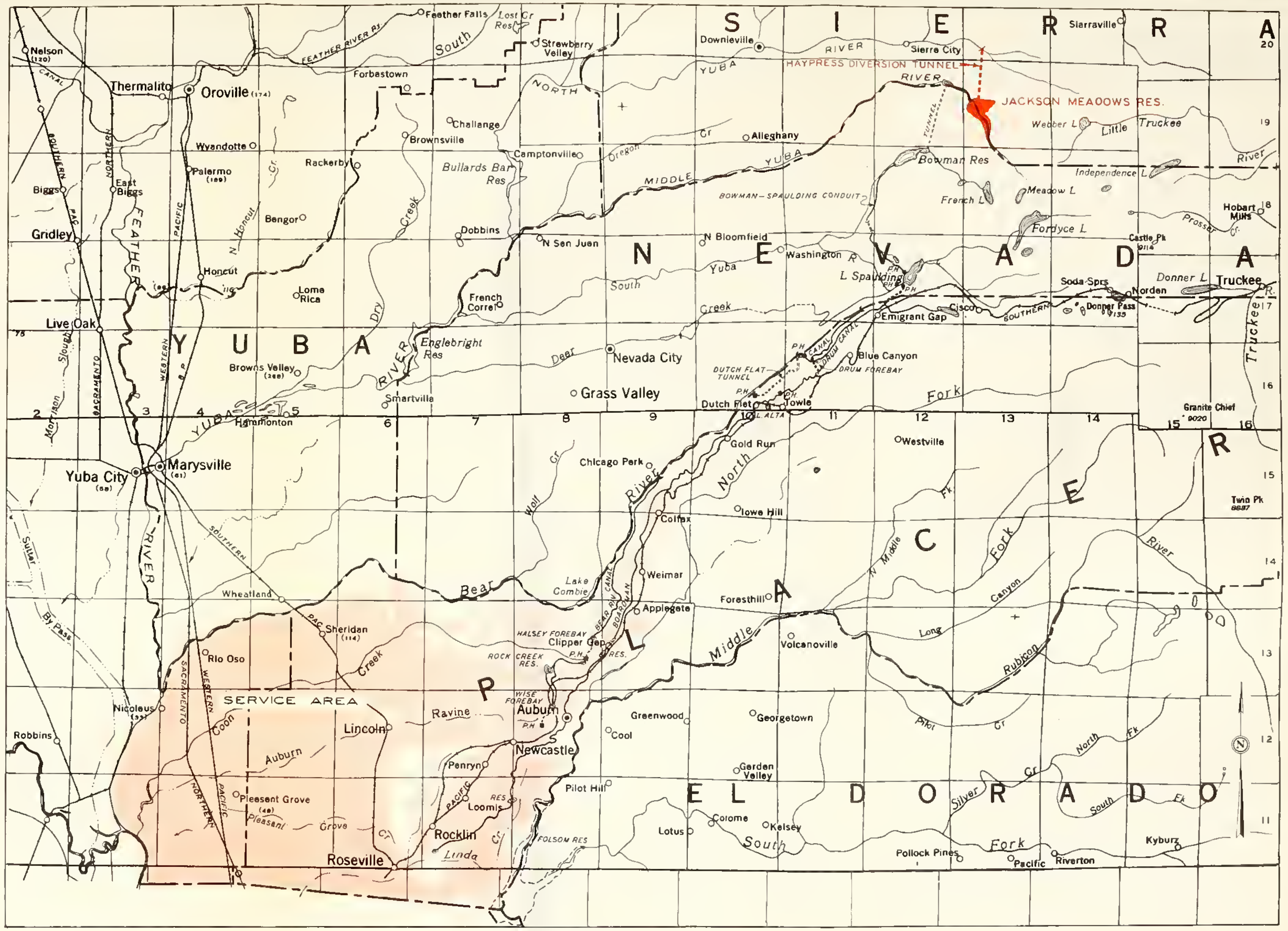
GENERAL PLAN

SCALE OF FEET 0 200 400



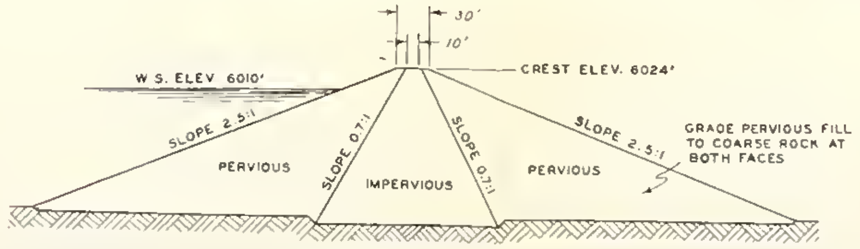
PROFILE OF DAM

LOOKING UPSTREAM



PROJECT AREA

SCALE OF MILES 4 0 4 8



SECTION OF DAM

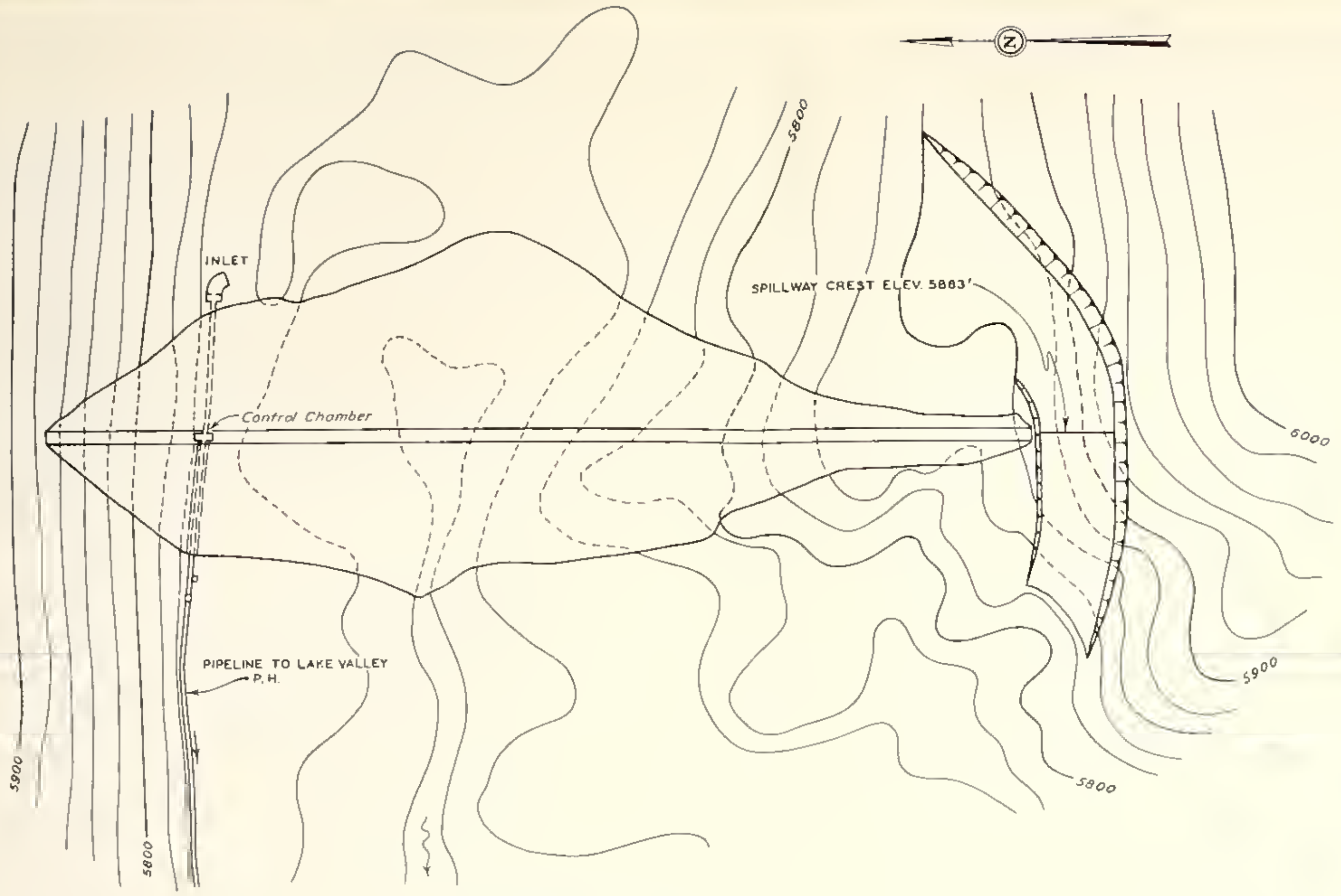
SCALE OF FEET 0 100 200

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

JACKSON MEADOWS PROJECT

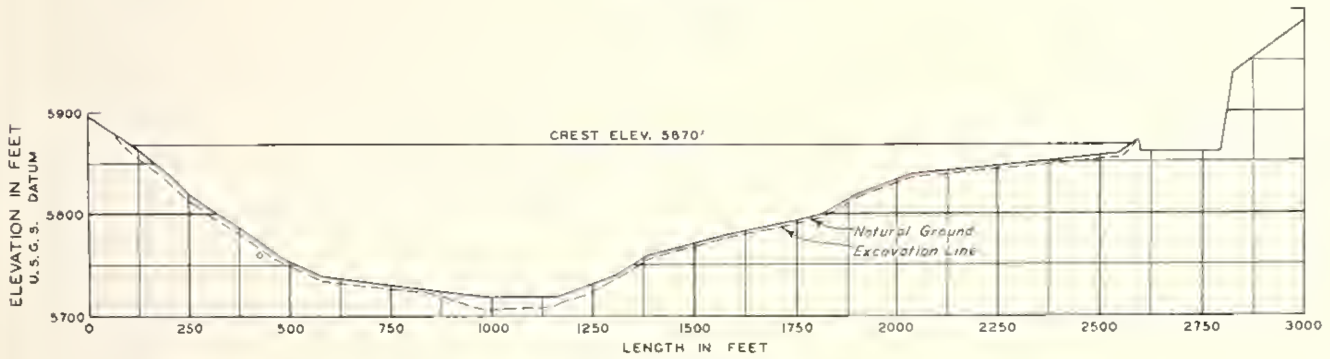
1954



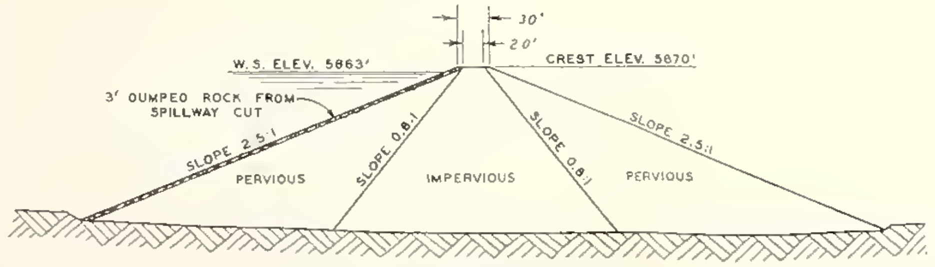
LAKE VALLEY DAM

GENERAL PLAN

SCALE OF FEET
0 250 500

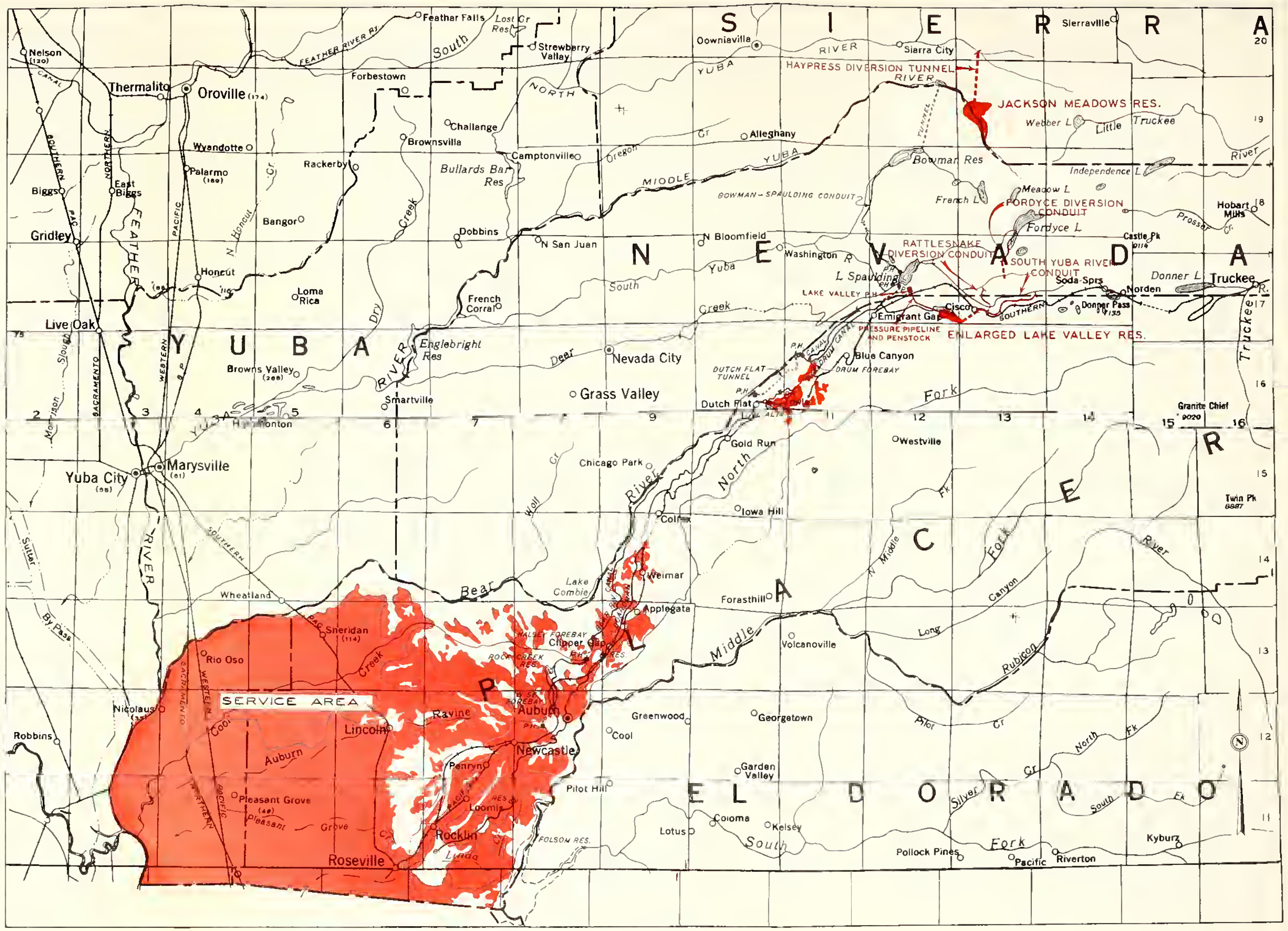


PROFILE OF DAM
LOOKING UPSTREAM



SECTION OF DAM

SCALE OF FEET
0 100 200



PROJECT AREA

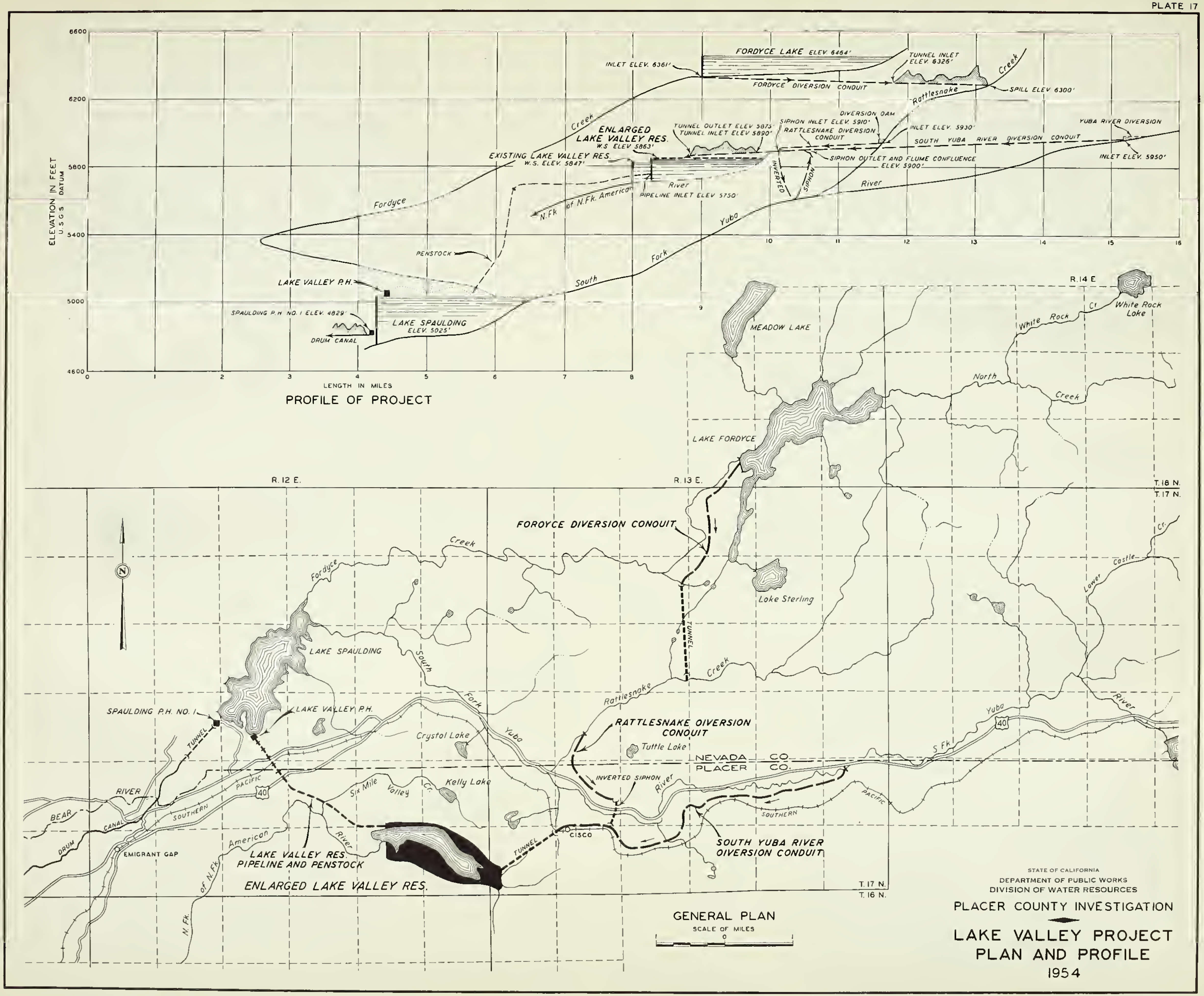
SCALE OF MILES
4 0 4 8

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

LAKE VALLEY PROJECT

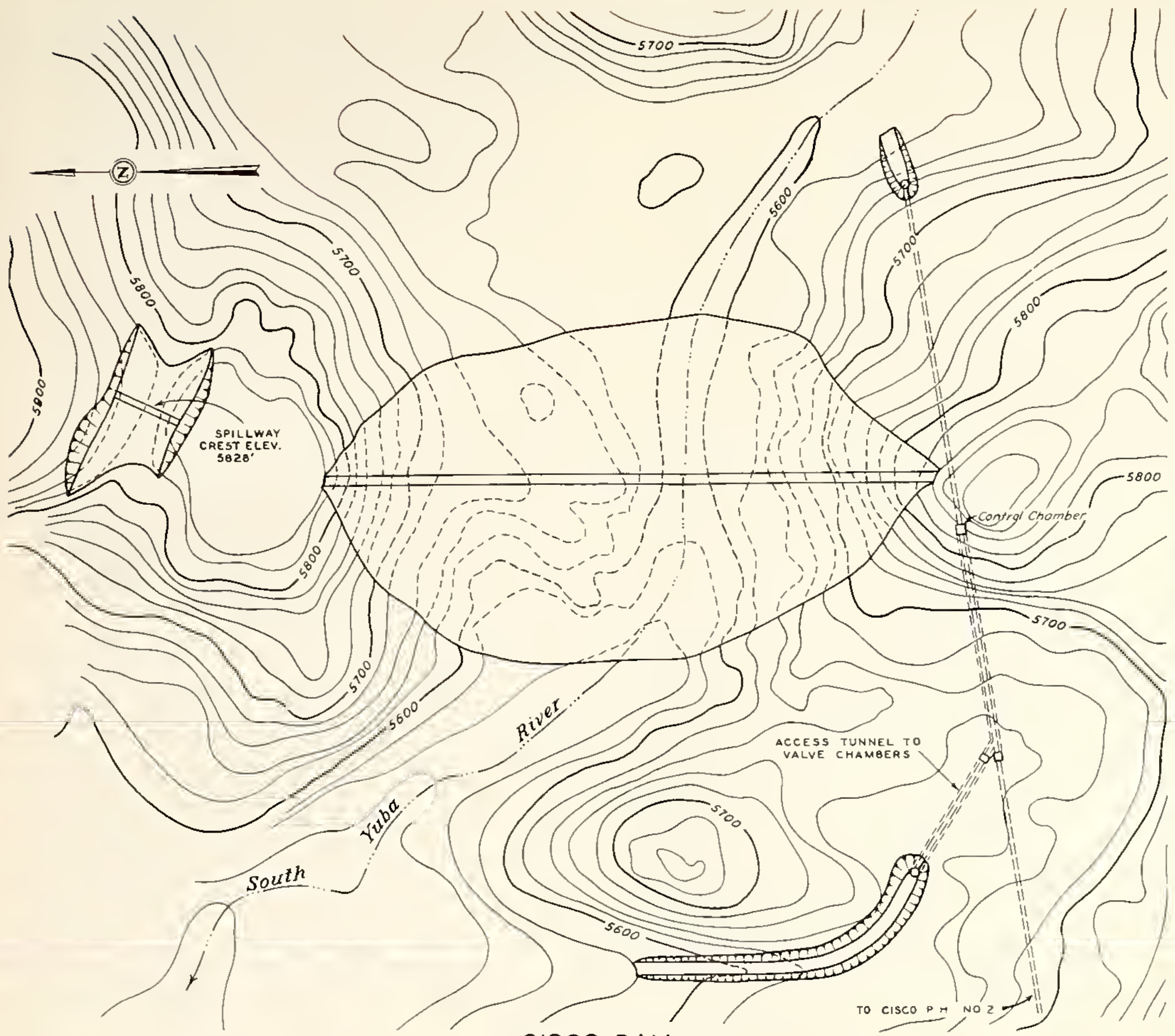
1954



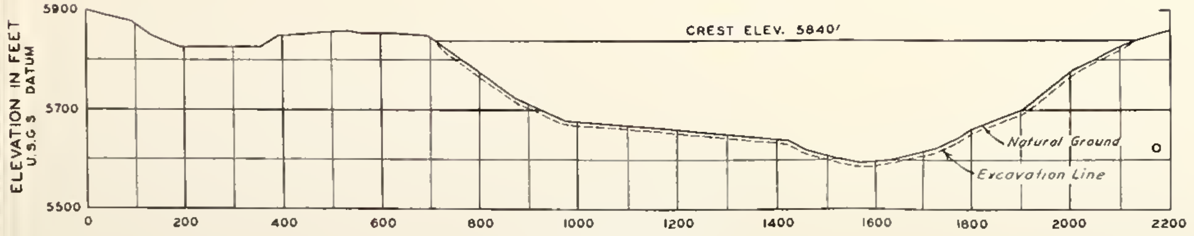
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

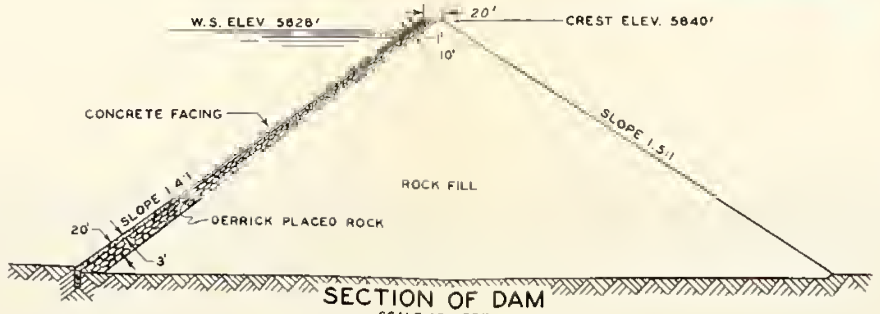
LAKE VALLEY PROJECT
PLAN AND PROFILE
1954



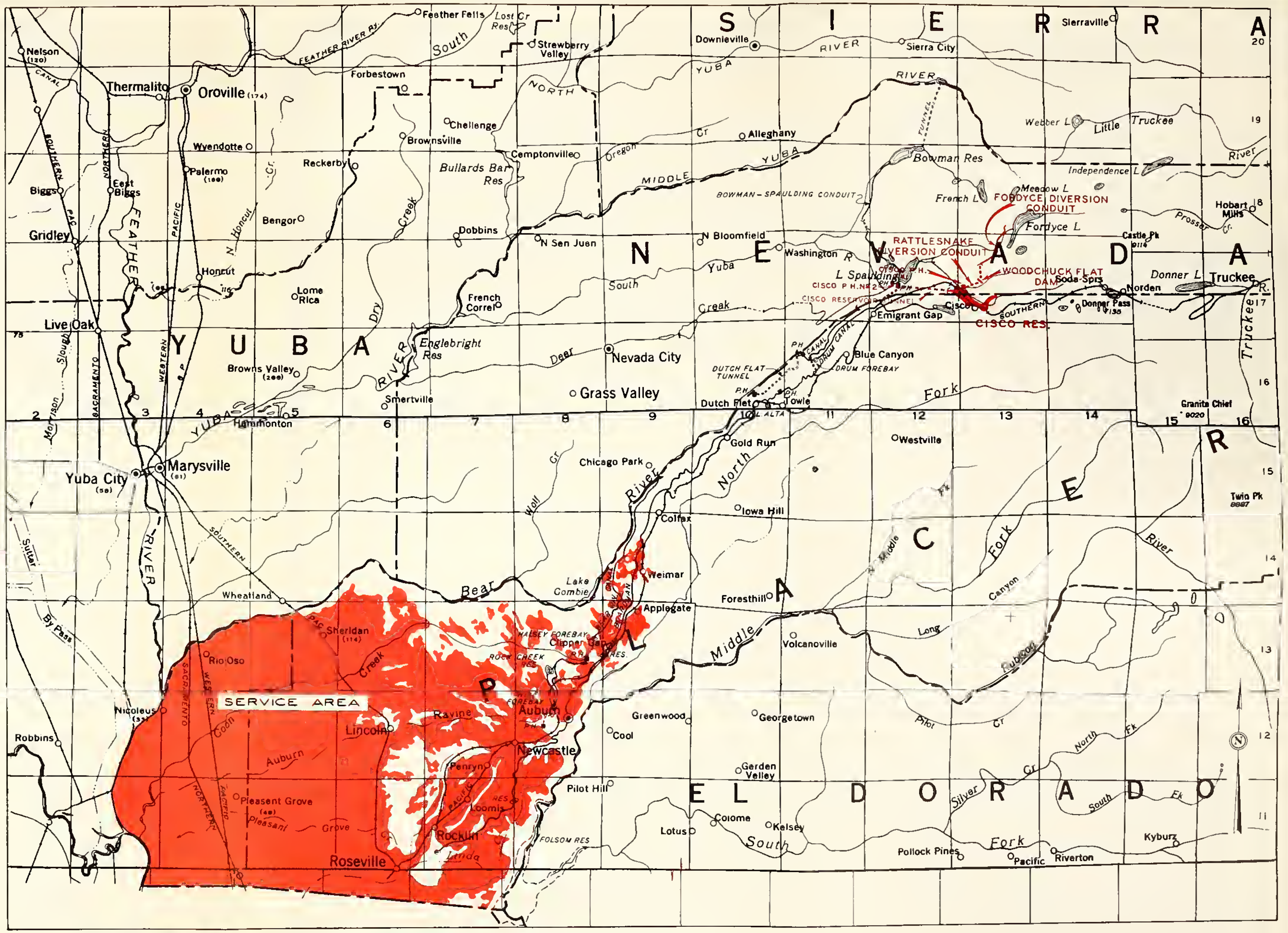
CISCO DAM
GENERAL PLAN
SCALE OF FEET
0 200 400



PROFILE OF DAM
LOOKING UPSTREAM



SECTION OF DAM
SCALE OF FEET
0 100 200

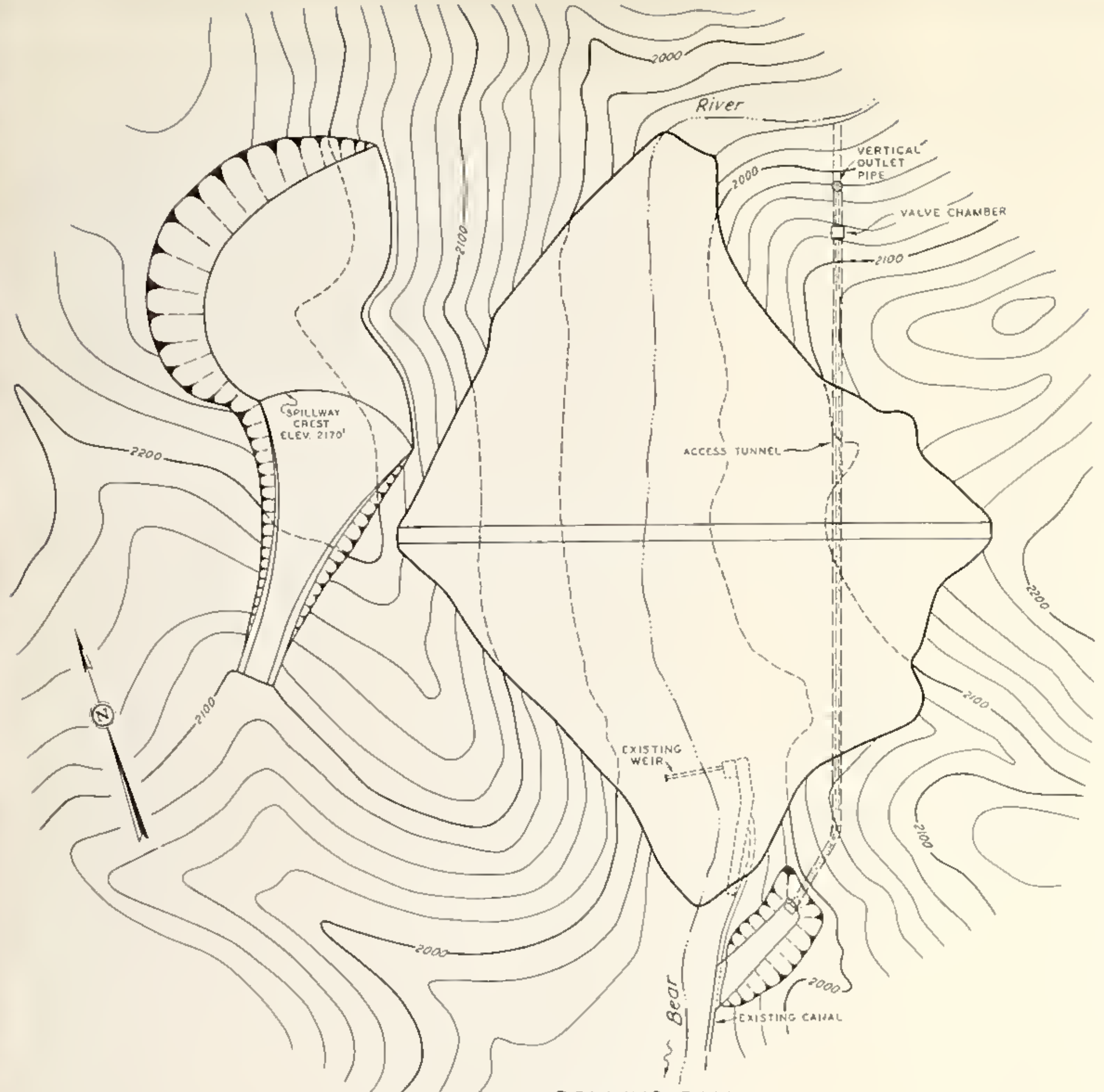


PROJECT AREA
SCALE OF MILES
4 0 4 8

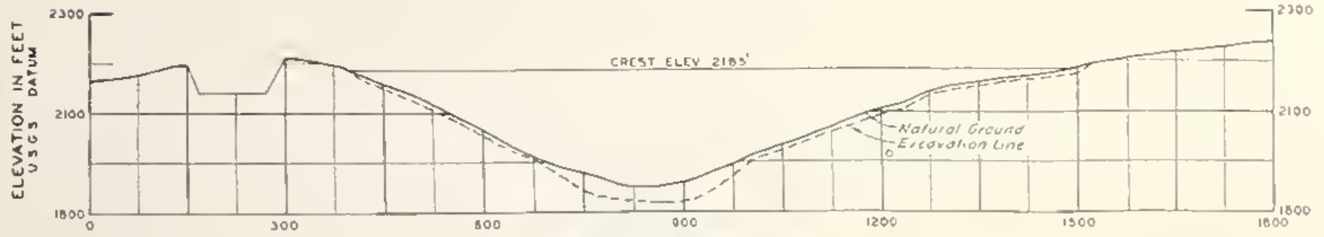
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

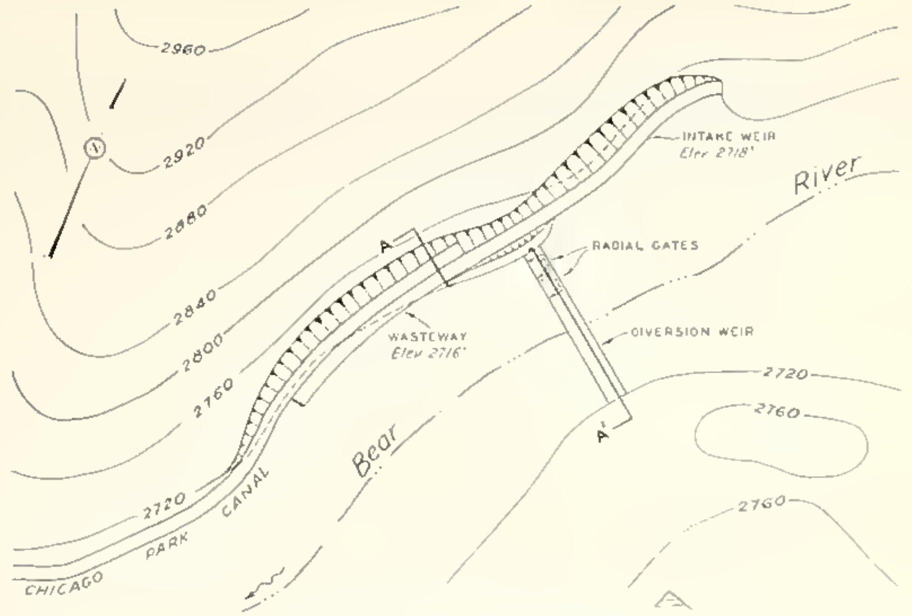
CISCO PROJECT
1954



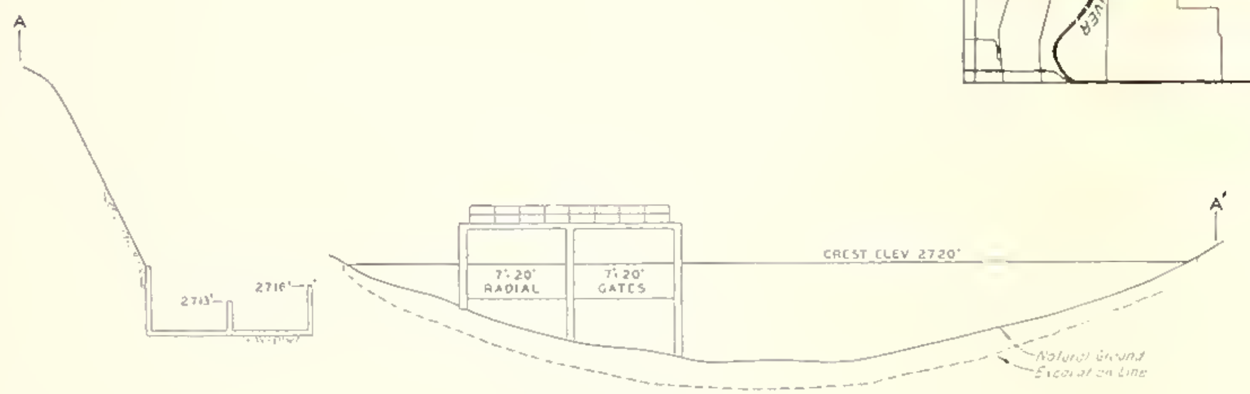
ROLLINS DAM
GENERAL PLAN
SCALE OF FEET
0 150 300



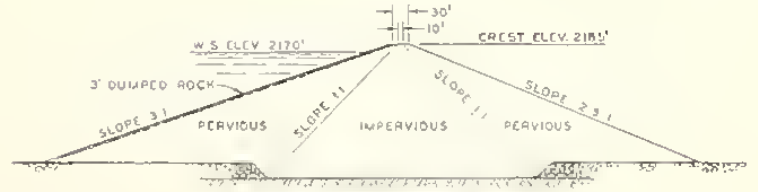
PROFILE OF DAM
LOOKING UPSTREAM



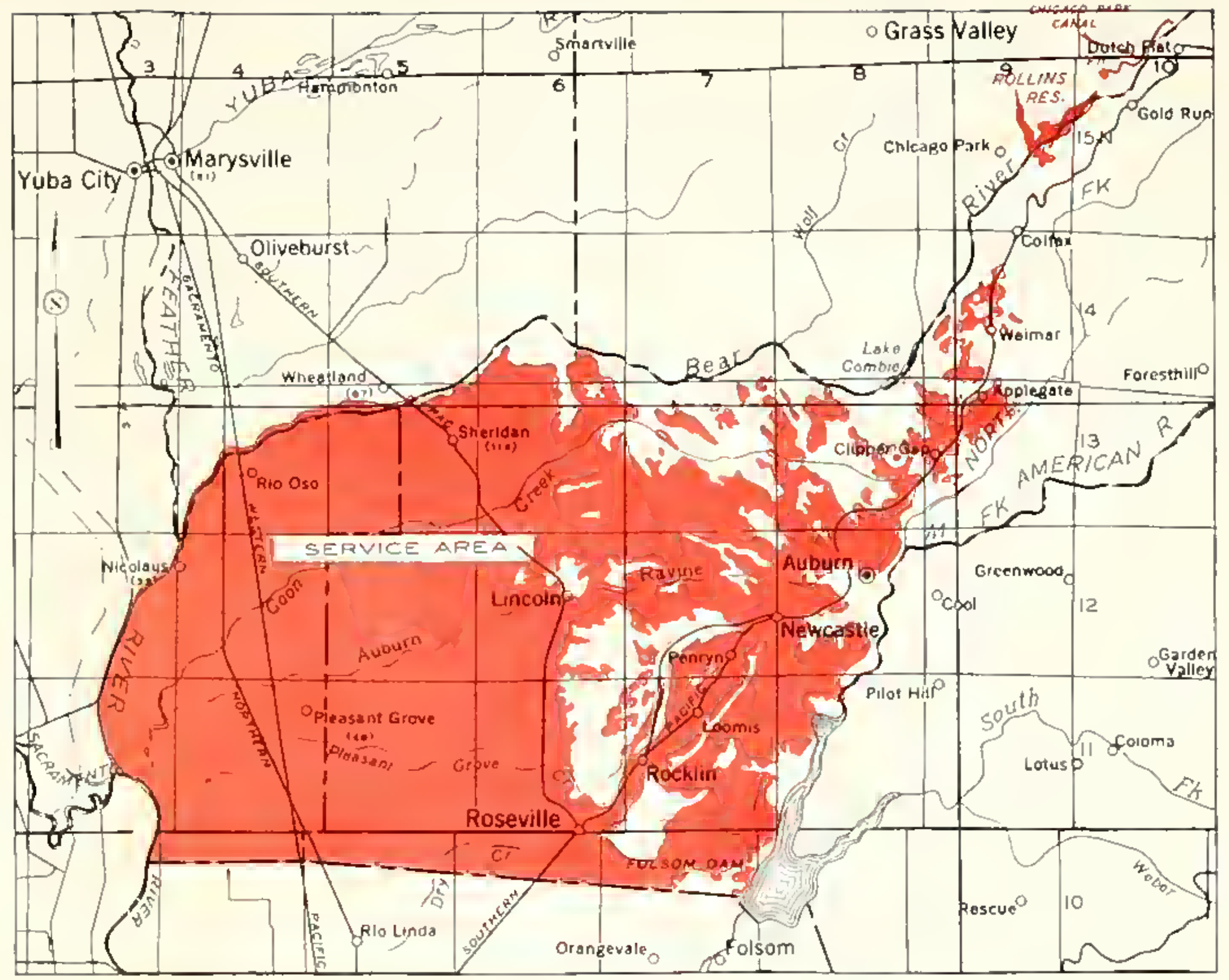
CHICAGO PARK DIVERSION
SCALE OF FEET
0 100 200



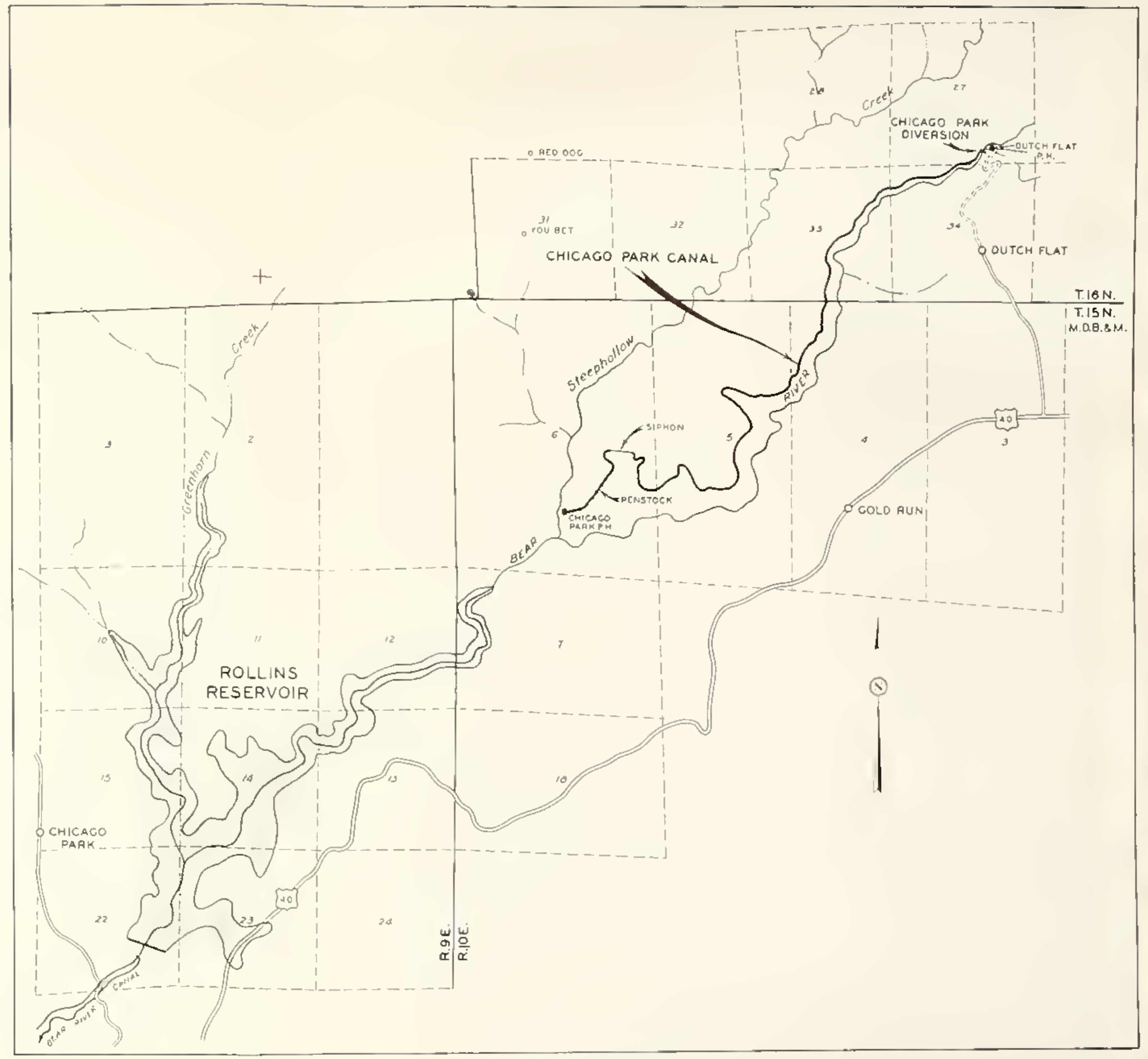
SECTION A–A'
CHICAGO PARK DIVERSION
SCALE OF FEET
0 20 40



SECTION OF DAM
SCALE OF FEET
0 200 400



PROJECT AREA
SCALE OF MILES
0 4 8



PLAN OF PROJECT
SCALE OF FEET
0 2000 4000

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

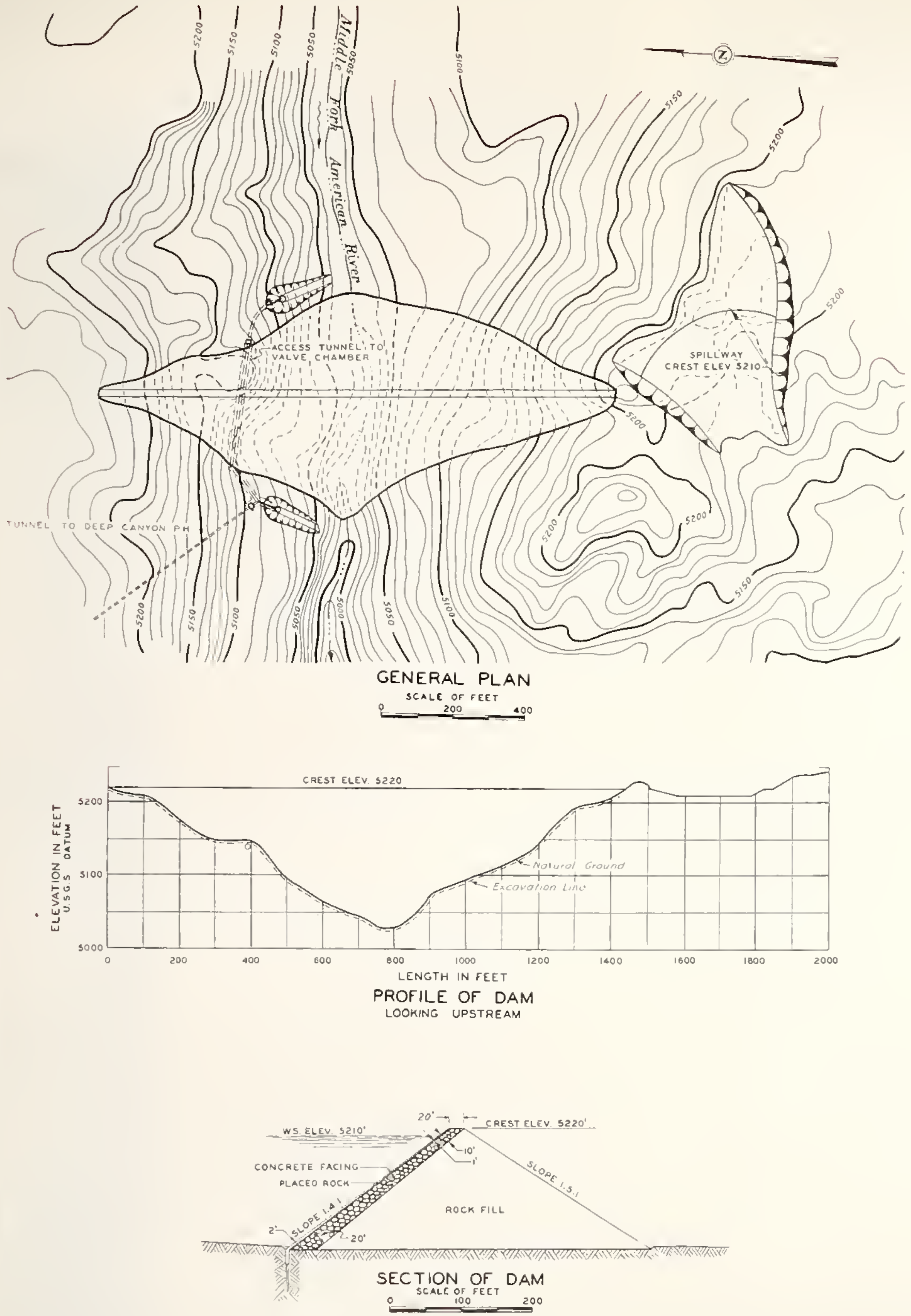
PLACER COUNTY INVESTIGATION

ROLLINS PROJECT

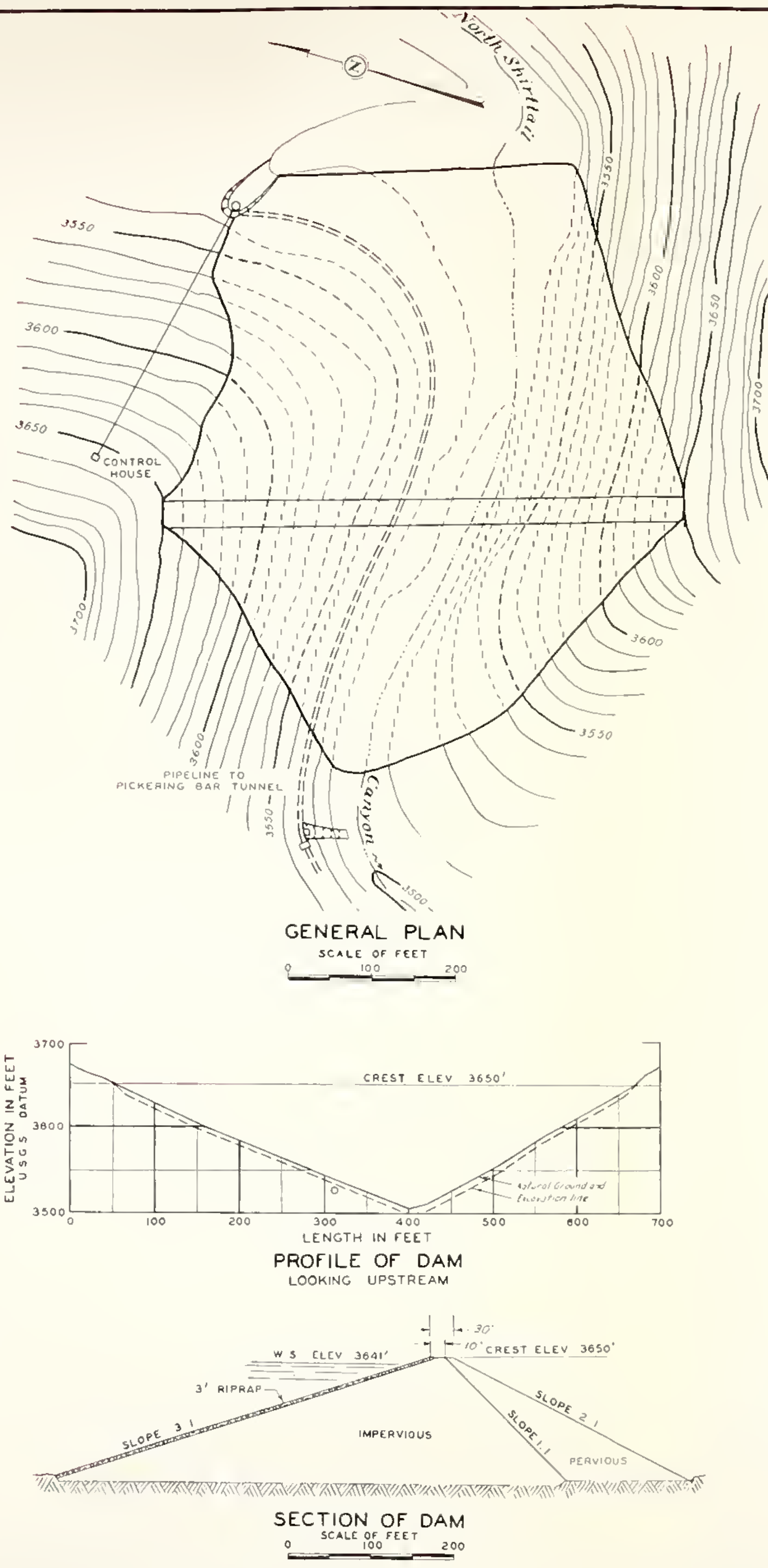
1955

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION

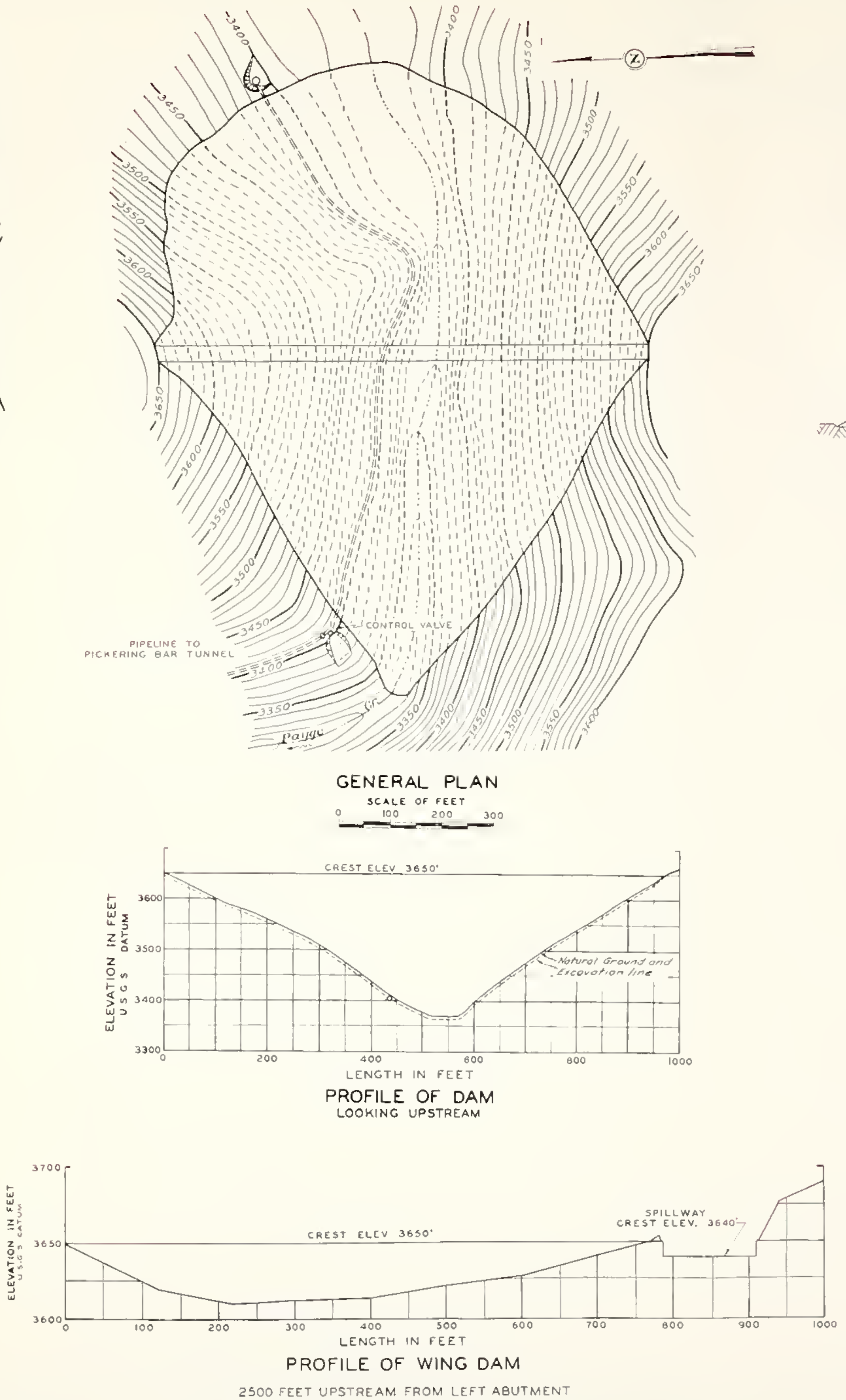
FRENCH MEADOWS PROJECT
PLAN, PROFILE AND PROJECT AREA
1954

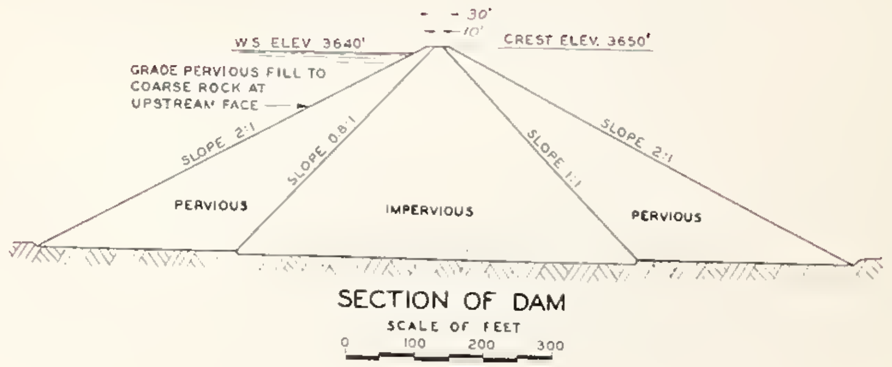


FRENCH MEADOWS DAM



SUGAR PINE DAM

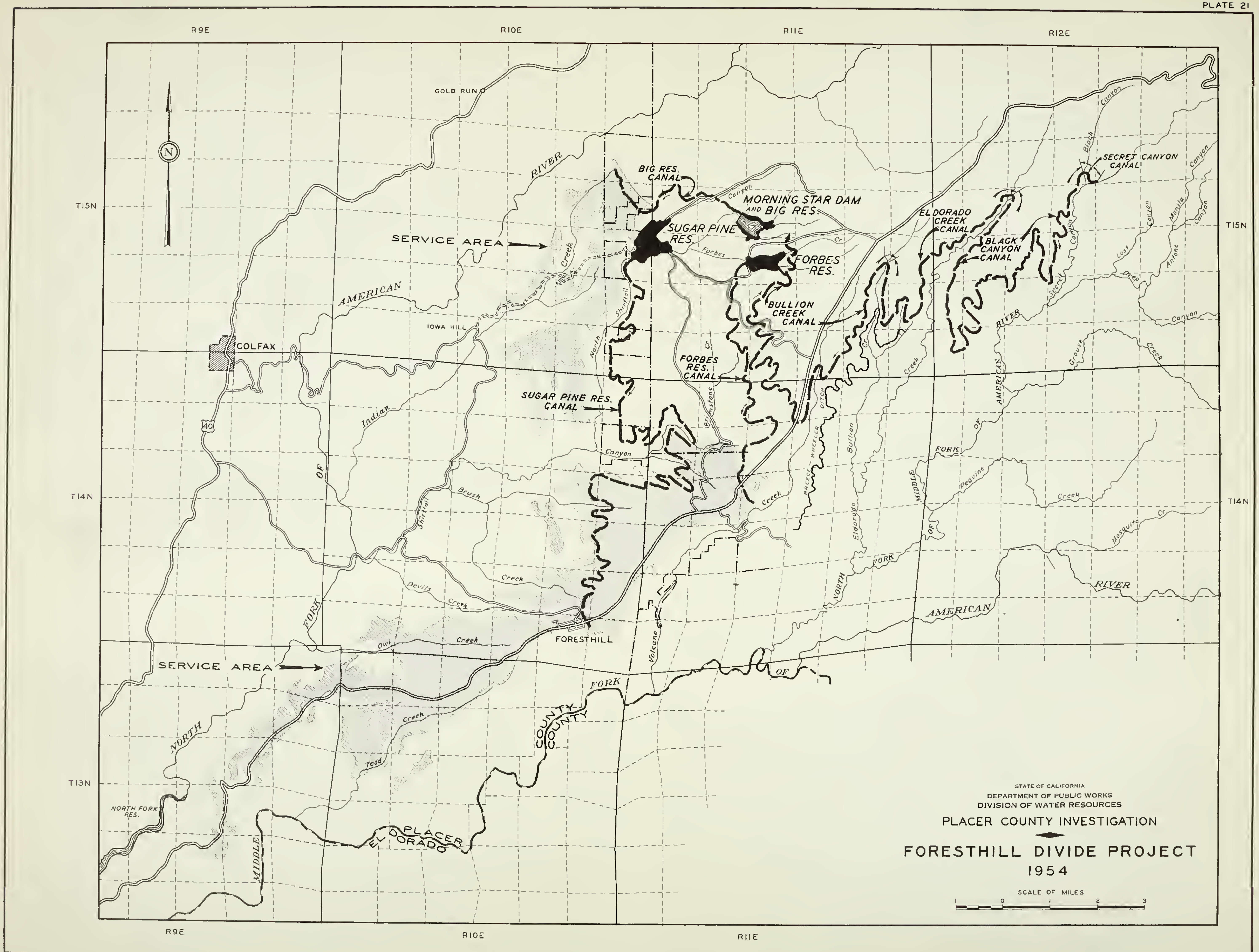


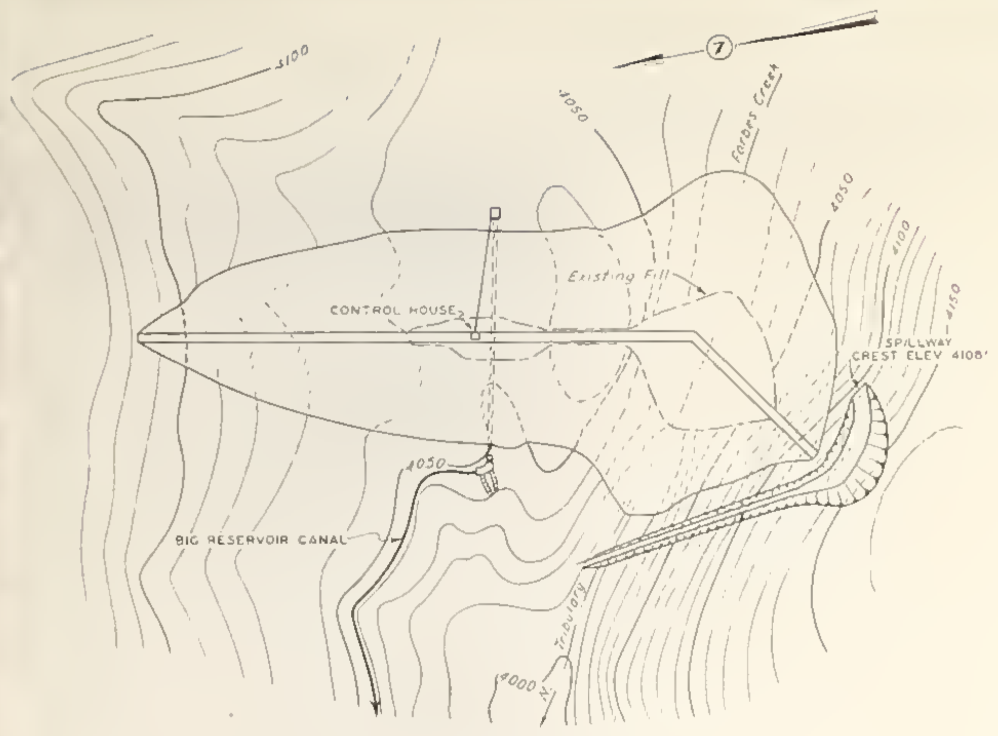


PAGGE DAM

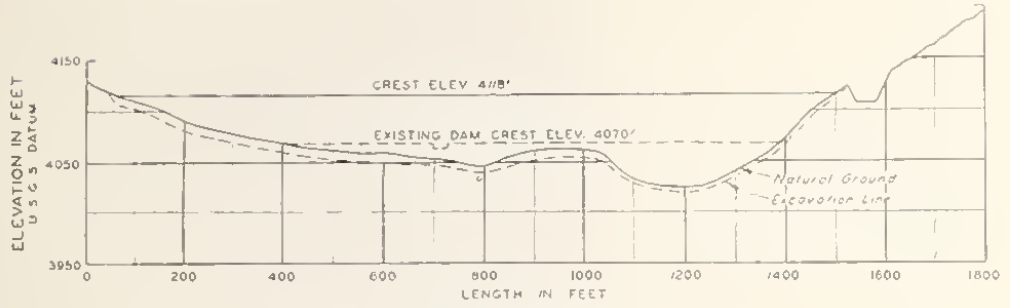
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION

FRENCH MEADOWS PROJECT DAMS
1954

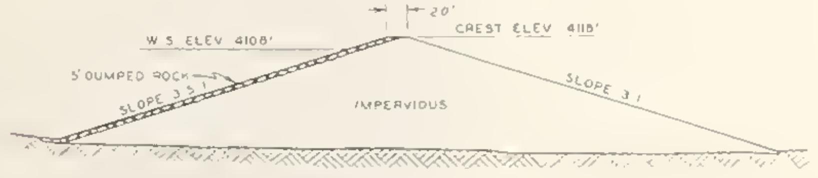

R9E
R10E
R11E
R12E
T15N
T14N
T13N
GOLD RUN
COLFAX
IOWA HILL
FORESTHILL
NORTH FORK RES.
40
SERVICE AREA
SERVICE AREA
BIG RES. CANAL
MORNING STAR DAM AND BIG RES.
SUGAR PINE RES.
FORBES RES.
EL DORADO CREEK CANAL
BLACK CANYON CANAL
SECRET CANYON CANAL
BULLION CREEK CANAL
FORBES RES. CANAL
SUGAR PINE RES. CANAL
NORTH FORK OF AMERICAN RIVER
MIDDLE FORK OF AMERICAN RIVER
NORTH FORK OF MIDDLE FORK OF AMERICAN RIVER
Indian Creek
Shirttail
North Shirttail
Brush Creek
Devils Creek
Owl Creek
Todd Creek
Canyon
Forbes Cr.
Brimstone Cr.
Volcano
Eldorado Cr.
Bullion Cr.
REECE WHEELER DITCH
Peavine Creek
Mosquito Cr.
Grouse Creek
Secret Canyon
Black Canyon
Lost Canyon
Deep Canyon
Antone Canyon
Manila Canyon
PLACER COUNTY
EL DORADO COUNTY
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
FORESTHILL DIVIDE PROJECT
1954
SCALE OF MILES
1 0 1 2 3



GENERAL PLAN
SCALE OF FEET
0 200 400

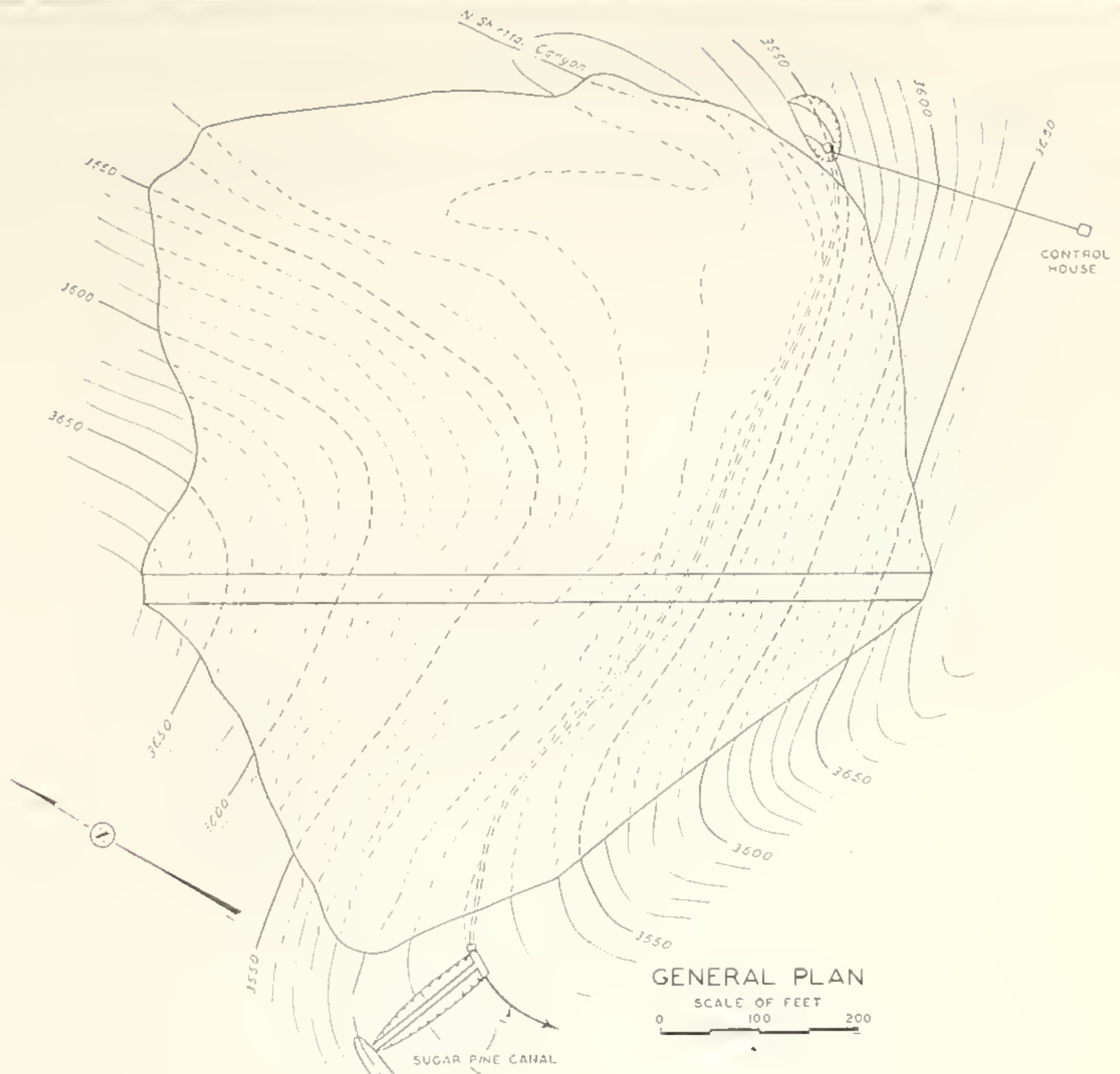


PROFILE OF DAM
LOOKING UPSTREAM

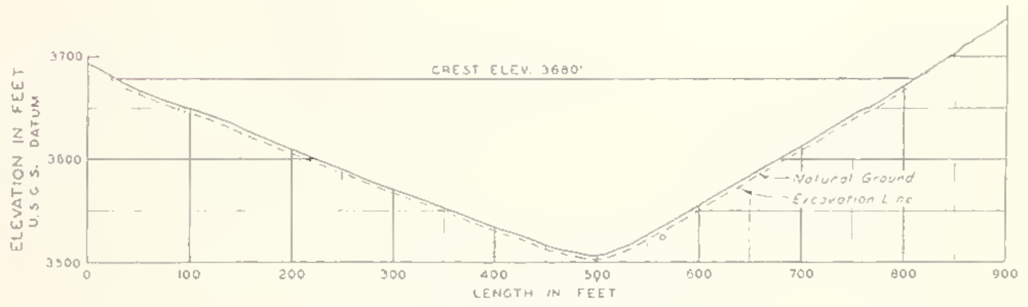


SECTION OF DAM
SCALE OF FEET
0 100 200

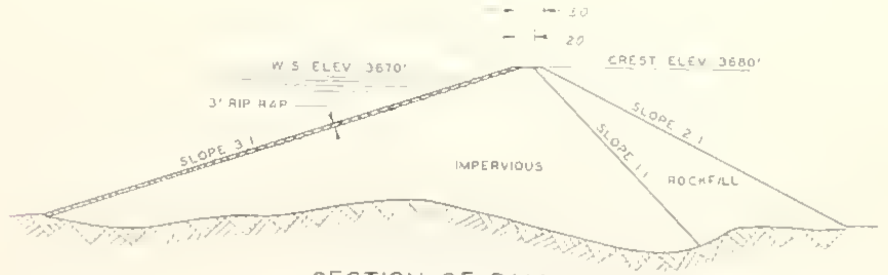
ENLARGED MORNING STAR DAM



GENERAL PLAN
SCALE OF FEET
0 100 200

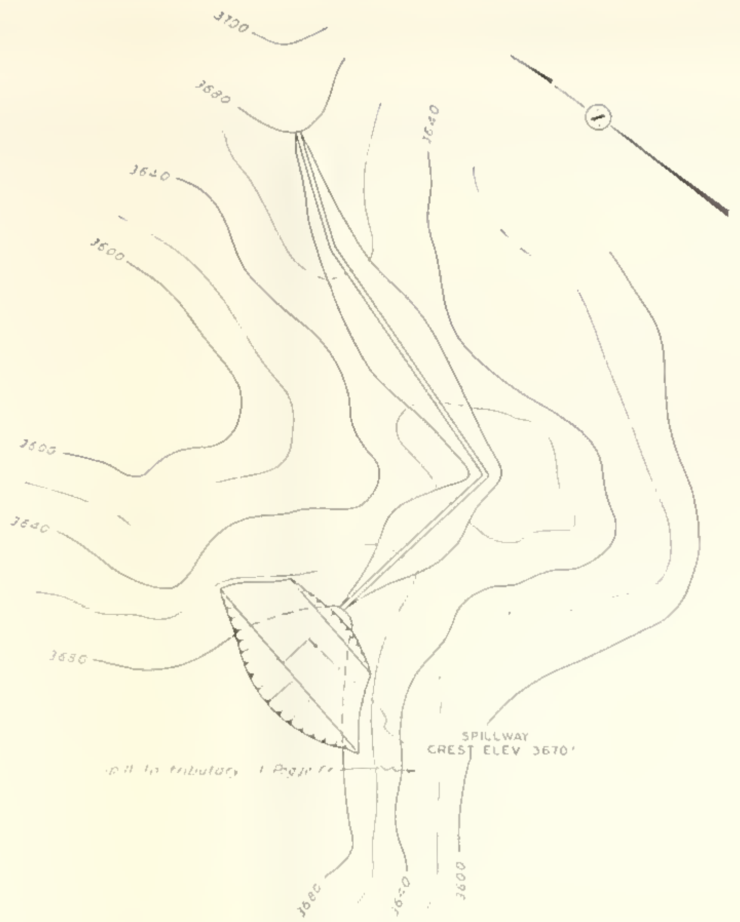


PROFILE OF DAM
LOOKING UPSTREAM

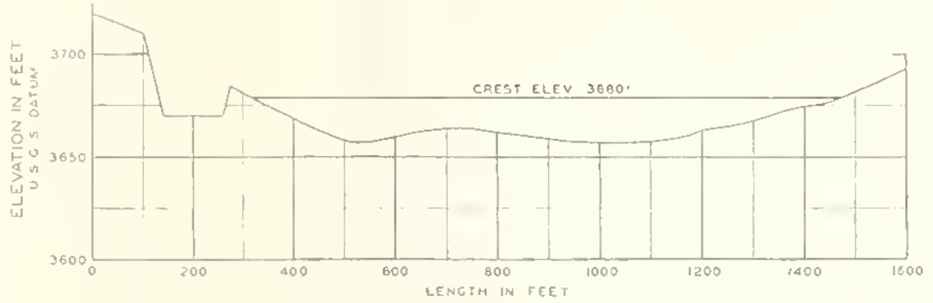


SECTION OF DAM
SCALE OF FEET
0 100 200

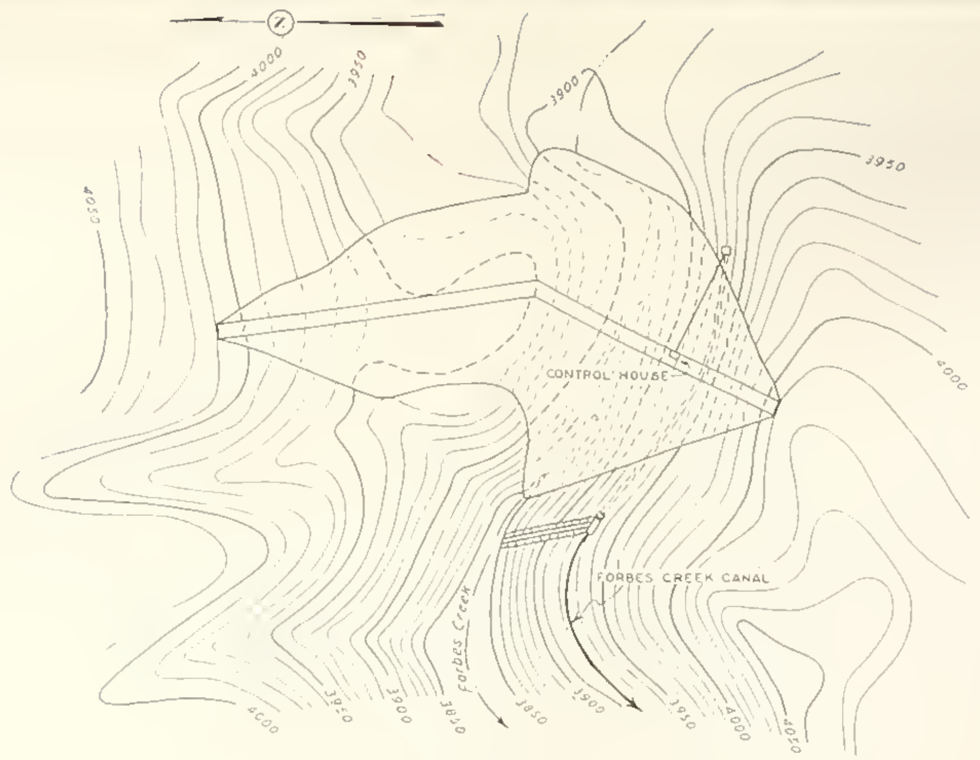
SUGAR PINE DAM



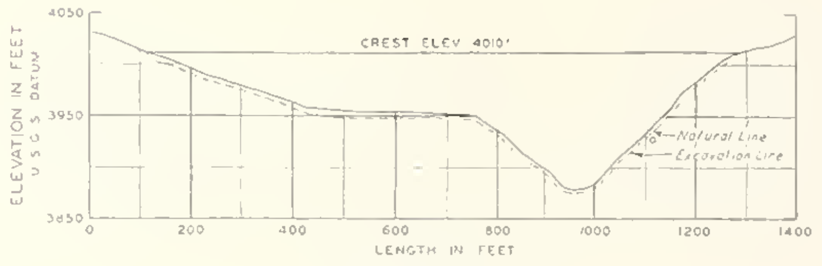
PLAN OF SUGAR PINE SADDLE DIKE AND SPILLWAY
1000 FEET UPSTREAM FROM LEFT ABUTMENT
SCALE OF FEET
0 200 400



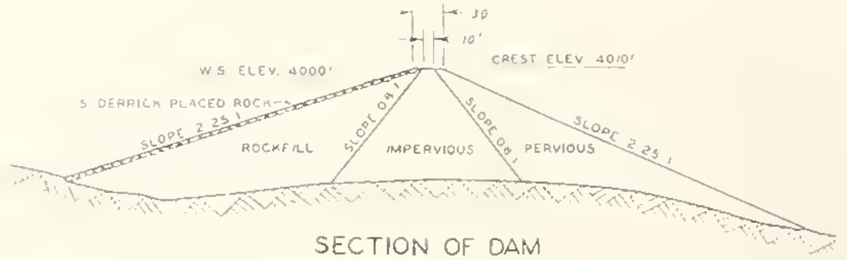
PROFILE OF DIKE AND SPILLWAY SECTION



GENERAL PLAN
SCALE OF FEET
0 200 400

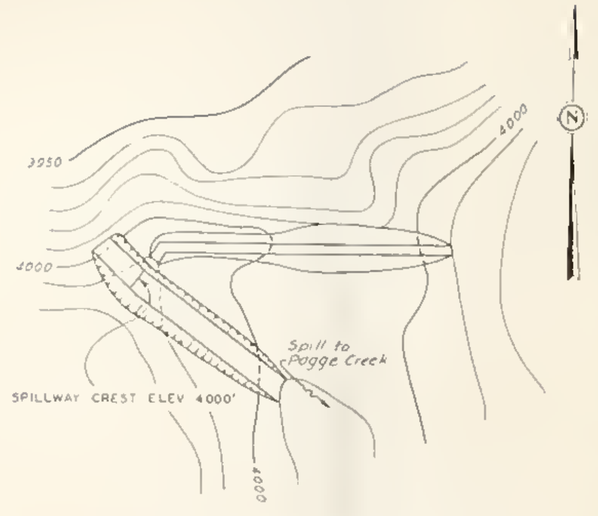


PROFILE OF DAM
LOOKING UPSTREAM

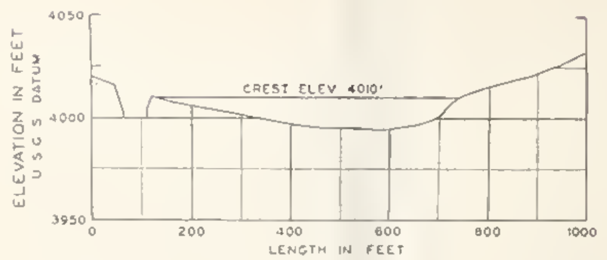


SECTION OF DAM
SCALE OF FEET
0 100 200

FORBES DAM



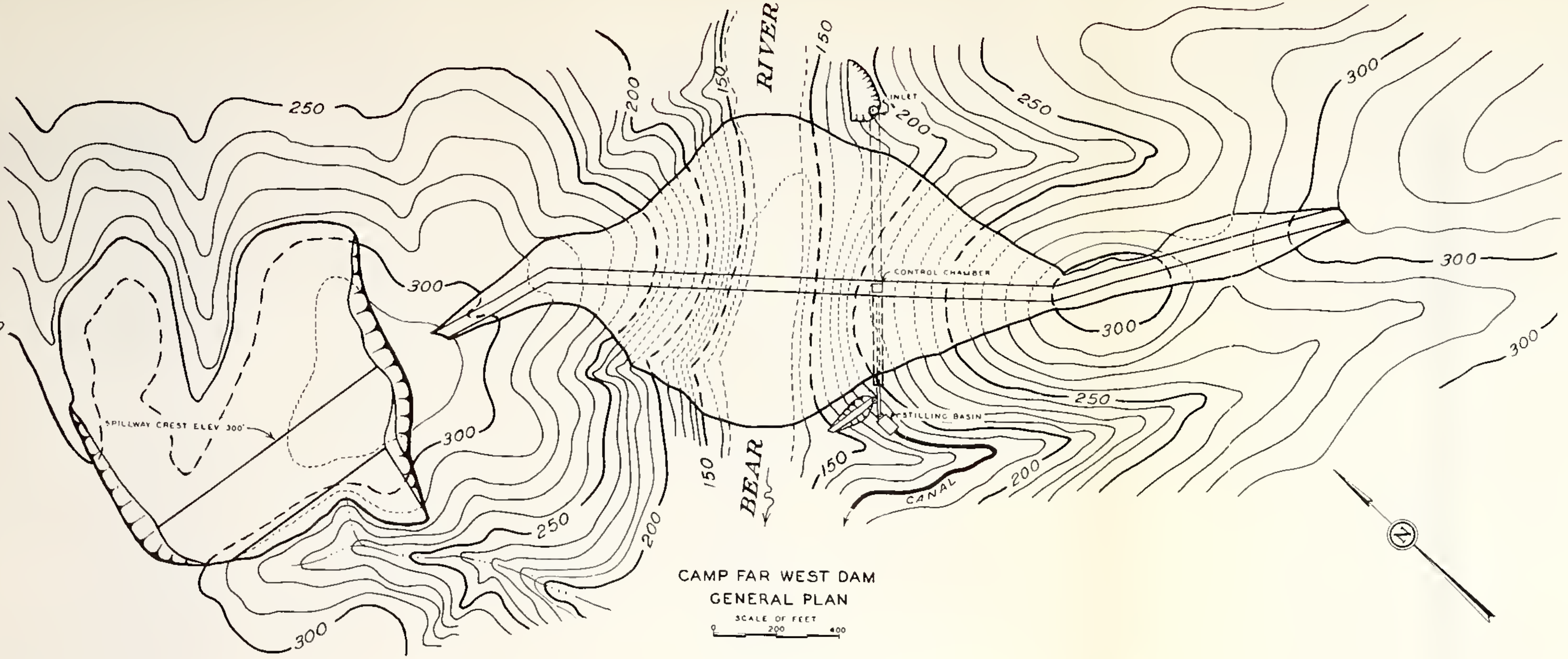
PLAN OF DIKE AND SPILLWAY
3000 FEET UPSTREAM FROM LEFT ABUTMENT
SCALE OF FEET
0 200 400



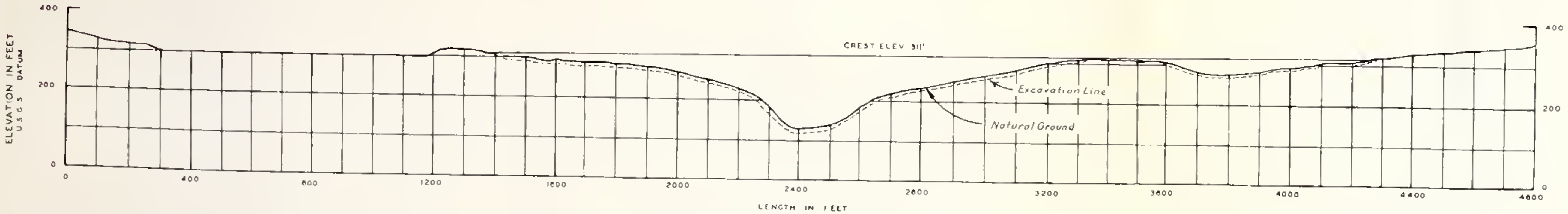
PROFILE OF DIKE AND SPILLWAY SECTION

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION

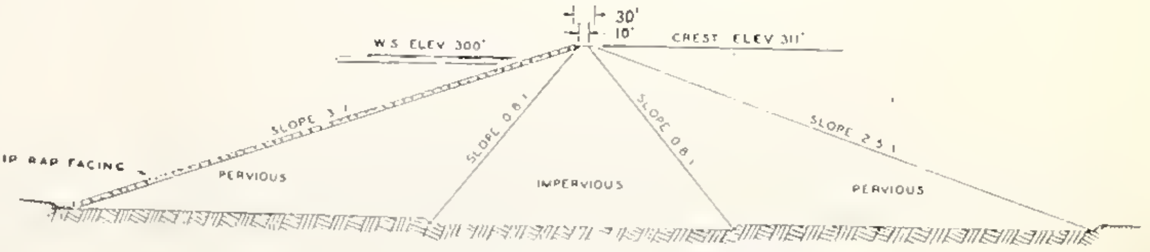
FORESTHILL DIVIDE PROJECT DAMS
1954



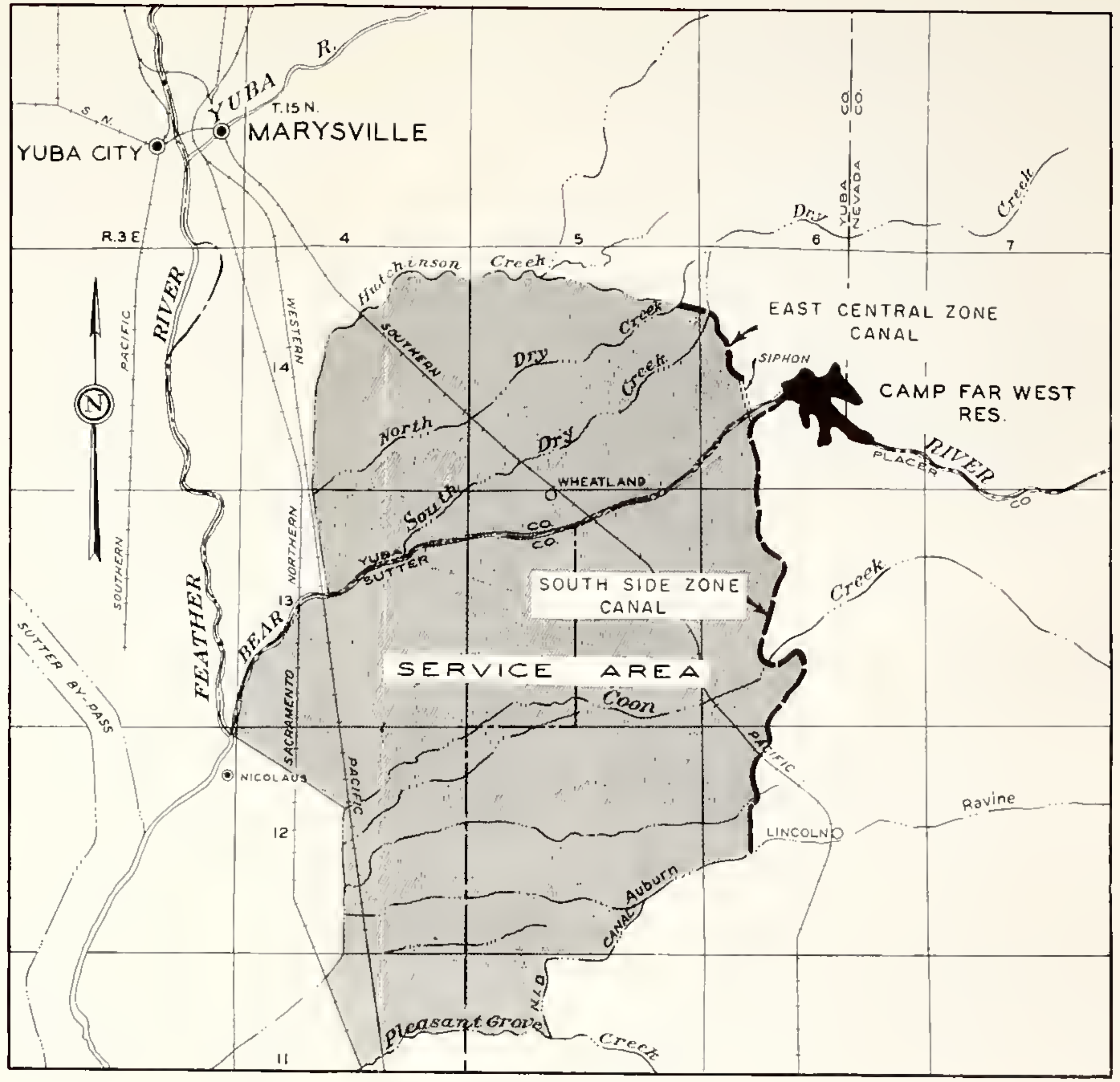
CAMP FAR WEST DAM
GENERAL PLAN
SCALE OF FEET
0 200 400



PROFILE OF DAM
LOOKING UPSTREAM



SECTION OF DAM
SCALE OF FEET
0 100 200

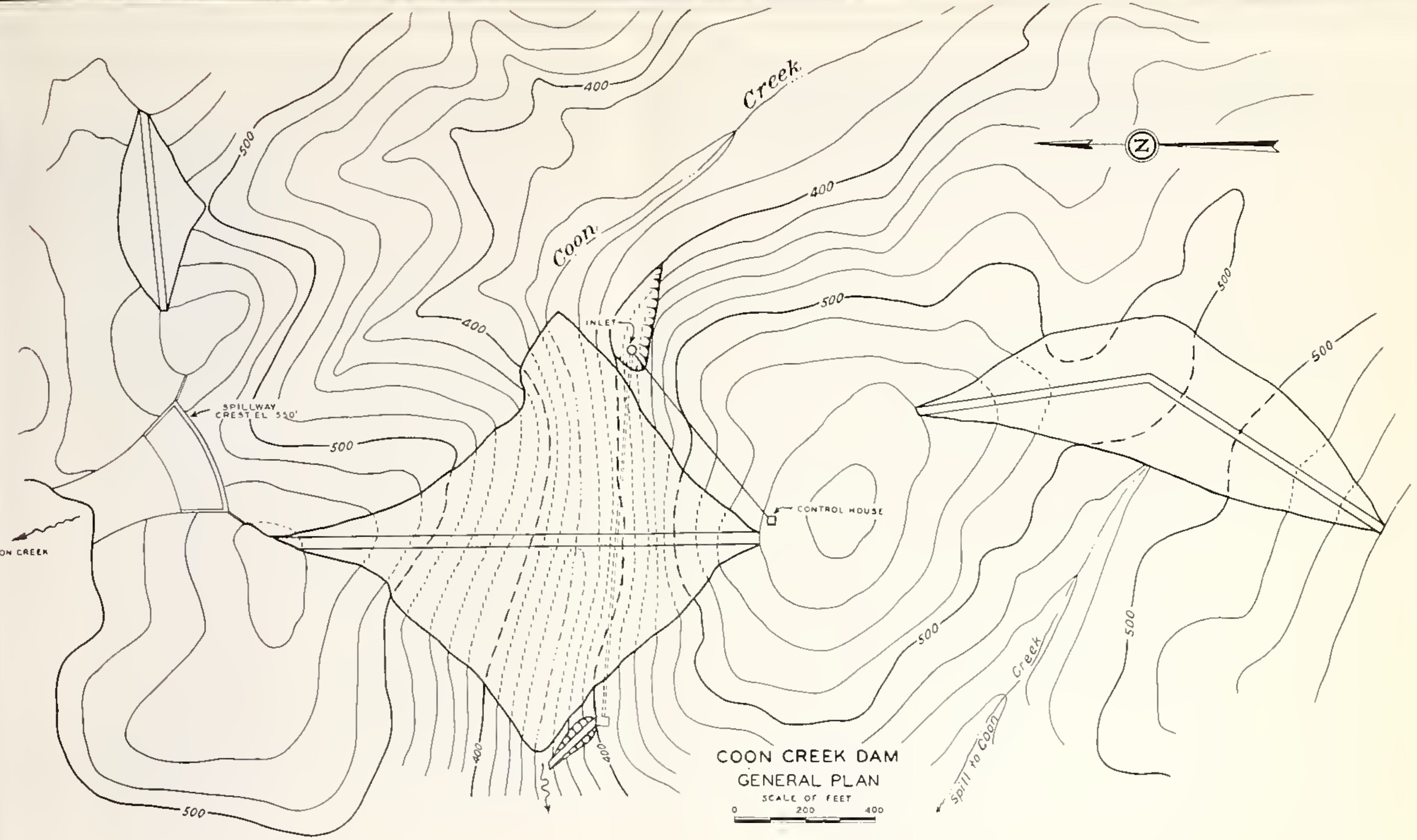


PROJECT AREA
SCALE OF MILES
2 0 2 4

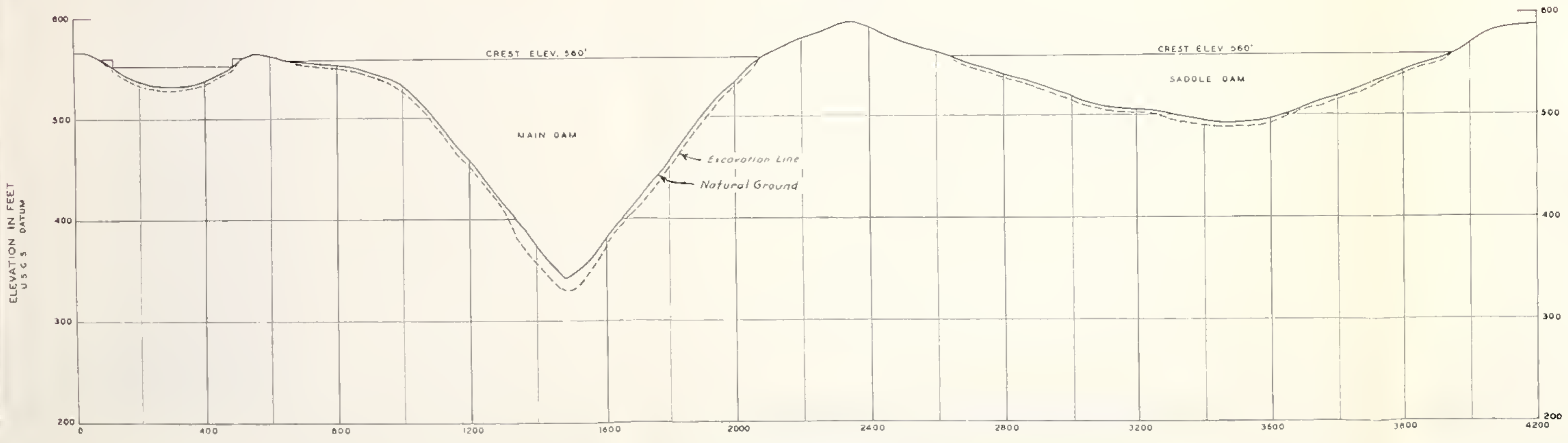
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

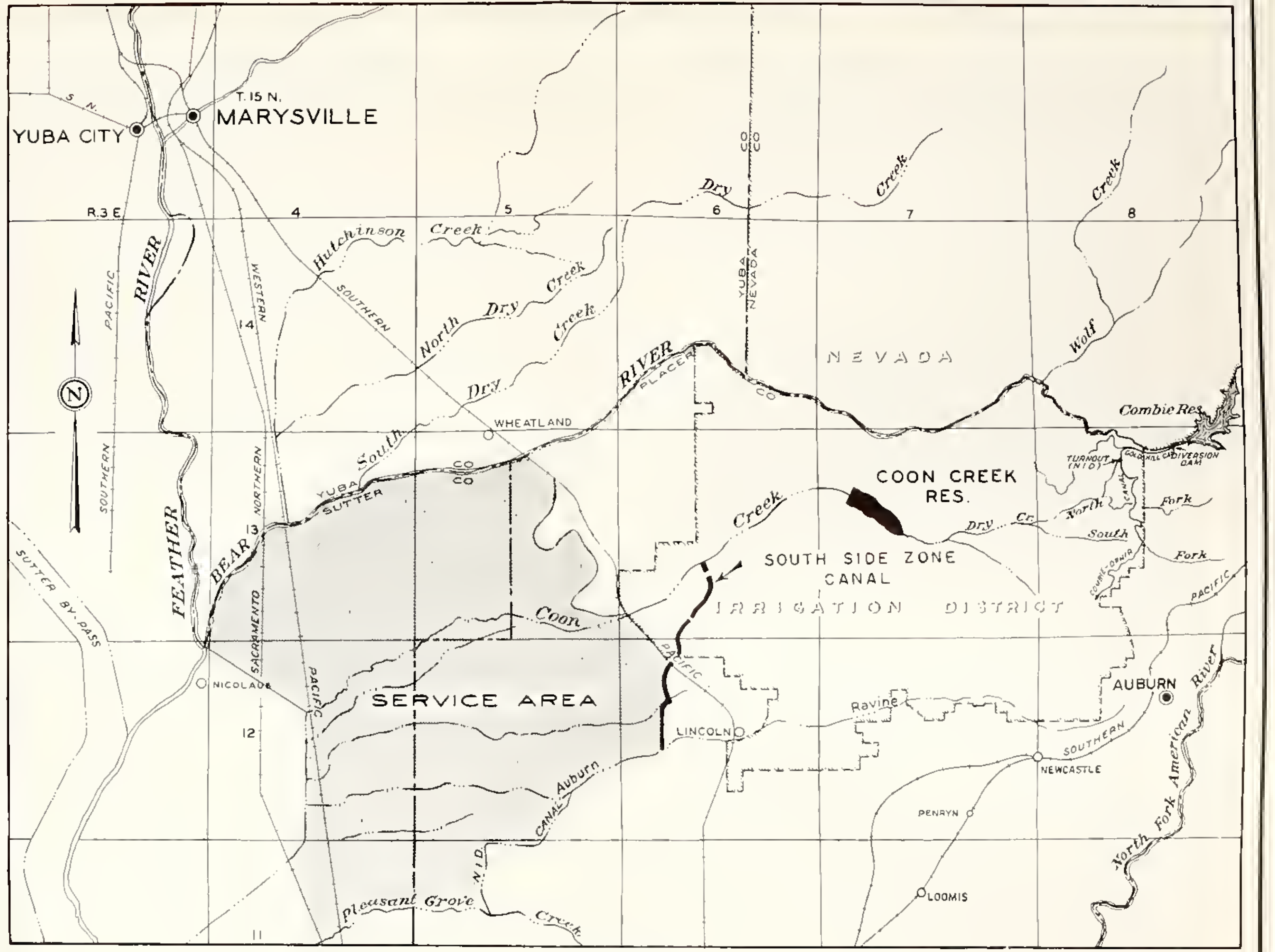
CAMP FAR WEST PROJECT
1954



COON CREEK DAM
GENERAL PLAN

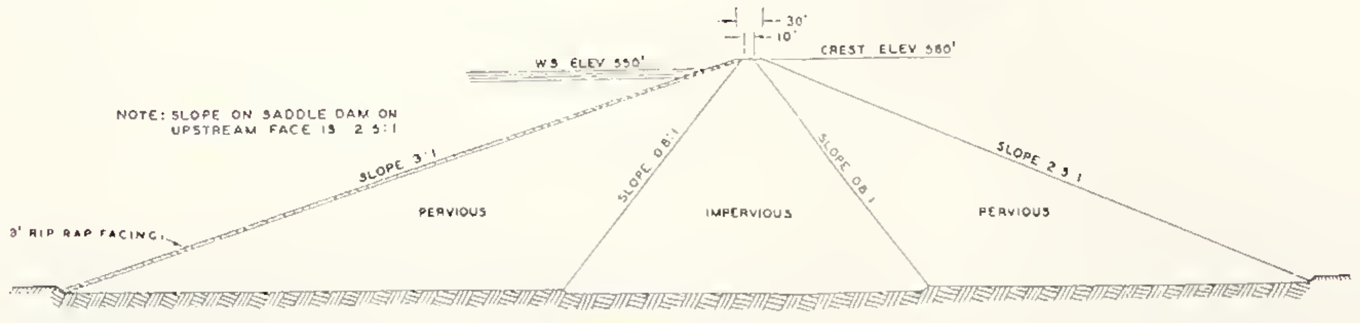


PROFILE OF DAMS
LOOKING UPSTREAM



PROJECT AREA

SCALE OF MILES



SECTION OF DAMS
SCALE OF FEET
0 100 200

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

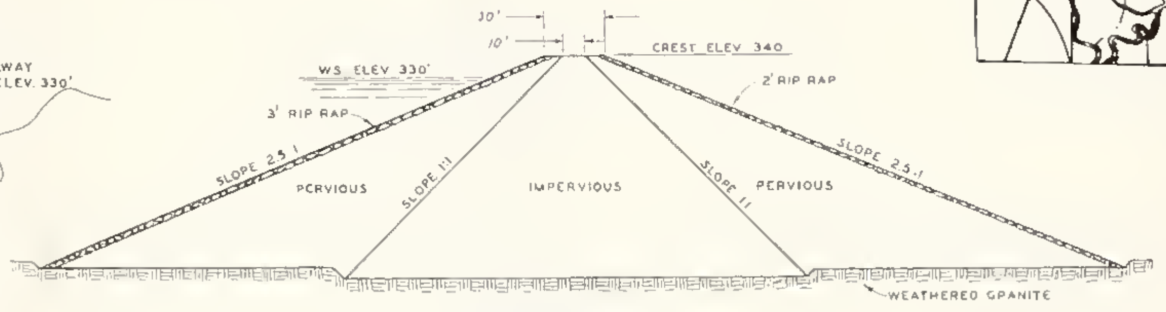
COON CREEK PROJECT
1954

DOTY RAVINE DAM

GENERAL PLAN

SCALE OF FEET

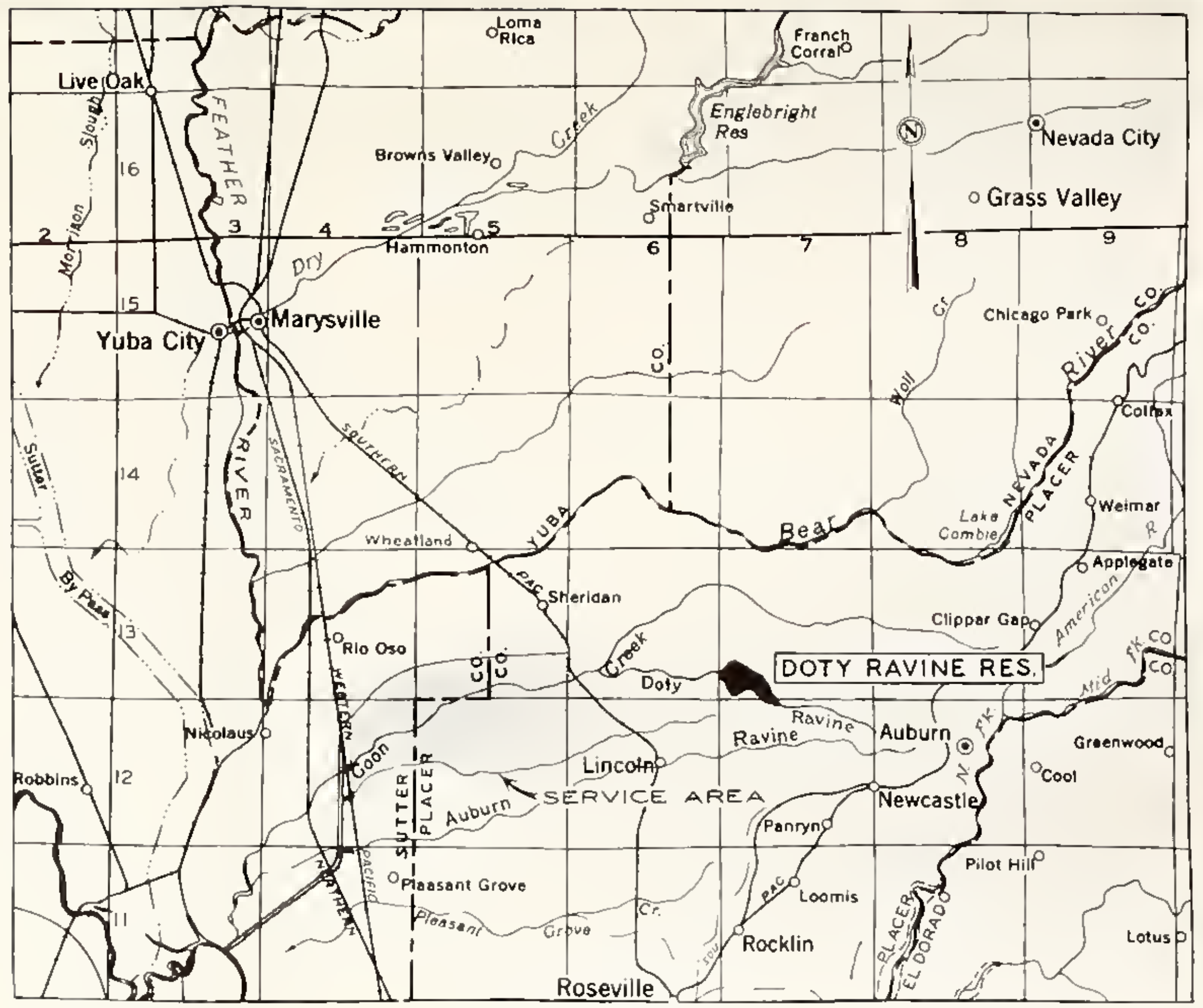
0 330 660



SECTION OF DAM

SCALE OF FEET

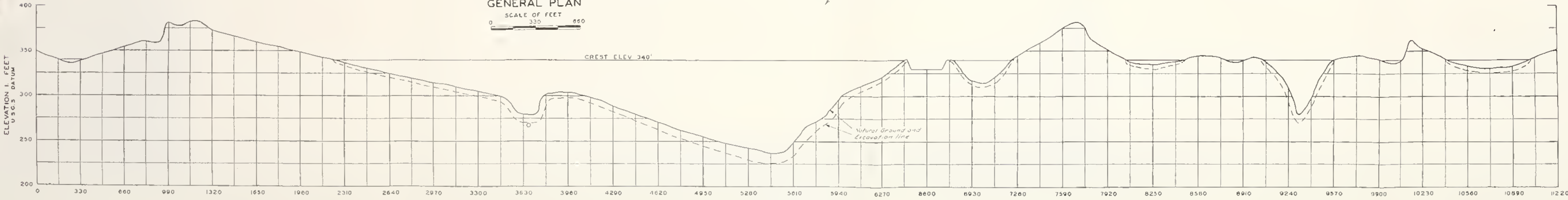
0 50 100



PROJECT AREA

SCALE OF MILES

4 0 4 8



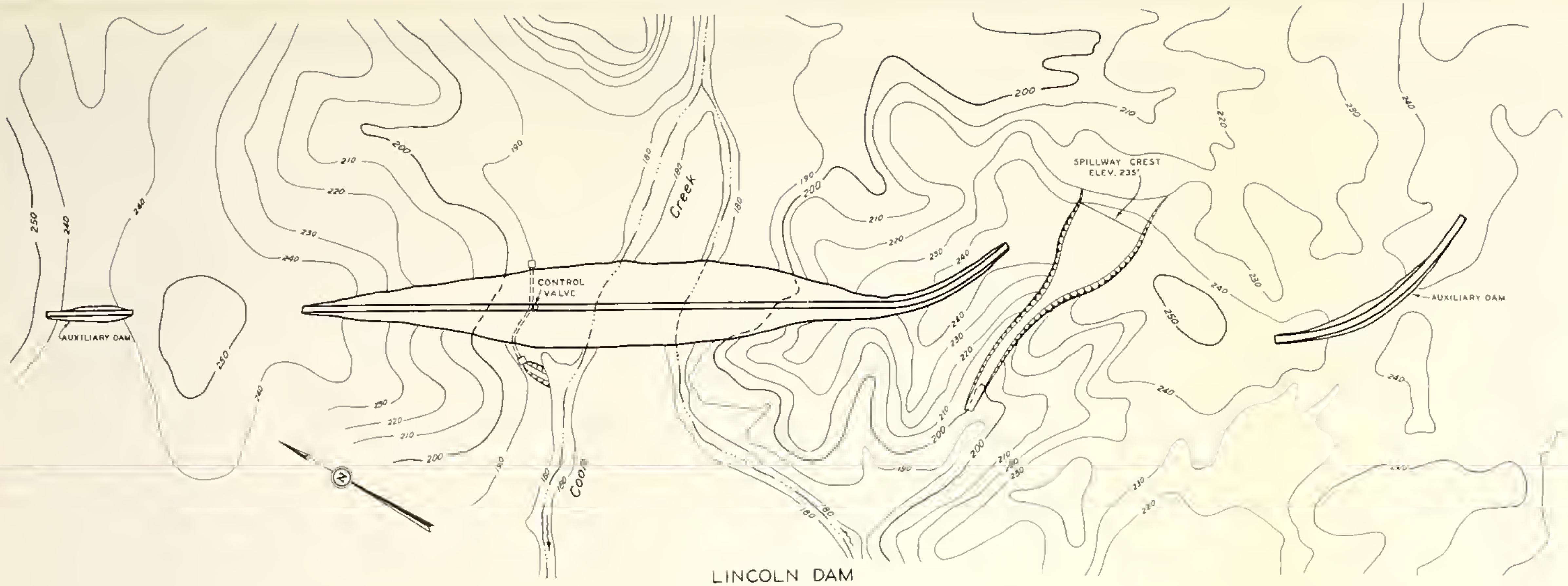
PROFILE OF DAM

LOOKING UPSTREAM

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

DOTY RAVINE PROJECT
1954

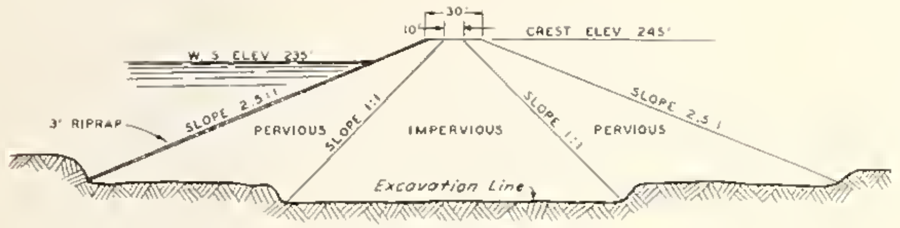


LINCOLN DAM

GENERAL PLAN

SCALE OF FEET

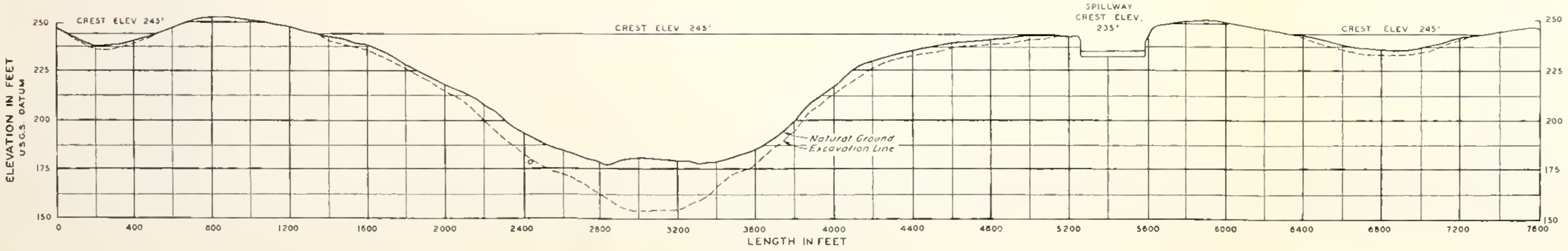
0 400 800



SECTION OF DAMS

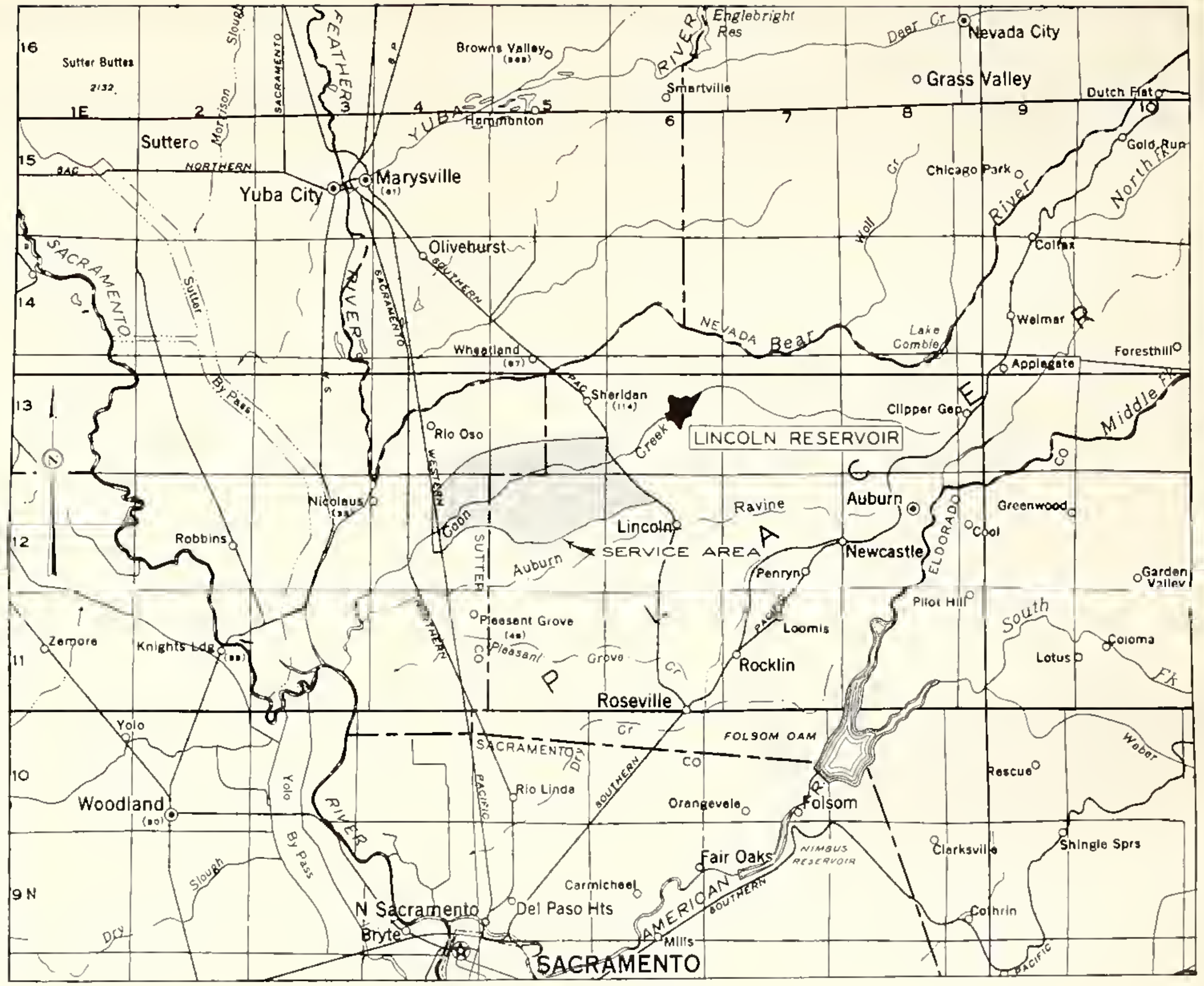
SCALE OF FEET

0 50 100



PROFILE OF DAM

LOOKING UPSTREAM



PROJECT AREA

SCALE OF MILES

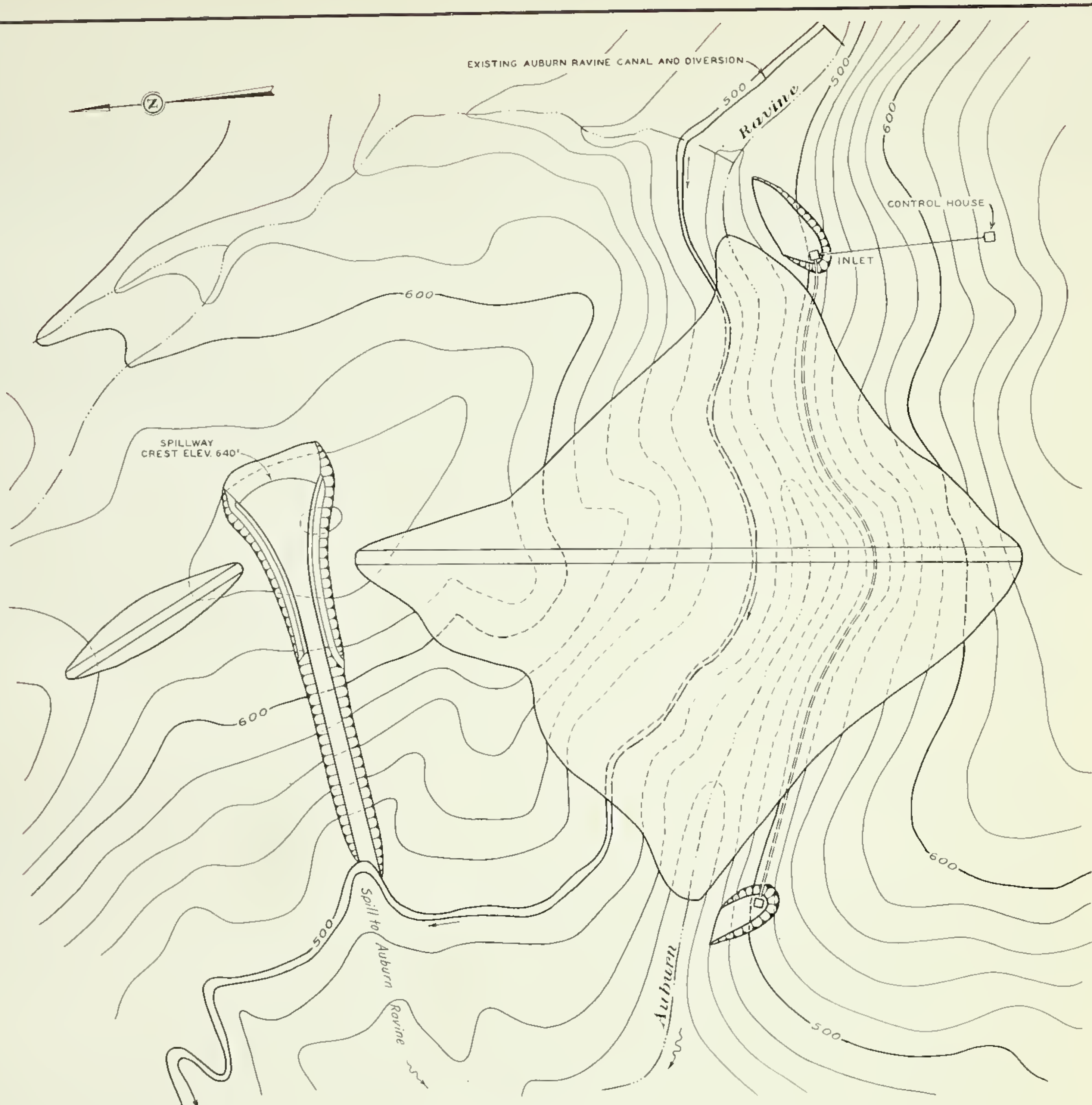
0 4 8

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

LINCOLN PROJECT

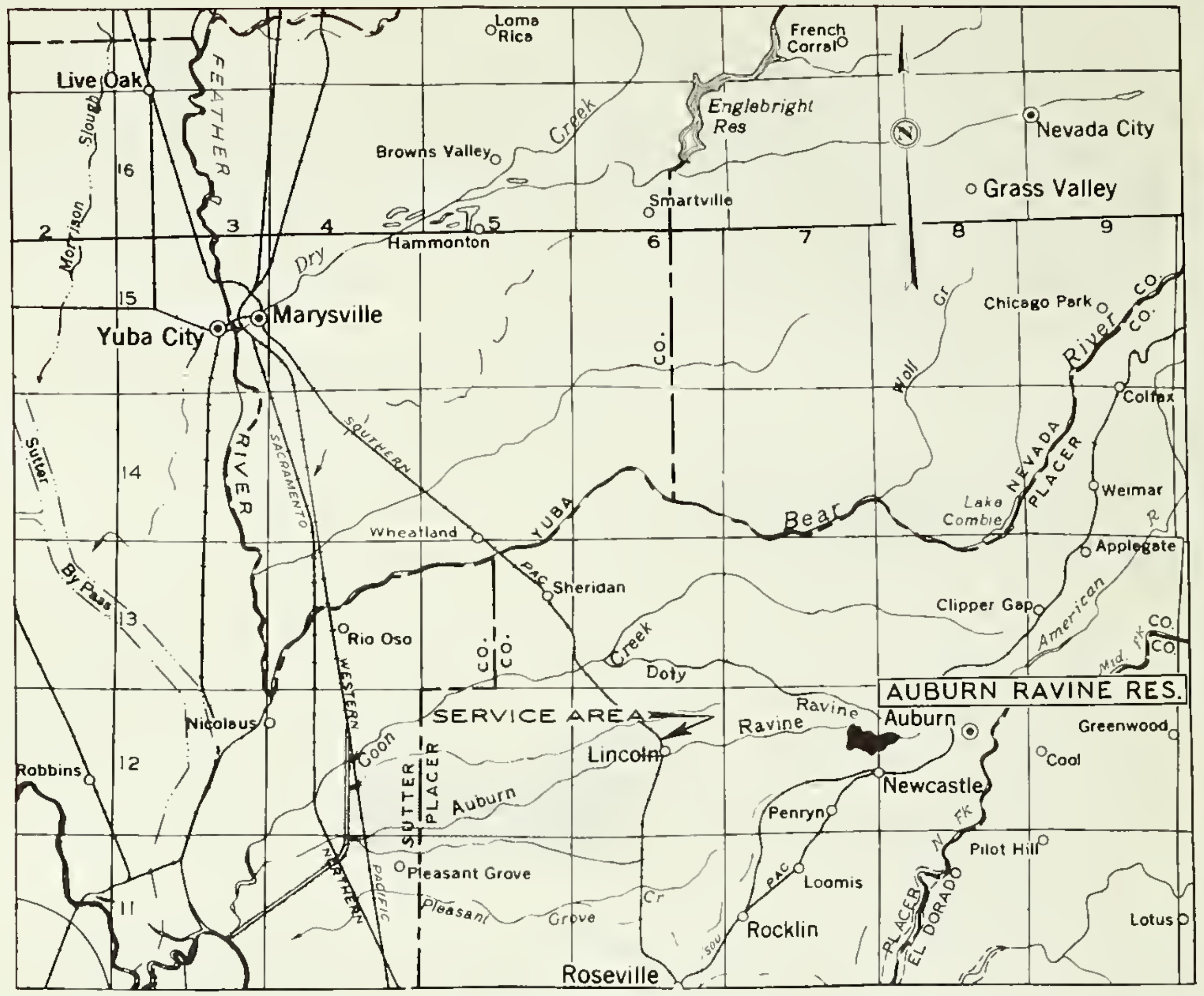
1955



AUBURN RAVINE DAM

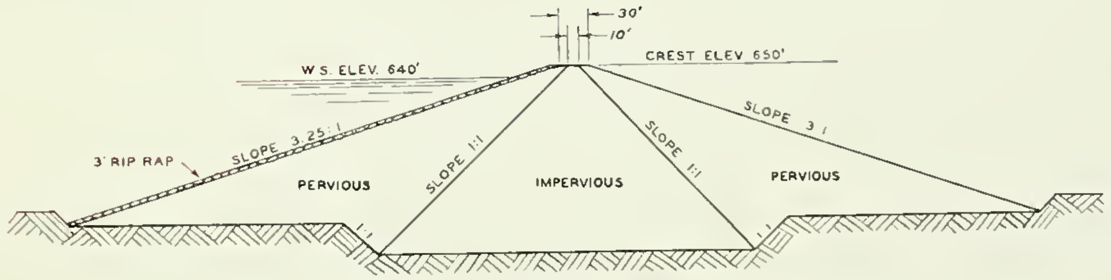
GENERAL PLAN

SCALE OF FEET 0 150 300



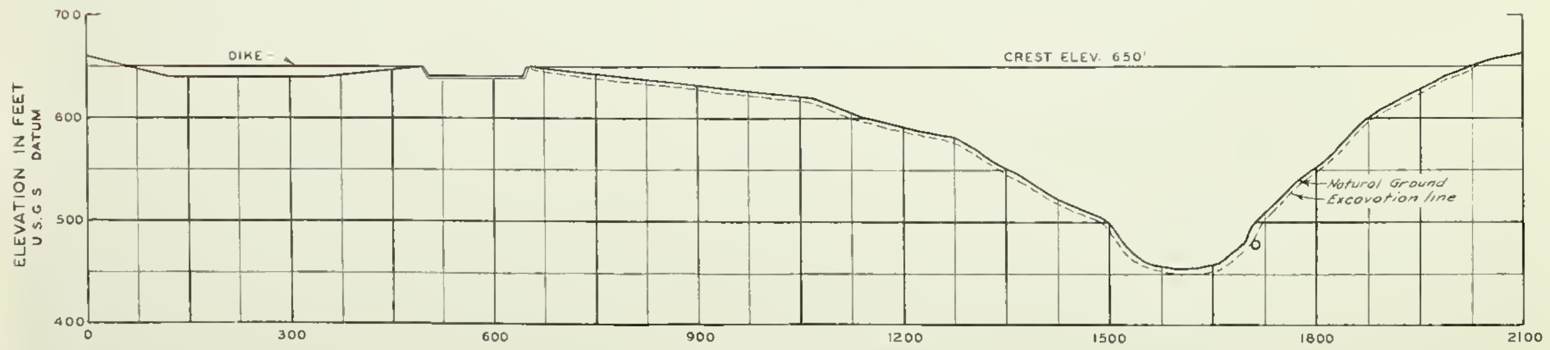
PROJECT AREA

SCALE OF MILES 4 0 4 8



SECTION OF DAM

SCALE OF FEET 0 100 200



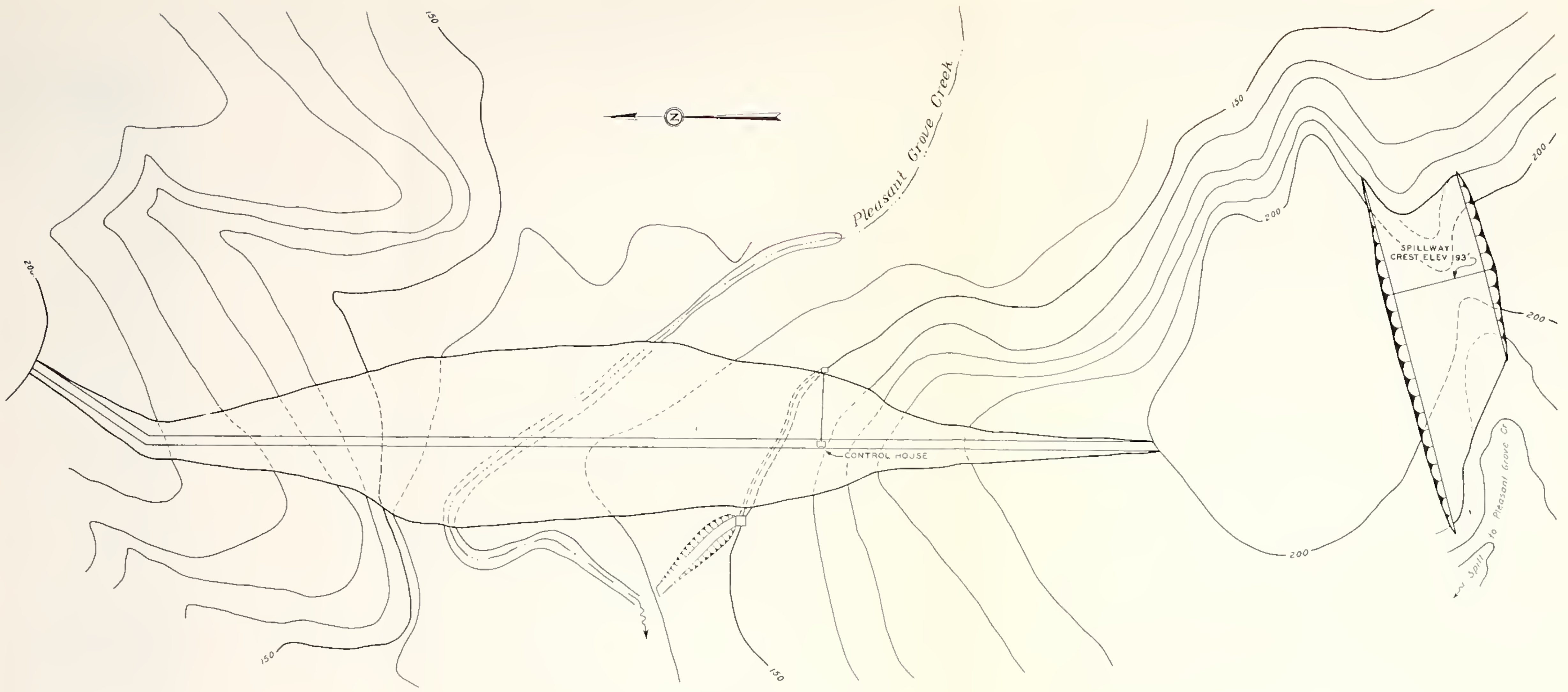
PROFILE OF DAM

LOOKING UPSTREAM

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

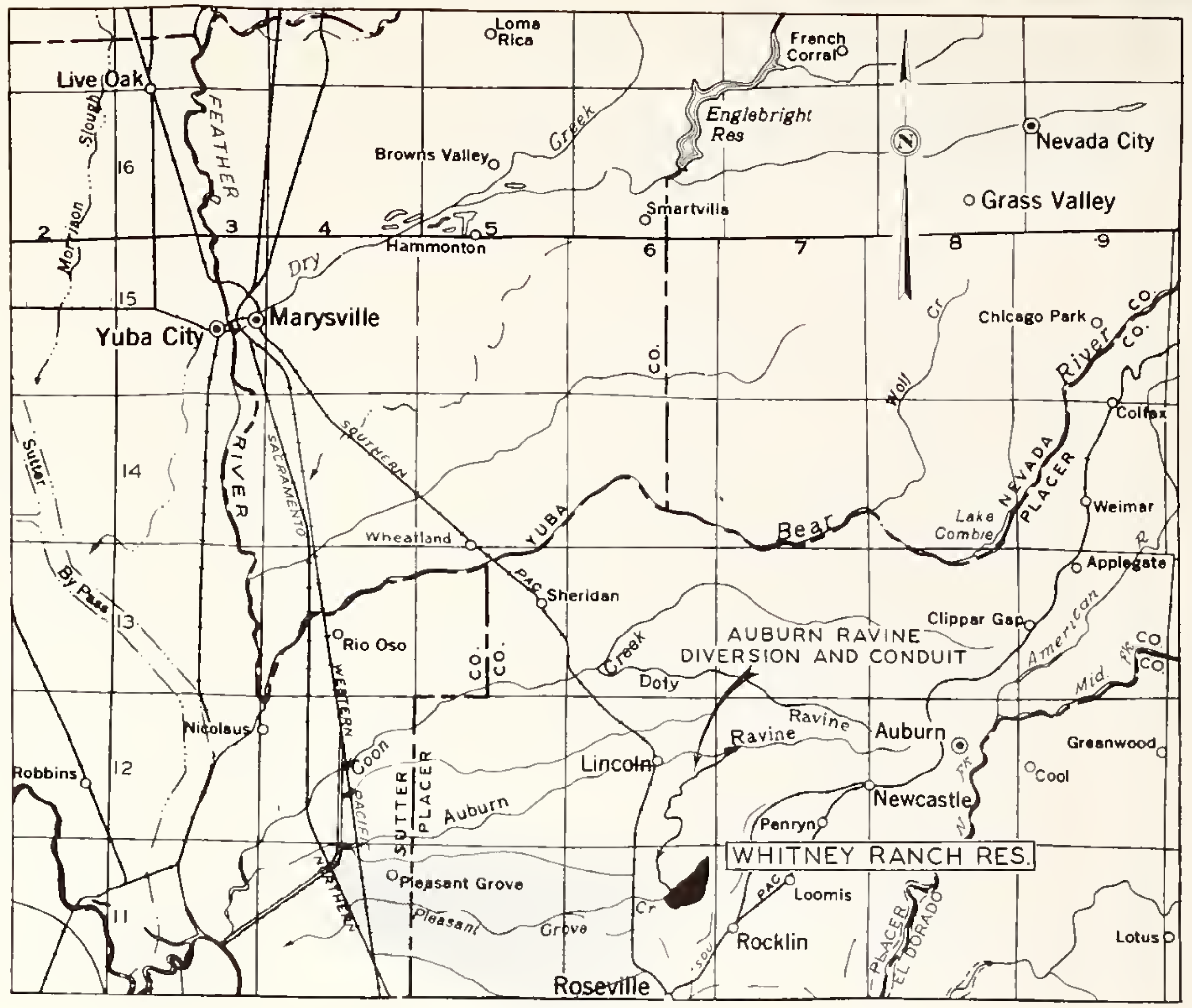
AUBURN RAVINE PROJECT
1954



WHITNEY RANCH DAM

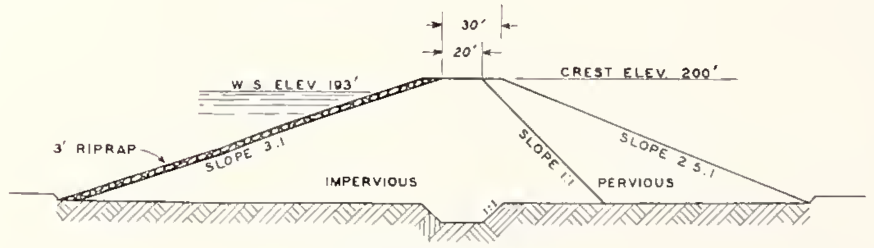
GENERAL PLAN

SCALE OF FEET
0 150 300



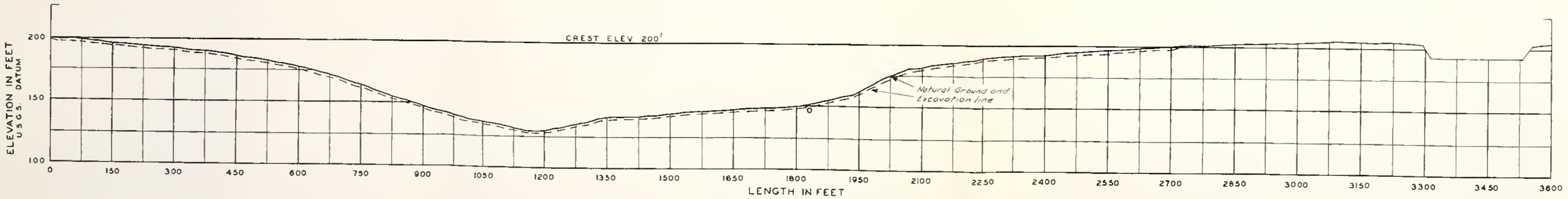
PROJECT AREA

SCALE OF MILES
4 0 4 8



SECTION OF DAM

SCALE OF FEET
0 50 100



PROFILE OF DAM

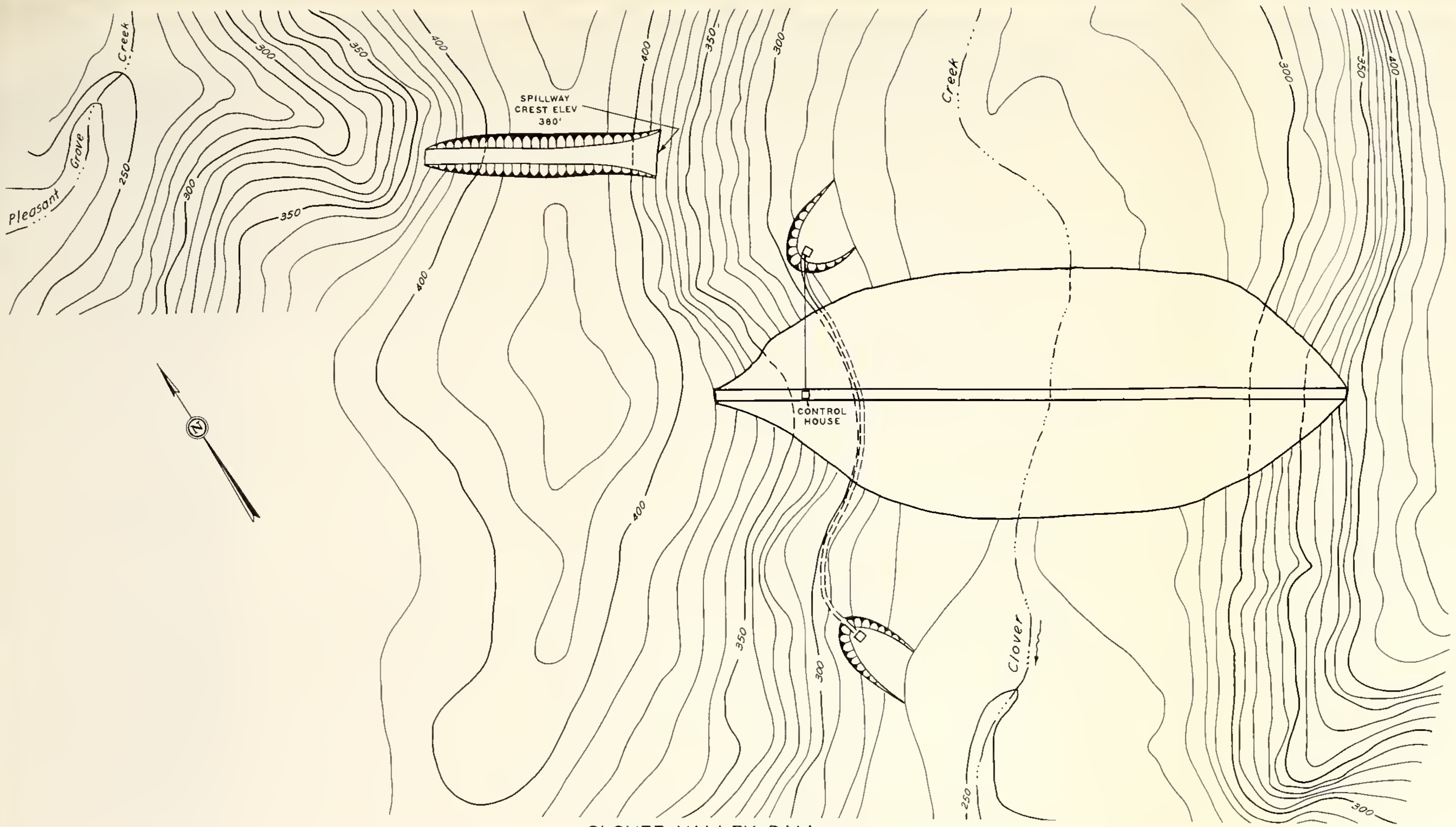
LOOKING UPSTREAM

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

WHITNEY RANCH PROJECT

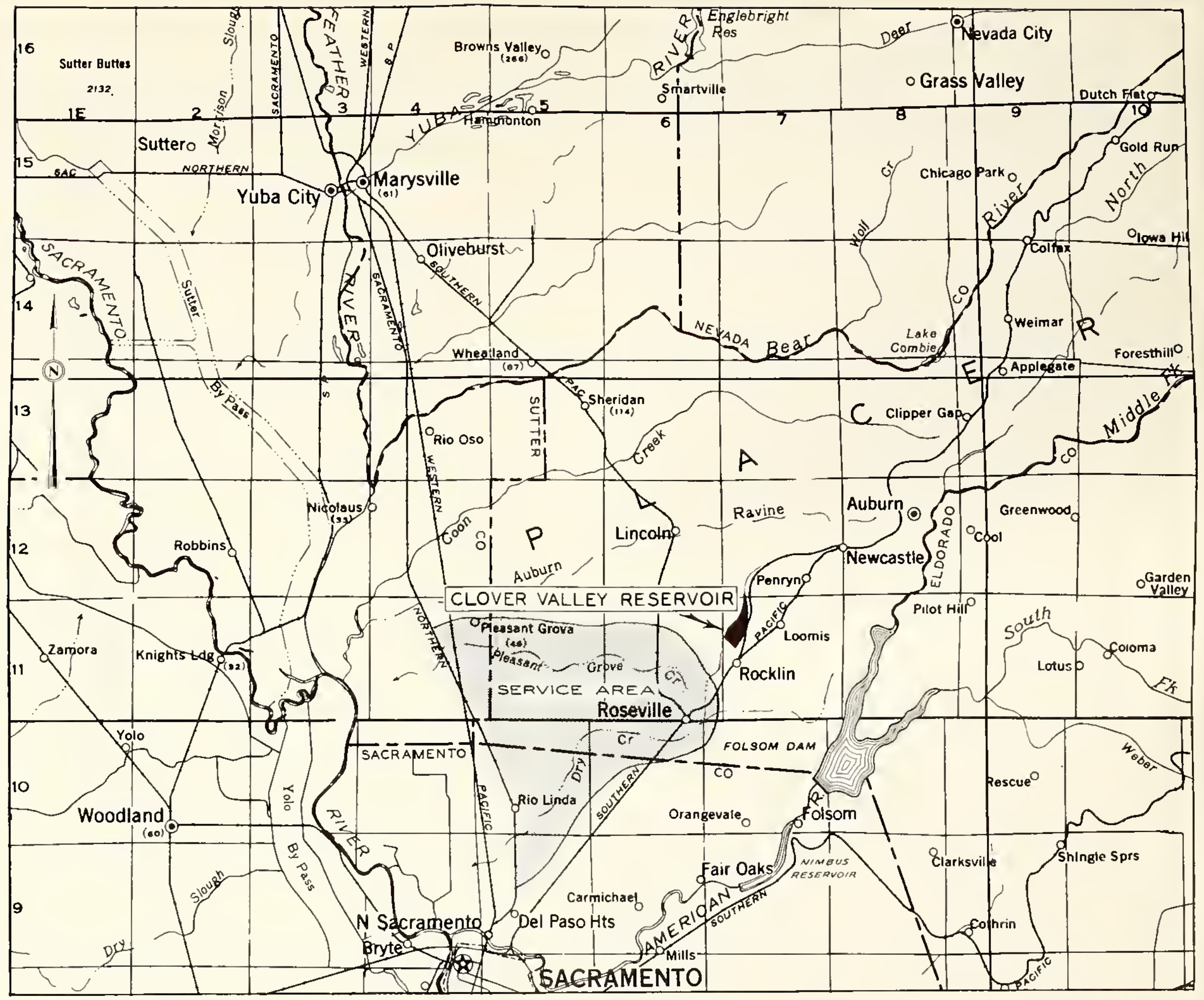
1954



CLOVER VALLEY DAM

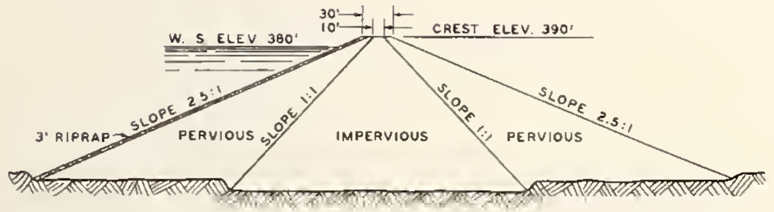
GENERAL PLAN

SCALE OF FEET 0 100 200



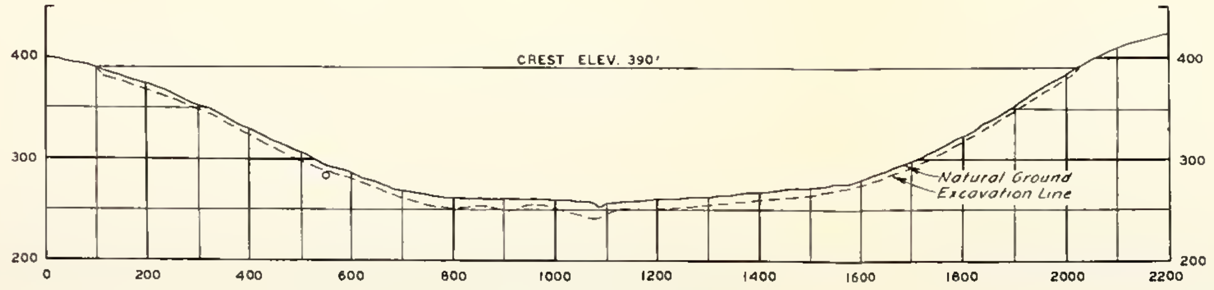
PROJECT AREA

SCALE OF MILES 0 4 8



SECTION OF DAM

SCALE OF FEET 0 100 200



PROFILE OF DAM

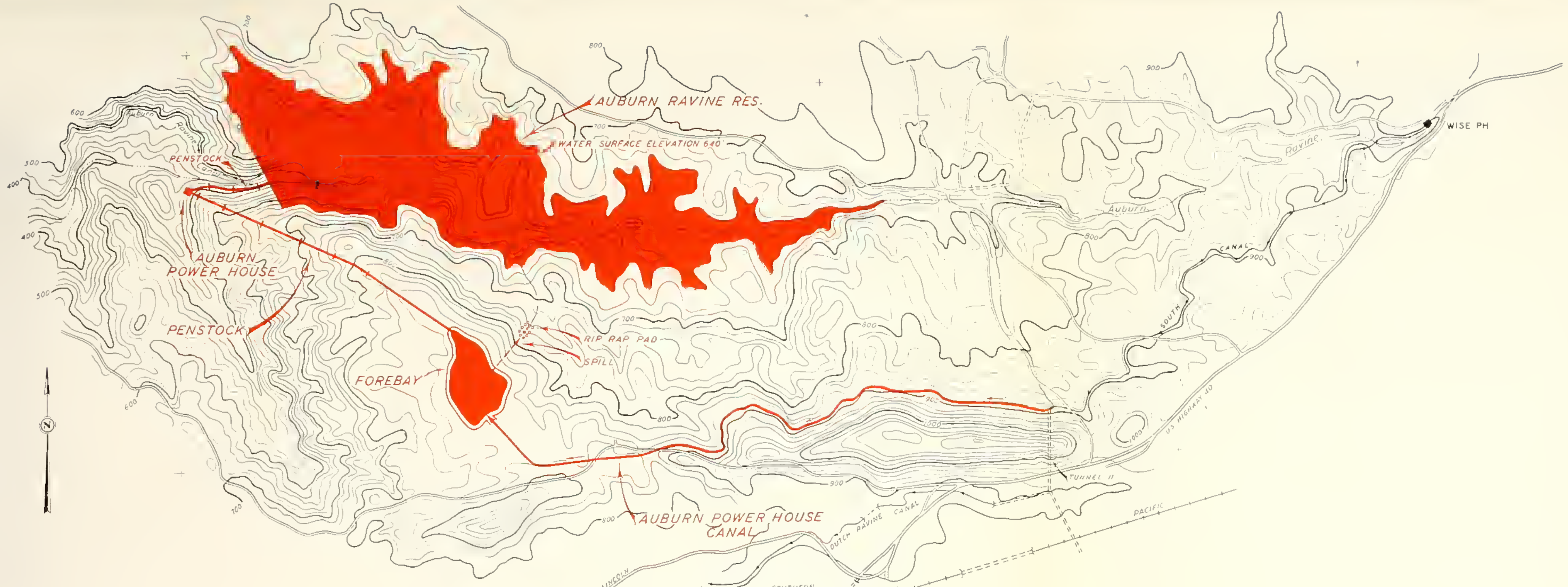
LOOKING UPSTREAM

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

CLOVER VALLEY PROJECT

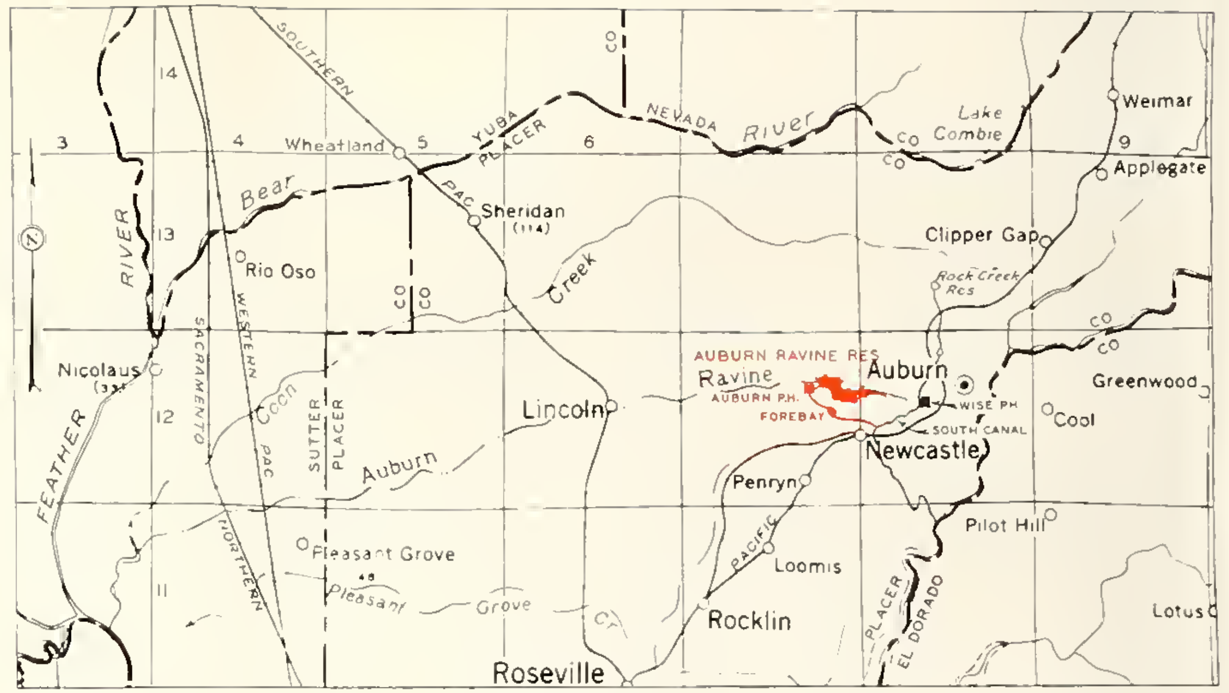
1955



GENERAL PLAN

SCALE OF FEET

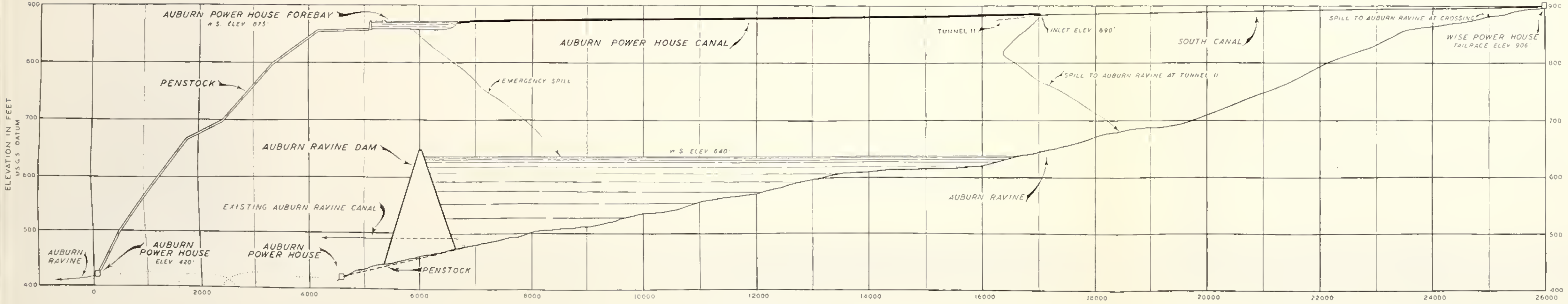
1000 0 1000 2000



LOCATION MAP

SCALE IN MILES

2 0 2 4 6



PROFILE OF PROJECT

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

PLACER COUNTY INVESTIGATION

AUBURN RAVINE
POWER DEVELOPMENT PROJECT
1954

APPENDIX A

AGREEMENTS BETWEEN THE STATE WATER RESOURCES BOARD, THE COUNTY OF PLACER, AND THE DEPARTMENT OF PUBLIC WORKS

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AGREEMENTS BETWEEN THE STATE WATER RESOURCES BOARD, THE COUNTY OF PLACER, AND THE DEPARTMENT OF PUBLIC WORKS

AGREEMENT BETWEEN THE STATE WATER RESOURCES BOARD, THE COUNTY OF PLACER, AND THE DEPARTMENT OF PUBLIC WORKS

THIS AGREEMENT, executed in quintuplicate, entered into by the State Water Resources Board, hereinafter referred to as the "Board"; the County of Placer, hereinafter referred to as the "County"; and the Department of Public Works, State of California, acting through the agency of the State Engineer, hereinafter referred to as the "State Engineer":

WITNESSETH:

WHEREAS, by the State Water Resources Act of 1945, as amended, the Board is authorized to make investigations, studies, surveys, hold hearings, prepare plans and estimates, and make recommendations to the Legislature in regard to water development projects including flood control plans and projects; and

WHEREAS, by said act, the State Engineer is authorized to cooperate with any county, city, state agency or public district on flood control and other water problems and when requested by any thereof may enter into a cooperative agreement to expend money in behalf of any thereof to accomplish the purposes of said act; and

WHEREAS, the County by resolution, dated August 13, 1948, has requested the Board to make an overall comprehensive survey of water and water conditions within said County and has certified that said County will provide monies to the extent of Five Thousand Dollars ($5,000) within the 1948-49 fiscal year from said County's present appropriation to be used in making said survey; and

WHEREAS, the Board on October 1, 1948, by formal motion requested the State Engineer to cooperate with the County in making said investigation and report; and

WHEREAS, the County desires and hereby requests the Board to enter into a cooperative agreement for the making of an investigation and report on water resources, both surface and underground, as more particularly set forth hereinafter in Article I;

NOW THEREFORE, in consideration of the premises and the several promises to be faithfully performed by each as hereinafter set forth, the Board, the County and the State Engineer do hereby mutually agree as follows:

ARTICLE I—WORK TO BE PERFORMED

The work to be performed under this agreement shall consist of an investigation and report on the water resources of Placer County, both surface and underground, comprising (a) an inventory of the water resources of the county, (b) a classification of lands for agricultural use, (c) a survey of the location, extent and type of use of water under existing conditions, (d) an estimate of water requirements under ultimate development of the county, and (e) a general plan for the ultimate development and utilization of the water resources in or available to said county and estimates of the cost of such plan. The work under said items (a) to (d), both inclusive, is to be performed during the first two years and that under said Item (e) including a report on the entire investigation during the third year of the three-year investigation provided for herein.

The Board by this agreement authorizes and directs the State Engineer to cooperate in making said investigation and report.

During the progress of said investigation and report all maps, plans, information, data and records pertaining thereto which are in the possession of any party hereto shall be made fully available to any other party hereto for the due and proper accomplishment of the purposes and objectives hereof.

The work under this agreement shall be diligently prosecuted with the objective of completion of the investigation and report on or before December 31, 1951, or as nearly thereafter as possible.

ARTICLE II—FUNDS

The County, upon execution by it of this agreement, shall transmit to the State Engineer the sum of Five Thousand Dollars ($5,000) for deposit, subject to the approval of the Director of Finance, into the Water Resources Revolving Fund in the State Treasury, for expenditure by the State Engineer in performance of the work provided for in this agreement. Also, upon execution of this agreement by the Board, the Director of Finance will be requested to approve the transfer of the sum of Five Thousand Dollars ($5,000) from funds appropriated to the Board by Item 335 of the Budget Act of 1948, for expenditure by the State Engineer in performance of the work provided for in this agreement and the State Controller will be requested to make such transfer.

If the Director of Finance, within thirty (30) days after receipt by the State Engineer of said Five Thousand Dollars ($5,000) from the County, shall not have approved the deposit thereof into said Water Resources Revolving Fund, together with the transfer of the sum of Five Thousand Dollars ($5,000) from funds appropriated to the Board by Item 335 of the Budget Act of 1948, for expenditure by the State Engineer in performance of the work provided for in this agreement, said sum contributed by the County shall be returned thereto by the State Engineer.

It is understood by and between the parties hereto that the sum of Ten Thousand Dollars ($10,000) to be made available as hereinbefore provided is adequate to perform that portion of the above specified work during the first year of said three-year investigation. It is the further understanding that the County will make a further sum of Seven Thousand Dollars ($7,000) available at the commencement of the second year of said investigation which will be subject to a matching or contribution in an equal sum by the Board to defray expenses incurred during the second year thereof, and will make a further sum of Seventeen Thousand Five Hundred Dollars ($17,500) available at the commencement of the third year of said investigation which will be subject to a matching or contribution in an equal sum by the Board for the completion of said investigation and report, contingent upon availability of county and Board funds for such purposes.

The Board and the State Engineer shall under no circumstances be obligated to expend for or on account of the work provided for under this agreement any amount in excess of the sum of Ten Thousand Dollars ($10,000) as made available hereunder and when said sum is exhausted, the Board and the State Engineer may discontinue the work provided for in this agreement and shall not be liable or responsible for the resumption and completion thereof until further sums as specified in the preceding paragraph are made available.

Upon completion of and final payment for the work provided for in this agreement, the State Engineer shall furnish to the Board and to the County a statement of all expenditures made under this agreement. One-half of the total amount of all said expenditures shall be deducted from the sum advanced from funds appropriated to said Board, and one-half of the total amount of all said expenditures shall be deducted from the sum advanced by the County and any balance which may remain shall be returned to the Board, and to the County, in equal amount.

ARTICLE III—EFFECTIVE DATE

This agreement shall become effective upon its execution by all of the parties hereto, and its approval by the Director of Finance.

IN WITNESS WHEREOF, the parties hereunto have affixed their signatures, the County of Placer on the 12th day of November, 1948, the Board on the 12th day of November, 1948, and the State on the 23rd day of December, 1948.

Approved as to Form:
/s/ C. E. TINDALL
District Attorney,
County of Placer

Approval Recommended:
/s/ HENRY HOLSINGER
Principal Attorney,
Division of Water Resources

Approval Recommended:
/s/ C. C. CARLETON
Chief Attorney,
Department of Public Works

Approved:
/s/ JAMES S. DEAN
Director of Finance

COUNTY OF PLACER [SEAL]
By /s/ W. M. HAINES
Chairman, Board of Supervisors
/s/ L. RECHENMACHER
Clerk, Board of Supervisors

STATE WATER RESOURCES BOARD
By /s/ C. A. GRIFFITH
Vice-Chairman

DEPARTMENT OF PUBLIC WORKS
STATE OF CALIFORNIA [SEAL]
By /s/ C. H. PURCELL
Director of Public Works
/s/ EDWARD HYATT
State Engineer

SUPPLEMENTAL AGREEMENT BETWEEN THE STATE WATER RESOURCES BOARD, THE COUNTY OF PLACER, AND THE DEPARTMENT OF PUBLIC WORKS

THIS AGREEMENT, executed in quintuplicate, by the State Water Resources Board, hereinafter referred to as the "Board"; the County of Placer, hereinafter referred to as the "County"; and the Department of Public Works of the State of California, acting through the agency of the State Engineer, hereinafter referred to as the "State Engineer."

WITNESSETH:

WHEREAS, by agreement heretofore entered into by and between the County, the Board and the State Engineer, executed by the County on the 12th day of November, 1948, by the Board on the 12th day of November, 1948, and by the State Engineer on the 23rd day of December, 1948, it was provided that the work to be performed thereunder shall consist of the making by the State Engineer of an investigation and report on the water resources of Placer County, both surface and underground, comprising (a) an inventory of the water resources of the County, (b) a classification of lands for agricultural use, (c) a survey of the location, extent and type of use of water under existing conditions, (d) an estimate of water requirements under ultimate development of the County, and (e) a general plan for the ultimate development and utilization of the water resources in or available to said county and estimates of the cost of such plan, and that the work under said items (a) to (d), both inclusive, shall be performed during the first two years; and that the plan under said item (e) including a report on the entire investigation shall be made during the third year of the contemplated three year investigation period; and

WHEREAS, under said agreement the County made available the sum of Five Thousand Dollars ($5,000) which was matched in an equal amount by the Board for expenditure by the State Engineer in the performance of the work provided for in said agreement; and

WHEREAS, it was the expressed intention in said agreement that at the commencement of the second year of said investigation the County would make available a further sum of Seven Thousand Dollars ($7,000) subject to a matching or contribution in equal amount by the Board for the continuation of said investigation, and that the County will make a further sum of Seventeen Thousand Five Hundred Dollars ($17,500) available at the commencement of the third year of said investigation which will be subject to a matching or contribution in an equal sum by the Board for the completion of said investigation and report, contingent upon availability of County and Board funds for such purpose; and

WHEREAS, the funds provided for under said prior agreement to which this agreement is supplemental have been exhausted and additional funds are now required to continue said investigation, and it is the desire of the parties hereto that an additional sum of Fourteen Thousand Dollars ($14,000) shall be provided, Seven Thousand Dollars ($7,000) thereof by the County, and Seven Thousand Dollars ($7,000) thereof by the Board;

NOW THEREFORE, in consideration of the premises and of the several promises to be faithfully performed by each of the parties hereto as hereinafter set forth, the Board, the County, and the State Engineer do hereby mutually agree as follows:

1. The County, upon execution by it of this agreement, shall transmit to the State Engineer the sum of Seven Thousand Dollars ($7,000) for deposit, subject to the approval of the Director of Finance, into the Water Resources Revolving Fund in the State Treasury for expenditure by the State Engineer in continuing performance of the work provided for in said prior agreement to which this agreement in supplemental.

2. Upon execution of this agreement by the Board, the Director of Finance will be requested to approve the transfer of the sum of Seven Thousand Dollars ($7,000) from funds appropriated to the Board by Item 259 of the Budget Act of 1949 for expenditure by the State Engineer in continuing performance of the work provided for in said prior agreement to which this agreement is supplemental, and the State Controller will be requested to make such transfer.

3. The Board and the State Engineer shall under no circumstances be obligated to expend for or on account of the work provided for in said prior agreement to which this agreement is supplemental any amount in excess of the sum of Twenty Four Thousand Dollars ($24,000) as made available under said prior agreement and this supplemental agreement and if such funds so made available are exhausted before completion of said work, the Board and the State Engineer may discontinue said work and shall not be liable or responsible for the resumption or completion thereof until further funds are made available at the commencement of the third year as provided in said prior agreement.

4. In so far as consistent herewith and to the extent adaptable hereto, all of the terms and provisions of said prior agreement to which this agreement is supplemental are hereby made applicable to this agreement and are hereby confirmed, ratified, and continued in effect.

In Witness Whereof, the parties hereunto have affixed their signatures, the County on the 9th day of November, 1949, the Board on the 17th day of November, 1949, and the State Engineer on the 21st day of November, 1949.

Approved as to form:
/s/ C. E. Tindall
District Attorney
Placer County

Approval Recommended:
/s/ Henry Holsinger
Principal Attorney
Division of Water Resources

Approval Recommended:
/s/ C. R. Montgomery
Chief Attorney
Department of Public Works

Approved:

Director of Finance

COUNTY OF PLACER

[SEAL]

By /s/ W. M. Haines
Chairman, Board of Supervisors

/s/ L. Rechenmacher
Clerk, Board of Supervisors

STATE WATER RESOURCES BOARD

By /s/ C. A. Griffith
Chairman

DEPARTMENT OF PUBLIC WORKS
STATE OF CALIFORNIA

C. H. Purcell [SEAL]
Director of Public Works

By /s/ Frank B. Durkee
Deputy Director

/s/ Edward Hyatt
State Engineer

E.J.R. Form	F.J.M. Budget	Value	Descript.

DEPARTMENT OF FINANCE
APPROVED
Dec. 19, 1949
James S. Dean, Director

Original signed by
Louis J. Heinzer
Administrative Adviser

SUPPLEMENTAL AGREEMENT BETWEEN THE STATE WATER RESOURCES BOARD, THE COUNTY OF PLACER, AND THE DEPARTMENT OF PUBLIC WORKS

This Agreement, executed in quintuplicate entered into as of November 9th, 1950, by the State Water Resources Board, hereinafter referred to as the "Board"; the County of Placer, hereinafter referred to as the "County"; and the Department of Public Works of the State of California, acting through the agency of the State Engineer, hereinafter referred to as the "State Engineer".

WITNESSETH:

Whereas, by agreement heretofore entered into by and between the County, the Board and the State Engineer, executed by the County on the 12th day of November, 1948, by the Board on the 12th day of November, 1948, and by the State Engineer on the 23rd day of December, 1948, and by supplemental agreement executed by the County on the 9th day of November, 1949, by the Board on the 17th day of November, 1949, and by the State Engineer on the 21st day of November 1949, it was provided that the work to be performed thereunder shall consist of the making by the State Engineer of an investigation and report on the water resources of Placer County, both surface and underground, comprising (a) an inventory of the water resources of the County, (b) a classification of lands for agricultural use, (c) a survey of the location, extent and type of use of water under existing conditions, (d) an estimate of water requirements under ultimate development of the County, and (e) a general plan for the ultimate development and utilization of the water resources in or available to said county and estimates of the cost of such plan, and that the work under said items (a) to (d), both inclusive, shall be performed during the first two years; and that the plan under said item (e) including a report on the entire investigation shall be made during the third year of the contemplated three year investigation period; and

Whereas, under said prior agreement the County made available the sum of Five Thousand Dollars ($5,000) on November 12, 1948, and under said supplemental agreement an additional sum of Seven Thousand Dollars ($7,000) on November 9, 1949, which sums were matched in equal amounts by the Board for expenditure by the State Engineer in the performance of the work provided for in said agreement; and

Whereas, it was the expressed intention in said prior agreement and supplemental agreement that at the commencement of the third year of said investigation the County would make available a further sum of Seventeen Thousand Five Hundred Dollars ($17,500), subject to a matching or contribution in an equal sum by the Board for the completion of said investigation and report, contingent upon availability of County and Board funds for such purpose; and

Whereas, the funds provided for under said prior agreement and supplemental agreement to which this agreement is supplemental have been exhausted and additional funds are now required to continue said investigation, and it is the desire of the parties hereto that an additional sum of Thirty-five Thousand Dollars ($35,000) shall be provided, Seventeen Thousand Five Hundred Dollars ($17,500) thereof by the County, and Seventeen Thousand Five Hundred Dollars ($17,500) thereof by the Board;

Now Therefore, in consideration of the premises and of the several promises to be faithfully performed by each of the parties hereto as hereinafter set forth, the Board, the County, and the State Engineer do hereby mutually agree as follows:

1. The County, upon execution by it of this agreement, shall transmit to the State Engineer the sum of Seventeen Thousand Five Hundred Dollars ($17,500) for deposit, subject to the approval of the Director of Finance, into the Water Resources Revolving Fund in the State Treasury for expenditure by the State Engineer in continuing performance of the work provided for in said prior agreements to which this agreement is supplemental.

2. Upon execution of this agreement by the Board, the Director of Finance will be requested to approve the transfer of the sum of Seventeen Thousand Five Hundred Dollars ($17,500) from funds appropriated to the Board by Item 257 of the Budget Act of 1950 for expenditure by the State Engineer in continuing performance of the work provided for in said prior agreements to which this agreement is supplemental, and the State Controller will be requested to make such transfer.

3. The Board and the State Engineer shall under no circumstances be obligated to expend for or on account of the work provided for in said prior agreements to which this agreement is supplemental any amount in excess of the sum of Fifty Nine Thousand Dollars ($59,000) as made available under said prior agreements and this supplemental agreement and if such funds so made available are exhausted before completion of said work, the Board and the State Engineer may discontinue said work and shall not be liable or responsible for the resumption or completion thereof.

4. In so far as consistent herewith and to the extent adaptable hereto, all of the terms and provisions of said prior agreement to which this agreement is supplemental are hereby made applicable to this agreement and are hereby confirmed, ratified, and continued in effect.

In Witness Whereof, the parties hereto have executed this agreement to be effective as of the date hereinabove first written.

Approved as to form:
/s/ C. E. Tindall
District Attorney
County of Placer

Approval Recommended:
/s/ Henry Holsinger
Principal Attorney
Division of Water Resources

Approval Recommended
/s/ Robert E. Reed
Chief Attorney
Department of Public Works

Approved:
/s/ James S. Dean
Director of Finance

Approved as to number and funds
/s/ E. R. Higgins
Comptroller

COUNTY OF PLACER
By /s/ W. M. Haines
Chairman, Board of Supervisors
[SEAL]
/s/ L. Rechenmacher
Clerk, Board of Supervisors

STATE WATER RESOURCES BOARD
By /s/ C. A. Griffith
Chairman

DEPARTMENT OF PUBLIC WORKS
STATE OF CALIFORNIA
C. H. Purcell [SEAL]
Director of Public Works

By /s/ Frank B. Durkee
Deputy Director
/s/ A. D. Edmonston
State Engineer

A. J. R. Form	F. J. M. Budget	Value	Descript.

DEPARTMENT OF FINANCE
APPROVED
Dec. 29, 1950

APPENDIX B

GEOLOGY OF PLACER COUNTY

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TABLES

PLATES

GEOLOGY OF PLACER COUNTY

INTRODUCTION

Placer County, located northeast of the City of Sacramento, extends eastward from the Sacramento Valley across the Sierra Nevada to the California-Nevada state line. The county is over 90 miles in length, and its width varies from about 7 to about 25 miles.

Previous Work and Acknowledgments

The geology of Placer County was first described in detail in folios of the Geologic Atlas of the United States, published by the U. S. Geological Survey. Portions of Placer County geology are included in the following folios: Placerville folio, no. 3, 1894; Sacramento folio, no. 5, 1894; Smartsville folio, no. 18, 1895; Truckee folio, no. 39, 1897; Colfax folio, no. 66, 1900. Ground water conditions in Placer County were described in a report on the Sacramento Valley by Kirk Bryan, published in 1923 as United States Geological Survey Water-Supply Paper 495.

The geology of the Valley Unit and portions of the Foothill Unit of Placer County has been studied more recently as part of an investigation of the Sacramento Valley conducted by the Ground Water Division of the United States Geological Survey in cooperation with the Division of Water Resources. The following geologic appendix plus the section in the main body of the report discussing underground hydrology is largely based on this work.

Scope of Investigation

This appendix briefly deals with the major features of the geology of Placer County. Both nonwater-bearing and water-bearing rocks are considered. The nonwater-bearing rocks underlie those parts of the county in the Sierra Nevada, and it is the erosion of these rocks that has produced the younger water-bearing sediments to the west of the mountains. Description of the water-bearing rocks in this appendix is more complete, since they comprise the principal reservoirs for ground water storage.

This appendix also includes a description of the methods of estimating storage capacity of the water-bearing deposits of the county, and estimates of capacity made for storage units within the county.

GEOMORPHOLOGY

Placer County includes parts of two of the major geomorphic provinces of California, the Great Valley and the Sierra Nevada. These were defined by Olaf P. Jenkins on the Geomorphic Map of California, published by the California Division of Mines in 1938. The boundary between these provinces as modified by the Geological Survey extends generally in a north-northwest direction, passing about one mile east of Roseville and two miles east of Lincoln.

The Sierra Nevada province is developed on a great block, the eastern margin of which is uplifted above the Basin and Range province, which lies to the east, along major faults. The western flank of the province slopes from 120 to 180 feet per mile to the west and finally extends in that direction beneath the alluvial fill of the Sacramento Valley. This slope is dissected by deep canyons which, in Placer County, have been cut by the American and Bear Rivers and their tributaries. The peaks on the crest of the Sierra Nevada in eastern Placer County are about 9,000 feet above sea level. There is much evidence of Pleistocene glaciation in the upper elevations of the Sierra Nevada.

The portion of Placer County lying in the Sacramento Valley has been divided by the Geological Survey, in connection with their investigation of geology and ground water storage capacity of the Sacramento Valley, into three geomorphic units: Dissected alluvial uplands, low alluvial plains and fans, and flood plains. The dissected alluvial uplands consist of gently rolling terrain merging with the Sierra Nevada foothills on the east and the low alluvial plains on the west. The uplands are being subjected to erosion rather than to deposition at the present time. The low alluvial plains and fans occupying the westernmost part of the county are also being subjected to some dissection. Flood plains mapped by the United States Geological Survey occur along the Bear River, Coon Creek, Auburn Ravine, Markham Ravine, Pleasant Grove Creek, and Linda Creek.

GEOLOGIC FORMATIONS

The geologic formations of Placer County range from Paleozoic to Recent in age. They may be divided into two groups for the purpose of ground water study. These are (1) those formations which yield adequate quantities of water to wells of heavy pumping draft, and (2) those formations which ordinarily do not yield large quantities of water to wells. The former are classed as water-bearing formations and the latter as nonwater-bearing formations.

A geologic map of the Valley Unit of Placer County appears as Plate B-1 of this appendix. Geology of each of the dam sites studied during the current investigation is described in Chapter IV of the bulletin.

Nonwater-bearing Group

The pre-Cretaceous crystalline rocks of the Sierra Nevada comprise the nonwater-bearing group in Placer County. These rocks make up the so-called "Bedrock series" in the Sierra Nevada. They consist of ancient igneous and sedimentary rocks metamorphosed during the Nevadan orogeny of the late Jurassic period, and deep-seated igneous rocks intruded during that period.

Calaveras Group. The Calaveras group includes an assemblage of metamorphosed igneous and sedimentary rocks generally considered to be Carboniferous in age. This group is subdivided, in the Colfax folio of the Geological Survey, into the formations shown in the following tabulation:

Formation	*Lithology*
Clipper Gap formation	Clay slates, chert, and limestone
Delhi formation	Black siliceous rocks, rarely schistose
Cape Horn formation	Fissile clay slates
Relief formation	Chert and quartzite
Blue Canyon formation	Fissile clay slates, quartzitic sandstone, chert, limestone, and contact metamorphic rocks, chiefly mica schist.

Rocks of the Calaveras formation, in places overlain by Tertiary volcanics, outcrop over most of the county between Auburn and the vicinity of Cisco, near the crest of the Sierra Nevada.

Sailor Canyon Formation. The rocks of the Sailor Canyon formation are somewhat less metamorphosed than are the Calaveras rocks, and were probably deposited unconformably upon the latter early in the Jurassic period. The formation is composed principally of fissile clay slates, black calcareous shale without pronounced fissility, chert, quartzite, and limestone. Where subjected to contact metamorphism, these rocks have recrystallized chiefly as mica schist and hornfels. Sailor Canyon rocks occur in several areas east of the Calaveras formation outcrops.

Mariposa Formation. The Mariposa formation in Placer County is composed of black shales varying to black slates with poor fissility, sandstones, and conglomerates. The formation is probably upper Jurassic in age. In Placer County the Mariposa formation occurs only in a belt a few miles wide which extends across the county through Colfax in a north-northwesterly direction.

Greenstone Series. A series of interrelated rocks of igneous origin, comparable to the rocks of the sedimentary series in age, occurs in Placer County, mainly on the western slope of the Sierra Nevada. This assemblage of rocks is loosely grouped together as the Greenstone series. The lithologic types include diabase, gabbro, diorite, peridotite, pyroxenite, porphyrite, amphibolite, and serpentine. These rocks are generally dark green in color, and in places show notable foliation.

Granitic Rocks. Granitic rocks occur in several places in Placer County. The largest area of outcrop lies in the lower Sierras between Auburn and Lincoln, where the rock is chiefly granodiorite. The second largest area is in the eastern part of the county, where granodiorite, covered in many places by Tertiary volcanics, extends westward from Lake Tahoe.

Other granitic rocks appearing in the quadrangle include granite, diorite, and gabbro. The intrusion of all these rocks probably occurred in late Jurassic or very early Cretaceous time.

Water-bearing Group

The formations of Tertiary and Quaternary age in Placer County are all water-bearing to some degree. Formations of these periods in the Sacramento Valley act as ground water aquifers, but the permeability of Tertiary and Quaternary formations in the Sierra Nevada is significant mainly in that some leakage may occur from surface reservoirs in these rocks. The Tertiary and Quaternary formations in the Sierra compose the "Superjacent series."

Tertiary Gravels of the Sierra Nevada. The Tertiary gravels include sands, gravels, and clays laid down in the channels of streams which drained the Sierra Nevada during the Tertiary period. Dissection after the most recent uplift of the Sierra Nevada has cut the present canyons through the Tertiary gravels, whose remnants remain on high ground and are in some places preserved beneath a capping of volcanic rocks. The largest area of outcrop of this formation in Placer County extends south-southwest from Dutch Flat.

Volcanic Rocks. The principal volcanic activity in the Sierra Nevada occurred during three different periods: the lavas formed during the first period were rhyolitic, during the second andesitic, and during the third basaltic. The rhyolite includes both tuffs and massive rhyolite. The original mass of these rocks was much less than that of the andesite which followed, and their present distribution is much more limited. The andesite was probably originally over 1,000 feet thick at the crest of the Sierra, but thinned to the west. The most common volcanic rock type in the Sierra is an andesitic tuff breccia, but andesitic sands, clays, and fine-grained tuffs are also present. Erosion has removed much of this volcanic material, although extensive areas of eastern Placer County are still covered by andesitic rocks. Basalt occurs in the eastern part of the county, particularly east of the crest of the Sierras. The rhyolite is considered to be Miocene in age, the andesite Miocene and possibly Pliocene, and the basalt Pleistocene.

An area of volcanics is exposed at the base of the Sierras in the Lincoln-Roseville area. Near the clay quarries at Lincoln, andesite tuff-breccia overlies a rhyolitic sequence of sand, sandy clay, gravel, and grayish-white clay. Between Lincoln and Roseville, the volcanic rocks include andesite tuff-breccia, and tuff intercalated with andesitic conglomerates and sandstones.

The volcanics dip gently from the base of the Sierra Nevada beneath younger materials toward the trough of the Sacramento Valley. Their water-yielding capacity is generally high in Placer County. Two of a number of deep wells obtaining large yields from the volcanics are located at Roseville. One of these, well 10N 6E-2K1, drilled for the City of Roseville, entered "lava" at a depth of 165 feet, and was completed at 245 feet, the lowest 40 feet being in sand and gravel. Yield of this well is reported as 1,200 gallons per minute. Another well in Roseville, 10N 6E-2Q1, drilled for the Pacific Fruit Express Company, entered volcanic rock at a depth of 179 feet, below which were logged "lava," clay, sandstone, and gravel. This well reportedly yields 525 gallons per minute.

Ione Formation. The Ione formation is composed of light-colored sands and clays, dark brownish to reddish sandstones, gravels, conglomerates, and some lignitic material. It occurs only in scattered areas of outcrop along the eastern edge of the Sacramento Valley, notably just north and just south of Lincoln. The sediments of the Ione formation appear to have been deposited under deltaic conditions. Interfingerings to the east with the Tertiary gravels of the Sierras are common. The age of the formation is middle Eocene.

A few irrigation wells southwest of Wheatland are known to produce fresh water from clean white sands of the Ione formation. Where wells pierce marine Eocene beds, water abnormally high in chloride content is often found. Three wells having high chlorides in the Lincoln area are reported by Bryan (1923), and the source of the chlorides in these wells may well be the marine Eocene sediments.

Old Alluvium. The area underlain by old alluvium approximately coincides with the "dissected alluvial uplands" geomorphic unit. It also corresponds in general with the "red lands" described by Bryan in U.S.G.S. Water-Supply Paper 495. Old alluvium extends all along the eastern margin of the Sacramento Valley in Placer County except where transected by younger formations. It is the approximate equivalent of three separate formations, the Laguna formation, the Arroyo Seco gravel, and gravel deposits of uncertain age, mapped by the United States Geological Survey in the Mokelumne area and reported in Water-Supply Paper 780.

The old alluvium includes several lithologic types, namely: reddish- to yellowish-brown silt and silty sand, light gray indurated siltstone, and gravel. The sands and gravels are often cross-bedded. The gravels are generally dirty and contain a matrix of silt. Gravel deposits correlative with the Arroyo Seco and other gravels of the Mokelumne area are particularly common near the eastern margin of the old alluvium north of Auburn Ravine.

The old alluvium dips gently to the west in Placer County, and thus underlies the intermediate alluvium farther west at shallow depths. The thickness of the old alluvium generally increases westward toward the trough of the Sacramento Valley.

Well logs show the old alluvium to be composed mainly of silt, clay, sand, sandstone, and some gravel. The fine, tight sediments predominate, but individual sand or gravel beds are sufficiently permeable in some places to furnish adequate yield to irrigation wells.

Intermediate Alluvium. The area underlain by the intermediate alluvial deposits coincides in general with the geomorphic unit here called "low alluvial plains and fans." These deposits occupy the western part of Placer County from about two miles south of the Bear River south to the Sacramento county line. They are continuous with the Victor formation of the Mokelumne area, and are assumed to be of the same age.

The intermediate alluvium is composed of sand, gravel, silt, and clay, largely deposited by shifting streams from the Sierra Nevada. The ratio of sand and gravel to the finer sediments is higher in Placer County than farther west in the Sacramento Valley.

The coarse stringers and lenses in the intermediate alluvium yield water freely to wells. However, the total volume of production from the intermediate alluvium into any given well is limited by the thickness of these deposits, which in Placer County probably nowhere exceeds 50 feet.

Stream Channel Deposits. Stream channel deposits generally underlie the beds, natural levees, and flood plains of major streams flowing westward from the Sierra Nevada. The principal stream channel deposits in Placer County occur along the Bear River, but deposits of lesser significance occur along the smaller creeks.

The stream channel deposits consist essentially of unconsolidated gravels, sands, and silts. They form the most recent series of deposits in Placer County.

Wells in the flood plain of the Bear River obtain large amounts of water from the stream channel deposits. Since these deposits are thin, most wells of heavy draft in this area also obtain part of their supply from the underlying sediments.

GROUND WATER GEOLOGY

The preceding report on the general geology of Placer County serves as a foundation from which a more detailed analysis of the ground water geology may be made. Such an analysis follows.

Yield of Wells

Data on discharges of wells in Placer County have been furnished by the Pacific Gas and Electric Company, and additional measurements were made by the Division of Water Resources during 1951. These discharge measurements were used to compute specific capacities, as averaged in the tabulation below, for 13 wells of known depth. Specific capacity is obtained by dividing the discharge of a well in gallons per minute by the drawdown, which is the difference between static and pumping levels in a well, in feet. Specific capacity is a measure of the productivity of a well per foot of drawdown. The yield factor of a well is computed by dividing the specific capacity of the well by the thickness of saturated material the well penetrates, and multiplying the result by 100. A listing of average discharges, specific capacities, depths, and yield factors of these 13 wells in Placer County follows:

Average discharge, in gallons per minute	752
Average specific capacity	35.6
Average depth in feet	486
Average yield factor	8.2

Comparison of yield factors of wells gives an approximate comparison of the permeabilities of the water-yielding materials penetrated by the wells. A comparison of the average yield factor obtained above with yield factors obtained for the Sutter-Yuba Counties Investigation in neighboring areas to the north and west reveals that permeabilities in Placer County are generally lower. It is thus usually necessary to drill wells to greater depths in this county to obtain comparable well discharges. No significant pattern of permeability variation within the Valley Unit of Placer County is shown by the known yield factors of wells.

Assignment of Specific Yield Values

All water-bearing deposits reported in well logs in Placer County have been grouped into five classes. This was necessary in order that specific yield values could be assigned to the many different types of material logged. Specific yield is the ratio, usually expressed in per cent, of the volume of water which a given material will yield by gravity, after saturation, to its own volume. The procedure adopted in assigning specific yield values to the many types of material reported in the well logs of the Sacramento Valley has been summarized by the Geological Survey in Appendix D to Bulletin No. 1, "Water Resources of California," a publication of the State Water Resources Board. The following is a tabulation of the five general classes showing the specific yield values assigned to each:

Material	*Specific yield, in per cent*
Gravel	25
Sand, gravelly sand, sand and gravel, quicksand, etc.	20
Fine sand, tight sand, sandstone, etc.	10
Cemented sand or gravel, clay and gravel, etc.	5
Clay, silt, gumbo, shale, lava, and similar materials of relatively low permeability	3

Selection of Depth Zones

Three depth zones have been chosen for computation of the storage capacity of the Valley Unit of Placer County. These depth zones are from 20 to 50 feet, 50 to 100 feet, and 100 to 200 feet below the land surface. For economic reasons, it seems unlikely that water levels will ever be lowered to more than 200 feet below the ground surface in Placer County. The water table probably will not be drawn down below even the 100-foot level for many years to come. It likewise does not seem likely that it would be practicable to store water in the shallow deposits less than 20 feet beneath the ground surface. Therefore, the storage capacity of water-bearing materials above 20 and below 200 feet was not considered in this computation.

Subdivision Into Storage Groups

The Valley Unit of Placer County has been divided into three storage groups for the purpose of estimating underground storage capacity within the unit. The storage groups were set up by the United States Geological Survey in their study of the whole Sacramento Valley. Boundaries of the groups in Placer County appear to be principally dependent on the subsurface character of the deposits above a depth of 200 feet.

A. River Flood-Plain and Channel Deposits. Storage capacity of deposits of this storage group are calculated separately in Placer County only for the deposits of the channel and flood plain of the Bear River on the northern edge of the Valley Unit. The deposits of this group consist principally of Pleistocene and Recent sands and gravels, although some sediments of late Pliocene age may occur at depth. The average specific yield of this group is higher than the specific yields of either of the other groups in the depth zones above 100 feet.

B. Low Alluvial-Plain Deposits. Only a small area in the extreme western Placer County, south of Coon Creek and north of Markham Ravine, is included in this storage group. Intermediate alluvium comprises a larger proportion of the depth zones here than in either of the other storage groups, the remainder being principally old alluvium.

C. Dissected Alluvial Deposits. Most of the Valley Unit of Placer County is included in this

TABLE B-1

ESTIMATED TOTAL GROUND WATER STORAGE CAPACITY OF VALLEY UNIT OF PLACER COUNTY

	Area, in acres	Depth zone						All zones	
		20-50 feet		50-100 feet		100-200 feet		20-200 feet	
		Specific yield, in per cent	Storage, in acre-feet	Specific yield, in per cent	Storage, in acre-feet	Specific yield, in per cent	Storage, in acre-feet	Specific yield, in per cent	Storage, in acre-feet
. River flood-plain and channel deposits	3,020	13.9	12,600	6.8	10,300	5.4	16,300	7.2	39,200
. Low alluvial-plain deposits	2,060	6.5	4,000	6.0	6,200	4.4	9,100	5.2	19,300
. Dissected alluvial deposits	103,390	4.9	152,000	4.9	253,300	5.4	558,300	5.2	963,600
TOTALS	109,470	5.1	168,600	4.9	269,700	5.3	583,700	5.2	1,022,100

storage group. Old alluvium is the principal lithologic unit in this group, as it occurs not only in the area mapped as old alluvium on Plate B-1 but beneath thin deposits of intermediate alluvium in most of the western part of the county as well.

Table B-1 summarizes the estimated ground water storage capacity, in acre-feet, for the three groups of the Valley Unit.

Ground Water Occurrence

The great preponderance of water from wells in the water-bearing formations underlying the Valley Unit of Placer County is pumped from deposits of old alluvium. On the surface these deposits extend westward from the volcanic rocks, small patches of Eocene sediments, and crystalline rocks on the east, to the edge of the intermediate alluvium. Farther west, as described above, they extend beneath a thin coating of the intermediate alluvium to and beyond the county line. Their depth below the surface is generally less than 20 feet; so nearly all water production comes from the older alluvial deposits.

Wells producing water from Eocene sediments southwest of Wheatland and in the Lincoln area and wells producing water from the Sierran volcanic rocks have already been described. Wells producing water at least in part from the volcanics are quite numerous in the eastern part of the area of old alluvium, particularly in the vicinity of Roseville.

The intermediate alluvial deposits in extreme western Placer County and the stream channel deposits of the Bear River channel yield water to a number of wells at shallow depths.

Deep drilling has established the base of the fresh water body at many points on the east side of the Sacramento Valley, and contours on the base of the fresh water have been drawn by the Geological Survey. These contours show that the base of the fresh water dips to the west-southwest and that it varies from sea level along a line lying a few miles west of Lincoln to 1,000 feet below sea level near the southwestern corner of the county. Deep oil wells strike Eocene marine sediments below the base of the fresh water, and beneath the Eocene, Upper Cretaceous marine sediments and finally pre-Cretaceous crystalline rocks are encountered. All these formations dip gently toward the axis of the Sacramento Valley, and thus occur at greater depth in a westerly direction.

The only ground water break or very steep gradient in the water-bearing formations of Placer County occurs about a mile and a half south of Lincoln. The water table is shown dropping 55 feet in three-tenths of a mile on the ground water elevation contour map for fall, 1952, and a similar break is shown on all other maps made during the present investigation. The axis of the break or steep gradient extends in a northwesterly direction, the high water table being on the northeast and the low on the southwest. Wells northeast of the break are domestic and stock wells having low yields, whereas irrigation wells having ample yields occur southwest of the break. There is also a difference in water quality across the break, wells to the southwest producing better quality water.

The break or steep gradient appears to represent the difference in levels between water in two different formations, with the higher levels being in Eocene sediments and the lower levels in old alluvium and perhaps also in volcanics. The break probably occurs along a northwesterly-trending fault, northeast of which the Eocene has been uplifted relative to the younger formations to the southwest. The moderately water-bearing beds of the Eocene are apparently truncated by the fault, or they may possibly pinch out south-westward before the fault is reached, since they are probably deltaic sediments whose source was to the east. The one well log available northeast of the break shows a predominance of clay and "black mud," but includes some "sand rock" and a little sand. Southwest of the break, alluvium and possibly some volcanics are present, although the Eocene may occur at greater depth. The log of a well located one mile south of Auburn Ravine and 100 yards east of

U. S. Highway 99E contains a large proportion of gravel and boulders to a depth of 121.5 feet. These deposits probably belong to the older alluvium.

Direction of Movement and Source Of Ground Water

Lines of equal elevation of ground water in the fall of 1952, as shown on Plate 9 of the main report, show that movement of ground water in the water-bearing series is generally in a direction slightly south of west toward the central Sacramento Valley. The gradient in the fall of 1952 was about seven feet per mile in most of this area, although the gradient was steeper to the east. The steeper gradient is due to the less permeable material of the eastern area. Slopes of the water table as defined by these ground water contours indicate that subsurface outflow occurs to the west across the county line into Sutter County.

The major source of replenishment of ground water in the water-bearing formations of the Valley Unit apparently is percolation both from surface streams and from irrigation water. In addition, it is probable that direct rainfall penetration and subsurface inflow from the area of nonwater-bearing rocks on the east constitute minor sources of ground water replenishment. There are, however, indications that percolation of surface water as stream flow, irrigation water, or precipitation is restricted in the Valley Unit of Placer County by shallow layers of hardpan. It was noted, during the period of the investigation, that runoff from precipitation collecting in natural basins and roadside borrows did not percolate but remained to evaporate. The fact that a large part of the return water from irrigation reaches the streams and is available for re-use appears also to substantiate the assumption that the hardpan retards and reduces percolation to the water table.

It was also pointed out in Chapter III of the main report, in the section on "Application of Water," that in the case of the use of ground water the hardpan layer is probably effective in reducing application of water, as indicated by a comparison of the values of application of water to pasture and rice in areas in Placer County with underlying hardpan, and in eastern Sutter County, outside the hardpan area.

Measurements of surface streams in the Valley Unit indicate, however, that there is a net loss of water from these streams. The amount of percolation from Auburn Ravine and Coon Creek can be approximated by comparing the flow of these streams at the gaging stations at U. S. Highway 99E with their combined flow at the Reclamation District No. 1001 Channel at Pacific Avenue, about three miles west of the county line. These comparisons are significant in regard to percolation only during periods when neither rainfall nor diversions for irrigation were large in amount. Table B-2 compares flows for periods when the indicated difference could largely be attributed to percolation:

TABLE B-2

INDICATED PERCOLATION LOSSES FROM COON CREEK AND AUBURN RAVINE

Period	Combined flow of Coon Creek and Auburn Ravine at U. S. Highway 99E		Flow of Reclamation District No. 1001 Channel at Pacific Avenue, in acre-feet	Difference, in acre-feet	Loss, in per cent
	Total discharge, in acre-feet	Average daily discharge, acre-feet			
2/19/50 through 3/16/50	3,220	124	2,516	704	21.9
11/ 5/50 through 11/12/50	972	122	848	124	12.8
3/13/51 through 4/27/51	5,952	129	4,784	1,168	19.6
10/ 5/51 through 10/23/51	2,142	113	1,528	624	29.0
11/ 4/51 through 11/11/51	1,192	149	932	260	21.8
12/13/51 through 12/25/51	2,602	260	1,938	664	25.5
10/16/52 through 11/30/52	1,812	50	1,786	26	1.4

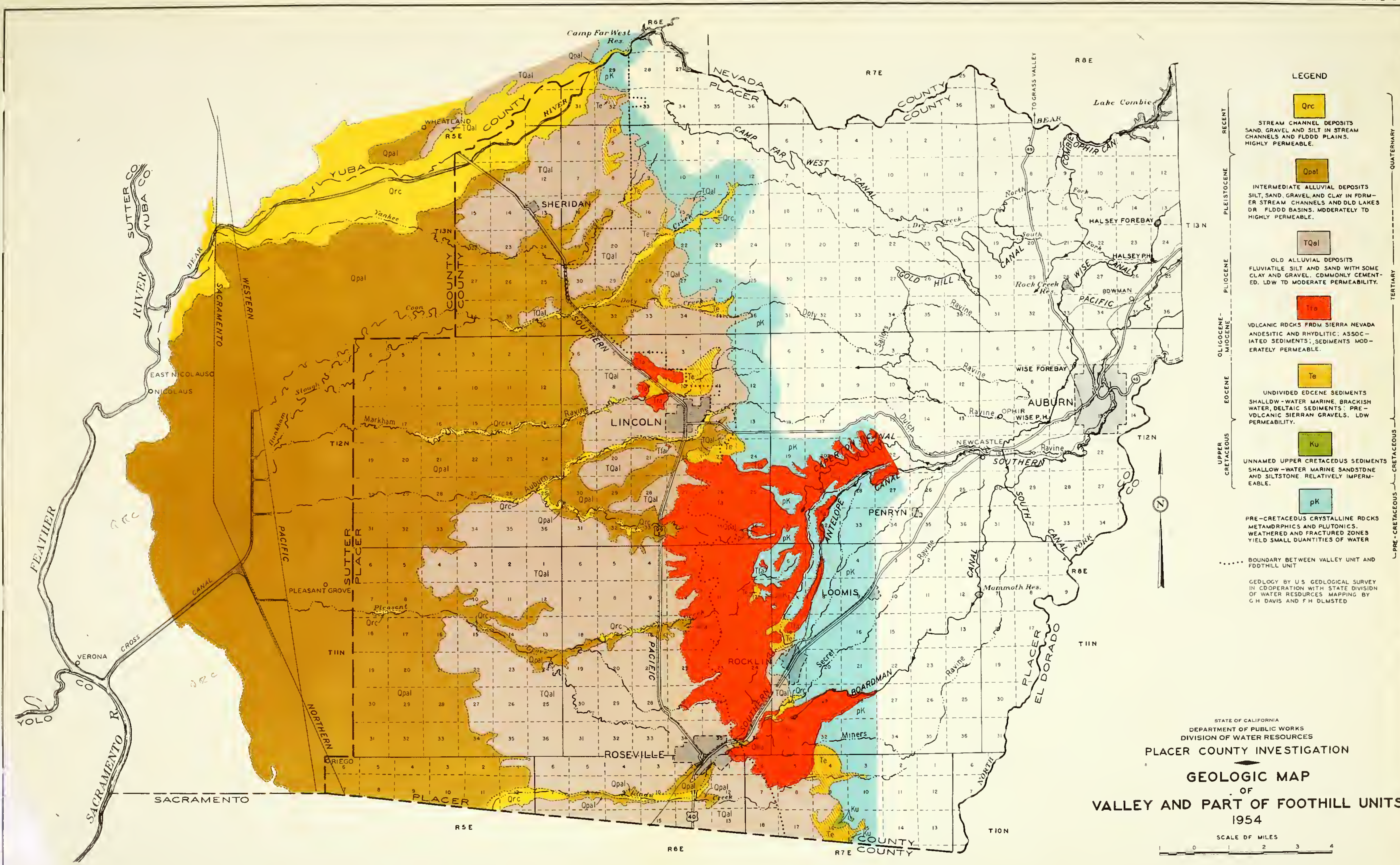
The above table indicates that, except during the last of the above periods, uniform losses occurred ranging between 13 and 29 per cent of the inflow. During the last period the average daily discharge was less than one-half that during the other periods, which fact may account for the near absence of percolation loss.

Current meter measurements made at various points on Coon Creek, Auburn Ravine, and Linda Creek also indicate percolation losses. These measurements are shown in Table B-3.

TABLE B-3

CURRENT METER MEASUREMENTS SHOWING LOSSES AND GAINS FROM COON CREEK, AUBURN RAVINE, AND LINDA CREEK

Stream	Date	Station	Discharge, in second-feet	Loss or gain, in second-feet	Length of reach, in miles	Loss or gain, in per cent	Loss or gain, in second-feet per mile
Coon Creek	3/16/51	Coon Creek at road to McCourtney Crossing	33.8				
		Doty Ravine at road to McCourtney Crossing	26.8				
		Total	60.6				
		Coon Creek at U. S. Highway 99E	63.8	+3.2	5.0	+5.3	+0.6
		Coon Creek at Cross Canal	55.1	—8.7	15.0	—13.6	—0.6
Coon Creek	3/17/53	Coon Creek at road to McCourtney Crossing	27.8				
		Doty Ravine at road to McCourtney Crossing	23.7				
		Total	51.5				
		Coon Creek at U. S. Highway 99E	47.3	—4.2	5.0	—8.2	—0.8
		Coon Creek above Bunkham Slough	45.3	—2.0	4.0	—4.2	—0.5
		Cross Canal below Jopson Ranch	21.4				
		Bunkham Slough above Cross Canal	21.5				
		Total	42.9	—2.4	10.0	—5.3	—0.2
Auburn Ravine	3/15/51	Auburn Ravine at U. S. Highway 99E	100.9				
		Auburn Ravine at Pleasant Grove Road	96.9	—4.0	12.0	—4.0	—0.3
Auburn Ravine	3/18/53	Auburn Ravine above Old Virginiatown	10.0				
		Auburn Ravine at Lincoln	15.2	+5.2	4.5	+52	+1.2
		Auburn Ravine below Brewer Road	20.9	+5.7	10.5	+38	+0.5
		Auburn Ravine below Western Pacific Railroad	20.0	—0.9	4.0	—4.3	—0.2
Linda Creek	6/27/51	Linda Creek at Roseville	15.0				
		Linda Creek below Sewer Plant	12.7	—2.3	0.5	—15.3	—4.6
		Linda Creek at Elverta Road	13.7	+1.0	6.5	+7.9	+0.2



LEGEND
Qrc
STREAM CHANNEL DEPOSITS SAND, GRAVEL AND SILT IN STREAM CHANNELS AND FLOOD PLAINS. HIGHLY PERMEABLE.
Qpal
INTERMEDIATE ALLUVIAL DEPOSITS SILT, SAND, GRAVEL AND CLAY IN FORMER STREAM CHANNELS AND OLD LAKES OR FLOOD BASINS. MODERATELY TO HIGHLY PERMEABLE.
TQal
OLD ALLUVIAL DEPOSITS FLUVIATILE SILT AND SAND WITH SOME CLAY AND GRAVEL. COMMONLY CEMENTED. LOW TO MODERATE PERMEABILITY.
Tfa
VOLCANIC ROCKS FROM SIERRA NEVADA ANDESITIC AND RHYOLITIC; ASSOCIATED SEDIMENTS; SEDIMENTS MODERATELY PERMEABLE.
Te
UNDIVIDED EOCENE SEDIMENTS SHALLOW-WATER MARINE, BRACKISH WATER, DELTAIC SEDIMENTS; PRE-VOLCANIC SIERRAN GRAVELS. LOW PERMEABILITY.
Ku
UNNAMED UPPER CRETACEOUS SEDIMENTS SHALLOW-WATER MARINE SANDSTONE AND SILTSTONE. RELATIVELY IMPERMEABLE.
pK
PRE-CRETACEOUS CRYSTALLINE ROCKS METAMORPHICS AND PLUTONICS. WEATHERED AND FRACTURED ZONES YIELD SMALL QUANTITIES OF WATER
BOUNDARY BETWEEN VALLEY UNIT AND FOOTHILL UNIT
RECENT
PLEISTOCENE
PLIOCENE
OLIGOCENE-MIOCENE
EOCENE
UPPER CRETACEOUS
QUATERNARY
TERTIARY
CRETACEOUS
PRE-CRETACEOUS
GEOLOGY BY U S GEOLOGICAL SURVEY IN COOPERATION WITH STATE DIVISION OF WATER RESOURCES MAPPING BY G H DAVIS AND F H OLMSTED
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
PLACER COUNTY INVESTIGATION
GEOLOGIC MAP
OF
VALLEY AND PART OF FOOTHILL UNITS
1954
SCALE OF MILES
0 1 2 3 4
Camp Far West Res.
Lake Combie
WHEATLAND
SHERIDAN
LINCOLN
ROSEVILLE
ROCKLIN
LOOMIS
PENRYN
NEWCASTLE
AUBURN
OPHIR
HALSEY FOREBAY
HALSEY P.H.
WISE FOREBAY
WISE P.H.
BOWMAN
Rock Creek Res.
Mammoth Res.
EAST NICOLAUS
NICOLAUS
PLEASANT GROVE
VERONA
RIEGO
YUBA
BEAR RIVER
FEATHER
SACRAMENTO R.
YOLO CO
SUTTER CO
YUBA CO
NEVADA COUNTY
PLACER COUNTY
SUTTER COUNTY
PLACER COUNTY
SACRAMENTO
PLACER
PLACER
EL DORADO
COUNTY
COUNTY
CAMP FAR WEST CANAL
GOLD HILL
WISE CANAL
COMBIE OPHIR CANAL
CAPER OPHIR CANAL
ANTELOPE CANAL
BOARDMAN CANAL
SOUTH CANAL
NORTH CANAL
CROSS CANAL
SACRAMENTO WESTERN
SOUTHERN PACIFIC
WESTERN PACIFIC
NORTHERN
TO GRASS VALLEY
North Fork
South Fork
Dry Creek
Doty Creek
Coon Creek
Markham Ravine
Auburn Ravine
Pleasant Creek
Dutch Ravine
Secret Ravine
Miners Ravine
Antelope Creek
Yankee Slough
Dunham Slough
R5E
R6E
R7E
R8E
T13N
T12N
T11N
T10N

APPENDIX C

COMMENTS OF CONCERNED AGENCIES ON PRELIMINARY DRAFT OF BULLETIN NO. 10, "PLACER COUNTY INVESTIGATION"

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CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
SACRAMENTO DISTRICT
WRIGHT BLDG., 1209 8TH ST.
SACRAMENTO, CALIFORNIA

2 November, 1954

THE SECRETARY
State Water Resources Board
Public Works Building
Sacramento 5, California

DEAR SIR: Reference is made to your letter of 18 October 1954, transmitting for review and comment a draft of your Bulletin No. 10, entitled "Placer County Investigation," dated July 1954.

This report contains valuable information on water supply, land classification, ultimate water requirements, and plans for supplying future irrigation needs of Placer County, which will be very useful in future studies in this office.

A cursory review of the report indicates that none of the plans investigated are in conflict with proposed or authorized projects of the Corps of Engineers. Therefore, no specific comments are made at this time. The opportunity to review your report is appreciated.

FOR THE DISTRICT ENGINEER:

Sincerely yours,

A. D. WILDER
Lt Col, CE
Executive Officer

NEVADA IRRIGATION DISTRICT
144 SO. AUBURN STREET
GRASS VALLEY, CALIFORNIA

November 2, 1954

MR. A. D. EDMONSTON, *State Engineer*
State Water Resources Board
Public Works Building, P. O. Box 1079
Sacramento 5, California

SUBJECT: Draft of Bulletin No. 10, "Placer County Investigation"—File 625.150

DEAR MR. EDMONSTON: Attached hereto are my comments on the draft of Bulletin No. 10, which you requested in your letter of October 6th.

This bulletin covers a wide territory including much with which I am not familiar. Therefore, the observations are confined to those areas which we have recently been investigating with the object of developing new water to meet the District's mounting needs, to wit: Haypress, the Upper Middle Yuba, the South Yuba, and the Bear River.

The studies contained in Bulletin No. 10 should prove an effective contribution in clarifying our local water problems. They should also enable the residents of both Placer and Nevada Counties to take the necessary steps to assure an ample supply for their future needs.

Volumes 1 and 2 are being returned under separate cover.

Yours very truly,

NEVADA IRRIGATION DISTRICT
T. D. SAWYER, Chief Engineer

Comments and Suggestions in Regard to the Placer County Investigation by the State Water Resources Board as Outlined in Draft of Bulletin No. 10, Dated July, 1954

Explanation: The following comments and suggestions are made pursuant to a request from the State Water Resources Board dated October 6, 1954, for any comments and/or suggestions from the undersigned which could be included in the final report.

The writer's investigations of the areas considered in Bulletin No. 10 have been limited to a study of the Nevada Irrigation District's power potential in the mountain area, together with the development of additional irrigation water in the lower Bear River. Accordingly, the following comments will be confined to the projects comprehended within this area.

Haypress-Jackson Meadows

A project somewhat similar to the one proposed in Bulletin No. 10 was developed by the undersigned on behalf of the Nevada Irrigation District for submission to the P. G. & E. and is at present under study by their engineering department. See report dated April 22, 1954, submitted to the Division of Water Resources by letter dated August 25, 1954, in support of the District's water applications.

This project, unlike the one in Bulletin No. 10, proposed a small regulation reservoir of 1,500 a.f. capacity located at an elevation of 6,525 feet on Haypress Creek well above its intersection with Tehuantepec Creek. A three-mile tunnel, about two miles downstream from the reservoir, at the junction with Long Valley, would convey runoff into the existing Milton Diversion, which would be enlarged from an actual storage of 1,600 a.f. to 11,000 a.f. This would increase the capacity of the Milton-Bowman tunnel by placing it under pressure. A dam of 23,500 a.f. was proposed at Jackson Meadows, but subsequent study of the project suggests the advisability of increasing it to 46,000 a.f. with the maximum water surface at an elevation of 6,015, closely approximating the one proposed in Bulletin No. 10. A rock fill dam was used for estimating purposes, as it appeared questionable whether sufficient impervious material could be located in the vicinity for the more economical rolled-fill type.

Incidentally, locating the Haypress-Middle Fork tunnel so as to discharge into the Milton Diversion rather than into Jackson Meadows Reservoir enables the tunnel to pick up runoff from two Milton Creek creeks with approximately two square miles of watershed. It further adds two or more square miles to the watershed from Haypress.

The hydrographic study in Bulletin No. 10, Vol. 1, P. K-3, shows the estimated average annual runoff from the Middle Fork at the damsite from 1920 to 1935 to be less than 60,000 a.f., while the average diverted from Haypress is estimated at 28,700 a.f. The measured annual average runoff of the Middle Fork at Milton Diversion (two miles below the damsite), from 1928 to 1951, inclusive, amounts to 72,100 a.f., which suggests that the 60,000 figure may be unduly conservative. As for the Haypress estimate, this closely approximates the writer's, which amounts to 36,400 a.f. average annual runoff, of which about 31,500 a.f. would be received at Milton. Considering the greater watershed, this about checks with Bulletin No. 10. The District has just installed a recording station at its proposed diversion site at Long Valley, and by next year should have a continuous record to correlate with those of the adjoining watersheds.

Bowman

While no such project appears in Bulletin No. 10, the District also has under consideration the possibility of raising Bowman Dam to increase storage from 70,000 a.f. to 100,000 a.f. The economies of this project have yet to be weighed in connection with the Haypress project and Jackson Meadows at three different capacities. Raising Bowman would have one advantage in that the Bowman South Arch, which involves unduly heavy maintenance expense, would be covered with a rock fill.

The District proposes conveying the new water developed by this program over the Bowman-Spaulding Conduit, doubled in capacity, and dropping it 2,100 feet through a 29,500 HP power station located on the South Yuba below Fall Creek at an elevation of 3,215. Plans for the disposition of this new water below 3,215 are awaiting P. G. & E. reactions to the project. If financing is possible it can be carried 16-18 miles by ditch along the south side of the South Yuba and dumped into Scott's Flat Reservoir via a $1\frac{3}{4}$ mile tunnel. Or possibly it could be utilized for another South Yuba station which would tail into the Excelsior Ditch—increased in capacity—for servicing the Beale area and South Sutter district. Details of this have yet to be worked out.

Bear River

Bulletin No. 10, Vol. 1, Plate 14, shows three proposed developments on the Bear River, to wit: At Rollins, Garden Bar, and Camp Far West. No data is shown on the first two, while the Camp Far West enlargement would provide a reservoir with 104,000 a.f. storage at a cost of $3,726,000 for irrigation below the 150-foot contour. Maximum water surface elevation is 300 feet.

The Army Engineers have a project for Garden Bar, concurred in by the Reclamation Bureau, to provide 195,000 a.f. storage, with 42,000 a.f. reserved for flood control. It provides for a concrete gravity section dam at a cost of $22,031,000. Maximum elevation water surface is indicated at 590 and tail water at 288. (The project is contained in House Document No. 367 to the 1st Session of the 81st Congress.) It acknowledges an apparent annual net deficit of $579,-000 for the Project!

The District's engineer, the late Fred H. Tibbetts, reported on several Bear River damsites in his report dated February 15, 1926, to the District's Board of Directors, which presumably the Division of Water Resources must have in their files. These sites, which were, of course, primarily for fulfilling District needs, were called Combie, Parker, Dog Bar, and Rollins. The Combie site was shortly afterwards occupied by the District's Combie Dam for 7,500 a.f. storage, but he recommended Parker as the site for a dam with an ultimate capacity of 235,000 a.f., rejecting both Dog Bar and Rollins. This decision was predicated largely on the river gradient, which below Combie amounts to 85 feet per mile, drops to 26 feet per mile from Combie to near the upper end of the proposed Parker Reservoir, and then rises sharply. He comments in this report on the Rollins site as follows: "The Rollins damsite does not appear favorable, and storage there would undoubtedly be more expensive than at the Parker site. The steep gradients on the Greenhorn River above this site would also greatly increase the likelihood of the reservoir quickly filling up with mining debris." As the writer has had no opportunity as yet to investigate these sites in the field, this is offered as information for what it may be worth.

The Parker site incidentally, cannot be developed to its ultimate of 235,000 a.f., as its maximum water level would undermine the P. G. & E.'s Bear River Canal over large stretches, and the District could not undertake the expense of relocating it. However, the P. G. & E. engineers have indicated that the Parker Reservoir might be utilized to an elevation sufficiently below the canal level to assure its stability. Just what they consider a safe elevation, they have not as yet advised us.

Coon Creek

This project, as outlined in Bulletin No. 10, provides for a storage capacity of 59,000 a.f. with maximum water surface at elevation 550. Over half of the water to fill it would come from the Bear River over the existing (or enlarged) Combie-Ophir Canal.

It is a considerably more ambitious project than the one which the District has in mind. Its field engineers have just completed a field topographic survey of this site, but only up to approximately the 500-foot contour. The storage capacity up to this level has not yet been determined, but judging from the figures on Page 4-109, Vol. 1, it would not be over 26,000 a.f. The District also has under consideration a project for a canal from the Bear River with diversion below Wolf Creek junction, to help in filling the Coon Creek Reservoir. However, with only 26,000 a.f. storage, this canal would hardly be required as the Coon Creek basin runoff alone should be sufficient to fill it.

Filling the larger reservoir (59,000 a.f.) by means of the Combie-Ophir as suggested in Bulletin No. 10, could present a problem. During the process of filling Coon Creek, the existing Combie Reservoir would have to be used for regulation to avoid undue loss by spill, but Combie should end the wet season completely full to assure filling irrigation requirements above the Coon Creek level. Difficulty in assuring this might then justify the cost of providing the canal with diversion below Wolf Creek junction.

T. D. Sawyer
R.E. 5189

UNITED STATES
DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Tahoe National Forest

Nevada City, California
December 7, 1954

State Water Resources Board
Public Works Building
Sacramento 5, California

Gentlemen: Reference is made to your letter of October 6, 1954 and to Draft of Bulletin No. 10, "Placer County Investigation" transmitted therewith.

We have reviewed the draft of Bulletin No. 10 and have only a couple of suggestions for changes.

Page 4-20, paragraph 4. "Several United States Forest Service fire roads, etc., etc." The roads in this area belong to Nevada and Placer counties. The Forest Service has a cabin on Pass Creek that would be flooded. There would also be approximately 25 MM b.m. of merchantable timber in the reservoir area.

Page 4-52, last paragraph. "There is little of value, etc., etc." There is a good logging road now across Duncan Canyon to the top of Red Star Ridge and a survey for its extension into French Meadows. This road is also proposed eventually to cross the top of the French Meadows Dam to connect with the Georgetown road and also to follow above the flow line of the reservoir to connect with the Soda Springs end of the road at the upper end of the reservoir. There would be approximately 35 MM b.m. of merchantable timber to remove from the reservoir site. There is also a Forest Service Station (cabin and garage) and two small campgrounds to move as well as a private cabin.

There are probably other reservoir sites in the report that would cover some valuable timber. However, French Meadows and English Meadows stand out because of the large volumes involved.

We appreciate the opportunity to review the Bulletin before publication and we're sorry we couldn't find the time to do it sooner and more thoroughly.

Very truly yours,

L. A. Rickel, Forest Supervisor
By: J. M. Shock, Acting

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGIONAL OFFICE, REGION 2
P. O. BOX 2511
SACRAMENTO, CALIFORNIA

December 13, 1954

MR. A. D. EDMONSTON, *State Engineer*
Secretary, State Water Resources Board
Public Works Building
Sacramento 5, California

DEAR MR. EDMONSTON: In response to your letter of October 18, over Mr. Sam R. Leedom's signature, acknowledged by Acting Regional Director Calland's letter of October 26, we have reviewed your draft of Bulletin No. 10, Placer County Investigation, dated July 1954. Completion of our review has run beyond our estimated thirty days. I hope the delay has not inconvenienced you.

Because of limited time and other work requirements, our attention has been confined to the major findings presented, and further limited to the areas in which we have some background information from studies previously made or now in progress. We have no comments to offer on several of the proposed plans of development because we have not had occasion to study the area or plan involved. These proposed plans include those listed as the Bear River and Upper Yuba River Basins and Truckee River Basin, the Jackson Valley Project, the Lake Valley Project, and the Cisco Project. Our comments on the principal subjects covered, including the aspects of plans of development with which we have some familiarity, follow.

Factual Information

The factual information on geography, climate, precipitation, surface water supply and present water supply development appears to be adequate and complete and forms a valuable source of information for this area. In reviewing this information we did not check figures in detail.

Geology, Underground Hydrology and Quality of Water

These subjects appear to be adequately treated for this type of report. We have no significant comments.

Land Use and Supplemental Requirements

Derivation of requirements for water supply is by a somewhat different process than used in our own studies, so some of the units are not comparable; however, both methods of derivation seem to result in about the same net supplemental water requirement.

Plans for Water Development—General

We have two suggestions which, if appropriate, might enhance the total accomplishments of the proposed plans. The first concerns the ratio of kilowatt-hours to kilowatts used for estimating dependable hydroelectric capacity. Consideration of the large percentage of steam-electric capacity in Northern California indicates that it might be appropriate to use a somewhat smaller ratio, thereby increasing the dependable-capacity estimates.

Second, some of the proposed upstream reservoirs in the American River Basin, particularly those involving hold-over storage and power generation, increase amounts of usable inflows to Folsom Reservoir during certain critical dry years. The amount of improvement has not been evaluated by this office, but some value for this potential improvement at Folsom would seem to be properly creditable to these upstream reservoirs.

One other thought concerns the evaluation of power from new and existing plants. For new firm energy generated in existing plants a figure of six mills/kwh is used; unless there is some factor that escapes us, it would seem appropriate to evaluate new energy from existing plants in the same manner as energy from proposed new plants.

American River Basin (page 4-4)

This section describes a tentative plan for development of the Middle Fork American River. As you know, this office is currently studying this same area and so far is considering plans generally similar to those described. Our studies have not yet progressed sufficiently to decide whether all proposed features will be similar.

French Meadows and Foresthill Divide Projects (pages 4-45 and 4-72)

These projects are planned primarily for the purpose of providing a water supply to the Foresthill area. In the case of French Meadows Project, this includes generation of power. Our own studies on this problem are incomplete, but it may be of interest to note that we have also developed a plan quite similar to your proposal. We have not yet completed an analysis of a French Meadows Project for Foresthill, nor compared it with possible alternates, such as your Foresthill Divide Project. We are also still looking for new alternates but, because of the high elevation of the Foresthill Divide and its remoteness from a sizable drainage area of equal or higher elevation, it seems unlikely that any more economical means of service could be developed.

The French Meadows Project would have highest repayment capacity when most or all of the water is used for power generation rather than irrigation. This suggests that it might be necessary or desirable to build the project for power operation in advance of irrigation use to recover a portion of the project costs that could not be borne by irrigation repayment.

Foresthill Divide Project has the favorable aspect of permitting stage construction and development to meet irrigation needs. Since costs of providing water to Foresthill Divide will be quite high, presumably the repayment of Foresthill Divide Project would be assisted by integration with a power development project. The question thus arises whether it is more economic to use a portion of the French Meadows Reservoir yield on the Foresthill Divide, as contemplated by the French Meadows Project, or whether the lowest overall cost would result from a Foresthill Divide Project integrated with a Middle Fork power development that utilizes French Meadows Reservoir. We plan to further explore this possibility in connection with our own studies and will keep you informed of any analyses we make.

Valley Unit (page 4-92)

You may know that some time ago we gave preliminary consideration to the possibility of serving lands west of Highway 99E and south of the Bear River from Folsom Reservoir. We compared the cost of this service with the cost of water stored on the Sacramento River watershed and pumped from the Sacramento or Feather Rivers and found that, for a good portion of the area at least, the cost of service from these rivers was slightly less than from Folsom. We have not put these costs on a price base comparable to your costs for service from the Valley Unit Projects, so cannot compare them on a cost basis. However, we can say in general that we strongly favor developments of local water supply, such as those proposed in your Valley Unit, to imports from more distant sources.

In connection with the proposed Auburn Ravine power development project, it may be appropriate to note that water conveyed from the Wise powerplant through the proposed 455 foot Auburn Ravine drop would be diverted from an average drop of 300 feet through the Folsom powerplant, so that the net increase in power production over conditions prevailing at the time of completion of Folsom would be the difference between the two drops. This decrease in Folsom power production would also attend other plans involving local consumptive use of the Wise spills. However, we are in agreement that all Wise powerplant spills should eventually be reregulated to provide additional water supply for irrigation and other consumptive uses, particularly for areas too remote or too high in elevation to be economically reached from other sources. From this point of view we think that any power that might be generated in connection with such reregulation can, in the long run, be regarded as a net gain.

You are probably aware that a small area in southern Placer County east of Roseville is a part of the San Juan Suburban Water District, which is considering service from Folsom Reservoir. This service area would not overlap any of the service areas of your proposed Valley Unit Projects.

In conclusion, I very much appreciate the opportunity of reviewing the draft of Bulletin No. 10 and hope that the above comments will be of some interest or assistance to you. The Bulletin comprises a valuable addition to information and plans for the development of the water resources of the area.

Very truly yours,

C. H. Spencer
Regional Director

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
California Region

630 Sansome Street
San Francisco 11, California
December 30, 1954

Mr. A. D. Edmonston, *Secretary*
State Water Resources Board
Public Works Building
Sacramento 5, California

Dear Mr. Edmonston: By letter of October 6, file 625.150, you transmitted to us copy No. 45 of the draft of Bulletin No. 10, "Placer County Investigation," and Appendixes. You asked that we furnish any comments the Forest Service might have on your publication.

We greatly appreciate the opportunity to review this report. It appears to be an excellent plan for the development of the water resource potential in Placer County. It will be of considerable value to the Forest Supervisors of the Eldorado National Forest, with headquarters at Placerville, and the Tahoe National Forest, with headquarters at Nevada City, in preparation of their resource use and management plans, particularly as they relate to the maintenance or improvement of watershed conditions in the interest of providing the maximum amount of usable water. We should appreciate it if copies could be made available to the Supervisors of these two Forests.

We note that in chapter 4 several references to the details of the Bureau of Reclamation's plans for the Truckee River-Lake Tahoe watershed were probably obtained from an old draft of the Bureau's "Washoe Project." Perhaps when you revise the report you may want to refer to their latest report on the Washoe Project, which is their "Feasibility Report of September 1954," since their new report represents a modification of their previous project proposals.

Again we thank you for the opportunity to review this report before its publication.

Sincerely yours,

J. J. BYRNE, Chief
Division of Engineering
By JOHN H. LAWRENCE

PACIFIC GAS AND ELECTRIC COMPANY
245 MARKET STREET
SAN FRANCISCO 6, CALIFORNIA

February 8, 1955

DIVISION OF WATER RESOURCES
Public Works Building, P. O. Box 1079
Sacramento 5, California

Attention: MR. A. D. EDMONSTON
State Engineer
Re: (1) Bulletin 10, "Placer County Investigation"
(2) Plans for Operation of Wise Power House

GENTLEMEN: We have received your letter of February 3, 1955, requesting our comments on the proposed Auburn Ravine Power Development. Our Engineering Department has recently completed a general review of Bulletin 10, and has a few comments concerning the Auburn Ravine Development as well as other parts of the report.

In brief, these comments are:

(1) Company studies indicate that after about 1970, all of the summer flow below Wise Power House will be used for irrigation in the area served by South Canal and that winter flow will be reduced in dry years to about 20,000 acre feet. Thus, a power development in Auburn Ravine would have no dependable capacity and would not be economically feasible.

(2) The value of 6 mills assigned to power generated in existing plants with new water could only apply if new dependable capacity were obtained. This is not possible with existing installations, so that a reduction in the value of power appears to be in order.

(3) No mention is made in Bulletin 10 of transmission conduits to deliver water developed above Lake Spaulding. Company studies indicate that the capacity of existing canals will limit deliveries within a relatively short time.

It is felt that discussion of the above matters may be more profitably carried on in a conference between our engineers and representatives of your office, rather than in extended correspondence. If you are agreeable to such a meeting, would you please contact Mr. H. V. Lutge of our Department of Engineering to arrange a mutually satisfactory time and place.

Very truly yours,

L. HAROLD ANDERSON

PLACER COUNTY
BOARD OF SUPERVISORS

June 30, 1955

Mr. A. D. EDMONSTON, *Secretary*
State Water Resources Board
Public Works Building
Sacramento 5, California

DEAR MR. EDMONSTON: Receipt is acknowledged of copies of the draft of State Water Resources Board Bulletin No. 10, "Placer County Investigation."

This Board, which initiated the investigation, appreciates the opportunity to review the findings of the investigation and to transmit to you certain of our comments. When the report was forwarded to the Placer County Board of Supervisors, the Board wanted recommendations on the report and suggestions as to what action the Board should take, if any. The Board therefore appointed a committee to study or cause to be studied the report and make recommendations to the Board. The committee appointed by the Board is as follows: Wm. D. Bethell, Newcastle, Chairman; Elmer Johnson, Lincoln; Wm. Aiken, Foresthill; Donly Gray, Pleasant Grove; Chester Gibbs, Colfax; Mason Gerhart, Roseville; Eugene Power, Lincoln; W. J. Moore, Auburn; J. E. Little, Foresthill and N. R. Mayfield of Tahoe City.

The committee, after reviewing the bulletin concurs, in general, with the findings presented therein, and considers that the bulletin will be a valuable guide and source of information for future plans of vater development for Placer County. However, upon dvice of the committee, and after consideration, the Board of Supervisors wish to set down certain reser- ations regarding their acceptance of the estimates of he area of irrigable land in Placer County and esti- nates of ultimate water requirements which are pre- ented in Chapter III. This Board is of the opinion hat, although such estimates may be based upon full onsideration of all present factors, they may, be- ause of unforeseen changes in the economy of this rea and possible technological advances, prove to be n error, to the detriment of the County, if such esti- nates are used as a basis of allocation of water.

The water resources of Placer County are vital to ur development and this Board views with concern he setting at the present time of any limit on the use f waters originating in the County.

This Board recently compared, within the area of the Placer County Soil Conservation Service, the land irrigability survey of the Division of Water Resources and the land capability survey of the Soil Conservation Service. Within this area the Division of Water Resources had classified 52,800 acres as irrigable, while within the classification of the Soil Conservation Service 76,300 acres could be considered to be irrigable. Some of this discrepancy could be attributed to differences in standards of the two surveys; nevertheless it illustrates why the Board at this time is not willing to accept or concur in the setting of a limit on the use of our native water resources.

Very truly yours,

PLACER COUNTY BOARD OF SUPERVISORS
WESLEY WADDLE, Chairman

6—81627

APPENDIX D

RECORDS OF MONTHLY PRECIPITATION IN PLACER COUNTY NOT PREVIOUSLY PUBLISHED

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RECORDS OF MONTHLY PRECIPITATION IN PLACER COUNTY NOT PREVIOUSLY PUBLISHED

RECORD OF MONTHLY PRECIPITATION AT APPLEGATE, CALIFORNIA

County: Plocer
Dote estoblished: 1906
Type of goge: Non-recording

Elevotion: 2,130 feet, U. S. G. S. dotum
Locotion: NW ¼, Sec. 10, T. 13 N., R. 9 E., M. D. B. & M.
Record obtained from: Mrs. Cook

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1906-07	0	0	0	0	2.50	13.50	*	20.82	21.00	2.50	0.38	2.69	63.39
07-08	0	0	0	1.00	0	13.28	6.26	*	5.70	0.94	4.88	0.44	32.50
08-09	0.03	0	0	2.88	2.38	10.13	30.51	12.40	3.88	0	0.25	0.25	62.68
09-10	0	0	0.38	3.44	10.77	12.51	12.07	6.26	7.94	0	0	0	53.37
10-11	0	0	1.25	2.25	2.51	5.38	37.64	5.38	11.76	3.88	1.51	0.31	71.87
11-12	Tr.	0	0.13	1.00	2.81	*	9.20	0.44	5.44	4.51	1.38	1.51	26.42
12-13	0	0	2.44	2.32	3.50	*	*	*	14.76	Tr.	1.50	0.81	25.33
13-14	0	0	0.13	0	7.82	*	35.97	8.19	0.88	2.38	2.51	1.25	59.13
14-15	0	0	0	2.89	0	8.44	*	26.52	2.87	3.13	8.14	0	51.99
15-16	0	0	0	0.13	4.01	10.32	21.33	*	14.64	0.50	0.75	0	51.68
16-17	0.75	0	0.31	2.32	1.88	11.19	5.31	12.64	1.95	0	0	0	36.35
17-18	0	0	0	0	4.01	1.19	1.75	10.58	*	13.37	0	0	30.90
18-19	0	0	5.57	0	5.59	2.37	3.82	15.38	6.25	0	0	0	38.98
19-20	0	0	*	1.69	*	8.52	1.82	2.75	11.07	6.44	0	0.19	32.48
20-21	0	0	0.50	5.50	10.58	12.26	10.51	4.88	6.82	0.81	3.13	0.31	55.30
21-22	0	0	0	0	2.81	11.75	*	24.14	9.20	0	3.31	0	51.21
22-23	0	0	0	1.63	8.50	*	25.31	2.50	0	12.38	0	0	50.32
23-24	0	0	2.00	2.00	0.88	*	7.63	2.50	*	3.50	0.18	0	18.69
1924-25	0	0	2.00	3.38	3.50	12.26	3.13	23.26	5.07	4.31	0	0	56.91
25-26	0	0	0.38	1.63	0.50	0	*	17.69	0	7.88	0	0	28.08
26-27	0	0	0	3.00	16.50	1.00	8.25	21.75	8.88	3.64	0	2.00	65.02
27-28	0	0	0	2.00	6.88	7.69	1.63	4.50	17.44	4.00	Tr.	0	44.14
28-29	0	0	0	0.75	5.12	5.94	2.32	5.45	3.81	2.45	0.31	2.44	28.59

* Amount carried to next month.

RECORD OF MONTHLY PRECIPITATION AT CRANSTON RANCH, CALIFORNIA

County: Plocer
Date estoblished: 1948
Type of goge: Non-recording

Elevotion: 1,225 feet, U. S. G. S. datum
Locotion: SW ¼, Sec. 1, T. 13 N., R. 7 E., M. D. B. & M.
Record obtoined from: Mr. Grahm Cranston

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1948-49	----	----	----	----	-----	8.00	1.90	2.20	10.90	0	1.50	0	-----
49-50	0	0.10	0	0	2.40	2.70	9.30	4.40	5.50	2.10	1.20	0	27.70
50-51	0	0	0.40	3.10	13.15	9.39	9.25	2.98	1.80	1.50	2.75	0	44.32
51-52	0	0	0	4.18	4.14	9.10	15.40	5.10	6.80	1.10	0.10	0.70	46.60
52-53	0.05	0	0.10	0	3.00	8.95	6.20	0.60	3.45	5.40	1.40	1.10	30.25
53-54	0	Tr.	----	----	-----	----	-----	----	-----	----	----	----	-----

RECORD OF MONTHLY PRECIPITATION AT DRUM FOREBAY, CALIFORNIA

County: Plocer
Dote estoblished: 1915
Type of gage: Non-recording
Elevotion: 4,563 feet, U. S. G. S. dotum

Lotitude: 39° 15.7′
Longitude: 120° 46′
Record obtained from: Pacific Gos ond Electric Compony

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1915-16	----	----	----	----	-----	8.51	25.43	9.22	8.46	1.17	2.10	0	-----
16-17	0	0	1.07	3.88	5.63	12.42	4.07	14.82	3.84	5.73	1.22	0	52.68
17-18	0.10	0.05	0.12	0	3.04	4.73	1.78	13.65	14.20	3.40	0.28	0	41.35
18-19	0	0	7.02	3.15	5.36	2.81	5.00	18.98	5.93	2.21	0.30	0	50.76
1919-20	0	0	1.42	2.07	1.36	8.20	1.94	4.76	12.11	7.35	0.08	0.98	40.27
20-21	0	0.66	0.80	6.46	11.95	11.19	12.96	5.11	7.51	1.27	3.69	0.61	62.21
21-22	0	0	0.50	1.64	2.43	14.24	5.51	18.94	14.12	1.60	4.06	0.54	63.58
22-23	0.06	0	0.06	2.85	8.43	17.26	7.28	2.53	0.83	10.54	1.08	1.62	52.54
23-24	0	0.16	3.76	2.15	0.85	4.17	3.39	5.90	4.17	1.38	0.03	0	25.96
1924-25	0	0	0.01	7.08	3.30	9.51	4.26	13.19	5.08	6.14	3.04	2.02	53.63
25-26	0	0.29	1.72	3.16	4.91	3.89	5.29	15.02	0.70	7.94	2.23	0	45.15
26-27	0.01	0.19	0.07	2.61	15.91	3.14	10.52	19.42	7.24	7.75	1.66	1.03	69.55
27-28	0	0	0.31	3.70	10.95	7.42	4.88	4.12	22.84	5.90	0.30	0.28	60.70
28-29	0.03	0	0.90	0.54	5.61	6.36	4.49	6.37	6.74	7.18	0.58	4.89	43.69
1929-30	0	0	0	0.34	0	15.12	10.51	5.93	6.82	4.91	2.57	0	46.20
30-31	0	0.18	1.17	0.27	8.76	0.85	8.51	5.31	4.91	2.16	2.52	3.44	38.08
31-32	0	0	0.65	5.01	6.74	14.91	7.96	6.73	2.77	6.92	5.65	0.66	58.00
32-33	0	0	0.27	0.35	1.98	3.27	6.68	1.90	6.58	1.36	5.09	0.07	27.55
33-34	0	0	0.56	5.53	0.04	10.00	3.66	7.81	3.39	2.10	1.64	2.13	36.86
1934-35	0	0.10	1.40	3.75	9.72	4.29	8.93	4.34	7.07	14.25	0.92	0	54.77
35-36	0.01	0	0.07	4.66	2.70	4.73	16.50	21.62	5.79	4.11	2.11	3.39	65.69
36-37	0.01	0	0.40	0.59	0.23	6.79	8.52	13.04	12.07	3.74	0.62	1.71	47.72
37-38	0	0	0	2.81	9.80	12.09	8.58	27.81	23.01	5.40	1.22	0.14	90.86
38-39	0	0	0.45	2.94	3.63	3.09	8.00	5.79	9.05	0.34	4.36	0.01	37.66
1939-40	0	0	0.94	4.48	1.32	4.20	24.01	22.44	15.80	2.10	1.59	0.08	76.96
40-41	0	0	1.55	2.67	-----	-----	-----	-----	-----	8.61	----	-----	-----
41-42	----	----	----	----	-----	-----	-----	-----	-----	-----	----	-----	-----
42-43	----	----	----	----	-----	-----	-----	-----	-----	-----	----	-----	-----
43-44	----	----	----	2.33	-----	-----	10.05	11.80	6.08	6.22	2.28	2.27	49.15
1944-45	0.08	0	0.31	3.78	13.45	-----	-----	17.24	9.72	2.15	4.64	2.25	-----
45-46	Tr.	Tr.	0.06	8.19	8.98	21.45	4.41	5.89	10.07	0.21	1.39	0	60.65
46-47	0.58	0	0.78	1.90	10.54	6.33	3.13	6.53	12.33	1.55	1.09	3.57	48.33
47-48	0	0	0	10.79	2.30	1.44	7.21	6.33	13.73	18.68	4.82	0.20	65.50
48-49	0	0	Tr.	0.41	6.20	10.87	4.40	8.10	12.05	0.62	1.91	0	44.56
1949-50	0	0.64	0.04	0.23	5.75	5.56	18.67	5.54	11.39	6.53	3.38	0.50	58.23
50-51	0.04	0	0.68	8.48	25.27	19.71	17.01	8.03	8.05	3.54	4.19	0	95.00
51-52	0	Tr.	0	9.10	11.34	18.96	22.32	12.55	11.91	2.94	1.71	1.77	92.60
52-53	0.28	0	1.45	0.03	5.50	16.80	-----	-----	-----	-----	----	----	-----

RECORD OF MONTHLY PRECIPITATION AT ROSEVILLE HIGH SCHOOL, ROSEVILLE, CALIFORNIA

County: Placer
Date established: 1926
Type of gage: Non-recording
Elevation: 160 feet, U. S. G. S. datum

Latitude: 38° 45′
Longitude: 121′ 17′
Record obtained from: Mr. A. E. Babb

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1926-27	-	-	----	2.23	6.16	1.25	3.55	4.94	1.36	1.78	0.25	0.56	----
27-28	0	0	0	1.39	2.57	2.60	1.27	1.99	3.20	0.10	0	0	13.12
28-29	0	0	0	0.60	3.00	3.34	3.55	1.05	2.65	3.05	0	0	17.24
1929-30	0	0	0	0	0	4.16	5.06	1.48	3.33	1.38	0.15	0	15.56
30-31	0	0	0.18	0.46	1.58	0.08	3.20	2.71	1.70	0.26	0.85	1.30	12.32
31-32	0	0	0	0.91	1.70	5.94	1.36	2.88	0.53	1.50	0.35	0	15.17
32-33	0	0	0	0	0.65	1.61	4.00	1.39	2.69	0.19	1.27	0	11.80
33-34	0	0	0.05	1.24	0	6.70	1.94	3.30	0.15	0.15	0.47	0.26	14.26
1934-35	0	0	0.10	1.03	2.82	2.43	5.46	2.95	2.16	5.52	0	0	22.47
35-36	0	0	0	1.70	1.10	1.81	4.12	9.06	1.17	1.58	0.48	0.15	21.17
36-37	0	0	0	0.45	0	2.61	3.28	5.83	5.61	1.28	0	0.30	19.36
37-38	0	0	0	0.66	3.32	2.26	2.84	7.25	4.12	1.30	0.93	0.05	22.73
38-39	0	0	0.16	1.56	0.72	1.05	1.93	1.15	2.57	0.05	1.59	0	10.78
1939-40	0	0	0.40	0.91	0.04	0.97	7.64	7.15	3.81	0.70	0.16	0	21.78
40-41	0	0	0	0.84	1.55	5.81	4.55	6.17	1.94	3.04	0.98	0	24.88
41-42	0	0	0	1.15	0.84	5.99	3.65	3.51	2.27	4.27	1.40	0	23.08
42-43	0	0	0.11	0.14	2.63	2.26	4.64	2.00	4.19	2.43	0.31	0	18.71
43-44	0	0	0	0.20	0.91	2.36	2.39	6.25	1.18	1.25	0.67	0.08	15.29
1944-45	0	0	0	1.37	3.59	1.55	1.38	6.28	2.93	0.36	0.74	0.12	18.32
45-46	0	0	0	1.76	2.81	6.07	0.66	1.28	2.36	0	0.85	0	15.79
46-47	0	0	0.25	0.54	2.29	1.91	0.58	2.01	3.25	0.60	0.11	0.55	12.09
47-48	0	0	0	2.41	1.26	0.89	1.24	1.44	3.39	3.15	1.95	0	15.73
48-49	0	0	0	0.36	1.03	4.15	1.05	2.29	6.15	0	0.44	0	15.47
1949-50	0	0	0.06	0	1.11	1.69	4.17	2.83	2.67	1.21	0.53	0.14	14.41
50-51	0	0	0.19	2.25	5.00	5.00	2.98	1.86	0.81	0.71	1.16	0	19.96
51-52	0	0	0	1.64	2.47	4.48	8.36	2.02	4.43	1.25	0.16	0.53	25.34
52-53	0	0	0.28	0	1.77	5.38	3.64	0.25	1.38	2.45	1.47	0.61	17.23

RECORD OF MONTHLY PRECIPITATION AT LINCOLN, CALIFORNIA

County: Placer
Date established: 1946
Type of gage: Non-recording

Elevation: 160 feet, U. S. G. S. datum
Location: N. ½, Sec. 19, T. 11 N., R. 7 E., M. D. B. & M.
Observer: Mr. Valjean Austin

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1946-47	0	0	0.32	0.73	2.83	2.34	0.71	2.44	3.73	0.67	0.31	0.60	14.68
47-48	0	0	0	3.03	1.77	1.08	1.27	1.95	4.47	4.37	2.48	0.07	20.49
48-49	0	0	0	0.35	1.25	5.08	1.67	2.50	7.82	0	0.48	0	19.15
1949-50	0	0.07	0.07	0	1.39	2.12	5.26	4.77	3.81	1.26	0.78	0.08	19.61
50-51	0	0	0.48	2.55	7.37	6.54	4.06	2.18	1.00	1.06	1.65	0	26.89
51-52	0	0	0.11	2.15	2.67	5.97	9.81	2.25	6.09	1.24	0.23	0.72	31.24
52-53	0.05	0	0.48	0	2.45	7.38	5.16	0.35	2.14	3.69	0.59	0.80	23.09

RECORD OF MONTHLY PRECIPITATION AT LOOMIS, CALIFORNIA

County: Placer
Date established: January, 1948
Type of gage: Non-recording

Elevation: 380 feet, U. S. G. S. datum
Location: NW corner, Sec. 4, T. 11 N., R. 9 E., M. D. B. & M.
Record obtained from: Pacific Fruit Exchange—Loomis

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1947-48	----	----	----	----	----	----	2.70	2.35	3.84	3.84	2.10	0	----
48-49	0	0	0	0.39	1.54	4.10	0.60	0.96	2.47	0	0	0	10.06
1949-50	0	0.03	0.02	0.06	1.12	2.12	5.62	3.57	3.31	1.24	0.74	0	17.83
50-51	0	0	0	2.56	7.06	5.78	4.21	2.66	1.40	0.80	1.63	0	26.10
51-52	0	0	0	1.94	2.55	6.20	11.92	2.47	5.40	1.24	0.07	0	31.79
52-53	0	0	0.08	0	2.60	7.80	5.62	0.03	2.58	3.69	1.07	0.73	24.20
53-54	0	Tr.											

RECORD OF MONTHLY PRECIPITATION AT MOUNT PLEASANT, CALIFORNIA

County: Placer
Date established: 1944
Type of gage: Non-recording

Elevation: 500 feet, U. S. G. S. datum
Location: NE ¼, Sec. 23, T. 13 N., R. 7 E., M. D. B. & M.
Observer: Mr. T. V. Doub

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1944-45	----	----	----	----	----	*11.40	1.05	6.75	4.80	1.00	0.90	0.60	26.50
45-46	0	0	0	3.00	3.85	8.05	1.30	2.70	4.10	0.15	1.35	0	24.50
46-47	0.06	0	0.65	1.39	3.70	2.50	0.90	2.90	5.70	0.90	0.15	1.10	19.95
47-48	0	0	0	3.26	1.99	1.20	1.65	2.90	4.95	5.35	2.25	0	23.55
48-49	0	0	0	0.20	1.90	5.25	1.80	2.85	8.75	0	0.80	0	21.55
1949-50	0	0	0	0	1.90	2.30	6.25	3.95	3.90	1.72	0.88	0	20.90
50-51	0	0	0.25	2.50	8.75	7.60	5.90	2.60	1.95	1.30	2.00	0	32.85
51-52	0	0	0.05	3.15	4.30	6.85	12.15	3.00	6.10	1.05	0.40	0.90	37.95
52-53	0	0	0.25	0	2.60	7.90	6.35	0	3.40	3.85	1.65	1.00	27.00
53-54	0	Tr.											

* Season to date.

RECORD OF MONTHLY PRECIPITATION AT PENRYN, CALIFORNIA

County: Placer
Date established: November, 1948
Type of gage: Non-recording

Elevation: 600 feet, U. S. G. S. datum
Location: NW ¼, Sec. 25, T. 11 N., R. 7 E., M. D. B. & M.
Observer: Mr. George Perry

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1948-49	----	----	----	----	1.9	5.9	2.9	3.1	8.1	0	0.2	0	22.1
1949-50	0	0	0	0	2.1	1.7	6.6	3.9	4.1	2.2	0.6	0	21.2
50-51	0	0	1.1	2.8	7.6	7.5	5.3	3.2	1.0	1.1	0	0	29.6
51-52	0	0	0	1.6	4.0	8.7	11.9	2.5	6.8	1.3	0	0.5	37.3
52-53	0	0	0.2	0	2.6	7.5	6.0	0.4	3.2	5.0	1.2	0.8	26.9

RECORD OF MONTHLY PRECIPITATION AT WERNER RANCH, CALIFORNIA

County: Placer
Date established: February, 1934
Type of gage: Non-recording

Elevation: 1,200 feet, U. S. G. S. datum
Location: NW ¼, Sec. 21, T. 12 N., R. 8 E., M. D. B. & M.
Observer: Mr. Charles Werner

(In inches)

Season	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Total
1933-34	----	----	----	----	----	----	----	5.30	0.51	0.99	0.42	1.06	----
1934-35	0	Tr.	0.20	2.41	4.19	3.27	6.29	2.65	3.89	8.46	0.39	0	31.75
35-36	0	0	0	2.83	1.66	2.96	9.52	14.30	2.42	2.05	0.87	0.74	37.35
36-37	0	0	0.01	0.68	0	5.01	5.71	9.47	9.97	2.62	0.28	1.25	35.00
37-38	0	0	0	1.59	5.80	5.15	5.87	11.80	7.69	2.68	0.40	0.13	41.11
38-39	0	0	0.26	2.94	1.00	2.27	4.20	2.76	5.77	0.15	3.40	0.01	22.76
1939-40	0	0	0.69	0.96	0.44	2.14	14.65	10.32	7.91	1.15	0.36	0.01	38.61
40-41	0	0	0.28	1.70	2.78	11.46	6.79	10.13	3.10	5.16	1.81	0.18	43.39
41-42	0	0.01	0.18	1.34	2.72	10.39	6.87	6.34	3.46	8.24	2.93	0	42.48
42-43	0	0	0.05	0.91	6.57	5.45	8.72	3.48	8.13	2.86	0.92	0	37.04
43-44	0	0	0	0.27	1.38	2.94	4.32	9.61	2.19	2.16	1.12	0.11	24.10
1944-45	Tr.	0	0	2.91	6.15	3.16	3.14	6.77	4.68	1.34	1.05	0.81	30.01
45-46	0	0	0.01	3.30	4.74	9.98	1.71	2.56	4.76	0.09	1.18	0	27.06
46-47	0.06	0	0.93	3.28	4.56	1.71	1.19	3.17	5.19	0.83	0.30	0.68	21.00
47-48	0	0	0	5.44	2.28	1.00	2.57	2.78	5.04	5.80	3.97	0.01	28.99
48-49	0	0	0	0.28	2.37	6.72	2.15	3.43	8.95	0	0.62	0	24.52
1949-50	0	0.08	0.06	0.05	1.87	2.05	8.20	4.43	4.59	1.97	1.09	0.23	24.62
50-51	0	0	0.26	3.64	11.74	8.26	7.51	3.39	3.01	1.53	2.64	0	41.92
51-52	0	Tr.	0.12	3.24	5.29	9.16	12.63	3.88	6.53	1.03	0.29	0.61	42.78
52-53	0.03	0	1.00	0	2.92	8.59	7.46	0.43	2.72	4.86	0.81	1.08	29.79
53-54	0	Tr.											

APPENDIX E

RECORDS OF MONTHLY RUNOFF IN PLACER COUNTY NOT PREVIOUSLY PUBLISHED

TABLE OF CONTENTS

RECORDS OF MONTHLY RUNOFF IN PLACER COUNTY NOT PREVIOUSLY PUBLISHED

DIVERSION TO GOLD HILL FROM SOUTH CANAL AT WISE POWER HOUSE

Location: NE ¼ SE ¼, Sec. 17, T. 12 N., R. 8 E., M. D. B. & M. Source of record: Nevada Irrigation District

Runoff season	Monthly diversion, in acre-feet												
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1938-39	----	----	----	----	----	----	----	----	3,443	3,644	3,109	2,337	----
1939-40	369	116	113	0	0	0	0	2,878	3,132	3,585	3,471	2,876	16,540
40-41	1,023	0	0	0	0	0	0	1,155	2,957	3,426	3,483	3,032	15,076
41-42	1,430	0	0	0	0	0	0	203	2,777	3,499	3,587	3,456	14,952
42-43	1,792	91	0	0	0	0	0	2,782	3,398	3,599	3,582	3,271	18,515
43-44	618	0	0	0	0	0	621	2,277	2,970	3,547	3,003	1,466	14,502
1944-45	993	3	0	0	0	0	651	3,326	3,025	3,516	3,020	3,327	17,861
45-46	1,574	55	0	0	0	0	951	3,141	3,155	3,465	3,445	3,077	18,863
46-47	1,481	389	120	0	0	0	304	2,872	1,900	3,463	2,949	2,542	16,020
47-48	1,007	0	0	0	0	0	0	1,572	2,701	3,090	3,065	2,771	14,206
48-49	813	31	0	0	0	0	991	3,161	3,334	3,457	3,510	3,216	18,513
1949-50	1,401	229	0	0	0	0	0	2,015	4,960	5,385	5,384	4,158	23,532
50-51	1,842	55	0	0	0	0	0	0	4,983	5,154	5,095	3,854	20,983
51-52	1,943	0	0	0	0	0	273	3,626	4,434	5,388	5,410	4,352	25,426

DIVERSION TO GOLD HILL FROM SOUTH CANAL AT TUNNEL 11

Location: NW ¼ NE ¼, Sec. 19, T. 12 N., R. 8 E., M. D. B. & M. Source of record: Nevada Irrigation District

Runoff season	Monthly diversion, in acre-feet												
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1939-40	----	----	----	----	----	----	----	----	----	1,206	985	233	----
1940-41	0	0	0	0	0	0	0	149	713	1,205	1,199	514	3,780
41-42	0	0	0	0	0	0	0	0	1,054	1,454	1,593	424	4,525
42-43	0	0	0	0	0	0	0	1,137	893	2,492	1,918	703	7,143
43-44	0	0	0	0	0	0	0	1,609	2,011	3,002	3,547	1,856	12,025
1944-45	0	0	0	0	0	0	0	1,426	2,204	3,658	2,967	1,913	12,168
45-46	0	0	0	0	0	0	34	1,367	1,891	2,805	2,772	1,128	9,997
46-47	0	0	0	0	0	0	41	3,022	3,353	3,403	3,467	1,791	15,077
47-48	0	0	0	0	0	0	0	661	1,810	3,912	3,468	1,719	11,570
48-49	0	0	0	0	0	0	323	1,870	3,374	3,447	2,999	486	12,499
1949-50	0	0	0	0	0	0	733	3,434	1,538	2,941	2,199	816	11,661
50-51	0	0	0	0	0	0	0	0	1,900	2,360	2,336	177	6,773
51-52	0	0	0	0	0	0	55	641	1,524	962	1,283	300	4,765

FLOW OF AUBURN RAVINE CANAL NEAR HEAD

Location: NE ¼ NE ¼, Sec. 14, T. 12 N., R. 7 E., M. D. B. & M. Source of record: Nevada Irrigation District

Runoff season	Monthly flow, in acre-feet												
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1939-40	839	510	571	614	571	896	235	1,645	1,577	1,750	1,760	1,437	12,405
40-41	1,023	490	458	397	297	602	732	1,004	1,616	1,957	1,881	1,681	12,138
41-42	1,127	408	379	162	0	571	129	289	1,147	2,192	2,126	1,666	10,196
42-43	931	412	0	0	0	0	0	1,008	1,224	1,273	1,277	1,296	7,421
43-44	553	0	0	0	0	0	0	1,294	1,524	1,966	2,091	2,010	9,438
1944-45	1,284	0	0	0	206	246	478	1,501	1,715	2,188	1,704	2,079	11,401
45-46	1,288	418	396	305	275	309	774	1,539	1,837	2,355	2,437	2,268	14,201
46-47	1,209	470	766	400	360	396	566	1,813	2,176	2,370	2,379	2,383	15,288
47-48	1,187	345	340	347	325	350	389	1,202	2,005	2,720	2,586	2,450	14,246
48-49	1,610	0	267	150	0*	0*	1,102	1,934	2,366	2,758	2,480	2,350	15,017
1949-50	2,140	733	453	0	0	0	862	2,057	2,565	2,930	2,830	2,419	16,989
50-51	1,981	0	0	207	0	462	737	1,803	2,730	2,871	2,904	2,441	16,136
51-52	1,683	0	376	445	0	0	1,019	2,265	2,776	2,941	3,032	2,682	17,219

* Construction during this period.

FLOW OF GOLD HILL CANAL BELOW COMBIE DAM

Location: SE ¼ NE ¼, Sec. 3, T. 13 N., R. 8 E., M. D. B. & M. Source of record: Nevada Irrigation District

Runoff season	Monthly flow, in acre-feet												
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1930-31	1,334	988	805	744	489	639	785	633	387	486	393	345	8,028
31-32	276	273	246	252	218	258	594	1,258	1,532	1,694	1,590	1,515	9,706
32-33	1,365	678	326	222	206	203	470	707	1,580	1,480	1,368	1,308	9,913
33-34	1,283	534	501	475	426	490	1,152	1,429	1,362	1,453	1,447	1,314	11,866
1934-35	898	495	572	547	514	573	557	952	1,434	1,539	1,582	1,486	11,149
35-36	1,200	747	743	1,140	892	809	720	1,299	1,418	1,480	1,624	1,571	13,643
36-37	1,191	1,084	1,086	920	700	725	766	1,535	1,390	1,209	1,322	1,278	13,206
37-38	1,415	1,070	964	1,105	952	1,016	1,015	1,573	1,708	1,759	1,720	1,526	15,823
38-39	1,176	737	659	475	344	578	1,156	1,550	1,525	1,617	1,853	1,834	13,504
1939-40	1,212	868	598	251	145	373	636	1,716	1,659	1,733	1,775	1,809	12,775
40-41	1,176	737	659	170	233	242	446	1,534	1,649	1,985	2,008	1,976	12,815
41-42	1,479	745	278	0	0	314	303	1,001	1,905	2,045	2,097	2,133	12,300
42-43	2,112	1,295	0	0	0	0	473	1,954	1,869	2,112	942	505	11,262
43-44	405	0	0	0	0	238	1,785	1,845	1,863	1,932	2,038	1,842	11,948
1944-45	1,420	380	0	0	0	0	813	2,841	2,840	2,642	3,155	2,966	17,057
45-46	2,766	1,128	1,041	745	969	1,303	1,965	2,993	2,723	2,522	2,814	2,769	23,738
46-47	2,905	1,990	2,209	1,104	2,134	3,247	2,660	3,024	2,559	2,413	2,478	2,593	29,316
47-48	2,979	0*	0*	0*	0*	0*	0*	3,694	3,868	4,288	3,655	2,725	21,209
48-49	1,799	0	0	0	0	0	1,785	5,215	4,481	4,408	4,289	3,768	25,745
1949-50	3,442	1,160	0	0	0	0	3,004	4,809	5,550	4,765	4,548	3,450	30,728
50-51	2,805	267	0	0	0	0	3,595	5,005	2,963	3,049	3,489	2,792	23,965
51-52	2,156	0	0	0	0	0	0	2,905	5,408	4,944	2,943	2,740	21,096

* Construction during this period.

APPENDIX F

RECORDS OF DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY

The wells are numbered in accordance with a system adopted by the United States Geological Survey. The numbering system indicates the well locations according to the rectangular land surveys. An explanation of the numbering system is given on page 33 of this bulletin.

Reference point elevations given to the nearest foot have been estimated from United States Geological Survey topographic maps. Reference point elevations given to the nearest 0.1 foot have been established by field surveys.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

10N/4E-12A1—Reference point—hole in side of pump, elevation 43.1 feet. 0.10 mile west of Pleasant Grove Road, 0.70 mile south of Reigo Road. 12/23/47, 22.0; 3/3/48, 20.6; 12/7/48, 28.1; 4/6/49, 23.2; 11/23/49, 36.1; 12/1/49, 27.2; 3/15/50, 29.5; 3/30/50, 28.7.

10N/5E-2L1—Reference point—top of casing, elevation 98.4 feet. 2.53 miles east of Brewer Road, 0.18 mile south of Base Line Road. 3/25/49, 48.8; 5/12/49, 48.9; 6/27/49, 49.3; 7/29/49, 49.8; 8/26/49, 50.1; 10/6/49, 50.5; 11/23/49, 52.0; 2/15/50, 50.4; 3/15/50, 50.5; 4/4/50, 50.5; 11/14/50, 52.8; 3/21/51, 52.0; 11/19/51, 55.2; 4/2/52, 54.0; 11/7/52, 57.7.

10N/5E-3N1—Reference point—top of casing, elevation 73 feet. 0.50 mile south of Base Line Road, 1.23 miles east of Brewer Road. 5/8/50, 37.7; 5/9/51, 38.9; 4/2/52, 39.6.

10N/5E-5F1—Reference point—top of concrete floor in pit, elevation 55 feet. 0.45 mile west of Brewer Road, south of Base Line Road. 11/23/48, 10.1; 3/28/49, 9.5; 11/23/49, 13.1; 4/4/50, 12.7; 11/14/50, 15.7; 3/22/51, 14.1; 11/30/51, 17.0.

10N/5E-5N1—Reference point—top of concrete base, elevation 52 feet. 0.80 mile west of Brewer Road, 0.53 mile south of Base Line Road. 11/23/48, 17.7; 3/28/49, 17.2; 11/23/49, 21.2; 4/4/50, 20.0; 11/15/50, 26.1; 3/22/51, 24.3

10N/5E-6J1—Reference point—top of wooden shoring for pit. 12.5 feet above casing, elevation 46 feet. 0.12 mile south of Reigo Road, 0.82 mile east of Pleasant Grove Road. 12/24/47, 27.1; 3/3/48, 27.0; 12/7/48, 33.9; 4/6/49, 29.6; 12/1/49, 33.6; 3/30/50, 34.9; 11/9/50, 40.3; 9/5/51, 38.2; 12/5/51, 33.1; 4/8/52, 42.4.

10N/5E-6J2—Reference point—top of casing, elevation 45 feet. 0.81 mile east of Pleasant Grove Road, 0.25 mile south of Base Line Road. 11/23/48, 26.0; 3/28/49, 24.5; 11/23/49, 32.7; 4/4/50, 29.1.

10N/5E-6J3—Reference point—top of bolt plug in well pipe, elevation 52 feet. 0.76 mile east of Pleasant Grove Road, 0.05 mile south of Base Line Road. 11/23/48, 16.7; 4/4/50, 19.4.

10N/5E-6K1—Reference point—top of 8″ x 8″ across top of pit, elevation 51.9 feet. 0.53 mile east of Pleasant Grove Road, 0.03 mile south of Base Line Road. 11/23/48, 32.5; 3/28/49, 29.0; 11/23/49, 39.4; 2/14/50, 36.8; 4/5/50, 35.0; 11/14/50, 40.3; 3/22/51, 38.7; 11/19/51, 39.1; 4/2/52, 36.3; 11/6/52, 40.9.

10N/5E-6M1—Reference point—top of casing, elevation 40 feet. 0.03 mile east of Pleasant Grove Road, 0.10 mile south of Base Line Road. 11/23/48, 29.9; 4/4/50, 31.4.

10N/5E-8L1—Reference point—top of casing, elevation 55 feet. 1.39 miles east of Pleasant Grove Road, 1.22 miles south of Base Line Road. 11/23/48, 24.0; 3/28/49, 21.6; 11/23/49, 32.7; 4/4/50, 24.0; 11/15/50, 26.1; 3/22/51, 25.2.

10N/5E-8N1—Reference point—hole in pump base, elevation 51 feet. 1.01 miles east of Pleasant Grove Road, 1.33 miles south of Base line Road. 11/23/48, 26.8; 3/28/49, 26.1; 11/23/49, 31.1; 11/15/50, 31.8; 3/22/51, 30.0; 11/28/51, 34.5.

10N/5E-9L1—Reference point—top of concrete base, elevation 67 feet. 2.25 miles east of Pleasant Grove Road, 1.13 miles south of Base Line Road. 11/24/48, 27.5; 3/28/49, 27.5; 11/23/49, 29.6; 4/5/50, 29.4; 11/15/50, 31.5; 3/21/51, 29.8; 11/23/51, 33.4; 4/2/52, 32.8; 11/7/52, 37.6.

10N/5E-10J1—Reference point—hole in pump base, elevation 87 feet. 0.12 mile southwest of angle point in road at E. ¼ corner of Sec. 10, T. 10 N., R. 5 E. 11/24/48, 42.0; 2/24/49, 42.0; 3/25/49, 41.5; 11/23/49, 43.5; 4/4/50, 42.6; 11/15/50, 45.4; 3/23/51, 44.6; 11/19/51, 48.2; 4/2/52, 46.2.

10N/5E-11E1—Reference point—top of casing, elevation 89 feet. 0.20 mile northeast of angle in road at W. ¼ corner of Sec. 11, T. 10 N., R. 5 E. 9/25/50, 53.6; 11/19/51, 51.4; 4/2/52, 49.7.

10N/5E-11F1—Reference point—top of steel rim, elevation 93 feet. 0.55 mile northwest of junction of roads at E. ¼ corner of Sec. 11, T. 10 N., R. 5 E. 11/24/48, 46.3; 3/25/49, 46.4; 11/23/49, 47.6; 4/4/50, 47.5; 11/15/50, 50.3; 3/22/51, 49.3; 11/19/51, 52.2; 4/2/52, 50.6.

10N/5E-11G1—Reference point—½″ hole above pump base, elevation 98.6 feet. 0.40 mile northwest of junction of roads at E. ¼ corner of Sec. 11, T. 10 N., R. 5 E. 6/1/49, 50.3; 7/1/49, 50.6; 7/29/49, 50.5; 8/31/49, 50.6; 10/6/49, 50.8; 11/23/49, 51.5; 2/15/50, 50.7; 3/15/50, 51.7; 4/4/50, 47.5; 5/8/50, 51.0; 6/7/50, 53.9; 7/7/50, 53.0; 8/7/50, 54.6; 9/5/50, 55.2; 10/3/50, 55.1; 11/15/50, 54.4; 12/15/50, 54.2; 1/4/51, 53.1; 2/6/51, 54.2; 3/8/51, 52.4; 3/22/51, 53.6; 5/9/51, 53.5; 6/5/51, 59.4; 7/10/51, 60.5; 8/23/51, 59.3.

10N/5E-11J1—Reference point—top of casing, elevation 91 feet. 0.10 mile southwest of junction of roads at E. ¼ corner, Sec. 11, T. 10 N., R. 5 E. 11/24/48, 51.0; 3/25/49, 51.0; 11/23/49, 50.7; 4/4/50, 50.6; 11/15/50, 54.0; 3/22/51, 52.8.

10N/5E-12E1—Reference point—top of casing, elevation 85 feet. 0.96 mile south of junction of roads at northwest corner of Sec. 1, T. 10 N., R. 5 E. 12/14/48, 50.9; 3/25/49, 51.9; 8/1/49, 52.5; 10/6/49, 52.5; 11/23/49, 52.8; 3/31/50, 53.0; 11/15/50, 55.6; 3/23/51, 55.0; 11/29/51, 57.3; 4/2/52, 55.8; 11/10/52, 59.7.

10N/5E-12M1—Reference point—top of casing, elevation 93 feet. 0.45 mile north of junction of roads at southwest corner, Sec. 12, T. 10 N., R. 5 E. 12/13/48, 38.2; 3/25/49, 37.6.

10N/5E-12N1—Reference point—hole in side of pump, elevation 100 feet. 0.20 mile east of junction of roads at southwest corner of Sec. 12, T. 10 N., R. 5 E. 12/13/48, 68.0; 2/24/49, 67.7; 3/25/49, 67.5; 11/25/49, 67.0; 3/31/50, 67.7; 11/15/50, 70.1.

10N/6E-3M1—Reference point—top of casing, elevation 136 feet. 0.05 mile east of and 0.10 mile south of junction of roads at northwest corner, Sec. 3, T. 10 N., R. 6 E. 2/17/49, 77.3; 3/24/49, 76.9; 11/25/49, 79.9; 4/4/50, 77.7; 11/27/50, 83.9; 3/20/51, 79.9; 5/9/51, 81.6; 6/5/51, 83.0; 11/28/51, 83.0; 4/10/52, 80.7; 11/10/52, 84.9.

10N/6E-3P1—Reference point—top of casing, elevation 148 feet. 0.26 mile east of and 0.42 mile south of junction of roads at northwest corner of Sec. 3, T. 10 N., R. 6 E. 2/28/49, 94.3; 4/4/50, 89.0; 11/28/51, 94.1.

10N/6E-4P1—Reference point—edge of pump base, elevation 141 feet. 0.45 mile east of junction of roads at southwest corner of Sec. 4, T. 10 N., R. 6 E. 12/15/48, 88.8; 4/4/50, 88.0; 11/15/50, 90.1.

10N/6E-5L1—Reference point—hole in pump base, on southwest side of pump, elevation 130 feet. 0.50 mile west of, 0.18 mile south of junction of roads at northeast corner of Sec. 5, T. 10 N., R. 6 E. 12/14/48, 77.4; 3/24/49, 76.0; 11/23/49, 80.5; 11/15/50, 86.6; 3/20/51, 85.1; 4/2/52, 79.7.

10N/6E-7K1—Reference point—hole in pump base on the northeast side, elevation 95 feet. 0.63 mile south of and 0.31 mile west of angle in road at northeast corner of Sec. 7, T. 10 N., R. 6 E. 12/13/48, 36.5; 3/24/49, 31.7; 11/25/49, 35.6; 3/31/50, 33.8; 11/15/50, 35.1; 3/22/51, 33.5; 11/29/51, 36.6; 4/2/52, 30.6; 11/10/52, 37.0.

10N/6E-7Q1—Reference point—edge of pump base at hole in south side, elevation 121 feet. 1.25 miles east of Dry Creek School on Dry Creek Road. 12/13/48, 63.7; 3/24/49, 68.2; 3/31/50, 70.3; 3/22/51, 70.1; 11/29/51, 74.4; 4/2/52, 73.5.

10N/6E-8A1—Reference point—top of casing, elevation 135 feet. 0.12 mile south and 0.07 mile west of junction of roads at northeast corner of Sec. 8, T. 10 N., R. 5 E. 3/15/50, 71.0; 3/31/50, 70.5.

10N/6E-8B1—Reference point—top of casing, elevation 132 feet. 0.35 mile west of junction of roads at northeast corner of Sec. 3, T. 10 N., R. 6 E. 12/14/48, 74.5; 3/24/49, 74.0; 11/23/49, 78.6; 3/31/50, 74.1.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

10N/6E-8J1—Reference point—edge of concrete casing, elevation 114 feet. 0.58 mile south of junction of roads at northeast corner of Sec. 8, T. 10 N., R. 6 E. 12/14/48, 17.0; 3/24/49, 14.5; 11/25/49, 16.8; 3/31/50, 17.8; 11/15/50, 16.8; 3/20/51, 14.5; 11/28/51, 16.1; 4/2/52, 12.8; 11/10/52, 17.0.

10N/6E-8R1—Reference point—pipe in base, elevation 143 feet. 0.13 mile north of, 0.04 mile west of junction of roads at southeast corner of Sec. 8, T. 10 N., R. 6 E. 12/13/48, 90.8; 2/24/49, 90.3; 3/24/49, 90.1; 11/25/49, 92.9; 3/31/50, 93.5; 11/15/50, 94.6; 3/20/51, 92.6; 4/2/52, 93.8.

10N/6E-9D1—Reference point—hole in base of pump, elevation 141 feet. 0.25 mile east of junction of roads at northwest corner of Sec. 9, T. 10 N., R. 6 E. 12/15/48, 84.1; 3/24/49, 84.0; 5/11/49, 85.2; 6/27/49, 87.5; 7/1/49, 88.9; 7/29/49, 88.1; 8/26/49, 87.7; 10/6/49, 87.6; 11/23/49, 86.7; 2/14/50, 85.5; 3/15/50, 85.5; 4/4/50; 85.2; 5/8/50, 85.7; 6/7/50, 87.6; 7/7/50, 90.0; 8/1/50, 89.9; 9/6/50, 90.0; 10/3/50, 89.2; 11/15/50, 88.1; 3/6/51, 86.3; 3/20/51, 86.3; 5/9/51, 86.6; 6/5/51, 90.8; 4/2/52, 87.8.

10N/6E-9R1—Reference point—hole in casing under pump, elevation 132 feet. 1.0 mile east of, 0.06 mile north of junction of roads at southwest corner of Sec. 9, T. 10 N., R. 6 E. 12/13/48, 78.5; 3/24/49, 77.7; 11/25/49, 81.4; 4/4/50, 80.3; 11/15/50, 79.6; 3/20/51. 78.8; 11/29/51, 80.5.

10N/6E-10C1—Reference point—hole in north side of 3″ x 12″ wooden pump support, elevation 151 feet. 0.68 mile west of and 0.5 mile south of junction of roads at northeast corner of Sec. 10, T. 10 N., R. 6 E. 12/15/48, 89.0; 2/17/49, 89.0; 3/24/49, 85.5; 4/4/50, 88.5; 11/27/50. 89.1.

10N/6E-12A1—Reference point—top of casing, elevation 175 feet. 0.37 mile east of junction of roads at N. ¼ corner of Sec. 12, T. 10 N., R. 6 E. 1/3/51, 87.1; 3/20/51, 84.1; 5/9/51, 84.6; 6/6/51, 84.6.

10N/6E-12D1—Reference point—hole in plug in top of casing, elevation 140 feet. 0.37 mile west of junction of roads at N. ¼ corner of Sec. 12, T. 10 N., R. 6 E. On Douglas Street, opposite end of Donner Avenue. 11/9/29, 38.5; 9/18/30, 33.6; 12/10/31, 33.0; 11/26/32, 33.3; 12/19/33, 34.1; 11/15/34, 33.8; 11/16/36, 32.5; 11/1/37, 32.1; 1/9/39, 31.0; 1/2/41, 31.0; 11/11/47, 30.5; 12/16/48, 32.5; 2/24/49, 31.7; 11/25/49, 30.5; 4/4/50, 32.6; 11/16/50, 29.9; 3/20/51, 25.8; 1/6/53, 25.4.

10N/6E-17A1—Reference point—hole in pump base, elevation 140 feet. 0.15 mile west of junction of roads at northeast corner of Sec. 17, T. 10 N., R. 6 E. 12/13/48, 84.3; 3/24/49, 80.5; 11/25/49, 83.2; 3/31/50, 86.2; 11/15/50, 85.6; 3/20/51, 83.0; 11/28/51, 86.0; 4/2/52, 84.4; 11/10/52, 88.3.

10N/7E-7E1—Reference point—base of movable hand pump, elevation 142 feet. 0.31 mile south of Douglas Street on road to Adamson Ranch. 1/5/51, 20.1; 3/20/51, 21.0.

11N/4E-1F1—Reference point—top of casing, elevation 49.3 feet. 0.80 mile south of Catlett Road, 0.25 mile east of Pleasant Grove Road. 12/22/47, 21.5; 3/22/48, 19.3; 12/18/48, 23.3; 3/29/49, 19.5; 12/2/49, 25.9; 3/27/50, 22.8; 11/8/50, 27.0; 11/16/51, 29.6.

11N/4E-12J2—Reference point—top of casing, elevation 56.8 feet. 0.58 mile south of Howsley Road, 0.78 mile south of Pleasant Grove Road. 12/23/47, 27.3; 3/3/48, 25.2; 12/8/48, 28.2; 3/31/49, 24.7; 11/17/49, 30.8; 11/30/49, 28.9; 4/11/50, 26.9; 11/14/50, 32.4; 4/5/51, 28.9; 11/15/51, 34.0; 4/3/52, 29.2.

11N/4E-12M1—Reference point—slot in concrete base, elevation 44.7 feet. 0.62 mile south of Howsley Road, 0.07 mile west of Pleasant Grove Road. 12/23/47, 22.8; 3/3/48, 19.8; 12/8/48, 24.6; 3/3/49, 20.4; 11/30/49, 27.2; 3/30/50, 23.1; 11/6/50, 28.2; 4/10/51, 23.5; 11/14/51, 35.0.

11N/4E-12M2—Reference point—top of casing, elevation 40 feet. 0.72 mile south of Howsley Road on west side of Pleasant Grove Road. 11/14/51, 31.8; 4/10/52, 22.8.

11N/4E-13D1—Reference point—top of casing, elevation 47.6 feet. 0.09 mile south of Fifield Road on west side of Pleasant Grove Road. 12/8/48, 28.5; 4/6/49, 18.0; 11/30/49, 27.0; 3/15/50, 23.3; 3/30/50, 24.1; 11/8/50, 30.1; 4/5/51, 25.0; 11/14/51, 32.6; 4/10/52, 25.2.

11N/4E-13M1—Reference point—top of casing in 12 foot pit, elevation 46 feet. 0.12 mile west of Pleasant Grove Road, 0.37 mile north of Keys Road. 12/8/48, 19.1; 3/31/49, 14.0; 11/30/49, 21.7.

11N/4E-23H1—Reference point—top of casing, elevation 53.1 feet. 0.02 mile west of Pleasant Grove Road, 0.46 mile south of Keys Road. 12/23/47, 19.5; 3/3/48, 18.1; 12/8/48, 24.1; 4/6/49, 19.7; 11/30/49, 32.2; 3/15/50, 25.3; 3/30/50, 24.6; 11/8/50, 30.7; 4/5/51, 29.6.

11N/4E-25M1—Reference point—hole in pump base, elevation 37 feet. 0.58 mile south of Sankey Road, 0.06 mile east of Pleasant Grove Road. 12/23/47, 19.0; 12/8/48, 24.9; 4/6/49, 21.0; 12/1/49, 34.6; 4/4/50, 34.9.

11N/4E-36E1—Reference point—top of concrete wall, elevation 39 feet. 0.07 mile east of Pleasant Grove Road, 0.70 mile north of Riego Road. 12/24/47, 22.3; 3/3/48, 23.0; 12/7/48, 28.9; 4/6/49, 24.9; 12/1/49, 38.7; 3/30/50, 23.2.

11N/4E-36H1—Reference point—top of casing, elevation 52 feet. 0.50 mile north of Base Line Road, on west side Sutter-Placer County Line Road. 9/25/51, 36.5; 11/16/51, 35.7; 2/27/52, 33.8; 4/2/52, 33.2.

11N/5E-1E1—Reference point—top of casing, elevation 107.4 feet. 0.60 mile north of junction of roads at southwest corner of Sec. 1, T. 11 N., R 5 E. 12/21/48, 47.5; 3/30/49, 47.2; 11/14/49, 49.7; 3/15/50, 49.2; 4/7/50, 49.0; 11/14/50, 50.4; 3/21/51, 49.9; 11/14/51, 52.0; 4/3/52, 51.5; 11/6/52, 53.9.

11N/5E-1N1—Reference point—top of casing, elevation 106.3 feet. 0.20 mile east and 0.08 mile north of junction of roads at southwest corner of Sec. 1, T. 11 N., R 5 E. 5/12/49, 45.9; 6/28/49, 46.8; 7/28/49, 47.6; 8/25/49, 47.7; 9/29/49, 48.0; 11/14/49, 48.1; 2/14/50, 47.9; 3/5/50, 47.7; 4/7/50, 57.9; 5/9/50, 47.8; 6/9/50, 48.0; 7/7/50, 48.1; 8/3/50, 48.2; 9/5/50, 48.9; 10/3/50, 48.9; 11/14/50, 49.2; 1/5/51, 48.8; 2/8/51, 48.6; 3/21/51, 48.6; 5/10/51, 48.5; 6/5/51, 48.6; 7/10/51, 49.1; 8/23/51, 49.5; 9/27/51, 53.7; 11/14/51, 50.1; 2/28/52. 50.0; 4/3/52, 50.3; 11/6/52, 51.7.

11N/5E-3H1—Reference point—pipe in concrete base, elevation 99.4 feet. 0.95 mile east of and 0.67 mile north of junction of roads at southwest corner of Sec. 3, T. 11 N., R. 5 E. 12/20/48, 45.2; 3/30/49, 44.3; 11/14/49, 47.9; 4/7/50, 46.2; 11/14/50, 48.0; 3/21/51, 46.9; 11/14/51, 50.9; 4/3/52, 49.0; 11/6/52, 53.5.

11N/5E-3M1—Reference point—pipe in concrete base, elevation 89.3 feet. 0.48 mile north of and 0.23 mile east of junction of roads at southwest corner of Sec. 3, T. 11 N., R. 5 E. 12/20/48, 37.0; 3/30/49, 36.0; 11/14/49, 39.6; 3/15/50, 38.0; 4/7/50, 37.8; 11/14/50, 39.6; 3/20/51, 38.2; 11/14/51, 42.6; 4/3/52, 40.6.

11N/5E-3M2—Reference point—top of casing, elevation 89.4 feet. 0.47 mile north of and 0.23 mile east of junction of roads at southwest corner of Sec. 3, T. 11 N., R. 5 E. 12/20/48, 37.8; 3/30/49, 36.9; 11/14/49, 41.3.

11N/5E-3M3—Reference point—hole in pump base, elevation 90.8. 0.33 mile north of junction of roads at southwest corner of Sec. 3, T. 11 N., R. 5 E., on east side of road. 11/14/49, 43.4; 3/15/50, 41.9; 4/7/50, 41.8; 10/3/50, 44.1; 11/14/50, 43.5; 3/20/51, 42.0; 11/14/51, 46.8; 4/3/52, 44.4.

11N/5E-4P1—Reference point—hole in pump base, elevation 106.2 feet. 0.60 mile west of and 0.25 mile north of junction of roads at southeast corner of Sec. 4, T. 11 N., R. 5 E. 6/9/49, 61.6; 11/14/49, 61.6; 4/7/50, 59.3; 11/14/50, 61.9; 3/20/51, 59.9; 11/14/51, 64.9; 4/3/52, 63.8.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

11N/5E-4Q1—Reference point—hole in pump base, elevation 104.0 feet. 0.35 mile west of junction of roads at southeast corner of Sec. 4, T. 10 N., R. 5 E., on north side of road. 11/30/48, 55.5; 12/20/48, 55.4; 3/30/49, 54.4; 5/12/49, 54.5; 6/28/49, 61.0; 7/28/49, 61.2; 8/25/49, 62.7; 9/29/49, 61.9; 11/14/49, 58.8; 2/15/50, 57.0; 3/15/50, 56.8; 4/7/50, 56.9; 5/9/50, 56.6; 6/7/50, 58.2; 7/7/50, 59.2; 8/1/50, 59.4; 9/5/50, 59.9; 10/3/50, 59.3; 11/14/50, 58.8; 12/15/50, 58.4; 1/4/51, 58.0; 2/6/51, 59.5; 3/20/51, 57.0; 5/9/51, 57.5; 6/5/51, 60.2; 7/10/51, 62.8; 8/23/51, 64.2; 9/25/51, 64.5; 11/14/51, 62.0; 2/28/52, 59.8; 4/3/52, 59.7; 11/6/52, 66.0.

11N/5E-6A1—Reference point—pipe in base, 0.6 feet above ground, elevation 59.6 feet. West side of Brewer Road, 0.75 mile north of Howsley Road. 12/17/48, 18.7; 3/30/49, 17.3; 5/12/49, 18.6; 6/27/49, 22.5; 7/28/49, 25.0; 7/29/49, 25.2; 9/29/49, 28.2; 11/10/49, 21.2; 2/14/50, 19.7; 3/15/50, 19.2; 4/10/50, 19.0; 5/8/50, 20.7; 10/4/50, 24.4; 11/14/50, 22.2; 12/13/50, 21.6; 1/4/51, 20.8; 2/6/51, 19.8; 3/21/51, 19.1; 5/9/51, 21.2; 9/25/51, 29.0; 11/14/51, 25.5; 2/28/52, 22.7; 4/3/52, 21.9; 11/6/52, 28.7.

11N/5E-6G1—Reference point—hole in pump base, elevation 56.2 feet. 0.50 mile west of Brewer Road, 0.52 mile north of Howsley Road. 11/30/48, 24.6; 3/30/49, 20.9; 11/10/49, 26.1; 3/15/50, 23.5; 4/10/50, 23.1; 5/8/50, 61.5*; 11/14/50, 27.2; 3/20/51, 23.1; 11/14/51, 30.3; 3/31/52, 26.4.

11N/5E-6N1—Reference point—joint in cover around casing, elevation 53.2 feet. North side of Howsley Road, 0.80 mile east of Pleasant Grove Road. 12/23/47, 24.7; 3/3/48, 22.6; 12/8/48, 25.1; 3/31/49, 22.8; 11/30/49, 25.9; 11/14/50, 28.7; 3/22/51, 26.2.

11N/5E-6Q1—Reference point—top of casing, elevation 58.3 feet. 0.48 mile west of junction of roads at southeast corner of Sec. 6, T. 10 N., R. 5 E., on north side of road. 11/30/48, 24.8; 3/30/49, 23.5; 6/27/49, 30.0; 7/28/49, 65.0; 11/10/49, 27.9; 2/14/50, 25.5; 3/15/50, 25.0; 4/10/50, 24.8; 5/8/50, 28.5; 6/7/50, 29.8; 7/3/50, 32.3; 8/1/50, 32.9; 9/5/50, 32.3; 10/3/50, 30.0; 11/14/50, 28.8; 12/13/50, 27.7; 1/4/51, 27.4; 2/6/51, 26.5; 3/20/51, 25.7; 4/5/51, 25.6; 5/9/51, 27.7; 6/5/51, 34.8; 7/10/51, 39.3; 8/23/51, 41.7; 9/25/51, 40.3; 11/14/51, 32.2; 2/28/52, 29.0; 3/31/52, 28.5; 11/12/52, 35.0.

11N/5E-6R1—Reference point—edge of pump base, elevation 61.0 feet. 0.10 mile north of and 0.03 mile west of junction of roads at southeast corner of Sec. 6, T. 10 N., R. 6 E. 12/17/48, 23.3; 3/30/49, 22.2.

11N/5E-7F1—Reference point—top of casing, elevation 56 feet. 0.50 mile west of and 0.27 mile south of junction of roads at northeast corner of Sec. 7, T. 11 N., R. 5 E. 11/14/50, 29.7; 3/22/51, 26.7.

11N/5E-7P1—Reference point—top of casing, elevation 52.3 feet. On south bank of Pleasant Grove Creek, 0.60 mile west of road on eastern boundary of Sec. 7, T. 11 N., R. 5 E. 11/30/48, 15.1; 11/17/49, 18.3; 4/11/50, 17.3; 11/14/50, 19.4; 3/22/51, 16.3; 11/15/51, 20.2; 4/3/52, 17.7; 11/12/52, 21.5.

11N/5E-7R1—Reference point—hole in base of pump, elevation 60.6 feet. North of Pleasant Grove Creek and west of road forming eastern boundary of Sec. 7, T. 11 N., R. 5 E. 11/26/48, 21.7; 3/29/49, 20.2; 5/12/49, 21.4; 6/27/49, 25.6; 7/28/49, 28.3; 8/25/49, 29.9; 9/29/49, 28.2; 11/18/49, 24.8; 2/14/50, 23.3; 3/14/50, 23.0; 4/11/50, 22.7; 5/8/50, 63.3*; 6/9/50, 64.7*; 7/3/50, 30.7; 8/1/50, 32.9; 9/5/50, 66.3*; 10/3/50, 28.9; 11/14/50, 26.3; 12/13/50, 25.4; 1/4/51, 24.6; 2/6/51, 24.7; 3/6/51, 24.2; 3/22/51, 23.6; 5/9/51, 27.1; 6/5/51, 32.5; 7/10/51, 35.0; 11/16/51, 29.7; 2/28/52, 26.5; 4/3/52, 26.0; 11/6/52, 31.8.

11N/5E-8B1—Reference point—top of casing, elevation 68.3 feet. 0.69 mile east of and 0.10 mile south of junction of roads at northwest corner of Sec. 8, T. 11 N., R. 5 E. 11/29/48, 25.4; 3/29/49, 24.3; 11/14/49, 27.7; 4/11/50, 26.0; 11/14/50, 28.8; 3/22/51, 27.1; 11/20/51, 32.0; 4/3/52, 29.5.

11N/5E-9K1—Reference point—edge of pit, elevation 70 feet. 1.5 miles east of road forming boundary between Secs. 7 and 8, T. 11 N., R. 5 E., and 0.10 mile north of Pleasant Grove Creek. 11/29/48, 25.4; 2/24/49, 25.7; 3/29/49, 24.1; 11/18/49, 28.6; 4/7/50, 26.5; 11/14/50, 29.0; 3/22/51, 26.4; 11/15/51, 30.6; 4/3/52, 27.2.

11N/5E-10L1—Reference point—hole in pump base 1 foot above ground, elevation 74.6 feet. 1.50 miles west of road forming boundary between Secs. 11 and 12, T. 11 N., R. 5 E., and 0.62 mile south of Howsley Road. 11/14/49, 26.3; 3/15/50, 25.0; 4/7/50, 24.5; 11/14/50, 26.4; 3/22/51, 25.4.

11N/5E-11A1—Reference point—hole in pump base, elevation 103 feet. 0.13 mile west of and 0.15 mile south of junction of roads at northeast corner of Sec. 11, T. 11 N., R. 5 E. 12/27/48, 43.2; 3/29/49, 46.0.

11N/5E-14P1—Reference point—outer edge of 2-foot discharge pipe, elevation 80.3 feet. 0.28 mile southeast of angle in road at W. ¼ corner of Sec. 14. 12/27/48, 29.8; 11/18/49, 33.1; 4/4/50, 32.6.

11N/5E-14P2—Reference point—hole in pump base, elevation 83.0 feet. 0.10 mile north of angle in road at S. ¼ corner of Sec. 14, T. 11 N., R. 5 E. 12/27/48, 29.7; 2/24/49, 29.3; 5/12/49, 28.9; 6/27/49, 31.1; 7/29/49, 31.7; 8/26/49, 32.2; 10/6/49, 32.0; 11/18/49, 31.6; 2/15/50, 30.9; 3/15/50, 30.9; 4/5/50, 30.7; 5/8/50, 30.8; 7/7/50, 49.0; 10/3/50, 32.6; 11/15/50, 33.0; 12/15/50, 32.4; 1/5/51, 33.1; 2/6/51, 31.4; 3/7/51, 31.5; 3/21/51, 31.4; 5/9/51, 32.0; 6/5/51, 32.5; 7/10/51, 34.3; 8/23/51, 35.2; 9/25/51, 35.3; 11/19/51, 34.3; 2/28/52, 33.0; 4/1/52, 32.7; 11/7/52, 34.0.

11N/5E-15G1—Reference point—top of casing, 0.7 foot above concrete, elevation 75.4 feet. 0.60 mile east of junction of roads at W. ¼ corner of Sec. 15, T. 11 N., R. 5 E., and on south bank of Pleasant Grove Creek. 11/29/48, 24.7; 3/29/49, 23.7; 11/18/49, 27.4; 4/11/50, 26.1.

11N/5E-16A1—Reference point—pipe in base, elevation 77.7 feet. 0.38 mile north of junction of roads at E. ¼ corner of Sec. 16, T. 11 N., R. 5 E., on west side of road. 11/29/48, 31.0; 3/29/49, 29.9; 11/18/49, 33.4; 2/15/50, 32.2; 3/15/50, 32.1; 4/11/50, 31.8; 5/9/50, 37.0; 6/7/50, 33.7; 7/7/50, 34.1; 8/7/50, 35.0; 9/6/50, 36.5; 10/3/50, 35.0; 11/14/50, 34.4; 12/15/50, 33.7; 1/4/51, 33.2; 2/7/51, 32.9; 3/21/51, 32.6; 5/9/51, 33.3; 6/5/51, 35.6; 7/10/51, 38.7; 8/23/51, 42.9; 9/25/51, 40.2; 11/21/51, 37.0; 4/1/52, 34.7; 11/7/52, 40.3.

11N/5E-16D1—Reference point—top of concrete base, elevation 72.0 feet. 4.33 mile northeast of junction of roads at W. ¼ corner of Sec. 16, T. 11 N., R. 5 E., on south side of private road. 5/23/49, 28.1; 11/18/49, 30.5; 4/11/50, 28.8; 11/14/50, 31.4; 3/21/51, 29.5; 11/15/51, 34.3; 4/1/52, 31.3; 11/7/52, 38.0.

11N/5E-17J1—Reference point—pipe in base, elevation 68.1 feet. 0.27 mile north of and 0.03 mile west of junction of roads at E. ¼ corner of Sec. 17, T. 11 N., R. 5 E. 11/29/48, 26.1; 3/29/49, 24.8; 11/18/49, 29.0; 4/4/50, 27.5; 11/14/50, 26.8; 3/21/51, 27.8; 11/15/51, 32.3; 4/1/52, 30.0; 11/7/52, 36.1.

11N/5E-18H1—Reference point—top of casing, elevation 62.8 feet. 50 feet west of and 200 feet north of junction of roads at E. ¼ corner of Sec. 18, T. 11 N., R. 5 E. 11/26/48, 24.0; 2/25/49, 22.7; 3/29/49, 22.0; 11/18/49, 28.0; 4/11/50, 26.0; 11/14/50, 29.5; 3/22/51, 26.9; 4/1/52, 29.5; 11/6/52, 35.2.

11N/5E-18N1—Reference point—top of casing, elevation 50 feet. North side of Keys Road, 0.85 mile east of Pleasant Grove Road. 12/24/47, 27.3; 3/3/48, 26.5; 12/18/48, 30.1; 11/30/49, 31.8; 11/14/50, 33.1; 3/22/51, 31.2.

11N/5E-19A1—Reference point—hole in top of pump base, elevation 61.6 feet. 0.13 mile south of junction of roads at northeast corner of Sec. 19, T. 11 N., R. 5 E., on west side of road. 6/27/49, 33.1; 7/29/49, 35.5; 11/18/49, 28.4; 2/14/50, 26.4; 3/14/50, 26.0; 4/11/50, 25.8; 11/14/50, 29.2; 3/22/51, 27.3; 7/6/51, 40.3; 11/16/51, 33.0; 2/25/52, 30.0; 4/1/52, 29.5; 11/6/52, 35.8.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources

(Depths to water in feet measured from reference point)

11N/5E-19H1—Reference point—top of casing, elevation 62.2 feet. 0.32 mile south of junction of roads at northeast corner of Sec. 19, T. 11 N., R. 5 E. 11/21/48, 23.5; 3/29/49, 23.0; 7/29/49, 73.0*; 11/18/49, 30.1; 2/14/50, 28.0; 3/14/50, 27.6; 4/11/50, 27.4; 5/8/50, 29.5; 6/7/50, 32.2; 7/7/50, 33.4; 8/1/50, 34.5; 9/5/50, 33.9; 10/4/50, 31.8; 11/14/50, 30.7; 12/13/50, 30.0; 1/4/51, 30.6; 2/6/51, 29.1; 3/6/51, 28.8; 3/22/51, 28.6.

11N/5E-19J1—Reference point—pipe in base, elevation 51.0 feet. 0.70 mile south of and 0.25 mile west of junction of roads at northeast corner of Sec. 19, T. 11 N., R. 5 E., on east bank of north branch Curry Creek. 11/26/48, 15.8; 3/29/49, 14.1; 6/30/49, 27.5; 11/17/49, 19.2; 3/14/50, 17.4; 4/11/50, 17.0; 6/27/50, 27.9; 11/14/50, 20.7; 3/22/51, 17.9; 11/16/51, 22.7; 4/1/52, 19.6; 11/6/52, 26.6.

11N/5E-19P1—Reference point—hole in pump base, elevation 54.8 feet. 0.47 mile east of and 0.13 mile north of junction of roads at southwest corner of Sec. 19, T. 11 N., R. 5 E. 11/17/49, 25.0; 3/14/50, 22.7; 4/11/50, 22.2; 10/4/50, 29.0; 11/14/50, 27.9; 3/22/51, 25.9; 4/1/52, 25.5.

11N/5E-21R1—Reference point—top of casing, elevation 70 feet 1.25 miles south of and 0.92 mile east of junction of roads at W. ¼ corner of Sec. 16, T. 11 N., R. 5 E. 3/31/49, 23.0; 11/17/49, 26.2; 4/11/50, 25.8; 11/14/50, 29.1; 3/22/51, 27.3.

11N/5E-24F1—Reference point—top of wooden floor covering pit, elevation 105.6 feet. 0.45 mile east of and 0.53 mile north of junction of roads at southwest corner of Sec. 24, T. 11 N., R. 5 E., south of private road. 12/28/48, 45.6; 11/18/49, 50.0.

11N/5E-28C1—Reference point—top of casing, elevation 70 feet. 0.45 mile north of and 0.45 mile east of junction of roads at W. ¼ corner of Sec. 28, T. 11 N., R. 5 E. 11/20/51, 33.7; 4/1/52, 31.8; 11/6/52, 36.5.

11N/5E-28H1—Reference point—top of 3″ x 3″ on north side, elevation 74 feet. 0.13 mile north of and 0.95 mile east of junction of roads at W. ¼ corner of Sec. 28, T. 11 N., R. 5 E. 11/30/48, 24.3; 4/1/49, 27.4; 11/17/49, 30.5; 4/11/50, 29.6; 11/15/50, 31.4; 3/22/51, 30.2; 11/29/51, 34.5; 4/1/52, 33.0; 11/6/52, 36.3.

11N/5E-28P1—Reference point—top of casing, elevation 72 feet. 0.50 mile south of and 0.50 mile east of junction of roads at W. ¼ corner of Sec. 28, T. 11 N., R. 5 E. 5/16/50, 58.0*; 5/2/50, 34.7; 10/2/50, 36.0; 11/13/50, 34.4; 3/22/51, 33.1; 5/9/51, 34.4; 11/20/51, 37.0; 4/1/52, 35.2; 11/6/52, 39.8.

11N/5E-29A1—Reference point—hole in pump base, elevation 67 feet. 0.5 mile north of junction of roads at E. ¼ corner of Sec. 29, T. 11 N., R. 5 E., on west side of road. 11/13/50, 31.9; 11/20/51, 34.5; 4/1/52, 32.3; 11/6/52, 37.2.

11N/5E-29G1—Reference point—top of casing, elevation 51 feet. 0.17 mile north of junction of private road with east-west road at S. ¼ corner of Sec. 29, T. 11 N., R. 5 E. Pump #1 by swimming pool. 11/26/48, 24.7; 4/4/50, 27.1.

11N/5E-29H1—Reference point—end of 3.5-foot flow pipe, 4.0-foot correction, elevation 62 feet. Northwest of junction of roads at E. ¼ corner of Sec. 29, T. 11 N., R. 5 E. 11/13/50, 32.7; 3/22/51, 35.2; 4/1/52, 33.2.

11N/5E-29K1—Reference point—top of casing, elevation 66.2 feet. 0.32 mile west of and 0.05 mile south of junction of roads at E. ¼ corner of Sec. 20, T. 11 N., R. 5 E. 11/24/48, 22.9; 3/30/49, 24.0; 11/17/49, 27.3; 2/14/50, 26.2; 4/4/50, 26.2; 10/2/50, 30.8; 11/13/50, 29.5; 12/13/50, 28.6; 1/4/51, 28.6; 2/6/51, 28.5; 3/22/51, 28.1; 11/20/51, 31.9; 4/1/52, 29.9.

11N/5E-29K2—Reference point—top of casing, elevation 65.4 feet. 0.28 mile west of junction of roads at E. ¼ corner of Sec. 29, T. 11 N., R. 5 E., on south side of road. 11/24/48, 24.4; 3/28/19, 22.5; 11/17/49, 26.1; 2/14/50, 25.1; 3/15/50, 25.0; 4/4/50, 27.8; 6/2/50, 39.3; 8/1/50, 58.8*; 10/2/50, 29.5; 11/13/50, 27.8; 12/13/50, 28.7; 1/4/51, 27.3; 2/6/51, 26.7; 3/22/51, 26.3; 11/20/51, 30.3; 4/1/52, 28.2.

11N/5E-30A1—Reference point—pipe in concrete base, elevation 60.5 feet. 0.05 mile south of junction of section roads at northeast corner of Sec. 30, T. 11 N., R. 5 E., adjacent to road on west side. 11/24/49, 24.7; 3/28/49, 23.5; 5/12/49, 24.2; 8/26/49, 35.2; 11/17/49, 28.6; 2/14/50, 27.1; 3/14/50, 26.8; 4/4/50, 26.5; 6/7/50, 31.1; 7/7/50, 32.5; 8/1/50, 33.8; 9/5/50, 34.0; 11/14/50, 30.4; 1/4/51, 32.0; 2/6/51, 28.4; 3/6/51, 28.7; 3/2/51, 27.8; 5/9/51, 29.7; 6/5/51, 31.8; 7/10/51, 33.1; 8/23/51, 35.7; 9/25/51, 38.6; 11/16/51, 31.8; 4/1/52, 29.8; 11/6/32, 34.2.

11N/5E-30L1—Reference point—top of casing below surface of ground, elevation 42.9 feet. 0.4 mile east of and 0.08 mile south of junction of section roads at northwest corner of Sec. 30, T. 11 N., R. 5 E. 11/24/48, 23.5; 3/28/49, 22.5; 11/23/49, 25.2; 4/4/50, 24.9; 11/14/50, 25.7; 3/22/51, 27.9; 11/16/51, 31.1; 4/2/52, 28.3.

11N/5E-30M2—Reference point—top of casing, elevation 49.0 feet. 1.05 miles east of Pleasant Grove Road, 0.51 mile south of Sankey Road. 11/24/48, 22.7; 3/28/49, 20.5; 11/23/49, 25.8; 4/4/50, 25.3; 11/14/50, 28.2; 3/22/51, 25.6; 11/21/51, 29.5.

11N/5E-31A1—Reference point—top of concrete base, elevation 55.7 feet. 0.98 mile north of Base Line Road on west side of Brewer Road. 11/24/48, 19.6; 3/28/49, 18.9; 5/12/49, 20.4; 6/27/49, 36.9; 6/30/49, 24.8; 8/31/49, 25.8; 10/4/49, 24.6; 11/23/49, 22.7; 2/14/50, 22.1; 3/15/50, 22.0; 4/4/50, 23.1; 5/8/50, 22.7; 6/3/50, 63.0 (operating); 10/2/50, 25.9; 12/13/50, 24.7; 1/4/51, 24.1; 2/6/51, 24.3; 3/6/51, 23.8; 3/22/51, 23.9; 5/9/51, 24.0; 6/5/51, 26.7; 7/10/51, 27.8; 8/23/51, 29.0; 9/25/51, 29.2; 11/10/51, 26.8; 4/1/52, 25.5; 11/6/52, 29.7.

11N/5E-31D1—Reference point—top of abandoned well casing, 6 feet from present well, elevation 51 feet. 0.93 mile west of Brewer Road, 0.25 mile north of Base Line Road. 11/24/48, 24.5; 3/28/49, 22.0; 11/23/49, 28.5; 4/4/50, 26.9; 11/15/50, 30.4; 3/22/51, 28.1; 11/21/51, 31.3.

11N/5E-31E1—Reference point—top of casing, elevation 52.2 feet. 0.50 mile north of Base Line Road on east side of Placer-Sutter county line road. 5/9/49, 29.5; 11/23/49, 32.5; 2/14/50, 31.0; 3/15/50, 31.0; 4/4/50, 30.0; 5/8/50, 30.3; 6/7/50, 33.0; 7/7/50, 34.2; 8/1/50, 34.5; 9/5/50, 35.5; 10/4/50, 35.0; 11/14/50, 34.4; 12/13/50, 33.6; 1/4/51, 33.4; 2/6/51, 32.7; 3/6/51, 32.1; 3/22/51, 31.7; 5/9/51, 31.4; 6/5/51, 38.6; 11/23/51, 34.0; 2/27/52, 33.1; 4/2/52, 32.7; 11/6/52, 36.8.

11N/5E-31N1—Reference point—top of casing, elevation 55 feet. 0.82 mile east of Brewer Road, on north side of Base Line Road. 5/12/49, 30.9; 6/27/49, 32.3; 7/29/49, 33.5.

11N/5E-32N1—Reference point—top of 5-inch casing, elevation 65.0 feet. 200 feet northeast of junction of Brewer Road and Base Line Road. 2/24/49, 19.6; 3/28/49, 28.9; 11/23/49, 31.0; 4/4/50, 32.8.

11N/5E-32N2—Reference point—top of casing, elevation 63.8 feet. 0.17 mile northeast of junction of Brewer Road and Base Line Road. 6/1/49, 28.1; 11/23/49, 28.5; 3/15/50, 28.7; 4/4/50, 28.4; 11/14/50, 31.1; 3/21/50, 30.1; 11/19/51, 32.5.

11N/5E-32P1—Reference point—top of casing, elevation 65.5 feet. 0.30 mile east of Brewer Road on north side of Base Line Road. 11/23/48, 27.5; 3/28/49, 27.6; 4/4/50, 29.6; 11/14/50, 31.8; 3/21/51, 31.7.

11N/5E-33P1—Reference point—plugged hole in pump base, elevation 75 feet. 1.41 miles east of Brewer Road, 0.25 mile north of Base Line Road. 4/24/50, 33.0; 11/19/51, 38.5.

11N/5E-34R1—Reference point—top of 6-inch casing at natural ground level, elevation 92.0 feet. 2.17 miles west of Lincoln Road, 0.13 mile north of Base Line Road. 11/20/34, 41.0; 11/16/36, 40.8; 11/3/37, 40.5; 1/10/39, 39.7; 1/4/41, 42.2; 11/11/47, 41.5; 11/24/48, 44.8; 3/25/49, 42.5; 11/23/49, 44.9.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

1N/5E-34R2—Reference point—top of 2″ x 6″ sill under pump, elevation 87 feet. 1.21 miles west of Lincoln Road, 0.13 mile north of Base Line Road. 11/9/29, 38.3; 9/18/30, 38.5; 12/10/31, 39.0; 12/5/32, 39.0; 12/21/33, 39.8; 11/20/34, 39.8; 1/4/41, 35.4.

1N/5E-36D1—Reference point—top edge of flange around pump, elevation 105 feet. 0.95 mile west of Lincoln Road, 0.90 mile north of Base Line Road. 12/16/48, 56.6; 3/28/49, 55.6; 11/23/49, 57.3; 4/4/50, 57.1; 11/15/50, 59.5; 3/21/51, 58.6; 4/10/52, 60.0.

1N/6E-5J1—Reference point—top of casing, elevation 141 feet. 1.30 miles east of and 0.28 mile north of junction of roads at S. ¼ corner of Sec. 6, T. 11 N., R. 6 E. 6/29/49, 76.1; 11/16/49, 75.7; 4/7/50, 74.6; 7/7/50, 77.1; 11/15/50, 77.4; 3/22/51, 76.0; 6/5/51, 77.1; 7/10/51, 77.0; 8/23/51, 78.6; 9/27/51, 78.6; 11/14/51, 78.2; 4/3/52, 77.1.

1N/6E-6L1—Reference point—ground surface, bottom of broken 2″ x 12″ across pit, elevation 115.7 feet. 0.30 mile north of Howsley Road on west side of Lincoln Road. 12/21/48, 50.7; 3/30/49, 49.2; 7/28/49, 52.5; 8/25/49, 52.5; 10/6/49, 52.8; 11/14/49, 51.8; 2/14/50, 51.0; 3/15/50, 51.3; 4/17/50, 51.1; 5/9/50, 51.2; 6/7/50, 52.2; 7/7/50, 52.8; 8/3/50, 53.0; 9/5/50, 54.6; 10/3/50, 54.9; 11/15/50, 53.0; 1/5/51, 52.7; 2/8/51, 51.5; 3/7/51, 51.8; 3/21/51, 52.0.

1N/6E-7F1—Reference point—top of casing, elevation 108.5 feet. 0.50 mile south of Howsley Road on west side of Lincoln Road. 12/27/48, 44.8; 2/24/49, 44.5; 3/29/49, 43.8; 11/18/49, 46.8; 4/5/50, 45.3; 11/15/50, 47.2; 3/21/51, 46.6.

1N/6E-15C1—Reference point—top of casing on north side, elevation 117.0 feet. 0.75 mile east of U. S. Highway 99 on south bank of Pleasant Grove Creek. 12/20/48, 44.2; 7/29/49, 44.6; 8/25/49, 44.7; 9/29/49, 44.8; 11/25/49, 44.7; 2/16/50, 45.0; 3/15/50, 44.9; 4/5/50, 44.9; 5/10/50, 45.0; 6/7/50, 45.1; 7/7/50, 45.8; 8/1/50, 45.2; 9/6/50, 45.5; 10/3/50, 45.3; 11/17/50, 45.0; 12/15/50, 45.4; 1/5/51, 45.6; 2/7/51, 45.6; 3/8/51, 45.6; 3/21/51, 44.4; 5/9/51, 45.7; 6/6/51, 45.7; 7/10/51, 45.7; 8/23/51, 45.8; 9/27/51, 46.0; 11/14/51, 46.0; 2/29/52, 45.6; 4/9/52, 46.2; 11/10/52, 47.0.

1N/6E-15C2—Reference point—top of pit, elevation 116.0 feet. 0.75 mile east of U. S. Highway 99, near south bank of Pleasant Grove Creek, 100 feet east of well number 11N/6E-15C1. 3/23/49, 7.3; 7/29/49, 15.9; 8/25/49, 16.1; 9/29/49, 16.4; 3/15/50, 9.2; 11/17/50, 18.2.

1N/6E-17J1—Reference point—hole in pump base, elevation 95.0 feet. 0.63 mile north of and 0.11 mile west of angle in section road at southeast corner of Sec. 17, T. 11 N., R. 6 E. 12/20/48, 32.4; 12/28/48, 32.4; 3/31/49, 32.0; 12/9/49, 33.7; 4/5/50, 33.1; 10/3/50, 35.5; 11/13/50, 35.2; 12/14/50, 34.9; 1/5/51, 34.9; 2/7/51, 34.3; 3/7/51, 34.2; 3/21/51, 34.0; 4/4/52, 35.0; 11/12/52, 37.1.

1N/6E-18G1—Reference point—ground surface, elevation 120 feet. 1.38 miles south of Howsley Road, 0.13 mile east of Lincoln Road. 12/27/48, 57.8; 3/29/49, 57.1; 4/5/50, 58.9.

1N/6E-18P1—Reference point—base of pump at top of casing, elevation 91 feet. 100 feet west of dwelling on west side of road, 1,700 feet east of southwest corner Sec. 18, T. 11 N., R. 6 E. 11/9/29, 30.0; 9/18/30, 29.3; 11/11/47, 31.6; 12/22/48, 33.0; 12/9/49, 34.1; 10/17/52, 29.0.

1N/6E-18P2—Reference point—top of wood cover, elevation 91 feet. North side of dwelling on west side of road, 1,800 feet east of southwest corner Sec. 18, T. 11 N., R. 6 E. 12/11/31, 31.9; 11/26/32, 32.3; 12/21/33, 32.4; 11/20/34, 33.3; 11/16/36, 31.3; 11/1/37, 30.2; 1/27/39, 30.3; 1/2/41, 29.5.

1N/6E-19M1—Reference point—top of casing, elevation 194.8 feet. 0.30 mile north of and 0.23 mile east of junction of Phillips Road and Lincoln Road at southwest corner of Sec. 19, T. 11 N., R. 6 E. 12/27/48, 45.5; 3/29/49, 44.7; 11/18/49, 45.5; 3/15/50, 45.8; 4/5/50, 46.1; 11/15/50, 46.5; 3/21/51, 45.1.

11N/6E-28R1—Reference point—top of casing, elevation 140.0 feet. 0.25 mile northwest of crossing of U. S. Highway 99 over Southern Pacific Railroad, 1.16 miles north of Base Line Road. 12/20/48, 80.1; 3/24/49, 78.4; 12/9/49, 81.7; 4/4/50, 79.4; 11/16/50, 82.5; 3/20/51, 80.9; 11/28/51, 84.7; 4/9/52, 81.8; 11/10/52, 85.3.

11N/6E-29B1—Reference point—top of casing, elevation 127.0 feet. 1.60 miles east of junction of Phillips Road and Lincoln Road at northwest corner of Sec. 30, T. 11 N., R. 6 E. 12/20/48, 60.4; 4/5/50, 62.0; 11/28/50, 65.1; 3/20/51, 63.2; 11/29/51, 66.0; 4/9/52, 64.2; 11/10/52, 67.2.

11N/6E-30M1—Reference point—top of casing, elevation 117.0 feet. 0.60 mile south of and 0.15 mile east of junction of Lincoln Road and Phillips Road, on north side of private road. 2/24/49, 64.8; 3/28/49, 61.9; 5/12/49, 62.1; 6/27/49, 62.9; 4/4/50, 63.1; 11/15/50, 65.6; 3/21/51, 64.5.

11N/6E-36L1—Reference point—top plank of pit cover, elevation 177 feet. Approximately 1 mile east of Roseville, south of U. S. Highway 40 and Southern Pacific Railroad, near spur line of Southern Pacific. 2/27/51, 17.0; 3/30/51, 18.2.

12N/4E-1B1—Reference point—top of casing, elevation 51 feet. 0.51 mile east of Pleasant Grove Road, on south side of Cornelius Avenue. 3/11/48, 20.0; 12/15/48, 21.4; 3/28/49, 20.3; 12/7/49, 26.2.

12N/4E-2B1—Reference point—hole in pump base, elevation 53 feet. 0.05 mile south of Cornelius Avenue, 0.50 mile west of Pleasant Grove Road. 12/22/47, 19.8; 3/11/48, 21.8; 12/13/48, 27.2; 3/29/49, 20.8; 12/7/49, 26.2; 5/27/50, 22.1; 11/6/50, 30.9.

12N/4E-2Q1—Reference point—hole in pump base, elevation 51 feet. 0.46 mile north of Trowbridge Road, 0.34 mile west of Pleasant Grove Road. 3/11/48, 15.7; 5/5/48, 13.3; 5/31/48, 14.7; 6/17/48, 35.2; 6/23/48, 38.0; 7/2/48, 20.3; 12/15/48, 17.9; 3/28/49, 11.6; 5/26/49, 19.5; 6/29/49, 20.9; 7/28/49, 21.7; 8/26/49, 21.2; 12/7/49, 19.0; 3/27/50, 15.4; 11/6/50, 23.9; 11/16/51, 26.3; 4/10/52, 13.8; 11/12/52, 24.3.

12N/4E-12A1—Reference point—top of casing, elevation 56 feet. South side of Lee Road, 0.50 mile west of Power Line Road. 12/20/48, 16.5; 4/1/49, 13.4; 11/10/49, 21.8; 3/15/50, 18.0; 4/10/50, 17.8; 10/2/50, 29.5; 11/13/50, 23.8; 3/21/51, 17.8; 5/9/51, 26.6; 11/14/51, 27.9; 3/13/52, 21.1.

12N/4E-12D1—Reference point—top of casing, elevation 52 feet. West side of Pleasant Grove Road, 0.24 mile north of Trowbridge Road. 3/11/48, 12.5; 12/14/48, 14.0; 3/28/49, 6.9; 12/7/49, 15.8.

12N/4E-13C1—Reference point—hole in pump base, elevation 51 feet. South of Marcum Road, 0.53 mile east of Pleasant Grove Road. 12/22/48, 12.6; 11/10/49, 18.0; 3/15/50, 13.9; 4/10/50, 13.4; 11/14/50, 19.9; 3/23/51, 12.3; 11/19/51, 23.5; 4/10/52, 14.6; 11/12/52, 31.5.

12N/4E-13D1—Reference point—top of casing, elevation 50 feet. 300 feet southeast of intersection of Pleasant Grove Road and Marcum Road. 3/11/48, 12.3; 12/14/48, 12.2; 3/29/49, 6.6.

12N/4E-24F1—Reference point—top of casing, elevation 51 feet. 0.50 mile east of Pleasant Grove Road, 0.75 mile north of Striplin Road. 5/31/48, 11.3; 12/18/48, 13.1; 3/29/49, 8.7; 12/2/49, 16.2; 4/10/50, 13.2; 11/13/50, 18.2; 3/21/51, 11.7; 11/16/51, 21.4; 11/7/52, 27.8.

12N/4E-24M1—Reference point—top of casing, elevation 50.9 feet. 75 feet east of Pleasant Grove Road, 0.25 mile north of Striplin Road. 12/22/47, 12.9; 3/22/48, 13.1; 12/18/48, 14.2; 3/29/49, 9.2; 12/2/49, 17.2; 3/15/50, 14.4; 3/27/50, 14.6; 11/6/50, 18.8; 11/16/51, 20.9; 4/10/52, 12.2; 11/12/52, 24.6.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

12N/4E-25M1—Reference point—hole in pump base, elevation 51.3 feet. 250 feet east of Pleasant Grove Road, 0.70 mile south of Striplin Road. 12/22/47, 15.7; 3/22/48, 15.1; 12/18/48, 17.4; 3/29/49, 13.3; 12/2/49, 20.6; 3/27/50, 17.5; 11/8/50, 22.8.

12N/4E-36Q1—Reference point—top of casing in bottom of pit, elevation 48 feet at ground surface. 0.47 mile south of Catlett Road, 0.63 mile east of Pleasant Grove Road. 4/11/51, 22.0; 11/16/51, 28.9.

12N/5E-1A1—Reference point—top of wooden platform over pit, elevation 112 feet. 0.13 mile south of and 0.12 mile west of junction of roads at northeast corner of Sec. 1, T. 12 N., R. 5 E. 12/23/48, 20.7; 3/18/49, 18.0; 11/15/49, 21.2; 4/5/50, 19.1; 11/15/50, 21.1; 3/21/51, 16.9; 11/20/51, 22.6.

12N/5E-1E1—Reference point—top of 4′ x 6′ concrete pit, elevation 101 feet. 0.45 mile south of and 0.05 mile east of junction of section roads at northwest corner of Sec. 1, T. 12 N., R. 5 E. 12/28/48, 21.3; 11/15/49, 21.8.

12N/5E-2B1—Reference point—top of concrete pit, elevation 99.2 feet. 2,665 feet west of and 450 feet south of northeast corner of Sec. 2, T. 12 N., R. 5 E. 12/21/33, 23.6; 11/20/34, 23.3; 11/23/36, 19.9; 11/1/37, 20.0; 1/27/39, 19.2; 1/2/41, 18.7; 11/7/47, 21.2; 12/22/48, 23.3; 3/18/49, 22.2; 5/13/49, 21.9; 7/28/49, 23.8; 8/25/49, 24.3; 9/29/49, 24.3; 11/10/49, 24.3; 2/15/50, 23.5; 3/15/50, 23.0; 4/6/50, 22.7; 5/8/50, 64.7*; 6/9/50, 63.0*; 11/14/50, 26.9; 12/15/50, 25.5; 1/5/51, 24.9; 2/8/51, 24.6; 3/7/51, 23.2; 3/23/51, 23.0; 5/9/51, 24.0; 6/5/51, 26.1; 9/27/51, 68.9*; 11/15/51, 28.9; 2/28/52, 24.0; 4/4/52, 24.0.

12N/5E-3A1—Reference point—top of casing, elevation 95 feet. 1.05 miles west of and 0.10 mile south of junction of roads at northeast corner of Sec. 2, T. 12 N., R. 5 E. 5/9/50, 24.9; 11/14/50, 33.2; 3/27/51, 29.6; 11/15/51, 35.7.

12N/5E-3A2—Reference point—hole in pump base, elevation 95.9 feet. 1.02 miles west of and 0.20 mile south of junction of roads at northeast corner of Sec. 2, T. 12 N., R. 5 E. 11/14/50, 33.4; 3/27/51, 30.3; 11/15/51, 35.6.

12N/5E-4A1—Reference point—top of wooden base, elevation 91.4 feet. 1.75 miles east of Brewer Road, 0.20 mile south of Cornelius Road. 12/28/48, 35.5; 3/18/49, 34.3; 11/10/49, 40.5.

12N/5E-4J1—Reference point—top of casing, elevation 85.5 feet. 1.95 miles east of Brewer Road, 0.65 mile south of Cornelius Road. 11/13/50, 38.6; 3/27/51, 34.9; 7/11/51, 46.6; 8/22/51, 48.4; 9/27/51, 45.8; 11/15/51, 41.6; 4/7/52, 37.0; 11/7/52, 49.6.

12N/5E-5R1—Reference point—hole in pump base, elevation 72.5 feet. 1.05 miles north of Marcum Road, 1.00 mile east of Brewer Road. 6/28/49, 33.0; 3/15/50, 28.0; 4/21/50, 70.4*; 5/1/50, 33.8; 10/2/50, 36.9; 11/13/50, 34.4; 3/23/51, 30.0; 11/15/51, 38.0; 3/31/52, 32.7; 11/12/52, 42.3.

12N/5E-6A1—Reference point—hole in top of pump base, elevation 69.8 feet. 1.80 miles north of Marcum Road on west side of Brewer Road. 12/17/48, 24.0; 4/1/49, 20.2; 11/10/49, 27.0; 2/15/50, 25.8; 3/15/50, 24.9; 4/6/50, 24.0; 5/8/50, 24.6; 6/7/50, 27.4; 9/5/50, 34.0; 10/3/50, 33.0; 11/13/50, 31.1; 12/13/50, 28.8; 1/4/51, 27.9; 2/6/51, 26.7; 3/23/51, 24.5; 5/9/51, 25.6; 6/5/51, 27.9; 7/11/51, 31.0; 8/27/51, 33.9; 9/26/51, 35.2; 11/15/51, 32.8; 2/28/52, 31.1; 4/7/52, 25.4; 11/5/52, 39.8.

12N/5E-6J1—Reference point—top of casing 1.5 feet above ground, elevation 67.3 feet. 1.33 miles north of Marcum Road, on west side of Brewer Road and on south bank of creek. 12/17/48, 9.7; 4/1/49, 7.0; 5/12/49, 10.3; 6/27/49, 12.0; 7/29/49, 12.5; 8/25/49, 12.6; 9/29/49, 10.6.

12N/5E-6J2—Reference point—top of casing, elevation 65.2 feet. 1.33 miles north of Marcum Road, 0.10 mile west of Brewer Road on south bank of creek. 12/17/48, 17.9; 4/1/49, 15.2; 9/29/49, 29.4; 11/10/49, 24.2; 4/6/50, 18.8; 5/8/50, 23.1; 7/7/50, 33.5; 8/7/50, 35.5; 9/5/50, 36.8; 11/15/50, 25.9; 3/25/51, 18.0; 11/15/51, 27.9; 4/7/52, 20.2.

12N/5E-6R1—Reference point—top of casing, 0.6 foot above ground level, elevation 69.0 feet. 1.10 miles north of Marcum Road on west side of Brewer Road. 12/17/48, 21.7; 4/1/49, 18.7; 11/10/49, 26.8; 2/15/50, 23.0; 3/15/50, 22.4; 4/6/50, 21.8; 10/2/50, 32.5; 11/13/50, 29.0; 12/13/50, 26.6; 1/4/51, 25.7; 2/7/51, 24.7; 3/23/51, 22.7; 5/9/51, 29.4; 7/11/51, 41.1; 11/15/51, 31.5; 2/28/52, 26.2; 4/7/52, 24.7; 11/10/52, 35.9.

12N/5E-9P1—Reference point—hole in pump base, elevation 79 feet. 0.17 mile north of Marcum Road, 1.48 miles east of Brewer Road. 6/27/50, 47.2; 10/2/50, 35.9; 11/14/50, 34.2; 12/13/50, 33.0; 1/4/51, 32.3; 2/6/51, 31.8; 3/21/51, 30.7; 5/9/51, 37.3; 11/14/51, 39.3; 4/17/52, 34.5.

12N/5E-12C1—Reference point—pipe in base, elevation 108 feet. 0.98 mile north of and 0.48 mile east of junction of roads at southwest corner of Sec. 12, T. 12 N., R. 5 E. 11/14/50, 26.3; 3/21/51, 23.5; 11/13/51, 27.8; 4/3/52, 25.0.

12N/5E-12E1—Reference point—top of casing, elevation 102.8 feet. 0.50 mile north of junction of roads at southwest corner of Sec. 12, T. 12 N., R. 5 E., on east side of road. 12/28/48, 22.7; 2/25/49, 22.7; 3/18/49, 22.8; 5/13/49, 22.9; 6/28/49, 23.0; 7/28/49, 23.1; 8/25/49, 23.2; 10/6/49, 23.4; 11/10/49, 23.6; 2/15/50, 23.9; 3/15/50, 24.0; 4/6/50, 23.9; 5/9/50, 24.0; 6/9/50, 24.5; 7/7/50, 25.0; 8/1/50, 25.7; 9/6/50, 26.6; 10/3/50, 26.8; 11/14/50, 26.9; 12/14/50, 25.9; 1/5/51, 26.3; 2/8/51, 26.0; 3/7/51, 25.4; 3/22/51, 26.2; 5/9/51, 26.5; 6/5/51, 27.3; 7/12/51, 27.8; 8/23/51, 28.9; 9/27/51, 30.0; 11/13/51, 29.5; 2/27/52, 28.6; 4/3/52, 28.4; 11/6/52, 31.5.

12N/5E-12R1—Reference point—top of tin covering over well, 1 foot above ground, elevation 107 feet. 0.87 mile east of and 0.5 mile north of junction of roads at southwest corner of Sec. 12, T. 12 N., R. 5 E. 12/28/48, 23.7; 3/30/49, 22.0; 11/15/49, 23.3.

12N/5E-13A1—Reference point—top of casing, elevation 109 feet. 0.98 mile west of and 0.05 mile south of junction of roads at northwest corner of Sec. 13, T. 12 N., R. 5 E. 3/15/50, 25.2; 4/23/50, 24.7; 10/11/50, 28.0; 11/15/50, 27.1; 12/14/50, 25.9; 1/5/51, 25.2; 2/8/51, 24.7; 3/7/51, 25.3; 3/21/51, 25.2; 11/13/51, 29.2; 2/28/52, 26.4; 4/4/52, 27.0; 11/6/52, 33.0.

12N/5E-14L1—Reference point—discharge pipe, 0.6 foot above top of casing, elevation 97.0 feet. 0.52 mile south of and 0.52 mile west of junction of roads at northeast corner of Sec. 14, T. 12 N., R. 5 E. 11/15/50, 39.0; 3/22/51, 36.5; 4/10/52, 49.2.

12N/5E-14R1—Reference point—top of casing, elevation 104.1 feet. 0.85 mile south of junction of roads at northeast corner of Sec. 14, T. 12 N., R. 5 E., 50 feet west of road. 12/21/48, 32.6; 3/30/49, 32.5; 11/14/49, 33.6; 3/15/50, 33.5; 4/6/50, 33.4; 11/15/50, 36.7; 3/21/51, 35.3; 11/13/51, 49.0; 2/28/52, 39.0; 4/13/52, 38.5; 11/7/52, 44.1.

12N/5E-16F1—Reference point—top of wooden cover, elevation 76 feet. 0.43 mile south of and 0.45 mile east of junction of roads at northwest corner of Sec. 16, T. 12 N., R. 5 E. 12/22/48, 22.3; 4/4/49, 22.3.

12N/5E-17A1—Reference point—discharge pipe 0.7 foot above top of casing, elevation 74 feet. 0.10 mile south of junction of roads at northeast corner of Sec. 17, T. 12 N., R. 5 E. 11/14/50, 33.4; 3/21/51, 29.1; 11/6/52, 40.1.

12N/5E-17B1—Reference point—top of casing, elevation 72.5 feet. 0.25 mile west of junction of roads at northeast corner of Sec. 17, T. 12 N., R. 5 E., on south side of road. 2/15/50, 24.3; 5/9/50, 24.9; 10/4/50, 38.2; 11/14/50, 33.9; 1/5/51, 30.9; 2/6/51, 30.3; 3/21/51, 28.7; 11/15/51, 38.9; 4/7/52, 33.2; 11/6/52, 37.2.

12N/5E-17C1—Reference point—top of casing, elevation 69 feet. 0.70 mile west of junction of roads at northeast corner of Sec. 17, T. 12 N., R. 5 E. 3/21/51, 24.1; 11/15/51, 34.6; 4/7/52, 28.6; 11/6/52, 34.4.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

12N/5E-19C1—Reference point—hole in pump base, elevation 63.7 feet. 0.51 mile west of junction of roads at northeast corner of Sec. 19, T. 12 N., R. 5 E., on south side of road. 12/20/48, 15.6; 4/4/49, 13.8; 11/10/49, 22.0; 3/15/50, 19.7; 4/10/50, 19.3; 4/21/50, 19.8; 5/1/50, 21.9; 6/2/50, 62.0*; 9/1/50, 28.7; 10/2/50, 30.1; 11/13/50, 26.1; 3/21/51, 20.7; 11/14/51, 31.9; 3/31/52, 24.8; 11/7/52, 38.7.

12N/5E-19D1—Reference point—top of casing, elevation 58 feet. 0.70 mile west of junction of roads at northeast corner of Sec. 19, T. 12 N., R. 5 E., on south side of road. 11/14/51, 30.2; 3/31/52, 23.3.

12N/5E-19J1—Reference point—top of casing, elevation 65.7 feet. 0.43 mile north and 0.05 mile west of junction of roads at southeast corner of Sec. 19, T. 12 N., R. 5 E. 12/17/48, 17.8; 2/25/49, 17.2; 3/30/49, 15.1; 5/12/49, 18.0; 6/27/49, 20.0; 7/29/49, 21.0; 8/25/49, 21.7; 9/29/49, 21.9; 11/10/49, 21.6; 2/15/50, 20.0; 3/15/50, 19.7; 4/6/50, 19.3; 5/8/50, 20.2; 6/9/50, 22.0; 7/7/50, 22.0; 8/1/50, 24.7; 9/5/50, 24.8; 10/4/50, 25.2; 11/13/50, 24.8; 12/13/50, 23.4; 1/4/51, 24.2; 2/6/51, 22.8; 3/21/51, 21.0; 5/9/51, 22.6; 6/5/51, 25.0; 7/11/51, 27.8; 8/23/51, 30.9; 9/26/51, 32.6; 11/21/51, 30.9; 2/28/52, 26.1; 4/3/52, 24.9; 11/6/52, 34.3.

12N/5E-19R1—Reference point—floor in pump house, elevation 63 feet. 500 feet north and west of junction of roads at southeast corner of Sec. 19, T. 12 N., R. 5 E. 11/23/29, 18.0; 9/26/30, 17.3; 12/11/31, 19.1; 11/23/32, 18.5; 12/20/33, 19.6; 10/27/34, 19.5; 11/23/36, 17.3.

12N/5E-20M1—Reference point—top of casing 2.2 feet above ground, elevation 68.3 feet. 0.73 mile south and 0.10 mile east of junction of roads at northwest corner of Sec. 20, T. 12 N., R. 5 E. 11/2/37, 17.5; 2/1/39, 16.6; 1/2/41, 16.1; 11/11/47, 18.3; 12/17/48, 19.8; 11/10/49, 23.3; 4/6/50, 21.0; 11/13/50, 26.3; 3/21/51, 22.5; 11/21/51, 31.8; 10/17/52, 36.1.

12N/5E-21N1—Reference point—top of casing, elevation 70.5 feet. 1.05 miles east of junction of roads at southwest corner of Sec. 20, T. 12 N., R. 5 E. 12/20/48, 20.6; 2/25/49, 19.9; 3/30/49, 19.3; 11/14/49, 22.5; 4/6/50, 21.6; 11/15/50, 25.7; 3/21/51, 23.3; 11/14/51, 31.4; 4/8/52, 27.5.

12N/5E-23H1—Reference point—top of casing, elevation 103.5 feet. 0.70 mile north of junction of roads at southeast corner of Sec. 23, T. 12 N., R. 5 E., on west side of road. 12/21/48, 32.8; 3/30/49, 34.1; 5/13/49, 33.6; 6/28/49, 34.5; 7/28/49, 34.8; 8/25/49, 34.8; 10/6/49, 34.1; 11/14/49, 33.9; 2/14/50, 33.5; 3/15/50, 33.5; 4/6/50, 33.4; 5/9/50, 33.5; 6/9/50, 37.0; 7/7/50, 37.6; 8/3/50, 38.4; 9/6/50, 39.2; 10/3/50, 36.6; 11/15/50, 36.2; 12/15/50, 35.6; 1/5/51, 35.4; 2/8/51, 35.1; 3/8/51, 34.9; 3/21/51, 34.8; 11/13/51, 56.5; 4/3/52, 36.7; 10/17/52, 42.1; 11/7/52, 42.2.

12N/5E-23J1—Reference point—top of casing, elevation 102.5 feet. 0.10 mile southwest of junction of roads at E. ¼ corner of Sec. 23, T. 12 N., R. 5 E. 11/14/49, 34.8; 4/6/50, 33.9; 11/15/50, 35.1; 3/21/51, 33.7.

12N/5E-23P1—Reference point—top of casing, elevation 94.8 feet. 388.0 feet west of and 500 feet north of junction of roads at southeast corner of Sec. 23, T. 12 N., R. 5 E., near lone tree. 2/24/49, 32.7; 3/30/49, 31.7; 11/14/49, 33.9; 3/15/50, 33.2; 4/6/50, 33.1; 5/9/50, 33.1; 6/9/50, 37.2; 7/7/50, 38.4; 8/3/50, 38.9; 9/6/50, 39.3; 10/3/50, 36.4; 11/15/50, 36.0; 12/15/50, 35.0; 1/5/51, 34.7; 2/8/51, 34.2; 3/7/51, 34.2; 3/21/51, 34.1; 6/5/51, 41.0.

12N/5E-25E1—Reference point—top of stone crib, elevation 93 feet. 0.30 mile south of and 0.20 mile east of junction of roads at northwest corner of Sec. 25, T. 12 N., R. 5 E., 100 feet north of Auburn Ravine. 12/21/48, 5.5; 2/24/49, 4.7; 3/30/49, 2.5; 11/15/49, 6.0; 4/10/50, 3.7; 11/15/50, 6.1; 3/21/51, 3.3; 11/20/51, 6.0; 4/8/52, 3.2.

12N/5E-30J1—Reference point—hole in base of pump, elevation 64.8 feet. 0.50 mile south of Striplin Road on west side of Brewer Road, on south bank of Auburn Ravine. 11/30/48, 20.1; 3/30/49, 13.7; 11/10/49, 21.3; 3/15/50, 19.2; 4/6/50, 18.9; 11/14/50, 23.6; 3/21/51, 18.9; 5/9/51, 21.2; 6/5/51, 26.9; 11/14/51, 28.6; 4/3/52, 21.6; 11/6/52, 30.8.

12N/5E-34G1—Reference point—top of brick crib, elevation 81.3 feet. 0.45 mile south of and 0.50 mile west of junction of roads at northeast corner of Sec. 34, T. 12 N., R. 5 E., 100 feet northeast of house. 12/20/48, 25.1; 2/25/49, 25.0; 3/30/49, 24.3; 11/14/49, 28.5; 4/10/50, 26.1.

12N/5E-35E1—Reference point—top of casing, elevation 90 feet. 0.25 mile south of and 0.95 mile west of junction of roads at northeast corner of Sec. 35, T. 12 N., R 5 E. 3/21/51, 36.2; 11/14/51, 40.5.

12N/5E-35E2—Reference point—edge of pump base, elevation 94.3 feet. 0.32 mile south of and 0.78 mile west of junction of roads at northeast corner of Sec. 35, T. 12 N., R. 5 E. 11/14/49, 38.1; 2/15/50, 37.1; 3/15/50, 36.8; 4/6/50, 28.7; 5/10/50, 36.9; 7/7/50, 39.1; 8/1/50, 41.2; 9/5/50, 39.1; 10/4/50, 39.2; 11/15/50, 38.9; 3/21/51, 37.4; 5/10/51, 38.2; 6/5/51, 40.8; 7/10/51, 43.0; 8/23/51, 44.2; 11/14/51, 41.9; 4/3/52, 39.9; 11/7/52, 44.7.

12N/5E-35G1—Reference point—top of casing, elevation 105.1 feet. 0.45 mile west of junction of roads at E. ¼ corner, Sec. 35, T. 12 N., R. 5 E., on north side of road. 12/21/48, 43.0; 3/30/49, 42.5; 11/14/49, 45.0; 3/15/50, 44.6; 4/6/50, 44.5; 5/10/50, 44.7; 6/9/50, 45.1; 7/7/50, 46.0; 9/6/50, 46.0; 10/4/50, 45.3; 11/15/50, 45.4; 12/15/50, 45.9; 1/5/51, 45.6; 2/8/51, 45.6; 3/8/51, 44.9; 3/21/51, 44.9; 5/10/51, 44.4; 7/10/51, 46.3; 8/23/51, 48.5; 9/27/51, 48.8; 11/14/51, 47.5; 1/23/52, 47.3; 2/28/52, 46.9; 4/3/52, 47.0; 11/7/52, 49.5.

12N/6E-2A1—Reference point—top of casing, elevation 214 feet. 0.42 mile east of junction of roads at N. ¼ corner of Sec. 2, T. 12 N., R. 6 E. 12/21/48, 12.2; 3/23/49, 8.0; 11/22/49, 10.3; 4/6/50, 8.3; 11/17/50, 9.8; 3/29/51, 8.4; 11/13/51, 7.5; 4/10/52, 10.0.

12N/6E-2R1—Reference point—top of casing, elevation 200 feet. 0.25 mile east of and 0.75 mile south of junction of roads at N. ¼ corner of Sec. 2, T. 12 N., R. 6 E., on south side of road. 12/21/48, 10.8; 3/23/49, 9.7; 11/22/49, 12.3; 4/6/50, 11.2; 11/17/50, 11.7; 3/29/51, 10.9; 11/13/51, 14.3; 4/9/52, 10.9.

12N/6E-5F1—Reference point—hole in pump base, elevation 133 feet. 0.38 mile south of, 2.38 miles east of junction of roads at northwest corner of Sec. 5, T. 12 N., R. 5 E., near U. S. Highway 99E. 12/28/48, 30.9; 3/18/49, 29.6; 11/15/49, 31.0; 4/6/50, 30.2; 11/15/50, 31.9; 3/23/51, 27.2; 11/19/51, 31.3; 4/7/52, 26.3; 11/10/52, 31.2.

12N/6E-6A1—Reference point—hole in base of pump, elevation 123 feet. South of junction of private road and road forming boundary between Townships 12 and 13. 0.30 mile west of U. S. Highway 99. 12/23/48, 27.0; 3/18/49, 24.9; 5/13/49, 26.8; 6/30/49, 27.5; 8/31/49, 35.0; 11/15/49, 28.0.

12N/6E-11D1—Reference point—hole in pump base, elevation 182 feet. 0.25 mile east of, 0.78 mile north of junction of roads at southwest corner of Sec. 11, T. 12 N., R. 5 E. 12/21/48, 12.3; 3/23/49, 3.0; 11/22/49, 15.1; 4/6/50, 5.1; 11/17/50, 9.5; 3/29/51, 4.5; 11/13/51, 15.0; 4/9/52, 3.8.

12N/6E-11L1—Reference point—top of board covering hole in base of pump, elevation 181 feet. 0.25 mile north of and 0.25 mile east of junction of roads at southwest corner of Sec. 11, T. 12 N., R. 6 E. 12/21/48, 13.1; 3/23/49, 11.8; 5/11/49, 11.1; 6/29/49, 11.3; 7/28/49, 11.3; 8/25/49, 11.7; 9/29/49, 12.3; 11/22/49, 12.9; 2/15/50, 12.7; 3/15/50, 12.5; 4/6/50, 12.1; 5/10/50, 11.9; 6/7/50, 12.0; 7/7/50, 11.9; 8/3/50, 12.1; 9/6/50, 12.3; 10/3/50, 12.8; 11/17/50, 13.0; 12/15/50, 12.7; 1/4/51, 12.3; 2/7/51, 11.8; 3/7/51, 11.2; 3/29/51, 10.8; 7/16/51, 11.0; 8/22/51, 11.3; 9/26/51, 12.0; 11/13/51, 12.4; 2/27/52, 10.4; 4/4/52, 9.3; 11/12/52, 11.3.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

12N/6E-11L2—Reference point—top of casing, elevation 187 feet. 0.35 mile north of and 0.25 mile east of junction of roads at southwest corner of Sec. 11, T. 12 N., R. 5 E. 9/29/49, 19.0; 11/22/49, 18.3.

12N/6E-14R1—Reference point—top of wooden pump support, 3.5 feet above ground level, elevation 188 feet. 0.88 mile south of and 0.88 mile east of junction of roads at northwest corner of Sec. 14, T. 12 N., R. 6 E. 12/21/48, 19.4; 2/2/49, 19.5; 3/23/49, 16.2; 11/22/49, 18.3; 4/6/50, 17.1; 11/17/50, 18.2; 3/28/51, 12.9; 11/13/51, 15.4; 4/9/52, 10.2.

12N/6E-16D1—Reference point—top of casing, elevation 136 feet. 1.50 miles west of U. S. Highway 99E on south side of Marcum Road. 12/29/48, 38.7; 2/23/49, 39.2; 11/22/49, 40.9; 11/17/50, 33.6; 3/28/51, 40.3; 11/13/51, 43.0.

12N/6E-16R1—Reference point—top of casing, 1.3 feet above ground, elevation 147.5 feet. 0.90 mile south of Marcum Road and 0.60 mile west of U. S. Highway 99E. 12/29/48, 16.7; 3/23/49, 12.5; 11/22/49, 16.8; 4/6/50, 14.4; 11/17/50, 15.1; 3/28/51, 10.5; 11/15/51, 16.5; 4/9/52, 8.0.

12N/6E-18A1—Reference point—top of board at base of pump, elevation 122 feet. 0.22 mile south of and 0.07 mile west of junction of roads at northeast corner of Sec. 18, T. 12 N., R. 6 E. 12/28/48, 30.4; 3/30/49, 28.2; 5/13/49, 29.3; 6/29/49, 30.4; 7/29/49, 31.0; 8/25/49, 31.4; 11/15/49, 31.0; 2/15/50, 29.7; 3/15/50, 30.4; 4/6/50, 29.3; 6/9/50, 30.5; 7/7/50, 31.5; 8/1/50, 32.3; 9/6/50, 32.8; 10/11/50, 32.5; 11/15/50, 32.3; 12/15/50, 30.0; 1/5/51, 30.1; 2/8/51, 30.0; 3/7/51, 29.5; 3/21/51, 29.0; 5/9/51, 29.8; 7/12/51, 32.6; 8/23/51, 33.7; 9/27/51, 33.8; 11/13/51, 33.1; 2/28/52, 29.9; 4/7/52, 29.6; 11/6/52, 35.6.

12N/6E-19A1—Reference point—ground level, elevation 121 feet. 0.75 mile north of junction of roads at southeast corner of Sec. 19, T. 12 N., R. 6 E., 12 feet west of road. 11/9/29, 17.3; 9/18/30, 17.3; 12/11/31, 17.4; 12/23/32, 17.5; 12/21/33, 16.9; 11/20/34, 17.8; 11/23/36, 17.4; 11/2/37, 18.7; 1/27/39, 18.7; 1/2/41, 12.8; 11/11/47, 16.0; 12/22/48, 16.2; 3/31/49, 12.3.

12N/6E-19H1—Reference point—top of concrete lining, elevation 112 feet. 0.67 mile north of and 0.18 mile west of junction of roads at southeast corner of Sec. 19, T. 12 N., R. 6 E. 11/9/29, 6.0; 9/18/30, 5.8; 12/11/31, 5.4; 11/23/32, 5.9; 12/21/33, 5.1; 11/20/34, 5.6; 11/23/36, 6.6; 11/2/37, 7.2; 1/27/39, 7.0; 1/2/41, 5.0; 11/11/47, 6.5; 12/22/48, 5.5; 3/31/49, 5.1; 11/15/49, 6.0.

12N/6E-20A1—Reference point—top of casing, elevation 133 feet. 1.15 miles south of junction of roads at northeast corner of Sec. 17, T. 12 N., R. 6 E., 0.07 mile southwest of angle in road. 12/27/48, 35.9; 3/31/49, 30.3; 11/22/49, 36.0; 4/10/50, 29.7; 11/17/50, 33.5; 3/28/51, 27.7; 11/19/51, 31.5; 4/8/52, 25.1; 11/10/52, 34.8.

12N/6E-21J1—Reference point—hole in pump base, elevation 141.6 feet. 0.25 mile west of U. S. Highway 99E, on north side of creek crossing highway, 1.23 miles south of Lincoln. 11/22/49, 69.4; 4/6/50, 46.2; 11/16/50, 75.3; 3/28/51, 68.2.

12N/6E-21L1—Reference point—hole in pump base, elevation 136.8 feet. 0.75 mile west of U. S. Highway 99E, on north side of creek crossing highway 1.23 miles south of Lincoln. 11/22/49, 64.8; 4/6/50, 60.4; 5/10/50, 83.0; 11/28/50, 64.3; 3/28/51, 63.7; 11/15/51, 70.8; 4/9/52, 65.0.

12N/6E-21N1—Reference point—hole in pump base, elevation 130.5 feet. 0.90 mile west of U. S. Highway 99E on south side of creek crossing highway, 1.23 miles south of Lincoln. 12/22/48, 53.4; 3/23/49, 53.6; 11/22/49, 60.0; 4/6/50, 56.1; 5/10/50, 83.0; 3/28/51, 58.5; 4/9/52, 64.7; 11/10/52, 66.2.

12N/6E-21P1—Reference point—hole in pump base, elevation 132.2 feet. 0.65 mile west of U. S. Highway 99E, 0.25 mile south of creek crossing highway, 1.23 miles south of Lincoln. 11/22/49, 62.1; 11/28/50, 65.0; 3/28/51, 60.1; 11/15/51, 67.8; 4/9/52, 61.4.

12N/6E-22A1—Reference point—top of casing, elevation 156 feet. 0.38 mile east of U. S. Highway 99E, at end of private road joining highway, 0.67 mile south of Lincoln. 12/21/48, 11.5; 3/23/49, 5.9; 11/22/49, 10.0; 4/6/50, 8.7; 11/17/50, 8.7; 3/28/51, 8.2; 11/14/51, 9.4; 4/9/52, 7.1.

12N/6E-22L1—Reference point—edge of pump base, elevation 145.0 feet. 1.30 miles south of Lincoln on east side of U. S. Highway 99E. 12/29/48, 7.0; 3/24/49, 2.4; 5/11/49, 5.1; 7/1/49, 6.0; 7/28/49, 6.7; 8/25/49, 7.2; 9/29/49, 6.6; 11/22/49, 6.4; 3/15/50, 5.3; 4/6/50, 5.5; 11/16/50, 6.5; 3/28/51, 5.5; 7/16/51, 7.0; 8/23/51, 7.8; 9/27/51, 6.9; 11/13/51, 7.4; 2/27/52, 3.1; 4/4/52, 4.2; 11/10/52, 18.1.

12N/6E-22L2—Reference point—top of casing, elevation 148.6 feet. 1.12 miles south of Lincoln and 0.10 mile east of U. S. Highway 99E. 3/8/50, 1.3; 11/27/50, 1.6; 3/28/51, 1.8; 11/13/51, 1.8; 11/10/52, 1.9.

12N/6E-26L1—Reference point—top of plank cover on east side, elevation 200 feet. 1.40 miles southeast of U. S. Highway 99E, on south bank of creek. 12/21/48, 4.0; 3/23/49, 1.4; 5/13/49, 9.9; 7/29/49, 10.3; 8/25/49, 10.8.

12N/6E-27D1—Reference point—hole in pump base, elevation 139.7 feet. 75 feet west of railroad tracks, southwest of junction of road and U. S. Highway 99E, 1.65 miles south of Lincoln. 12/20/48, 61.2; 3/23/49, 59.6; 8/25/49, 81.5; 11/22/49, 67.9; 2/16/50, 67.7; 3/15/50, 65.0; 4/6/50, 64.7; 5/10/50, 66.8; 9/6/50, 82.0; 11/15/50, 67.7; 12/15/50, 73.1; 1/4/51, 70.2; 2/7/51, 69.1; 3/8/51, 68.3; 3/28/51, 67.8; 5/9/51, 70.6; 11/14/51, 75.0; 4/4/52, 70.0; 11/10/52, 78.5.

12N/6E-28B1—Reference point—hole in pump base, elevation 134.5 feet. 0.38 mile west of angle in road at northeast corner of Sec. 28, T. 12 N., R. 6 E. 3/23/49, 55.2; 11/22/49, 64.4; 4/6/50, 61.5; 11/28/50, 63.2; 3/28/51, 62.6; 11/14/51, 70.5; 4/9/52, 63.8.

12N/6E-28M1—Reference point—hole in pump base, elevation 128 feet. 0.95 mile southwest of angle in road at northeast corner of Sec. 28, T. 12 N., R. 6 E. 5/17/50, 96.0; 11/20/50, 60.7; 3/28/51, 56.2; 11/15/51, 62.2; 4/9/52, 57.6; 11/10/52, 66.7.

12N/6E-29E1—Reference point—hole in pump base, elevation 114 feet. 0.50 mile south of and 0.25 mile east of junction of roads at northwest corner of Sec. 29, T. 12 N., R. 6 E. 12/21/48, 39.1; 3/31/49, 37.9; 11/16/49, 41.2; 4/10/50, 40.9; 11/15/50, 45.3; 3/22/51, 42.3.

12N/6E-29E2—Reference point—hole in pump base, elevation 121 feet. 0.12 mile east of and 0.30 mile south of junction of roads at northwest corner of Sec. 29, T. 12 N., R. 6 E. 11/16/49, 46.5; 3/22/51, 49.5.

12N/6E-29G1—Reference point—top of column inside discharge pipe, elevation 127 feet. 0.20 mile east of and 0.28 mile south of junction of roads at N. ¼ corner of Sec. 29, T. 12 N., R. 6 E. 3/22/51, 47.0; 11/21/51, 55.0; 4/9/52, 49.9.

12N/6E-30L1—Reference point—top of casing, elevation 108.7 feet. 0.55 mile south of junction of roads at N. ¼ corner of Sec. 30, T. 12 N., R. 6 E., on west side of road. 12/21/48, 31.0; 3/31/49, 29.2; 10/6/49, 32.2; 11/15/49, 33.0; 2/15/50, 29.9; 3/15/50, 31.8; 4/10/50, 31.7; 5/9/50, 32.2; 6/7/50, 37.3; 7/7/50, 38.3; 8/3/50, 38.8; 9/6/50, 39.3; 10/3/50, 37.8; 11/15/50, 36.3; 12/15/50, 29.2; 1/5/51, 28.5; 2/8/51, 26.6; 3/8/51, 26.9; 3/21/51, 32.7; 5/10/51, 34.8; 6/5/51, 37.5; 7/10/51, 38.9; 8/23/51, 33.2; 9/27/51, 33.7; 11/20/51, 37.5; 1/23/52, 35.0; 2/28/52, 34.0; 4/3/52, 33.2; 11/6/52, 41.3.

12N/6E-31G1—Reference point—floor of pump house, elevation 108.1 feet. 0.10 mile east of road, on south bank of creek. 12/27/48, 32.0; 11/15/49, 32.2; 4/10/50, 32.7.

12N/6E-32Q1—Reference point—hole in base of pump, elevation 121 feet. 1 mile east of junction of roads at S. ¼ corner of Sec. 31, T. 12 N., R. 6 E. 12/27/48, 49.7; 2/25/49, 49.6; 3/30/49, 49.2; 11/16/49, 52.7; 4/7/50, 52.0; 11/15/50, 54.1; 3/22/51, 52.7; 11/14/51, 55.4.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

13N/4E-35Q1—Reference point—top of casing, elevation 56.6 feet. 0.4 mile west of Pleasant Grove Road, 132 feet north of Cornelius Avenue. 3/11/48, 19.9; 12/13/48, 25.1; 3/29/49, 21.1; 12/7/49, 26.1; 11/19/51, 30.4.

13N/4E-36G1—Reference point—top of casing, elevation 58 feet. 528 feet north of Hicks Road, 0.6 mile east of Pleasant Grove Road. 3/9/48, 22.6; 11/16/48, 26.7; 4/4/49, 24.2.

13N/5E-2Q1—Reference point—slot in pump base, elevation 97 feet. 0.25 mile west of angle in road at southeast corner of Sec. 2, T. 13 N., R. 5 E., 10 feet north of road. 12/27/48, 14.6; 3/7/49, 15.6; 11/8/49, 16.8; 3/14/50, 16.8; 4/4/50, 16.7; 5/10/50, 16.8; 6/7/50, 17.6; 8/1/50, 27.5; 10/3/50, 21.5; 11/16/50, 17.3; 12/14/50, 15.7; 1/5/51, 15.5; 2/7/51, 15.1; 3/7/51, 14.8; 3/27/51, 14.8; 5/9/51, 15.3; 6/5/51, 19.4; 11/20/51, 17.0; 1/23/52, 16.0; 2/28/52, 15.5; 4/8/52, 15.0; 11/5/52, 20.3.

13N/5E-3Q1—Reference point—top of casing in bottom of pit, 10.6 feet to top of concrete crib, elevation 84 feet. 0.25 mile northeast of U. S. Highway 99E, 0.20 mile southeast of Bear River. 11/25/47, 4.4; 3/5/48, 5.5; 11/7/49, 6.0; 4/4/50, 4.9; 11/14/50, 5.7; 3/27/51, 2.0; 11/19/51, 6.3.

13N/5E-9H1—Reference point—top of casing, elevation 86.4 feet. 0.22 mile north of and 0.10 mile west of junction of roads at E. ¼ corner of Sec. 9, T. 13 N., R. 5 E. 2/18/49, 18.0; 3/30/49, 14.4; 11/7/49, 18.8.

13N/5E-9P1—Reference point—hole in pump base, elevation 80.4 feet. 0.50 mile north of Bear River Drive and 0.70 mile west of Placer Road. 11/26/47, 17.6; 11/4/48, 19.5; 3/30/49, 15.6.

13N/5E-9R1—Reference point—hole in pump base, elevation 83.6 feet. West side of Placer Road and 0.50 mile north of Bear River Drive. 2/18/49, 16.3; 3/16/49, 15.7; 7/29/49, 50.5*; 11/7/49, 19.9; 2/15/50, 17.6; 3/15/50, 17.2; 4/4/50, 16.7; 5/9/50, 18.1; 6/7/50, 20.0; 8/3/50, 21.9; 10/3/50, 22.2; 11/14/50, 20.3; 12/14/50, 16.5; 1/4/51, 15.2; 2/7/51, 13.2; 3/7/51, 12.8; 3/27/51, 12.6; 7/16/51, 23.7; 8/22/51, 24.9; 9/26/51, 19.5; 11/19/51, 19.6; 2/28/52, 13.5; 4/4/52, 12.0; 11/7/52, 21.2.

13N/5E-10K1—Reference point—top of casing, elevation 86 feet. 0.60 mile east of junction of roads at W. ¼ corner of Sec. 10, T. 13 N., R. 5 E., on south side of road. 11/19/51, 22.2; 4/4/52, 17.9; 11/5/52, 24.4.

13N/5E-10P1—Reference point—top of casing, elevation 85 feet. 0.35 mile south of and 0.30 mile east of junction of roads at W. ¼ corner of Sec. 10, T. 13 N., R. 5 E. 11/19/51, 24.5; 4/4/52, 17.8.

13N/5E-12D1—Reference point—top of casing, elevation 108 feet. 0.13 mile south of and 0.04 mile east of angle in road at northwest corner of Sec. 12, T. 13 N., R. 5 E. 12/27/48, 22.9; 3/17/49, 22.4; 11/8/49, 24.1; 4/4/50, 24.0.

13N/5E-12Q1—Reference point—edge of pump base on north side, elevation 119 feet. On northwest side of road extending diagonally across SE. ¼ and 0.65 mile southwest of junction of roads at E. ¼ corner of Sec. 12, T. 13 N., R. 5 E. 12/27/48, 38.7; 3/17/49, 38.6; 11/8/49, 39.1; 4/4/50, 39.0; 11/16/50, 40.3; 3/29/51, 39.2; 11/21/51, 41.1; 4/8/52, 40.0.

13N/5E-12R1—Reference point—top of casing, elevation 133 feet. 0.50 mile east of and 0.10 mile north of junction of roads at central ¼ corner of Sec. 12, T. 13 N., R. 5 E. 12/23/48, 50.3; 3/16/49, 51.8; 11/8/49, 51.0.

13N/5E-12R2—Reference point—top of casing, elevation 137 feet. 0.42 mile east of and 0.10 mile north of junction of roads at S. ¼ corner of Sec. 12, T. 13 N., R. 5 E. 11/8/49, 51.5; 4/5/50, 52.7; 11/16/50, 53.0; 3/29/51, 53.0; 11/21/51, 54.6; 4/8/52, 53.5; 11/12/52, 55.7.

13N/5E-13E1—Reference point—hole in base of pump, elevation 111 feet. On east side of U. S. Highway 99E, 0.20 mile northeast of junction of roads at W. ¼ corner of Sec. 13, T. 13 N., R. 5 E. 12/29/48, 34.7; 3/16/49, 35.1; 11/8/49, 35.5; 4/5/50, 37.0; 11/17/50, 37.0; 3/29/51, 36.0.

13N/5E-22A1—Reference point—top of casing, elevation 84.8 feet. 1.23 miles west of junction of roads at E. ¼ corner of Sec. 23, T. 13 N., R. 5 E., 0.10 mile north of road. 12/29/48, 16.2; 3/16/49, 15.5; 11/7/49, 19.0; 4/5/50, 16.8; 11/15/50, 20.1; 3/27/51, 15.8; 11/19/51, 22.1; 4/4/52, 16.3.

13N/5E-22C1—Reference point—top of casing, elevation 81.4 feet. 0.72 mile south of and 0.50 mile east of junction of roads at W. ¼ corner of Sec. 15, T. 13 N., R. 5 E. 12/27/48, 16.5; 3/16/49, 15.1; 11/7/49, 19.5.

13N/5E-22C2—Reference point—hole in pump base, elevation 80 feet. 0.50 mile east of and 0.70 mile south of junction of roads at W. ¼ corner of Sec. 15, T. 13 N., R. 5 E. 5/8/51, 15.0; 6/5/51, 22.4; 11/15/51, 20.7; 4/4/52, 14.0.

13N/5E-22F1—Reference point—top of casing on south side, elevation 76.6 feet. 0.80 mile south of and 0.50 mile east of junction of roads at W. ¼ corner of Sec. 15, T. 13 N., R. 5 E. 12/27/48, 10.9; 3/16/49, 8.3; 11/7/49, 13.4; 4/5/50, 10.4; 11/15/50, 14.9; 3/27/51, 9.0; 11/15/51, 15.9; 4/4/52, 6.0.

13N/5E-22P1—Reference point—top of casing, elevation 78 feet. 1.25 miles south of and 0.50 mile east of junction of roads at W. ¼ corner of Sec. 15, T. 13 N., R. 5 E. 5/8/51, 19.0; 11/15/51, 25.5; 4/4/52, 18.6.

13N/5E-23J1—Reference point—top of casing, elevation 85.6 feet. 0.25 mile southwest of junction of roads at E. ¼ corner of Sec. 23, T. 13 N., R. 5 E. 8/8/49, 9.1; 11/7/49, 9.5.

13N/5E-23P1—Reference point—top of board over concrete pit, elevation 84 feet. 0.25 mile south of and 0.55 mile west of junction of roads at E. ¼ corner of Sec. 23, T. 13 N., R. 5 E., on south bank of creek. 12/29/48, 11.5; 11/7/49, 11.8; 4/5/50, 11.2; 11/15/50, 13.7; 3/29/51, 8.2; 11/29/51, 15.5; 4/4/52, 7.6; 11/5/52, 18.0.

13N/5E-23R1—Reference point—top of casing, elevation 89.6 feet. 0.25 mile south of and 0.15 mile west of junction of roads at E. ¼ corner of Sec. 23, T. 13 N., R. 5 E. 8/8/49, 13.0; 11/7/49, 13.4.

13N/5E-23R2—Reference point—top of casing, elevation 93.7 feet. 0.30 mile south of and 0.10 mile west of junction of roads at E. ¼ corner of Sec. 23, T. 13 N., R. 5 E. 11/7/49, 17.5; 3/15/50, 15.8; 9/6/50, 20.5; 11/15/50, 19.9; 3/27/51, 15.4; 11/19/51, 21.7; 2/28/52, 17.4; 4/4/52, 16.4; 11/12/52, 25.2.

13N/5E-23R3—Reference point—top of casing, elevation 95 feet. 0.45 mile south of and 0.11 mile west of junction of roads at E. ¼ corner of Sec. 23, T. 13 N., R. 5 E. 4/5/50, 15.6; 1/4/51, 17.5; 2/6/51, 15.4; 3/7/51, 15.6; 6/5/51, 24.4; 8/22/51, 25.1; 9/26/51, 27.3.

13N/5E-24A1—Reference point—hole in top of casing, elevation 97.6 feet. 0.40 mile north of junction of roads at E. ¼ corner of Sec. 24, T. 13 N., R. 5 E. 11/9/49, 12.4; 3/15/50, 11.5; 4/5/50, 11.3; 5/10/50, 11.4.

13N/5E-24H1—Reference point—top of casing, 1.2 feet above ground, elevation 105.5 feet. 0.13 mile west of junction of roads at E. ¼ corner of Sec. 24, T. 13 N., R. 5 E., at end of road, near U. S. Highway 99E. 12/27/48, 20.8; 2/18/49, 19.8; 3/16/49, 6.1; 4/5/50, 21.2; 6/7/50, 22.7; 7/7/50, 23.4; 8/1/50, 24.0; 9/6/50, 23.9; 10/3/50, 23.3; 11/14/50, 23.5; 12/14/50, 2.0; 1/4/51, 9.0; 2/7/51, 2.9; 3/7/51, 3.4; 3/29/51, 20.6; 5/9/51, 21.8; 6/5/51, 26.9; 7/16/51, 28.0; 8/22/51, 30.1; 9/26/51, 27.1; 11/20/51, 27.9.

13N/5E-25D1—Reference point—top of wall of concrete pit, elevation 95.5 feet. 0.53 mile south of and 0.07 mile west of junction of roads at W. ¼ corner of Sec. 24, T. 13 N., R. 5 E. 12/29/48, 16.7; 3/16/49, 15.3; 11/9/49, 17.9; 4/5/50, 16.2; 11/15/50, 18.9.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

13N/5E-25H1—Reference point—top of casing, elevation 103.6 feet. 0.50 mile west of and 0.22 mile north of junction of roads at southeast corner of Sec. 25, T. 13 N., R. 5 E., on south bank of creek, near U. S. Highway 99E. 12/27/48, 18.3; 3/17/49, 17.0; 5/3/49, 16.7; 5/25/49, 67.0*; 6/30/49, 69.0*; 8/1/49, 26.0; 8/3/49, 20.5; 11/9/49, 21.7; 4/5/50, 17.6; 11/15/50, 20.4; 3/28/51, 15.9; 11/19/51, 21.2; 4/4/52, 16.5.

13N/5E-27C1—Reference point—top of casing, elevation 80 feet. 1.50 miles south of and 0.50 mile east of junction of roads at W. ¼ corner of Sec. 15, T. 13 N., R. 5 E. 5/8/51, 21.5; 11/15/51, 28.1; 4/4/52, 21.3.

13N/5E-27F1—Reference point—hole in pump base, elevation 82 feet. 1.95 miles south of and 0.50 mile east of junction of roads at W. ¼ corner of Sec. 15, T. 13 N., R. 5 E. 5/8/51, 23.2; 11/15/51, 30.0; 4/4/52, 23.5.

13N/5E-27R1—Reference point—edge of pump base, elevation 88 feet. 1.0 mile west of junction of roads at southwest corner of Sec. 25, T. 13 N., R. 5 E. 12/28/48, 20.8; 3/16/48, 20.3; 11/9/49, 22.8; 4/5/50, 19.8; 11/14/50, 23.3; 3/21/51, 18.8; 11/15/51, 25.8; 4/4/52, 20.4.

13N/5E-28A1—Reference point—slot in concrete base, elevation 82.4 feet. South side of Kempton Road, 1.8 miles east of Brewer Road. 11/5/48, 28.2; 4/4/49, 22.4; 5/12/49, 25.7; 7/1/49, 29.5; 7/29/49, 31.4; 8/25/49, 32.8; 9/29/49, 31.1; 11/10/49, 29.4; 2/15/50, 26.3; 3/14/50, 25.9; 4/5/50, 25.1; 5/8/50, 27.5; 6/17/50, 31.5; 7/7/50, 34.2; 8/1/50, 36.5; 9/6/50, 38.0; 10/3/50, 34.0; 11/14/50, 31.2; 1/4/51, 25.8; 2/7/51, 26.0; 3/27/51, 24.3; 5/9/51, 24.8; 11/15/51, 31.3; 2/28/51, 25.4; 3/31/52, 24.0; 11/5/52, 36.4.

13N/5E-28N1—Reference point—top of casing, elevation 80.7 feet. North side of Waltz Road, 1.25 miles east of Brewer Road. 11/5/48, 29.8; 1/26/49, 26.0; 4/4/49, 25.0; 11/10/49, 34.8; 3/15/50, 28.7; 4/5/50, 28.1; 9/5/50, 43.9; 10/3/50, 39.0; 11/14/50, 35.3; 12/14/50, 32.6; 1/4/51, 32.2; 3/23/51, 28.7; 11/15/51, 36.8; 3/31/52, 29.7; 11/5/52, 45.0.

13N/5E-28R1—Reference point—top of casing, elevation 84.7 feet. 0.10 mile north of Waltz Road, 2.00 miles east of Brewer Road. 11/5/48, 31.4; 4/4/49, 22.0; 9/29/49, 30.3; 11/9/49, 28.4; 2/15/50, 25.2; 3/15/50, 24.7; 4/5/50, 24.4; 5/9/50, 25.0; 6/7/50, 28.0; 7/7/50, 30.2; 8/1/50, 32.2; 9/5/50, 35.4; 10/3/50, 30.0; 12/14/50, 27.7; 1/4/51, 27.2; 3/23/51, 24.8; 5/9/51, 25.7; 6/5/51, 33.1; 7/16/51, 38.0; 8/22/51, 40.6; 9/26/51, 36.8; 11/15/51, 32.9; 2/28/52, 27.3; 3/31/52, 26.3; 11/5/52, 40.1.

13N/5E-30R1—Reference point—top of casing, elevation 71.9 feet. Northwest of intersection of Brewer and Waltz Roads. 11/5/48, 29.5; 4/4/49, 24.8; 11/9/49, 33.2; 2/15/50, 29.5; 3/14/50, 29.0; 4/5/50, 28.2; 11/15/51, 34.7; 3/31/52, 28.7.

13N/5E-31G1—Reference point—top of casing, elevation 68.9 feet. North side of Hicks Road, 0.35 mile west of Brewer Road. 11/5/48, 27.3; 1/26/49, 24.3; 4/4/49, 22.3; 11/10/49, 30.9; 2/16/50, 27.5; 3/14/50, 26.8; 3/30/50, 26.1; 11/10/50, 33.5.

13N/5E-32C1—Reference point—top of casing, elevation 74.0 feet. 0.35 mile east of junction of roads at northwest corner of Sec. 32, T. 13 N., R. 5 E., on south side of road. 2/25/49, 29.6; 4/1/49, 25.6; 5/12/49, 30.1; 6/27/49, 36.2; 7/29/49, 39.8; 8/25/49, 41.3; 9/29/49, 37.1; 11/9/49, 33.8; 2/15/50, 30.2; 3/15/50, 29.5; 4/5/50, 29.0; 5/9/50, 30.5; 6/7/50, 35.7; 7/7/50, 40.3; 8/__/50, 43.2; 9/5/50, 45.3; 10/3/50, 40.6; 11/14/50, 37.1; 12/14/50, 34.8; 1/4/51, 34.4; 3/23/51, 27.9; 5/9/51, 33.1; 6/5/51, 36.7; 7/11/51, 39.5; 8/22/51, 42.2; 9/26/51, 38.9; 11/15/51, 35.8; 2/28/52, 31.1; 3/31/52, 29.9; 11/5/52, 42.0.

13N/5E-33L1—Reference point—top of casing, elevation 80.1 feet. 0.35 mile north of Cornelius Avenue, 1.30 miles east of Brewer Road. 12/22/48, 27.5; 3/18/49, 25.3; 11/10/49, 34.3; 4/6/50, 28.2; 5/8/50, 28.9; 11/13/50, 35.0; 3/27/51, 29.1; 11/15/51, 37.8; 4/7/52, 30.6.

13N/5E-33P1—Reference point—top of casing, elevation 79.3 feet. 100 feet north of Cornelius Avenue, 1.3 miles east of Brewer Road. 12/22/48, 26.0; 3/18/49, 24.2; 11/10/49, 32.2; 4/6/50, 27.3; 11/13/50, 34.5; 3/27/51, 28.9; 11/15/51, 37.0; 4/7/52, 30.3.

13N/5E-34R1—Reference point—top of casing, elevation 94.5 feet. North side of Cornelius Avenue, 2.0 miles east of Brewer Road. 11/23/29, 21.3; 9/25/30, 20.4; 12/22/48, 25.1; 3/18/49, 23.7; 11/10/49, 24.0; 4/6/50, 24.4; 11/13/50, 28.3; 3/27/51, 24.2; 11/15/51, 29.8; 4/7/52, 25.0; 1/6/53, 31.8.

13N/5E-35A1—Reference point—top of concrete pit on east side, elevation 98.3 feet. 0.88 mile north of junction of roads at southeast corner of Sec. 35, T. 13 N., R. 5 E., 500 feet west of road. 12/28/48, 20.5; 4/4/49, 18.8; 11/15/49, 22.5; 3/15/50, 20.0; 4/5/50, 19.6; 5/9/50, 19.8; 6/7/50, 21.8; 7/7/50, 22.6; 8/1/50, 23.2; 9/5/50, 23.3; 10/3/50, 23.1; 11/14/50, 22.8; 12/15/50, 20.9; 1/5/51, 20.6; 2/7/51, 18.5; 3/7/51, 18.1; 3/23/51, 17.8; 5/9/51, 18.8; 6/5/51, 21.5; 7/12/51, 23.8; 8/22/51, 25.3; 9/27/51, 25.4; 11/15/51, 24.1.

13N/5E-35M1—Reference point—top of concrete pit, elevation 92.0 feet. 0.75 mile west of and 0.25 mile north of junction of roads at southeast corner of Sec. 35, T. 13 N., R. 5 E. 12/11/31, 16.3; 11/23/32, 16.5; 11/20/34, 16.2; 11/13/36, 16.2; 11/2/37, 14.8; 1/27/39, 13.6; 1/2/41, 13.0; 11/7/47, 14.5; 12/22/48, 18.0; 3/18/49, 16.6; 11/10/49, 19.0; 4/6/50, 16.0; 11/13/50, 21.4; 3/27/51, 16.9; 11/15/51, 22.7; 4/7/52, 17.7; 11/7/52, 26.6; 1/6/53, 25.8.

13N/5E-36P1—Reference point—hole in old pump base, 1.9 feet above ground, elevation 106 feet. 0.50 mile east of junction of roads at southwest corner of Sec. 36, T. 13 N., R. 5 E., on north side of road. 12/28/48, 20.2; 3/18/49, 17.3; 11/15/49, 20.6; 4/5/50, 18.7; 11/15/50, 22.9; 3/21/51, 16.3; 11/20/51, 22.7; 4/7/52, 15.6; 11/12/52, 24.7.

13N/6E-5N1—Reference point—base of pump, elevation 155 feet. 1.25 miles north of junction of roads at southeast corner of Sec. 8, T. 13 N., R 6 E., on east side of road. 12/23/48, 25.7; 3/17/49, 26.5; 11/8/49, 24.7; 4/4/50, 26.7; 11/16/50, 27.0; 3/29/51, 25.7; 11/21/51, 25.0; 4/8/52, 32.2.

13N/6E-6M1—Reference point—top of casing, elevation 175 feet. 0.20 mile south of angle in road at W. ¼ corner of Sec. 6, T. 13 N., R. 6 E., on east side of road. 12/27/48, 80.4; 2/23/49, 80.4; 3/17/49, 80.6; 11/8/49, 80.1; 4/4/50, 81.0; 11/16/50, 81.8; 3/29/51, 81.3; 11/21/51, 83.0; 4/8/52, 81.1.

13N/6E-7R1—Reference point—top of casing, elevation 116 feet. 100 feet northwest of junction of county roads, 1.75 miles east of Sheridan School. 12/23/48, flowing; 3/16/49, flowing; 5/13/49, 0.0; 6/29/49, 0.0; 8/25/49, flowing; 9/29/49, flowing; 10/8/49, 0.0; 2/15/50, 0.0; 4/4/50, 0.0; 5/10/50, 0.0; 11/16/50, 0.0; 3/29/51, 0.0; 11/19/51, 0.0; 11/12/52, 0.3.

13N/6E-9D1—Reference point—top of 4" x 4" concrete casing, elevation 160 feet. 1.20 miles east of and 0.88 mile north of junction of roads at southwest corner of Sec. 8, T. 13 N., R. 6 E. 12/23/48, 3.1; 3/17/49, 0.9; 11/8/49, 22.3; 4/4/50, 1.9; 11/16/50, 5.5; 3/29/51, 2.6; 11/21/51, 1.8; 4/8/52, 2.1.

13N/6E-9D2—Reference point—top of casing, 1.5 feet below ground surface, elevation 160 feet. 1.17 miles east of and 0.87 mile north of junction of roads at southwest corner of Sec. 8, T. 13 N., R. 6 E. 12/23/48, 3.0; 3/17/49, —0.5; 4/4/50, 2.7.

13N/6E-9N1—Reference point—top of wooden covering over well, elevation 192 feet. 1.21 miles east of and 0.6 mile north of junction of roads at southwest corner of Sec. 8, T. 13 N., R. 6 E. 11/11/29, 42.2; 9/18/30, 40.2; 12/11/31, 42.5; 12/10/32, 42.7; 12/19/33, 43.7; 11/20/34, 43.7; 11/23/36, 42.5; 11/22/37, 39.2; 1/27/39, 39.6; 1/2/41, 39.0.

DEPTHS TO GROUND WATER AT MEASUREMENT WELLS IN AND ADJACENT TO PLACER COUNTY—Continued

Measurements Made by Division of Water Resources
(Depths to water in feet measured from reference point)

13N/6E-9N2—Reference point—top casing, elevation 180 feet. 1.21 miles east of and 0.6 mile north of junction of roads at southwest corner of Sec. 8, T. 13 N., R. 6 E. 11/7/47, 26.8; 12/20/48, 26.7; 3/17/49, 26.9; 11/8/49, 26.2; 4/4/50, 26.5; 11/16/50, 27.5; 3/29/51, 22.9; 11/21/51, 25.6; 4/8/52, 19.5; 10/15/52, 24.5.

13N/6E-18B1—Reference point—pump base on south side, above crack in well covering, elevation 143 feet. 0.42 mile west of junction of roads at northeast corner of Sec. 18, T. 13 N., R. 6 E., south of road. 12/23/48, 51.1; 3/17/49, 52.0; 11/8/49, 52.3; 4/4/50, 53.1; 11/16/50, 53.8; 3/29/51, 53.6; 11/21/51, 54.2; 4/8/52, 53.7; 11/12/52, 54.9.

13N/6E-19A1—Reference point—top of casing, elevation 114.8 feet. 0.60 mile northeast of central ¼ corner of Sec. 19, T. 13 N., R. 6 E. 11/9/49, 14.1; 4/5/50, 14.5; 11/14/50, 14.8; 3/27/51, 14.7; 11/20/51, 15.9; 4/8/52, 15.3.

13N/6E-19B1—Reference point—top of casing, 1.0 foot above ground, elevation 132.4 feet. 0.30 mile north of central ¼ corner of Sec. 19, T. 13 N., R. 6 E. 12/28/48, 39.7; 3/16/49, 40.0; 11/9/49, 34.1; 4/5/50, 34.0; 11/14/50, 38.5; 3/29/51, 37.4; 11/20/51, 40.2; 4/8/52, 38.8.

13N/6E-22N1—Reference point—top of wooden casing, elevation 164 feet. 0.51 mile north of and 0.25 mile west of junction of roads at central ¼ corner of Sec. 27, T. 13 N., R. 6 E. 12/22/48, 2.9; 3/17/49, 1.5.

13N/6E-23F1—Reference point—top of wooden covering, elevation 226 feet. Southeast of angle in road at central ¼ corner of Section 23, T. 13 N., R. 6 E. 12/23/48, 12.4; 2/23/49, 11.8; 3/17/49, 8.7; 11/8/49, 13.0; 4/4/50, 11.5; 11/16/50, 13.5; 3/29/51, 10.7.

13N/6E-26K1—Reference point—top of wooden covering at door 1 foot north of pump column, elevation 263 feet. 0.45 mile north of junction of roads at S. ¼ corner of Sec. 26, T. 13 N., R. 6 E., on side of road. 12/23/48, 28.9; 3/17/49, 22.6; 11/9/49, 25.9; 4/4/50, 28.0; 11/16/50, 28.4; 3/29/51, 28.3.

13N/6E-27F1—Reference point—top of tile casing, elevation 187 feet. 1.4 miles northwest of junction of roads at central ¼ corner of Sec. 27, T. 17 N., R. 6 E. 6/29/49, 19.2; 7/28/49, 19.3; 8/25/49, 19.6; 9/29/49, 20.0; 11/9/49, 20.5; 2/15/50, 18.7; 3/15/50, 19.5; 4/4/50, 19.2; 11/16/50, 21.9; 3/29/51, 19.1; 11/19/51, 21.9; 4/8/52, 18.5; 11/12/52, 20.0.

13N/6E-28D1—Reference point—top of casing, elevation 138.3 feet. 0.40 mile north of and 0.79 mile west of angle in road at E. ¼ corner of Sec. 28, T. 13 N., R. 6 E. 12/22/48, 8.9; 3/17/49, 6.6; 11/9/49, 9.8; 4/4/50, 7.5; 11/16/50, 8.9; 3/29/51, 4.6; 4/8/52, 3.5.

13N/6E-28N1—Reference point—hole in pump base, elevation 140.0 feet. 0.86 mile west of and 0.47 mile south of angle in road at E. ¼ corner of Sec. 28, T. 13 N., R. 6 E. 11/16/50, 18.5; 3/28/51, 8.6; 11/13/51, 19.9.

13N/6E-28Q1—Reference point—top of casing 2.5 feet above ground, elevation 157.5 feet. 0.40 mile southwest of angle in road at E. ¼ corner of Sec. 28, T. 13 N., R. 6 E., on south side of road. 12/22/48, 14.6; 3/17/49, 14.1; 5/13/49, 14.0; 6/29/49, 13.9; 7/28/49, 13.9; 8/25/49, 14.0; 9/29/49, 13.0; 11/9/49, 13.8; 3/15/50, 14.0; 4/4/50, 14.4; 5/10/50, 14.0; 6/7/50, 14.3; 7/7/50, 13.8; 8/3/50, 14.0; 9/6/50, 13.9; 10/2/50, 13.8; 11/16/50, 13.9; 12/14/50, 13.6; 1/4/51, 13.7; 2/7/51, 12.8; 3/7/51, 12.6; 3/29/51, 13.6; 6/5/51, 13.7; 9/27/51, 13.8; 11/20/51, 14.0; 4/8/52, 13.1; 11/12/52, 14.0.

13N/6E-30M1—Reference point—hole in pump base on southwest side, elevation 108.2 feet. On opposite side of U. S. Highway 99E from junction of road and U. S. Highway 99E, 2.75 miles south of Sheridan. 12/27/48, 20.7; 3/16/49, 19.0; 5/3/49, 18.8; 5/11/49, 60.5*; 5/25/49, 63.0*; 6/1/49, 63.8*; 6/30/49, 64.0*; 8/2/49, 31.4; 11/9/49, 24.2; 2/16/50, 20.2; 3/14/50, 20.0; 4/5/50, 20.0; 8/7/50, 33.1; 9/6/50, 24.2; 10/3/50, 22.6; 11/15/50, 22.2; 12/14/50, 20.4; 1/4/51, 20.1; 2/6/51, 18.1; 3/7/51, 18.6; 3/28/51, 17.9; 5/9/51, 19.4; 11/19/51, 22.4; 2/29/52, 18.5; 4/4/52, 18.0; 11/5/52, 26.3.

13N/6E-32G1—Reference point—top of casing, 0.5 feet above ground, elevation 126 feet. 0.05 mile east of U. S. Highway 99E on north side of Ewing Road. 12/23/48, 10.6; 2/18/49, 8.2; 3/18/49, 5.3; 11/9/49, 10.4; 2/16/50, 8.2; 4/6/50, 6.7; 11/15/50, 8.2; 12/15/50, 1.5; 1/4/51, 2.3; 2/7/51, 1.6; 3/6/51, 2.6; 3/23/51, 3.6; 5/9/51, 4.3; 6/5/51, 6.3; 7/16/51, 7.5; 8/22/51, 7.9; 9/26/51, 6.4; 11/19/51, 6.9; 2/27/52, 1.8; 3/31/52, 2.9; 11/12/52, 6.4.

13N/6E-33C1—Reference point—top of pump base, elevation 142 feet. 1.0 mile north of junction of roads, located at a point 0.25 mile east of southwest corner Sec. 33, T. 13 N., R 5 E., on west side of road. 12/22/48, 21.4; 3/18/49, 11.7; 11/9/49, 31.9; 2/15/50, 16.2; 3/15/50, 14.9; 4/4/50, 13.6; 11/16/50, 22.6; 3/28/51, 11.5; 5/9/51, 15.3; 4/4/52, 11.2.

13N/6E-33K1—Reference point—top of pump base on south side, elevation 151 feet. 0.48 mile north of and 0.54 mile east of junction of roads located at a point 0.25 mile east of southwest corner of Sec. 33, T. 13 N., R. 6 E. 12/22/48, 29.7; 11/9/49, 41.7; 4/4/50, 23.8; 5/10/50, 64.9*; 11/16/50, 35.8; 3/28/51, 22.0; 11/13/51, 37.3; 4/4/52, 21.5; 11/10/52, 39.2.

13N/6E-33M1—Reference point—hole in pump base, elevation 147 feet. 0.36 mile north of junction of roads located at a point 0.25 mile east of southwest corner of Sec. 33, T. 13 N., R. 6 E. on west side of road. 12/22/48, 24.2; 5/11/49, 32.6; 6/29/49, 42.0; 7/28/49, 68.5*; 8/25/49, 67.9*; 9/29/49, 69.0*; 11/9/49, 39.5; 2/15/50, 24.2; 3/15/50, 21.1; 4/4/50, 19.9; 5/10/50, 46.7; 10/3/50, 44.0; 11/16/50, 30.7; 12/14/50, 25.0; 1/4/51, 22.1; 2/7/51, 19.3; 3/7/51, 18.7; 3/28/51, 18.1; 5/9/51, 20.3; 9/26/51, 49.7; 11/13/51, 31.5; 2/27/52, 19.0; 4/4/52, 17.7; 11/10/52, 39.2.

13N/6E-33M2—Reference point—hole in base of pump, elevation 140.5 feet. 0.44 mile north of and 0.25 mile west of junction of roads located at a point 0.25 mile east of southwest corner Sec. 33, T. 13 N., R. 6 E. 12/22/48, 29.7; 3/23/49, 14.2; 11/9/49, 34.1; 4/4/50, 15.4; 11/16/50, 25.5; 3/28/51, 13.7; 11/11/51, 27.6; 4/4/52, 13.2.

13N/6E-34F1—Reference point—top of casing, 4.5 feet above ground, elevation 173 feet. 0.25 mile south of angle in road at N. ¼ corner of Sec. 34, T. 13 N., R. 6 E. at end of private road. 12/21/48, 12.7; 2/23/49, 12.6.

13N/6E-34P1—Reference point—top of wood cover, 0.5 feet above ground level, elevation 165 feet. 0.21 mile west of junction of roads at S. ¼ corner of Sec. 34, T. 13 N., R. 6 E. 11/9/29, 8.5; 9/10/30, 10.7; 12/11/31, 9.4; 12/10/32, 8.8; 12/19/33, 7.5; 11/20/34, 7.5; 11/23/36, 8.0; 11/22/37, 7.8; 1/27/39, 7.6.

13N/6E-34P2—Reference point—top of concrete block, elevation 161 feet. 0.21 mile west of junction of roads at S. ¼ corner of Sec. 34, T. 13 N., R. 6 E. 1/27/39, 8.0; 1/2/41, 7.7; 11/7/47, 6.7; 3/23/49, 9.9; 10/16/52, 5.8.

13N/6E-35B1—Reference point—top of wood cover over well, elevation 205 feet. 0.10 mile east of and 0.04 mile south of junction of roads at N. ¼ corner of Sec. 35, T. 13 N., R. 6 E. 12/23/48, 23.1; 3/23/49, 20.3; 11/9/49, 22.8; 4/4/50, 21.5; 11/16/50, 23.7; 3/29/51, 19.3.

13N/6E-35F1—Reference point—top of 2" x 12" plank covering, 2.0 feet above ground, elevation 179 feet. 0.10 mile west of and 0.40 mile south of junction of roads at N. ¼ corner of Sec. 35, T. 13 N., R. 6 E. 12/21/48, 9.2; 3/23/49, 8.0; 11/9/49, 8.3; 4/6/50, 9.4; 11/17/50, 8.9; 11/13/51, 8.8.

13N/6E-35N1—Reference point—top of casing, elevation 182 feet. 0.42 mile west of junction of roads at S. ¼ corner of Sec. 35, T. 13 N., R. 6 E., 100 feet north of road. 12/21/48, 2.0; 3/23/49, 0.9; 11/22/49, 2.3; 4/6/50, 2.1; 11/17/50, 2.0; 3/29/51, 2.2; 11/13/51, 1.7; 4/10/52, 2.1.

* Pump operating.

APPENDIX G

RECORDS OF MINERAL ANALYSES OF WATERS IN AND ADJACENT TO PLACER COUNTY

TABLE OF CONTENTS

RECORDS OF MINERAL ANALYSES OF WATERS IN AND ADJACENT TO PLACER COUNTY

MINERAL ANALYSES OF REPRESENTATIVE SURFACE WATERS IN AND ADJACENT TO PLACER COUNTY

Station	Date of sample	Conductance, Ec×10⁶ at 25° C.	Boron, in ppm	Mineral constituents, in equivalents per million							Per cent sodium
				Ca	Mg	Na	$HCO_3 + CO_3$	Cl	SO_4	NO_3	
VALLEY AND FOOTHILL UNIT											
Gold Hill Dam below Combie Dam	5/14/51	45.3	0.02	0.14	0.31	0.07	0.36	0.01	0.08	0.01	15
	6/12/51	47.9					0.43	0.05			
	8/31/51	62.4				0.10	0.48	0.12			16
	10/5/51	56.1					0.43	0.34			
Bear River Canal, spill to Halsey Forebay	5/14/51	34.3	0.02	0.16	0.16	0.06	0.28	0.02	0.07	0.01	16
	6/11/51	47.2					0.30	0.05			
	8/31/51	33.3				0.09	0.23	0.03			27
	10/5/51	39.4					0.26	0.00			
	1/11/52	44					0.30	0.00			
Sailor Ravine below Francis Ranch	5/14/51	159	0.02	0.50	0.82	0.30	1.07	0.07	0.52	0.01	18
	6/11/51	136					0.85	0.02			
	8/31/51	121				0.25	0.84	0.08			20
	10/5/51	157					1.05	0.06			
	1/11/52	156					0.88	0.08			
Antelope Creek near Rocklin	5/11/51	132	0.02	0.60	0.61	0.23	1.08	0.08	0.21	0.01	16
	6/11/51	196					1.66	0.07			
	8/31/51	158				0.32	1.31	0.11			20
	10/5/51	130					0.92	0.06			
	1/11/52	201					1.21	0.17			
Linda Creek at Roseville	3/26/51	233	0.25	0.95	0.82	0.65	1.77	0.37	0.25	0.00	27
	5/11/51	174	0.02	0.75	0.64	0.48	1.38	0.22	0.20	0.01	25
	6/11/51	131					1.03	0.08			
	8/31/51	348				1.78	1.61	1.46			53
	10/5/51	254					1.18	0.90			
	1/11/52	189					1.15	0.25			
Pleasant Grove Creek at Lincoln Road	3/28/51	354	0.49	1.15	0.66	1.87	2.03	1.18	0.65	0.00	50
Auburn Ravine at U. S. Highway 99E	3/26/51	214	0.28	0.95	0.80	0.43	1.71	0.23	0.25	0.02	20
	5/11/51	120	0.02	0.48	0.55	0.27	1.05	0.10	0.16	0.02	20
	6/11/51	71					0.52	0.03			
	8/30/51	66				0.17	0.49	0.05			25
	10/5/51	131					1.08	0.11			
	1/11/52	151					1.08	0.14			
Coon Creek at U. S. Highway 99E	3/26/51	236	0.08	1.00	1.15	0.35	2.07	0.20	0.25	0.01	14
	5/11/51	204	0.00	0.24	0.98	0.32	1.80	0.13	0.11	0.01	15
	6/11/51	193					1.67	0.10			
	8/30/51	159				0.23	1.28	0.09			14
	10/10/51	177					1.57	0.11			
	1/11/52	150					1.21	0.11			
Reclamation District 1001 channel at Pacific Avenue	3/26/51	200	0.24	0.85	0.82	0.48	1.71	0.19	0.23	0.00	22
	5/11/51	193	0.08	0.75	0.78	0.43	1.67	0.19	0.21	0.01	22
	6/12/51	188	0.23	0.60	0.57	0.65	1.44	0.23	0.21	0.01	35
	7/23/51	205	1.01	0.80	0.90	0.56	1.87	0.19	0.16	0.00	25
	9/5/51	228	0.06	0.80	0.82	0.65	1.93	0.28	0.09	0.02	28
	10/10/51	193					1.60	0.17			
	1/11/52	153					1.11	0.17			
AMERICAN RIVER UNIT											
El Dorado Creek 25 feet below obsolete diversion of Breece-Wheeler Ditch. Sec. 26, T 15 N, R 12 E, MDB&M	9/—/49	58.8	0.00	0.23	0.22	0.34	0.57	0.00	0.02	0.00	43
Bullion Mine, Sec. 26, T 15 N, R 11 E, MDB&M	9/12/49	107	0.00	0.41	0.60	0.34	1.13	0.03	0.10	0.00	25
Big Reservoir, Shirttail Canyon	9/—/49	37.8	0.00	0.00	0.11	0.25	0.12	0.02	0.01	0.00	69
Mormon Creek at Pacific Gas and Electric Company South Canal near Auburn	5/14/51	131	0.02	0.48	0.64	0.22	1.05	0.07	0.25	0.01	16
	6/11/51	157					1.23	0.02			
	8/31/51	144				0.28	1.13	0.08			19
	10/5/51	160					1.21	0.90			
	1/11/52	208					1.31	0.23			
North Fork American River at bridge 2 miles downstream from North Fork Dam	5/8/52	39.7	0.00	0.24	0.08	0.02	0.38	0.01	0.03	0.00	6
Middle Fork American River 200 yards upstream from junction with North Fork	5/8/52	27.4	0.00	0.18	0.07	0.02	0.26	0.01	0.02	0.00	8
South Fork American River at Coloma Bridge	5/8/52	23.5	0.00	0.11	0.09	0.02	0.23	0.01	0.01	0.00	10
American River at Folsom Bridge	5/8/52	35.1	0.00	0.22	0.08	0.02	0.34	0.01	0.02	0.00	7

MINERAL ANALYSES OF REPRESENTATIVE SURFACE WATERS IN AND ADJACENT TO PLACER COUNTY—Continued

Station	Date of sample	Conductance, $E_c \times 10^6$ at 25° C.	Boron, in ppm	Mineral constituents, in equivalents per million							Per cent sodium
				Ca	Mg	Na	$HCO_3 + CO_3$	Cl	SO_4	NO_3	
BEAR RIVER UNIT											
Eden Valley drain near Colfax	5/11/51	84	0.02	0.36	0.40	0.13	0.79	0.04	0.10	0.01	14
	6/11/51	98					0.80	0.02			
	8/31/51	101				0.21	0.84	0.07			20
	10/ 5/51	120					0.82	0.14			
	1/11/52	77					0.49	0.11			
Bear River near Auburn	5/14/51	44.7	0.02	0.20	0.23	0.06	0.36	0.03	0.08	0.01	12
	6/11/41	91.6						0.17			
	8/31/51	93.5				0.21	0.59	0.16			24
	10/ 5/51	101					0.56	0.28			
	1/11/52	54					0.36	0.08			
Bear River near Wheatland	5/11/51	102	0.02	0.55	0.40	0.14	0.74	0.06	0.21	0.01	13
	6/11/51	180						0.01			
	8/30/51	303				0.32	2.26	0.23			10
	10/10/51	304					2.10	0.28			
TAHOE UNIT											
Lake Tahoe, north end, (Tahoe Vista) Sec. 14, T 16 N, R 17 E, MDB&M	5/15/51	101	0.20	0.48	0.24	0.22	0.92	0.06	0.04	0.00	22
	9/19/51	99	0.05	0.46	0.20	0.33	0.90	0.06	0.08	0.00	32
	5/19/52	97.5	0.01	0.48	0.20	0.26	0.89	0.03	0.05	0.00	27
Lake Tahoe, west side, (Tahoe City) at State Highway 89 bridge over Truckee River	5/15/51	94	0.02	0.46	0.24	0.22	0.90	0.03	0.04	0.00	22
	9/19/51	96	0.04	0.48	0.18	0.31	0.89	0.05	0.05	0.00	31
	5/20/52	89.2	0.02	0.43	0.22	0.26	0.90	0.06	0.04	0.00	27
Truckee River at Truckee	5/14/51	71.3	0.06	0.38	0.22	0.14	0.66	0.03	0.10	0.01	18
	9/19/51	99	0.09	0.50	0.20	0.30	0.90	0.05	0.07	0.00	30
	5/19/52	71.2	0.03	0.40	0.15	0.18	0.72	0.03	0.05	0.00	24
Truckee River at Farad	5/14/51	94	0.17	0.36	0.20	0.13	0.66	0.06	0.04	0.00	18
	9/19/51	74	0.04	0.44	0.26	0.24	0.84	0.05	0.06	0.01	25
	5/20/52	61.6	0.02	0.30	0.18	0.13	0.59	0.02	0.03	0.01	20

COMPLETE MINERAL ANALYSES OF GROUND WATERS IN PLACER COUNTY

Class	Well number	Depth, in feet	Use	Date of sample	Conductance, Ec×10⁶ at 25° C.	Boron, in ppm	Mineral constituents, in equivalents per million							Per cent sodium
							Ca	Mg	Na	HCO_3 + CO_3	Cl	SO_4	NO_3	
1	10N/5E-9L1		Irrigation	7/ 9/51	308	0.28	0.85	0.90	1.39	1.94	1.01	0.12	0.04	44
	10N/6E-16D1	385	Irrigation	7/ 6/51	260	0.10	0.95	0.82	0.96	2.23	0.42	0.03	0.02	35
	11N/5E-6A1	682	Irrigation	7/ 9/51	321	0.31	0.80	0.66	1.52	1.97	1.04	0.06	0.06	50
	11N/5E-10L1	580	Irrigation	7/ 9/51	294	0.15	0.85	0.82	1.22	2.06	0.84	0.08	0.01	42
	11N/5E-19H1	652	Irrigation	7/ 9/51	254	0.10	0.80	0.57	1.26	2.03	0.51	0.07	0.02	47
	11N/5E-31A1	213	Irrigation	6/27/50	340	0.29	0.85	0.90	1.52	2.10	0.59	0.10	0.07	26
	12N/5E-3A2	800	Irrigation	6/29/50	180	0.11	0.70	0.74	0.96	1.90	0.31	0.06	0.02	39
	12N/5E-5R1	630	Irrigation	7/ 3/51	240	0.20	0.90	0.68	0.91	1.97	0.48	0.06	0.04	36
	12N/5E-6R1		Irrigation	9/18/50	199	0.09	0.70	0.60	0.74	1.20	0.28	0.08	0.00	33
	12N/5E-14L1		Irrigation	9/ 8/50	274	0.40	0.70	0.65	1.56	2.33	0.54	0.04	0.00	52
	12N/5E-14L1		Irrigation	7/ 5/51	281	0.76	0.75	0.68	1.52	2.48	0.45	0.02	0.02	51
	12N/5E-17B1	455	Irrigation	6/27/50	180	0.06	0.60	0.74	1.26	1.71	0.25	0.06	0.04	48
	12N/5E-17B1	455	Irrigation	9/13/50	153	0.13	0.60	0.38	0.52	0.54	0.27	0.05	0.00	30
	12N/5E-23H1	870	Irrigation	7/ 5/51	284	0.56	0.75	0.71	1.39	2.05	0.79	0.04	0.05	48
	13N/5E-9H1		Irrigation	9/15/50	370	0.02	1.75	1.39	0.74	2.21	0.25	1.44	0.27	18
	13N/5E-23R2		Irrigation	7/ 9/51	342	0.26	0.95	0.82	1.48	1.72	1.35	0.21	0.06	45
	AVERAGE				268	0.23	0.84	0.75	1.18	1.90	0.59	0.16	0.04	40
2	11N/6E-17J1	210	Irrigation	7/ 5/51	627	1.42	1.50	1.07	3.09	1.51	3.60	0.54	0.04	54
	12N/5E-13A1		Irrigation	7/ 9/51	369	1.33	0.65	0.61	2.48	2.13	1.07	0.46	0.04	66
	13N/5E-10K1		Irrigation	7/ 2/51	1,400	0.94	3.90	0.61	7.83	1.44	10.49	0.62	0.05	63
	13N/5E-10P1		Irrigation	7/ 2/51	1,350	0.84	3.45	0.82	8.09	1.61	9.92	0.69	0.08	65
	13N/6E-33C1	391	Irrigation	6/27/50	510	1.61	1.30	1.48	3.00	2.51	2.20	0.79	0.10	52
	13N/6E-33C1	391	Irrigation	9/15/50	422	1.70	0.60	0.56	2.43	0.44	2.25	0.27	0.00	64
	13N/6E-33C1	391	Irrigation	7/ 2/51	574	1.98	1.30	1.23	3.04	2.61	2.25	0.71	0.05	54
	AVERAGE				750	1.40	1.81	0.91	4.28	1.75	4.54	0.58	0.05	60
3	12N/6E-27D1		Irrigation	9/20/49	1,450	2.85	3.70	1.18	10.16	1.30	11.49	1.45	0.07	68
	12N/6E-27D1		Irrigation	6/29/50	1,470	1.88	3.70	1.23	8.61	1.39	11.50	1.50	0.15	64
	12N/6E-27D1		Irrigation	7/ 2/51	1,650	2.33	3.90	0.98	10.00	1.44	12.11	1.54	0.18	67
	12N/6E-28M1	116	Irrigation	6/29/50	1,480	1.66	3.05	1.56	10.35	1.30	11.72	1.58	0.10	69
	12N/6E-28M1	116	Irrigation	9/13/50	1,420	1.60	1.15	0.81	9.05	0.56	10.41	1.35	0.00	70
	AVERAGE				1,494	2.06	3.10	1.15	9.63	1.20	11.44	1.48	0.10	68
	12N/6E-23C1	Spring	--------	5/24/51	20,200	32.00	47.45	1.56	180.43	0.33	202.25	27.50	0.02	78

PARTIAL MINERAL ANALYSES OF GROUND WATERS IN AND ADJACENT TO PLACER COUNTY

Well number	Depth, in feet	Use	Date of sample	Conductance, $E_c \times 10^6$ at 25°C.	Cl, in epm	Total solids, in ppm
10N/5E-3N1		Irrigation	8/7/50	316	1.10	
			9/12/50	308	1.08	
			5/22/51	314	1.08	
10N/5E-9L1		Irrigation	5/22/51	300	0.96	
10N/5E-10J1		Irrigation	7/7/49		0.56	215
			5/22/51	336	0.51	
10N/5E-11E1		Irrigation	5/18/51	282	0.54	
10N/5E-11G1		Irrigation	8/1/49		1.13	270
10N/5E-12E1	250	Irrigation	7/1/49		1.41	305
10N/6E-5L1		Irrigation	5/23/51	258	0.82	
10N/6E-9D1	351	Irrigation	9/20/49		0.28	150
10N/6E-11E3	400	Irrigation	5/23/51	472	1.69	
10N/6E-16D1	385	Irrigation	6/2/50	256	0.42	
			8/1/50	264	0.45	
			5/22/51	259	0.39	
11N/4E-10A1		Irrigation	5/23/51	272	0.45	
11N/4E-10H1		Irrigation	5/23/51	260	0.39	
11N/4E-12J2		Irrigation	5/23/51	289	0.62	
11N/4E-14D1		Irrigation	5/23/51	302	0.62	
11N/4E-23J1		Irrigation	5/23/51	292	0.51	
11N/4E-24L1		Irrigation	5/23/51	282	0.48	
11N/4E-25M1		Irrigation	5/24/51	329	0.51	
11N/5E-3H1		Irrigation	6/27/47		0.84	172
			9/13/49		0.28	170
11N/5E-3M3		Irrigation	7/7/49		1.97	305
11N/5E-4P1		Irrigation	9/13/49		0.84	190
11N/5E-6A1	682	Irrigation	7/7/49		1.13	200
			8/31/49		0.56	170
			5/29/50	328	1.15	
			8/1/50	314	1.01	
			9/12/50	311	0.99	
11N/5E-6G1	315	Irrigation	6/ /49		0.28	147
			8/30/49		0.28	130
			5/8/50	242	0.34	
11N/5E-6Q1	320	Irrigation	6/ /49		0.28	166
			8/30/49		0.28	130
11N/5E-7F1		Irrigation	5/22/51	230	0.39	
11N/5E-7L1		Irrigation	6/15/50	264	0.56	
			5/22/51	245	0.45	
11N/5E-7P1		Irrigation	6/15/50	288	0.68	
			9/12/50	261	0.51	
11N/5E-7R1		Irrigation	5/8/50	317	0.90	
			8/7/50	293	0.76	
			5/22/51	288	0.79	
11N/5E-14P1	480	Irrigation	6/2/50	288	0.70	
11N/5E-14P2	532	Irrigation	6/7/50	250	0.45	
			8/1/50	322	1.21	
			9/12/50	341	1.30	
11N/5E-15G1	135	Irrigation	5/16/50	319	0.93	
11N/5E-16D1	510	Irrigation	5/22/51	241	0.51	
11N/5E-17H1		Irrigation	6/27/49		0.84	152
11N/5E-18H1	480	Irrigation	7/7/49		0.56	160
			8/20/49		0.38	170
			5/22/51	255	0.54	
11N/5E-19A1	338	Irrigation	8/26/49		0.56	190
			8/30/49		0.56	180
11N/5E-19H1	652	Irrigation	7/7/49		0.56	152
			8/30/49		0.28	150
			5/22/51	268	0.62	
11N/5E-19J1	420	Irrigation	8/7/50	262	0.28	
11N/5E-19P1		Irrigation	6/8/49		0.56	182
			8/30/49		0.28	180
			6/27/50	281	0.73	
			9/12/50	292	0.73	
11N/5E-28P1	562	Irrigation	5/16/50	325	1.15	
			8/1/50	315	1.01	
11N/5E-29A1		Irrigation	5/22/51	277	0.62	
11N/5E-29G2		Irrigation	5/26/50	291	0.59	
11N/5E-29H1	303	Irrigation	5/17/50	319	0.82	
			8/7/50	311	0.82	
11N/5E-29K1		Irrigation	8/30/49		0.28	170
			6/2/50	303	0.76	
			8/1/50	295	0.73	
			9/12/50	290	0.73	
			5/22/51	288	0.73	
11N/5E-29K2		Irrigation	8/30/49		0.56	190
			5/17/50	297	0.84	
			8/1/50	290	0.82	
			9/12/50	287	0.82	
			5/22/51	291	0.84	
11N/5E-30A1	220	Irrigation	8/ /49		0.56	162
			8/30/49		0.28	160
11N/5E-31A1	213	Irrigation	7/7/49		1.13	188
			8/ /49		0.56	172
			5/26/50	295	0.68	
			8/1/50	295	0.65	
11N/5E-32N2		Irrigation	6/27/49		0.56	172
			8/31/49		0.28	170
11N/5E-33P1	336	Irrigation	5/22/51	257	0.56	
11N/6E-17J1	210	Irrigation	6/2/50	661	5.55	
			8/2/50	647	3.78	
			9/15/50	629	3.66	
			5/24/51	634	3.58	
12N/4E-2B1		Irrigation	5/17/51	220	0.23	
12N/4E-2Q1		Irrigation	5/24/51	269	0.24	
12N/4E-3A1		Irrigation	5/24/51	300	0.62	
12N/4E-10C1		Irrigation	5/17/51	258	0.28	
			5/24/51	257	0.28	
12N/4E-13R1		Irrigation	5/24/51	245	0.34	
12N/4E-15M1		Irrigation	5/25/51	263	0.31	
12N/4E-24A1		Irrigation	6/2/50	247	0.34	
12N/4E-24F1		Irrigation	5/24/51	232	0.34	
12N/4E-25C1		Irrigation	5/24/51	258	0.45	
12N/4E-34L1		Irrigation	5/24/51	328	0.45	

PARTIAL MINERAL ANALYSES OF GROUND WATERS IN AND ADJACENT TO PLACER COUNTY—Continued

Well number	Depth, in feet	Use	Date of sample	Conductance, Ec ×10⁶ at 25°C.	Cl, in epm	Total solids, in ppm
12N/5E-2B1	220	Irrigation	5/ 8/50	230	0.28	
			8/ 3/50	213	0.25	
			5/23/51	206	0.28	
12N/5E-3A1	310	Irrigation	5/24/50	206	0.25	
			6/28/50	204	0.28	
			8/ 8/50	202	0.28	
12N/5E-3A2	800	Irrigation	5/24/50	199	0.25	
			6/28/50	207	0.28	
12N/5E-4J1		Irrigation	5/24/50	192	0.28	
			9/12/50	207	0.25	
12N/5E-5R1	630	Irrigation	6/ 2/50	242	0.51	
			8/ 1/50	244	0.48	
			5/23/51	240	0.48	
12N/5E-6A1		Irrigation	6/ /49		0.28	133
			8/31/49		0.28	120
			9/13/49		0.28	120
12N/5E-6R1		Irrigation	6/27/49		0.56	120
			8/31/49		0.28	130
			5/ 8/50	207	0.23	
			9/12/50	213	0.28	
12N/5E-9P1		Irrigation	5/24/50	216	0.31	
			9/12/50	210	0.28	
12N/5E-12C1		Irrigation	5/17/51	306	0.59	
12N/5E-13A1		Irrigation	5/16/50	400	1.18	
			5/17/51	373	1.07	
12N/5E-13D1		Irrigation	5/16/50	253	0.39	
12N/5E-14L1		Irrigation	6/ 9/50	281	0.45	
12N/5E-14R1	653	Irrigation	5/17/51	290	0.73	
12N/5E-17A1	475	Irrigation	8/ 7/50	196	0.25	
			9/12/50	188	0.23	
12N/5E-17B1	455	Irrigation	8/17/50	199	0.23	
			9/12/50	190	0.25	
12N/5E-17C1		Irrigation	9/12/50	206	0.25	
12N/5E-18J1		Irrigation	5/23/51	220	0.34	
12N/5E-19C1		Irrigation	6/ 2/50	208	0.28	
			8/ 1/50	207	0.28	
12N/5E-19D1		Irrigation	5/24/51	208	0.28	
12N/5E-23H1	870	Irrigation	5/17/51	436	2.02	
12N/5E-23J1		Irrigation	5/17/51	234	0.54	
12N/5E-30J1		Irrigation	7/ 7/49		0.56	152
			8/ 7/50	335	0.39	
12N/5E-35E1		Irrigation	6/ /49		0.56	200
			9/20/49		0.28	170
			8/ 8/50	297	0.45	
12N/5E-35E2	252	Irrigation	6/ 9/50	268	0.51	
12N/6E-6A1		Irrigation	8/ /49		0.28	145
12N/6E-19A2		Irrigation	5/17/51	321	0.51	
12N/6E-21L1		Irrigation	5/10/50	429	1.58	
			8/ 8/50	430	1.30	
			5/22/51	423	1.21	
12N/6E-21N1		Irrigation	8/ 8/50	514	1.86	
			9/12/50	504	1.89	
			5/22/51	502	1.86	
12N/6E-21P1		Irrigation	5/10/50	399	1.52	
12N/6E-22L2	150	Non-operating	6/ 7/50	7,300	60.56	
12N/6E-27D1		Irrigation	8/25/49		11.53	926
			5/10/50	877	5.35	
			8/ 8/50	1,390	9.72	
			5/22/51	1,813	7.60	
12N/6E-28A1		Irrigation	5/22/51	529	2.82	
12N/6E-28B1		Irrigation	5/10/50	590	3.09	
			8/ 8/50	608	3.21	
			5/22/51	587	5.18	
12N/6E-28M1	116	Irrigation	5/17/50	1,850	13.87	
			8/ 8/50	1,500	11.04	
			9/12/50	1,460	10.65	
12N/6E-29G1		Irrigation	6/19/50	798	4.48	
12N/6E-30L1		Irrigation	6/ /49		0.56	160
			8/31/49		0.28	160
13N/4E-36J1		Irrigation	5/25/51	212	0.20	
13N/5E-7N1		Irrigation	5/10/50	192	0.28	
13N/5E-9H1		Irrigation	8/ 8/50	659	2.93	
13N/5E-9H2	715	Irrigation	5/17/50	395	0.51	
13N/5E-9R1		Irrigation	5/22/51	439	0.28	
13N/5E-10K1		Irrigation	5/22/51	1,899	15.00	
13N/5E-22C2	416	Irrigation	5/23/51	676	3.75	
13N/5E-22P1	465	Irrigation	5/23/51	193	0.28	
13N/5E-23P1	975	Irrigation	5/23/51	172	0.28	
13N/5E-23R2		Irrigation	6/21/50	383	1.52	
			5/23/51	317	1.15	
13N/5E-24A1	82	Irrigation	5/17/50	395	1.35	
13N/5E-25H1	240	Irrigation	8/ /49		0.51	162
			5/22/51	239	0.51	
13N/5E-27C1	442	Irrigation	5/23/51	193	0.34	
13N/5E-27F1	412	Irrigation	5/23/51	169	0.24	
13N/5E-28N1		Irrigation	6/27/49		0.56	118
			9/13/49		0.28	150
			5/ 8/51	204	0.56	
13N/5E-28R1		Irrigation	7/ 7/49		0.28	114
13N/5E-29Q1		Irrigation	6/27/49		0.84	160
13N/5E-30J1		Irrigation	5/18/51	223	0.42	
13N/5E-30L1		Irrigation	5/18/51	197	0.23	
13N/5E-30R1	470	Irrigation	5/18/51	203	0.34	
13N/5E-31G1		Irrigation	7/ 7/49		0.56	137
			9/13/49		0.28	150

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PARTIAL MINERAL ANALYSES OF GROUND WATERS IN AND ADJACENT TO PLACER COUNTY—Continued

Well number	Depth, in feet	Use	Date of sample	Conductance, Ec × 10⁶ at 25°C.	Cl, in epm	Total solids, in ppm
13N/6E-28N1	135	Irrigation	5/17/50	364	1.01	
			5/22/51	365	1.13	
13N/6E-30M1	270	Irrigation	8/31/49		0.28	120
			5/10/50	222	0.37	
			5/22/51	212	0.34	
13N/6E-33C1	391	Irrigation	7/14/49		2.26	330
			5/10/50	1,830	12.55	
			8/8/50	586	2.31	
13N/6E-33K1		Irrigation	9/13/49		0.28	210
			5/10/50	315	0.23	
			8/8/50	316	0.20	
			5/22/51	302	0.23	

Well number	Depth, in feet	Use	Date of sample	Conductance, Ec × 10⁶ at 25°C.	Cl, in epm	Total solids, in ppm
13N/6E-33M1		Irrigation	8/25/49		0.28	180
			5/10/50	290	0.31	
			8/8/50	284	0.28	
			9/15/50	287	0.34	
			5/22/51	288	0.28	
13N/6E-33M2		Irrigation	5/10/50	249	0.23	
			5/22/51	241	0.25	

APPENDIX H

EXISTING POWER HOUSES IN AND ADJACENT TO PLACER COUNTY

EXISTING POWER HOUSES IN AND ADJACENT TO PLACER COUNTY

(Owned by Pacific Gas and Electric Company)

Name	Location, M.D.B.&M.	Stream	Capacity, in kilowatts	Average static head, in feet	Elevation of tailrace U.S.G.S. datum, in feet
Alta	T.16N., R.10E., Sec. 25	Bear River	2,000	660	3,547
Deer Creek	T.17N., R.10E., Sec. 34	South Yuba River	5,700	837	3,661
Drum	T.16N., R.11E., Sec. 17	Bear River	52,000	1,375	3,397
Dutch Flat	T.16N., R.10E., Sec. 27	Bear River	22,000	643	2,730
Halsey	T.13N., R.8E., Sec. 25	Dry Canyon	10,600	331	1,493
Spaulding No. 1	T.17N., R.12E., Sec. 20	South Yuba River	6,400	197	4,829
Spaulding No. 2	T.17N., R.12E., Sec. 20	South Yuba River	3,750	344	4,679
Spaulding No. 3	T.17N., R.12E., Sec. 16	South Yuba River	5,200	318	5,025
Wise	T.12N., R.8E., Sec. 16	Auburn Ravine	12,600	519	906

APPENDIX I

APPLICATIONS TO APPROPRIATE WATER IN PLACER COUNTY, FILED WITH DIVISION OF WATER RESOURCES, DEPARTMENT OF PUBLIC WORKS, UNDER PROVISIONS OF WATER CODE, STATE OF CALIFORNIA

APPLICATIONS TO APPROPRIATE WATER IN PLACER COUNTY, FILED WITH DIVISION OF WATER RESOURCES, DEPARTMENT OF PUBLIC WORKS, UNDER PROVISIONS OF WATER CODE, STATE OF CALIFORNIA

Application number	Date filed	Name of applicant	Source of water supply	Location of diversion point, referenced to Mt. Diablo base and meridian					Amount of diversion		Purpose	Status
				¼	¼	Section	Township	Range	Second-feet	Acre-feet		
548	12/28/16	California Lands Company	Secret Ravine	NW	SW	36	12N	7E	0.22		Irrigation	License
				SW	SW	36	12N	7E				
753	7/30/17	Esther J. Dollar	Slim Jim Creek	near	center	33	16N	17E	0.50		Dam and power	License
1745	3/31/20	Vernon P. Owens	Antelope Ravine	SE	SE	27	12N	7E	0.15		Irrigation	License
1778	4/15/20	Minnie J. Thavanel	Unnamed creek	SW	SW	32	12N	7E	0.037		Irrigation	License
1923	7/19/20	I. R. Sousa, Mary Sousa	Sailors Ravine	SW	NE	34	13N	7E	0.125		Agriculture	License
2190	2/5/21	C. E. Holtz	Capp's Ravine	NW	SW	26	13N	7E	0.12		Agriculture and domestic	License
2753	2/9/22	Pacific Gas and Electric Company	Bear River	SW	SE	22	15N	9E	100		Power	License
2881	6/13/22	Camp Far West Irrigation District	Bear River, Yuba and Placer Counties	NE	SW	21	14N	6E		5,000	Irrigation	License
3038	9/15/22	William Kiessling	Auburn Ravine	S½	NE	16	12N	8E	0.024		Agriculture	License
3789	1/7/24	G. M. Duke	Pennsylvania Ravine	NE	SE	20	11N	7E	0.06		Irrigation	License
3843	2/11/24	Camp Far West Irrigation District	Bear River, Yuba and Placer Counties	NE	NW	29	14N	6E	11.76		Irrigation	License
4026	6/13/24	Jacob and Ida L. Meadows	Two unnamed ravines sometimes known as	NE	SW	27	11N	7E				
			Big Chief Creek and Boulder Creek	NE	SW	27	11N	7E	0.31		Irrigation	License
				NE	SW	27	11N	7E				
4717	8/4/25	Carl L. and Mary F. Virira	Unnamed creek	NW	NE	29	13N	7E	0.075		Irrigation	License
			Unnamed creek	NW	NE	29	13N	7E				
4851	11/30/25	Pacific Gas and Electric Company	Six Mile Valley	SE	NW	25	17N	12E		300	Irrigation, domestic	License
5041	6/1/26	J. J. Desmond	Doty Ravine	NE	NE	12	12N	7E	0.12		Irrigation	License
5184	9/2/26	Peter H. Rosebrook	Unnamed stream	NE	NW	34	16N	16E	17,000	g.p.d.	Irrigation and domestic	License
5413	4/11/27	T. M. Navas	Buckeye Ravine	SW	NW	36	12N	7E	0.19		Irrigation and domestic	License
5633	7/30/27	Department of Finance, State of California	Bear River, Placer and Nevada Counties		NW	30	14N	9E	120	110,000	Power	Application pending
5634	7/30/27	Department of Finance, State of California	Bear River, Placer and Nevada Counties		W½	21	14N	6E	400	110,000	Domestic, irrigation, flood control, salinity control	Application pending
			Bear River, Placer and Nevada Counties		NW	30	14N	9E				
5806	1/16/28	Harold H. and Guilda L. Donnelly, Giles A. and Jeannette A. Martin	Antelope Creek	SE	SE	5	11N	7E	0.11		Irrigation and domestic	License
5830	2/11/28	North Fork Ditch Company	North Fork American River	SE	NW	23	12N	8E	35		Irrigation and domestic	Permit
5887	4/23/28	K. R. Nutting	Flat Ravine	SE	NW	22	15N	13E	1		Mining	License
6039	8/30/28	W. B. Pendleton	Secret Canyon		S½	13	15N	13E	8		Mining	License
6332	6/19/29	Pacific Gas and Electric Company	Bear River	SW	SE	22	15N	9E	120		Power	License
6529	1/9/30	Nevada Irrigation District	Auburn Ravine	NW	NE	13	12N	6E	10		Irrigation	Permit
6540	1/20/30	Manuel Roman	Secret Ravine	SE	SW	10	11N	7E	0.2		Irrigation	License
6828	11/7/30	Bonnie C. Ware	Unnamed spring	NW	SW	1	13N	6E				
			Unnamed stream	NE	SW	1	13N	6E	0.14		Irrigation and domestic	License
			Unnamed stream	SW	SW	1	13N	6E				
6983	6/20/31	Oakwood Investment Company	Griff Creek	Lot	1	18	16N	18E	0.5		Irrigation and domestic	License
7260	5/21/32	Olive Blanche Tillotson	Peavine Creek	SW	SW	14	14N	12E	3		Mining and domestic	License
7334	7/30/32	Tahoe National Forest, United States	Brockway Tract Springs	NW	SE	12	16N	17E	0.05		Domestic and fire	Permit
7457	12/7/32	Annie G. Hardin	Auburn Ravine	SE	NW	28	12N	5E	2.5		Irrigation and stock	License
7564	5/25/33	Mrs. Jane Amundsen	Unnamed stream	SE	NW	11	12N	8E	0.025 16,000	g.p.d.	Irrigation and domestic	License
7577	6/5/33	K. R. Nutting	Unnamed stream	NE	SE	8	13N	10E	2		Domestic and mining	License
7646	8/14/33	Joe Baisa	Secret Ravine	SW	NE	20	11N	7E	0.12		Irrigation and domestic	License
7848	2/14/34	Tahoe National Forest, United States	Creek store spring in Spruce Canyon	NW	SW	8	14N	13E	1,000	g.p.d.	Domestic	License
7936	5/21/34	Department of Finance, State of California	North Fork American River			11	12N	8E	2,500	831,000	Power	Application pending
7937	5/21/34	Department of Finance, State of California	North Fork American River			11	12N	8E		831,000	Irrigation	Application pending

APPLICATIONS TO APPROPRIATE WATER IN PLACER COUNTY, FILED WITH DIVISION OF WATER RESOURCES, DEPARTMENT OF PUBLIC WORKS, UNDER PROVISIONS OF WATER CODE, STATE OF CALIFORNIA—Continued

Application number	Date filed	Name of applicant	Source of water supply	Location of diversion point, referenced to Mt. Diablo base and meridian					Amount of diversion		Purpose	Status
				¼	¼	Section	Township	Range	Second-feet	Acre-feet		
8015	7/ 9/34	Ralph B. Aitken	Antelope Creek	SW	NW	17	11N	7E	0.59		Irrigation	License
				SW	NW	17	11N	7E				
8037	7/25/34	George Mavria	Antelope Creek	SW	NE	25	11N	6E	0.44		Irrigation	License
8054	8/ 6/34	Fred W. Links, T. H. Mugford	Lake Tahoe	NW	NE	22	16N	17E	5,000	g.p.d.	Domestic	Permit
8070	8/16/34	Wendell T. Robie	East Fork Monumental Creek	NE	NE	21	16N	12E	20*		Mining	Permit
			Beaver Creek	SW	SW	12	16N	11E	25*			
			Monumental Creek	SE	NW	16	16N	12E	30*			
			Onion Valley Creek	NE	SW	8	16N	12E	10*			
			North branch, North Fork of North Fork of American River	NE	NW	8	16N	12E	35*			
			Unnamed stream	NE	NE	13	16N	11E	30*			
			Fuldo Creek	NW	NE	12	16N	11E	40*			
			Texas Creek	NW	NW	13	16N	11E	20*			
8175	11/27/34	Nevada Irrigation District	Bear River, Placer and Nevada Counties	SW	SE	22	15N	9E	120		Mining and domestic	Permit
				SW	NW	30	14N	9E		2,000	Mining and domestic	Permit
				SW	NW	2	13N	8E	60		Mining and domestic	Permit
8253	2/23/35	Stephen T. Riolo	Dry Creek	NE	SE	8	10N	6E	0.31		Irrigation	License
8324	5/ 3/35	Ida S. Hunt	Blue Canyon	SW	SE	28	16N	11E	25		Gravel mining	Permit
8726	7/ 6/36	James S. Colvin and W. D. Ledoux	West Branch Mosquito Creek	NW	NW	24	14N	12E	0.3		Mining and domestic	License
8928	3/29/37	Tahoe National Forest, United States	Temperance Creek	SE	NW	17	14N	11E	5,000	g.p.d.	Domestic and fire	License
8968	5/ 8/37	Ida S. Hunt	Rocky Springs	NW	SE	28	16N	11E	2.5		Mining and domestic	Permit
8985	6/ 3/37	Red Star Mining Company	Middle Fork American River	Lot	6	36	15N	13E	25		Mining	License
9133	10/ 2/37	Olive Blanche Tillotson	Peavine Creek	SW	SW	14	14N	12E	3		Power	Permit
9142	10/ 9/37	North Fork Ditch Company	North Fork American River	SW	NW	31	13N	9E		6,500	Irrigation	Permit
				SE								
9174	11/ 8/37	A. E. Bomar	Linda Creek	NW	NW	17	10N	7E	3		Irrigation	
9500	1/31/39	Harold L. and Guilda L. Donnelly and Giles A. and Jeannette A. Martin	Antelope Creek	SE	SE	5	11N	7E	0.23		Irrigation	License
					SE	5	11N	7E				
9536	3/30/39	Estate of John F. Thompson	El Dorado Canyon	SE	NE	19	15N	12E	75		Mining and domestic	Permit (Suspended)
			West Branch El Dorado Canyon	SW	NE	26	15N	11E	75			
			Volcano Canyon	SE	SE	9	14N	11E	75			
			Volcano Canyon	NW	NW	21	14N	11E				
9655	7/ 5/39	Eldorado National Forest, United States	Buckeye Spring	SW	SE	12	13N	11E	1,600	g.p.d.	Domestic, recreation, stock	License
9697	8/15/39	George S. Wheeler	Little Grizzly Creek	SW	NE	36	15N	12E	3		Mining, milling, domestic	Permit
9816	1/29/40	Tahoe National Forest, United States	Unnamed spring	SE	NW	6	15N	11E	6,500	g.p.d.	Recreation and fire	License
10012	9/24/40	Ray and Lillian Lafaille	Badger Ravine	NW	NE	21	12N	7E		18		
			Badger Ravine	NE	NW	21	12N	7E	1.0	25		
			Badger Ravine	SE	SW	16	12N	7E		20		
			Unnamed stream	SW	SW	16	12N	7E	0.2	9	Irrigation	Permit
10038	10/17/40	Tahoe National Forest, United States	Summit Springs No. 1 and No. 2	NW	NE	20	17N	15E	0.037 or 12,000 g.p.d. from each spring		Recreation and domestic	Permit
10039	10/17/40	Tahoe National Forest, United States	Emigrant Valley Spring	SE	NW	28	17N	15E	0.05		Recreation and domestic	Permit
10131	2/20/41	Tahoe National Forest, United States	Onion Creek Spring	SW	SW	1	16N	14E	0.015 9,700	 g.p.d.	Recreation, fire, domestic	Permit
10190	4/28/41	Camp Far West Irrigation District	Bear River, Yuba and Placer Counties	NE	SW	21	14N	6E		5,000**	Irrigation	License
10205	5/12/41	California Placer Mines, a partnership	Sailor Canyon	SW	SE	2	15N	13E	150		Mining and domestic	Permit
			New York Canyon	Lot	18	3	15N	13E				
			Little Sailor Canyon	Lot	27	2	15N	13E				
10221	6/13/41	Department of Finance, State of California	Bear River	W½		21	14N	6E	250	40,000	Domestic, irrigation, flood control, salinity control	Application pending
10445	5/ 6/42	Tahoe National Forest, United States	Long Valley Spring	NE	NW	8	16N	14E	2,000	g.p.d.	Stockwatering	License
10737	12/ 6/43	A. E. Bomar	Linda Creek	NW	NW	17	10N	7E		22	Irrigation, stockwatering	Permit
10751	1/18/44	Elmer A. Johnson	Unnamed stream	NE	NE	19	12N	7E	0.2		Irrigation, stockwatering	Permit

APPLICATIONS TO APPROPRIATE WATER IN PLACER COUNTY, FILED WITH DIVISION OF WATER RESOURCES, DEPARTMENT OF PUBLIC WORKS, UNDER PROVISIONS OF WATER CODE, STATE OF CALIFORNIA—Continued

Application number	Date filed	Name of applicant	Source of water supply	Location of diversion point, referenced to Mt. Diablo base and meridian					Amount of diversion		Purpose	Status
				¼	¼	Section	Township	Range	Second-feet	Acre-feet		
10840	7/17/44	R. H. Johnson	Tributary to Antelope Creek	NE	NW	19	11N	7E	0.2		Domestic and irrigation	Permit
10962	1/25/45	Charles M. Muskavitch	East Branch of Mormon Ravine	NW	NW	34	12N	8E	100	g.p.d.	Domestic and fire	License
11007	3/16/45	Red Star Mining Company	Middle Fork American River	Lot	6	36	15N	13E	42		Mining	License
11157	9/19/45	Tahoe National Forest, United States	Tadpole Spring	Lot	7	4	15N	13E	1,800	g.p.d.	Recreation and stock	License
11165	10/ 1/45	B. L. and Vernell E. Helm	Unnamed stream	NW	NW	15	10N	6E	6,000	g.p.d.	Irrigation	License
11258	1/10/46	G. F. Cane	Unnamed stream	NW	SW	27	11N	7E	0.75	10	Irrigation	Permit
11291	2/21/46	Fred F. Chapeauh	Miners Ravine	NE	SW	33	11N	7E	1		Irrigation	Permit
11449	6/25/46	Lake Tahoe Gold Mining Company	Ellis Creek	NW	SE	11	14N	16E	2		Mining and domestic	Permit
11454	7/ 1/46	James S. Colvin	East Branch Mosquito Creek	SE	SW	13	14N	12E	1		Mining and domestic	Permit
11523	8/21/46	Francis E. Holsclaw	Unnamed spring	NE	SW	16	14N	12E	0.05	1	Irrigation, domestic, fire	Permit
11524	8/21/46	Francis E. Holsclaw	Unnamed spring	NE	SW	16	14N	12E	18,000	g.p.d.	Recreation and domestic	Permit
11565	9/23/46	Basil T. Rogers	Miners Ravine	SE	NE	6	11N	8E	0.05		Irrigation and stock	License
11567	9/27/46	A. B. and Dorothy M. Reading	Two unnamed springs	NE	SW	27	12N	7E	0.05		Irrigation and domestic	Permit
11740	2/20/47	Joseph Galletto	Secret Ravine	SE	SE	17	11N	7E	0.25		Irrigation	Permit
11759	3/ 7/47	Estate of Herb Maxwell	Unnamed stream	NE	SW	9	15N	12E	0.025		Industrial and domestic	
			Indian Creek	NW	SW	9	15N	12E	0.025	8	Industrial and domestic	License
11787	3/19/47	Tahoe National Forest, United States	Unnamed spring	SW	SW	26	14N	11E	1,000	g.p.d.	Recreation	Permit
11797	3/25/47	W. E. Albertson and Edna Putnam Albertson	Ingram Slough	SW	NE	29	12N	6E	0.57		Irrigation and stock	License
11834	4/22/47	Tahoe National Forest, United States	Island Spring	NW	SW	32	16N	17E	0.01		Domestic and recreation	Permit
11835	4/22/47	Tahoe National Forest, United States	North Avenue Spring No. 1	NW	SW	12	16N	17E	3,500	g.p.d.	Domestic	
			North Avenue Spring No. 2	NW	SW	12	16N	17E	3,000	g.p.d.	Domestic	Permit
12007	7/24/47	El Dorado National Forest, United States	Jerrett Spring	SW	SE	8	14N	14E	9,360	g.p.d.	Domestic and fire	License
12036	8/12/47	Tahoe National Forest, United States	Pagge Creek	SE	SE	20	15N	11E	1,950	g.p.d.	Domestic and fire	License
12037	8/12/47	Tahoe National Forest, United States	Unnamed spring	NW	NW	31	15N	14E	1,950	g.p.d.	Domestic and fire	License
12040	8/13/47	Pat Walters	Grapevine Ravine	NW	NE	17	12N	7E		30	Irrigation and stock	Permit
				NW	NE	20	12N	7E		15		
12080	9/10/47	Allan F. and Evelyn E. Pollitt	Unnamed spring	NW	SW	32	16N	17E	1,440	g.p.d.	Domestic	Permit
12148	11/ 3/47	Virgil C. Jones	Unnamed spring No. 1	NE	NE	36	17N	14E	12,000	g.p.d.	Domestic and fire	Permit
			Unnamed spring No. 2	NE	NE	36	17N	14E	6,000	g.p.d.		
12335	2/16/48	Lawrence K. and Maryetta E. Snyder	Unnamed spring	SW	NW	22	14N	9E	0.025	0.0	Irrigation and domestic	Permit
			Live Oak Creek	SW	NW	22	14N	9E	0.050	3.0		
12445	3/31/48	William F. Hacker	Secret Ravine	NE	SE	16	11N	7E	0.31		Irrigation, stock, domestic	License
12456	3/31/48	County of Placer	North Fork American River	W½		13	16N	14E	25	15,000	Irrigation, municipal, domestic, and stockwatering	Application pending
					SW	30	16N	13E	100	100,000		
				W½		4	15N	11E	100	100,000		
				S½		1	15N	10E	25			
			Shirttail Canyon	E½		25	15N	10E	25	10,000		
			Middle Fork American River		NW	36	15N	13E		200,000	Irrigation, municipal, domestic, and stockwatering	Application pending
			Rubicon River			2	14N	14E		250,000		
						16	14N	14E				
			North Fork American River			11	12N	8E	800			
12457	3/31/48	County of Placer	Rubicon River			2	14N	14E	500	250,000		
						16	14N	14E			Power	Application pending
					SE	27	13N	12E	600			
			Middle Fork American River		NW	36	15N	13E	500			
					NE	36	14N	12E	700	200,000		
					W¼	2	13N	11E	2,000			

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Application number	Date filed	Name of applicant	Source of water supply	Location of diversion point, referenced to Mt. Diablo base and meridian					Amount of diversion		Purpose	Status
				¼	¼	Section	Township	Range	Second-feet	Acre-feet		
12458	3/31/48	County of Placer	American River			24	10N	1E		250,000	Irrigation and municipal	Application pending
12488	4/28/48	Barbara M. and Paul A. Kneebone	Unnamed spring	NW	NE	8	13N	9E	0.025		Stock and irrigation	Permit
12546	6/14/48	George C. Roeding, Jr.	Antelope Creek	SW	SE	8	11N	7E	2		Irrigation and domestic	Permit
			Unnamed stream	NW	SE	17	11N	7E				
12574	6/29/48	Oakwood Investment Company	Griff Creek	Lot 1		18	16N	18E	1		Municipal	Permit
12687	9/10/48	G. B. and Eula M. Huston	Unnamed stream No. 1	NW	NW	34	16N	16E	0.15		Domestic and industrial	Permit
			Unnamed stream No. 2	NW	NW	34	16N	16E	0.15			
12689	9/10/48	County of Placer	Silver Creek			30	12N	14E	1,000	250,000	Power	Application pending
12690	9/10/48	County of Placer	Silver Creek			30	12N	14E	1,000	250,000	Irrigation and domestic	Application pending
12691	9/10/48	County of Placer	American River			24	10N	7E		200,000	Irrigation and domestic	Application pending
12710	9/24/48	Tahoe National Forest, United States	Unnamed stream	Lot 19		3	15N	14E	0.06 6 mos.		Domestic, recreation, fire	Permit
12719	9/28/48	County of Placer and County of El Dorado jointly	American River			24	10N	7E	2,000	900,000	Power	Application pending
12731	10/7/48	Tahoe National Forest, United States	Talbot Creek	Lot 8		2	15N	14E	0.08 6 mos.		Domestic, recreation, fire	Permit
12732	10/7/48	Tahoe National Forest, United States	Rice Creek	NW	NW	14	15N	14E	0.05 6 mos.		Recreation, domestic, fire	Permit
12733	10/7/48	Tahoe National Forest, United States	Unnamed stream No. 1	Lot 21		2	15N	14E	0.01 6 mos.		Domestic, recreation, fire	Permit
			Unnamed stream No. 2	NW	SW	2	15N	14E	0.01 6 mos.		Domestic, recreation, fire	Permit
12735	10/7/48	Tahoe National Forest, United States	Dolly Creek	SW	SW	14	15N	14E	0.05		Domestic, fire, recreation	Permit
12755	10/25/48	County of El Dorado and County of Placer jointly	North Fork American River, Placer and El Dorado Counties			11	12N	8E	4,000	831,000	Power	Application pending
12756	10/25/48	County of Placer	North Fork American River	W½		31	13N	9E	1,000	16,000	Irrigation, domestic, stock	Application pending
12757	10/25/48	County of Placer	North Fork American River	W½		31	13N	9E	2,000	16,000	Power	Application pending
12759	10/25/48	County of El Dorado and County of Placer jointly	North Fork American River, Placer and El Dorado Counties			11	12N	8E	4,000	831,000	Irrigation, domestic, stock	Application pending
12786	11/4/48	County of Placer	North Fork American River (a)	N½		14	16N	14E		5,000	Irrigation, domestic, and stock	Application pending
			North Fork American River (b)		NE	20	16N	14E	100	10,000		
			Shirttail Canyon (c)	E½		17	15N	11E	25	5,000		
12787	11/4/48	County of Placer	North Fork American River (a)	E½		5	15N	11E	1,000#	100,000	Power	Application pending
			North Fork American River (b)	S½		1	15N	10E	1,250#	200,000		
			North Fork American River (c)	W½		21	15N	10E	1,500#	100,000		
			North Fork American River (d)	N½		30	14N	10E	2,000#	100,000		
12788	11/4/48	County of Placer	North Fork American River (a)	E¼		5	15N	11E	1,000#	100,000	Irrigation, domestic, and stockwatering	Application pending
			North Fork American River (b)	S¼		1	15N	10E	1,250#	200,000		
			North Fork American River (c)	W¼		21	15N	10E	1,500#	100,000		
			North Fork American River (d)	N¼		30	14N	10E	2,000#	100,000		
12790	11/5/48	Tahoe National Forest, United States	Unnamed stream	NE	SE	3	15N	16E	3,000 g.p.d.		Domestic	Permit
12791	11/5/48	Tahoe National Forest, United States	Unnamed spring	SW	NE	12	15N	16E	3,000 g.p.d.		Domestic	Permit
12849	12/6/48	Edmund B. Rippey	Unnamed spring	NW	NW	26	11N	7E	0.025		Domestic	Permit
12944	2/21/49	Joseph and Adele Zasso	Dutch Ravine	SE	NW	23	12N	7E	0.31		Irrigation and stock	Permit
12952	2/24/49	County of Placer and County of El Dorado jointly	American River			25	10N	7E	2,000	600,000	Power	Application pending
12967	3/9/49	Mrs. Florence P. Scribner	Two unnamed springs	SE	SE	21	14N	9E	0.1		Domestic and irrigation	Permit
12968	3/10/49	Tahoe National Forest, United States	Unnamed creek	NW	NE	3	15N	16E	0.005 3,250 g.p.d.		Domestic and fire	Permit

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Application number	Date filed	Name of applicant	Source of water supply	Location of diversion point, referenced to Mt. Diablo base and meridian					Amount of diversion		Purpose	Status
				¼	¼	Section	Township	Range	Second-feet	Acre-feet		
13055	4/26/49	Frank H. and Blanche H. Stark	Unnamed spring	NE	NW	26	11N	7E	0.025		Domestic and irrigation	Permit
13075	5/ 6/49	Ervin O. and Polly Perkuri	Secret Ravine	NE	SW	20	11N	7E	0.05		Irrigation, domestic, and stockwatering	License
13145	6/ 9/49	Dr. Henry C. Petroy	Unnamed stream	NE	NW	34	16N	16E	8,000 g.p.d.		Domestic	Permit
13160	6/17/49	John H. Lienau	Live Oak Creek	SE	NW	22	14N	9E		25	Fish culture	Permit
13172	6/23/49	John H. Lienau	(1) Live Oak Creek	SE	NW	22	14N	9E	22 g.p.m.		Fish propagation	Permit
			(2) An unnamed stream	SE	NW	22	14N	9E				
13274	8/ 2/49	A. C. Moorhead and Margaret Moorhead and Allen Morrow and Pauline Morrow	Unnamed stream	NE	NW	34	16N	16E	0.0062		Domestic	Permit
13370	10/ 1/49	Bureau of Reclamation, United States of America	American River	NW	SE	24	10N	7E	5/1– 8,000	11/1 1,000,000	Irrigation	Application pending
13371	10/ 1/49	Bureau of Reclamation, United States of America	American River	NW	SE	24	10N	7E	700	300,000	Municipal, industrial, domestic, and recreation	Application pending
13377	10/ 3/49	County of Placer	(1) El Dorado Canyon	SW	NE	19	15N	12E	10			
			(2) West Branch El Dorado Canyon	SE	NE	26	15N	11E	10	200	Irrigation and domestic	Application pending
			(3) Bullion Mine Tunnel	NW	SE	26	15N	11E	15			
13378	10/ 3/49	County of Placer	(1) El Dorado Canyon	SW	NE	19	15N	12E	10			
			(2) West Branch El Dorado Canyon	SE	NE	26	15N	11E	10	200	Mining and domestic	Application pending
			(3) Bullion Mine Tunnel	NW	SE	26	15N	11E	15			
13379	10/ 3/49	County of Placer	(1) El Dorado Canyon	SW	NE	19	15N	12E	10			
			(2) West Branch El Dorado Canyon	SE	NE	26	15N	11E	10	200	Industrial and domestic	Application pending
			(3) Bullion Mine Tunnel	NW	SE	26	15N	11E	15			
13394	10/11/49	Ralph B. Aitken	Antelope Creek	SW	NW	17	11N	7E		25	Irrigation	Permit
13419	10/26/49	J. A. Beek	Miners Ravine	NE	NE	35	11N	7E	0.65	72	Irrigation	Permit
13478	11/22/49	County of Placer	(1) Brimstone Creek		NW	5	14N	11E	10	1,000	Irrigation and domestic	Application pending
			(2) Mill Creek		NW	17	14N	11E	5			
13479	11/22/49	County of Placer	(1) Brimstone Creek		NW	5	14N	11E	10	1,000	Mining	Application pending
			(2) Mill Creek		NW	17	14N	11E	5		Mining	
13480	11/22/49	County of Placer	(1) Brimstone Creek		NW	5	14N	11E	10	1,000	Industrial	Application pending
			(2) Mill Creek		NW	17	14N	11E	5			
13513	12/16/49	Alta L. Asbcraft	Unnamed spring	SE	SE	21	14N	9E	0.01		Domestic	Permit
13542	1/18/50	W. D. Byers	Unnamed creek	NW	SE	12	12N	6E	0.5		Irrigation and domestic	Permit
13611	3/ 1/50	Charles H. and Minnie B. Barrett	Unnamed spring	SE	NW	8	13N	9E	4/15– 0.025	11/15	Domestic	Permit
13613	3/ 1/50	American River Pine Company	Spruce Creek	NW	SW	8	14N	13E	0.01		Fire, industrial, domestic	Permit
13655	3/28/50	Lester G. Hammond	Unnamed stream	NW	NW	35	13N	8E	5/1– 0.05	12/1	Domestic and irrigation	Permit
13670	4/ 3/50	Oliver Michael Browne	Deep Canyon Creek	NE	SW	15	15N	13E	1.25		Mining and domestic	Permit
13698	4/19/50	John K. Wilson	Unnamed stream	NW	SE	26	12N	7E	0.025	2.5	Domestic	Permit
13718	5/ 3/50	O'Farrell Welch	Unnamed stream	NE	SE	23	11N	7E	5/1–10/31	11/1–4/30 10	Irrigation and stock	Permit
13727	5/10/50	Blanche Schaw	Unnamed stream	NW	SW	20	11N	7E	10/15 0.13	–4/15	Irrigation and stock	Permit
13740	5/15/50	Alexander E. Buck	Unnamed stream	NE	NW	12	12N	6E	0.965	1.15	Irrigation	Permit
13748	5/22/50	Woodrow F. Larimore	Capps Ravine	NW	SW	26	13N	7E	4/1–10/31	10/1–4/1 8	Irrigation	Permit
13804	6/19/50	Ellis and Laura D. Petty	Strap Ravine	SE	SE	3	10N	7E	4/1–10/1 0.125	11/1–4/1	Irrigation	Permit
13818	6/27/50	Tahoe National Forest, United States	Silver Creek	SW	NE	21	16N	16E	0.01		Domestic and recreation	Permit
13839	7/ 6/50	Verner G. and Elma E. Kokila	Unnamed stream (1)	SE	NE	34	11N	7E	5/1–10/30	11/1–4/30 38	Irrigation and recreation	Permit
			Unnamed stream (2)	NE	SE	34	11N	7E	0.125	10		
13849	7/17/50	T. E. Allen	Unnamed stream	SE	SW	19	12N	7E	4/1–10/1 0.5 [a]	2/1–4/1 3.25	Domestic and irrigation	Permit

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Application number	Date filed	Name of applicant	Source of water supply	Location of diversion point, referenced to Mt. Diablo base and meridian: ¼	¼	Section	Township	Range	Amount of diversion: Second-feet	Acre-feet	Purpose	Status
13850	7/17/50	C.M. Newell	Unnamed stream	SE	SW	19	12N	7E	4/1–10/1	2/1–3/31	Domestic and irrigation	Permit
									0.5	17.5		
13866	7/25/50	Sandy Scott Caples	Spruce Canyon Creek	SW	SW	17	14N	13E	3		Mining	Permit
13893	8/14/50	Greenhalgn Bros. and Earl McNeely	Unnamed creek	SE	SW	17	10N	7E	11/1–	4/30	Irrigation and stock	Permit
										33		
13938	9/ 6/50	Henry H. Nader	Coon Creek	SE	NW	31	13N	6E	5/1–10/1		Irrigation	Permit
									1.3			
13944	9/ 8/50	H. J. Phillips	Unnamed drain	SE	NE	21	12N	6E	1.0	4/1–7/1	Irrigation	Permit
14060	11/20/50	California Fish and Game Commission	Lake Tahoe	NE	NE	5	15N	17E	20		Fish culture	Permit
14193	3/14/51	Tahoe National Forest, United States	Elliott Meadow Spring	SW	NE	9	15N	11E	0.03		Stock and irrigation	Permit
14194	3/14/51	Tahoe National Forest, United States	Elliott Ranch Spring	SE	NE	9	15N	11E	0.08		Domestic, stock and irrigation	Permit
14195	3/14/51	Tahoe National Forest, United States	Bear Spring	NE	NW	18	14N	13E	6,500	g.p.d.	Domestic and stockwater	Permit
14196	3/14/51	Tahoe National Forest, United States	Chicken Hawk Spring	NW	SE	34	15N	11E	0.01		Domestic and stock	Permit
14197	3/ 4/51	Tahoe National Forest, United States	Orchard Spring	NE	SE	8	15N	11E	0.02		Stock water	Permit
14198	3/14/51	Tahoe National Forest, United States	Secret House	Lot	10	1	15N	12E	0.04		Domestic, stock, fire, industrial	Permit
14229	4/ 5/51	Fred W. Boole	Unnamed spring	NW	NE	9	13N	9E		100	Irrigation, domestic, recreation, fire	Permit
14244	4/10/51	Robert M. and June I. Maxwell	Unnamed canyon (1)	NE	NW	12	11N	7E	0.238		Irrigation and stockwatering	Permit
			Unnamed canyon (2)	NE	NW	12	11N	7E	0.112			
			Unnamed canyon (3)	NW	NW	12	11N	7E	0.025			
14264	4/23/51	James E. Webb	Rock Creek	SE	NW	34	13N	8E	0.05		Domestic, irrigation, and stock	Permit
14265	4/23/51	Raymond and Stanley Woodward	Rock Creek	SE	NW	34	13N	8E	0.05	12	Irrigation, domestic and stock	Permit
14266	4/23/51	Alvin W. Musso	Unnamed creek	SE	NE	34	13N	8E	0.375		Irrigation	Permit
14291	5/ 3/51	William Carman	Unnamed stream	SE	NE	35	14N	9E	600	g.p.d.	Irrigation, domestic, and stock	Permit
14328	5/29/51	Antonio and Francis Montero	Antelope Creek	NE	NW	17	11N	7E	0.15		Irrigation	Permit
14356	6/21/51	Wilmer Norman Stark	Unnamed stream	NE	NW	11	15N	16E	0.02		Domestic and irrigation	Permit
14370	6/27/51	Lloyd E. Dixon and Rae A. Dixon	Dirty Face Ravine	NE	SE	29	12N	8E	0.07		Irrigation and stock	Permit
14389	7/12/51	D. L. Castle and Lillian D. Castle	Unnamed spring	SE	NW	26	13N	8E	0.28		Irrigation and stock	Permit
14410	7/30/51	Ruby Horn	Secret Ravine	SE	SW	10	11N	7E	0.10	4/1–10/31	Irrigation	Permit
14439	8/23/51	Howard A. and Tillie E. Grebin	Unnamed ravine	NE	SW	17	12N	7E		3.0	Irrigation and recreation	Permit
14469	9/ 6/51	Francis E. Holsclaw	Unnamed stream	SE	SE	3	11N	7E	0.125	15	Irrigation	Permit
14478	9/11/51	Estate of George P. Ahart and Nellie G. Tucker	Coon Creek (1)	SW	NE	36	13N	5E	0.75		Irrigation	
			Coon Creek (2)	SE	SW	35	13N	5E	0.75			Permit
14479	9/11/51	Floyd R. Bonnifield	Coon Creek (1)	SE	NW	34	13N	5E	0.75			
			Coon Creek (2) (Placer County)	NE	SW	34	13N	5E	0.75		Irrigation	Permit
									4/1–11/1			
14480		Richard H. Mariner	Coon Creek (1) (Sutter County)	NW	SW	35	13N	5E	1.15			
									4/1–11/1			
			Coon Creek (2)	NE	SE	33	13N	5E	0.85		Irrigation	Permit
14482	9/12/51	Harold W. and Norma E. Brown	Coon Creek (1)	SE	NE	34	13N	5E	0.63			Permit
			Coon Creek (2)	SW	NE	34	13N	5E	0.63		Irrigation	Permit
14508	10/ 3/51	Leslie A. Elliott	Unnamed stream	NE	NW	34	16N	16E	8,000	g.p.d.	Domestic	Permit
14525	10/16/51	J. A. Beek	Miners Ravine (1)	NW	SE	35	11N	7E	0.56	18	Irrigation	
			Unnamed stream (2)	SE	SE	35	11N	7E			Recreation	Permit
14545	11/ 1/51	Elmer A. and Mattie Van Dyke Johnson	An unnamed draw	SW	NW	20	12N	7E	0.05	6	Irrigation	Permit
14620	1/15/52	Tony Aquilar	Unnamed stream	SE	NW	34	12N	7E		10	Irrigation	Permit
14650	1/21/52	Godfrey W. Rodgers	Strap Ravine (1)	NW	NE	10	10N	7E	0.66	15		
			Unnamed stream (2)	NW	NE	10	10N	7E		5	Irrigation	Permit
14704	3/ 6/52	Nevada Irrigation District	Bear River			5	13N	7E	15		Irrigation	Application pending

APPLICATIONS TO APPROPRIATE WATER IN PLACER COUNTY, FILED WITH DIVISION OF WATER RESOURCES, DEPARTMENT OF PUBLIC WORKS, UNDER PROVISIONS OF WATER CODE, STATE OF CALIFORNIA—Continued

Application number	Date filed	Name of applicant	Source of water supply	Location of diversion point, referenced to Mt. Diablo base and meridian: ¼	¼	Section	Township	Range	Amount of diversion: Second-feet	Acre-feet	Purpose	Status
14705	3/ 6/52	Nevada Irrigation District	Coon Creek	NE	NW	17	13N	7E		41,000	Irrigation	Application pending
14719	3/19/52	Doyle Brothers	Linda (Dry) Creek	SE	NE	7	10N	6E	6/1–9/30 0.07		Irrigation	Permit
14731	3/25/52	Delbert and Bernice Dowd	Markham Ravine	SE	NE	14	12N	5E	0.38		Irrigation	Permit
14773	4/23/52	Vernon S. and Edna Jaquith and Barbara J. Haffey	Unnamed stream (1)						0.25	1.5	Irrigation and stockwatering	
			Unnamed stream (2)						0.25	24		
			Campbell Creek (3)							15		Permit
14791	5/ 2/52	John F. Tompson Estate, c/o W. E. Wilson	El Dorado Canyon (1)	SW	NE	19	15N	12E	15		Mining and incidental	
			West Branch El Dorado Canyon (2)	SE	NE	26	15N	11E	15		Domestic	Permit
14921	7/21/52	Lake Forrest Water Company	Lake Tahoe	NE	NW	4	15N	17E	0.23		Domestic	Permit
14989	8/21/52	Val M. Jacobson	Unnamed creek	SW	SE	20	11N	7E	0.03		Irrigation	Permit
15013	9/10/52	Mabel Wadhams Comeau	Unnamed stream	SW	SW	20	13N	9E	0.25		Mining, domestic, stockwatering	Permit
15030	9/24/52	Doyle Brothers	Linda (Dry) Creek	SE	NE	7	10N	6E	0.7		Irrigation	
			Linda (Dry) Creek	SE	NE	7	10N	6E	1.3			Permit
15042	10/ 7/52	Joseph L. Walker	Unnamed stream	SW	NW	9	13N	9E		10	Irrigation	Permit
15043	10/ 7/52	Frank and Marguerite Nute	Unnamed stream	NE	NE	21	11N	7E		40	Irrigation	Permit
15058	10/21/52	Virgil W. and Cathryn G. Zumalt	Linda (Dry) Creek	NW	SW	12	10N	5E	0.31		Irrigation	Permit
			Linda (Dry) Creek	NW	SW	12	10N	5E	0.31		Irrigation	Permit
15059	10/21/52	Clifford W. and Bette Faye Greene	Linda (Dry) Creek	NW	SW	12	10N	5E	0.5		Irrigation	Permit
			Linda (Dry) Creek	SE	NW	12	10N	5E				
15066	10/28/52	Morton S. Martin	Unnamed spring	NE	SE	3	15N	13E	800	g.p.d.	Domestic	Application pending
15067	10/28/52	Morton S. Martin	Unnamed spring	Lot 7		3	15N	13E	600	g.p.d.	Domestic	Application pending
15073	11/ 5/52	Joseph Opich	Linda (Dry) Creek	NE	SW	10	10N	6E	0.175		Irrigation	Permit
15077	11/ 5/52	Verner G. and Elma E. Kakila	Unnamed stream	SE	NE	34	11N	7E		17	Recreation and irrigation	Permit
15107	12/ 8/52	Everett J. Smith, Texas Smith and John H. Wilson	Unnamed stream	SW	NW	18	11N	8E	0.44		Irrigation and stock	Application pending
15108	12/ 8/52	Antone S. Riolo	Linda (Dry) Creek	SE	NE	12	10N	5E	1.10		Irrigation	Permit
15109	12/ 8/52	Steve H. Riolo	Linda (Dry) Creek	SW	NE	12	10N	5E	1.10		Irrigation	Permit
15128	12/19/52	C. V. and Rose Matranga	Linda (Dry) Creek	SW	NW	9	10N	6E	0.41		Irrigation	Permit
15133	12/22/52	Alfred B. and Ruth S. Clark	Linda Creek	NE	SE	9	10N	6E	1.75		Irrigation and domestic	Permit
				NW	SW	10	10N	6E	1.00			
15143	1/ 2/53	Pedro A. Galvez	Linda (Dry) Creek	NE	SW	10	10N	6E	0.06		Irrigation	Application pending
15167	1/21/53	Annie Barca	Linda (Dry) Creek	NE	SW	12	10N	5E	0.5		Irrigation	Permit
15182	2/ 2/53	Herman H. Gastman	North Fork Dry Creek	NW	NW	14	13N	8E		180	Irrigation	Permit
15183	2/ 2/53	Cyril Spinelli	Linda (Dry) Creek	SE	SE	11	10N	5E	1.9		Irrigation	Permit
15298	4/17/53	Ralph E. Enzler	South Fork Dry Creek	SW	NW	22	13N	8E	1.25		Irrigation	Application pending
15307	4/22/53	J. E. Stambuck	Linda (Dry) Creek	NW	SW	9	10N	6E	0.5		Irrigation	Application pending

* Total not to exceed 90 second-feet at any time.

** 5,000 acre-feet maximum collectable, but amount collected by License 2266 (Application 2881) plus that collected by this license limited to 5,000 acre-feet.

c These are maximum amounts from any one point, the total of any or all not to exceed 2,000 second-feet.

a Total diversion not to exceed 50 acre-feet per annum.

APPENDIX J

EXISTING DAMS IN AND ADJACENT TO PLACER COUNTY

EXISTING DAMS IN AND ADJACENT TO PLACER COUNTY, 1950

Name	Owner	County	Stream	Location M.D.B. & M.			Type	Crest length, in feet	Crest height, in feet	Elevation crest above sea level, in feet	Capacity, in acre-feet	Date constructed	Use
				Section	Township	Range							
Baldwin	North Fork Ditch Company	Placer	Tributary, Strap Ravine	14	10N	7E	Earth	1,850	41	394	305	1929	Irrigation
Blue Lake	Pacific Gas and Electric Company	Nevada	Tributary, Rucker Creek	9	17N	12E	Earth, rockwall	230	23	5,964	1,123	1870	Power
Bowman	Nevada Irrigation District	Nevada	Canyon Creek	5	18N	12E	Rockfill	700	171	5,567	68,000	1927	Irrigation
			Tributary, Canyon Creek	8	18N	12E	Arch	400	108				
Campbells Lake, Upper	Central Pacific Railway Company	Placer	Tributary, South Fork Yuba River	30	17N	13E	Gravity, masonry	54	11	6,324	87	1911	Domestic
Camp Far West	Camp Far West Irrigation District	Placer	Bear River	21	14N	6E	Gravity, curved	365	62	198	5,000	1928	Irrigation
Christian Valley	Pacific Gas and Electric Company	Placer	South Fork Dry Creek	26	13N	8E	Rockfill	222	33	1,457	110	1916	Power
Clover Valley	Pacific Gas and Electric Company	Placer	Tributary, Antelope Creek	28	12N	7E	Earth	180	35	654	29	1909	Power
Columbian	Ethel Mulligan	Placer	Tributary, Auburn Ravine	16	12N	7E	Earth	600	53.4	600	132	1895	Irrigation
Combie	Nevada Irrigation District	Nevada	Bear River	2	13N	8E	Variable radius arch	762	85	1,610	9,000	1928	Irrigation
Crystal Lake	Central Pacific Railway Company	Nevada	Tributary, South Fork Yuba River	24	17N	12E	Gravity, straight	300	9	5,895	200	1920	Domestic
Culbertson	Pacific Gas and Electric Company	Nevada	Tributary, Texas Creek	15	18N	12E	Earth, rockwall	258	19	6,708	850	1872	Power
Deer Creek Diver.	Nevada Irrigation District	Nevada	Deer Creek	10	16N	9E	Variable radius arch	334	92	2,902	1,400	1928	Irrigation
Donner Lake	Sierra Pacific Power Company and Truckee Carson Irrigation Dist.	Nevada	Donner Creek	18	17N	16E	Slab and buttress	45	16	5,937	11,000	1927	Irrigation
Drum Afterbay	Pacific Gas and Electric Company	Nevada	Bear River	17	16N	11E	Constant radius arch	324	80	3,385	275	1924	Power
Drum Forebay	Pacific Gas and Electric Company	Placer	Tributary, Bear River	16	16N	11E	Earth	2,620	53	4,766	444	1913	Power
French Lake	Nevada Irrigation District	Nevada	Canyon Creek	17	18N	13E	Rockfill	200	100	6,664	12,500	1859	Irrigation
Fuller Lake	Pacific Gas and Electric Company	Nevada	Jordan Creek	17	17N	12E	Earth	365	36	5,379	1,130	1870	Power
Halsey Forebay	Pacific Gas and Electric Company	Placer	Tributary, Dry Creek	13	13N	8E	Earth	1,167	42	1,819	185	1916	Power
Island Lake	Nevada Irrigation District	Nevada	Tributary, Canyon Creek	27	18N	12E	Rockfill	93	14	6,800	330	–	Irrigation
Jackson Lake	Nevada Irrigation District	Nevada	Jackson Creek	31	19N	13E	Earth	755	22	6,600	1,000	–	Irrigation
Kelly Lake	Pacific Gas and Electric Company	Placer	Tributary, N. Fork American River	25	17N	12E	Earth	500	21	5,910	360	1928	Power
Kidd Lake	Pacific Gas and Electric Company	Placer	Tributary, South Fork Yuba River	29	17N	14E	Earth, rockwall	430	40	6,772	1,492	1855	Power
Lake Alta	Pacific Gas and Electric Company	Placer	Tributary, N. Fork American River	35	16N	10E	Earth	955	21.6	3,398	270	1862	Power
Lake Angela	Central Pacific Railway Company	Nevada	Tributary, South Fork Yuba River	16	17N	15E	Gravity, straight	697	22	7,194	215	1924	Power
Lake Arthur	Pacific Gas and Electric Company	Placer	South Fork Dry Creek	19	13N	9E	Earth	290	44.3	1,494	94	1909	Power
Lake Fordyce	Pacific Gas and Electric Company	Nevada	Fordyce Creek	34	18N	13E	Rockfill	965	140	6,481	46,662	1926	Power
Lake Mary	Central Pacific Railway Company	Placer	Tributary, South Fork Yuba River	20	17N	15E	Earth	600	25	7,026	172	1926	Domestic
Lake Spaulding	Pacific Gas and Electric Company	Nevada	South Fork Yuba River	20	17N	12E	Variable radius arch	800	275	5,014	74,488	1913	Power
LakeSpauldingNo.2	Pacific Gas and Electric Company	Nevada	South Fork Yuba River	21	17N	12E	Gravity, curved	360	25				
LakeSpauldingNo.3	Pacific Gas and Electric Company	Nevada	South Fork Yuba River	16	17N	12E	Gravity, buttressed	800	55				
Lake Sterling	Pacific Gas and Electric Company	Nevada	Sterling Creek	10	17N	13E	Rockfill	225	25	6,700	1,648	1877	Power
Lake Tahoe	Bureau of Reclamation	Placer	Truckee River	6	15N	17E	Slab and buttress	109	14	6,233	732,000	1913	Irrigation
Lake Theodore	Pacific Gas and Electric Company	Placer	South Fork Dry Creek	18	13N	9E	Earth	402	40.2	1,595	344	1896	Power
Lake Valley	Pacific Gas and Electric Company	Placer	Tributary, N. Fork American River	35	17N	12E	Earth	940	74	5,853	8,127	1911	Power
Lake Van Norden	Pacific Gas and Electric Company	Nevada	South Yuba River	23	17N	14E	Earth	1,637	27	6,770	5,874	1916	Power
Loon Lake	Georgetown Divide Water Company	El Dorado	Gerle Creek	4	13N	15E	Dry masonry	650	33	6,305	8,000	1884	Domestic, irrigation
Lower Feeley Lake	Pacific Gas and Electric Company	Nevada	Tributary, Fall Creek	29	18N	12E	Earth, rockwall	150	17	6,936	184	1870	Power
LowerLindseyLake	Pacific Gas and Electric Company	Nevada	Tributary, Texas Creek	20	18N	12E	Earth, rockwall	486	17	6,508	320	1870	Power
Lower Peake Lake	Pacific Gas and Electric Company	Placer	Tributary, South Fork Yuba River	30	17N	14E	Earth, rockwall	655	32	6,586	494	1860	Power
Mammoth	Pacific Gas and Electric Company	Placer	Tributary, Dry Creek	12	11N	7E	Earth	2,360	23	716	115	1851	Power
Meadow Lake	Pacific Gas and Electric Company	Nevada	Tributary, Fordyce Creek	27	18N	13E	Earth, rockwall	1,020	37.5	7,252	4,800	1864	Power
MiddleLindseyLake	Pacific Gas and Electric Company	Nevada	Tributary, Texas Creek	21	18N	12E	Earth, rockwall	372	9.5	6,705	103	1870	Power
MiltonDiver.(Main)	Nevada Irrigation District	Nevada	Middle Fork Yuba River	12	19N	12E	Constant radius arch	286	32	5,695	270	1928	Irrigation
Morning Star	McGeachin Placer Gold Mining Company	Placer	Shirttail Canyon	17	15N	11E	Hydraulic fill	835	44	4,100	2,200	1870	Domestic, mining
North Fork	California Debris Commission	Placer	North Fork American River	31	13N	9E	Variable radius arch	620	147	718	14,600	1939	Debris dam
Putts Lake	Central Pacific Railway Company	Placer	Blue Canyon Creek	36	17N	11E	Earth	1,025	19	5,361	249	1916	Domestic
Quail Lake	D. H. Chambers	Placer	Tributary, Lake Tahoe	12	14N	16E	Earth, rockwall	70	12	6,705	70	1926	Domestic
Rock Creek	Pacific Gas and Electric Company	Placer	Rock Creek	28	13N	8E	Multiple arch	1,080	33	1,443	550	1916	Power
Rucker Lake	Pacific Gas and Electric Company	Nevada	Rucker Creek	8	17N	12E	Earth, rockwall	765	20	5,500	620	1871	Power
Sawmill Lake	Nevada Irrigation District	Nevada	Canyon Creek	11	18N	12E	Rockfill	384	50	5,780	3,040	1910	Irrigation
Scotts Flat	Nevada Irrigation District	Nevada	Deer Creek	11	16N	9E	Earth	660	140	3,050	26,300	1949	Irrigation, domestic
Upper Feeley Lake	Pacific Gas and Electric Company	Nevada	Tributary, Fall Creek	28	18N	12E	Earth, rockwall	186	22	6,996	780	1870	Power
Upper Peak Lake	Pacific Gas and Electric Company	Placer	Tributary, South Fork Yuba River	32	17N	14E	Earth, rockwall	290	37	6,611	1,607	1850	Power
Upper Rock Lake	Pacific Gas and Electric Company	Nevada	Tributary, South Fork Yuba River	15	18N	12E	Earth, rockwall	230	20	6,985	207	1855	Power
White Rock Lake	Pacific Gas and Electric Company	Nevada	Tributary, North Creek	22	18N	14E	Earth, rockwall	285	19.5	7,752	578	1850	Power

APPENDIX K

REPORT OF BOARD OF REVIEW ON THE LAND CLASSIFICATION SURVEY OF CALAVERAS AND TUOLUMNE COUNTIES

REPORT OF BOARD OF REVIEW ON THE LAND CLASSIFICATION SURVEY OF CALAVERAS AND TUOLUMNE COUNTIES CALIFORNIA

OCTOBER, 1950

At the request of A. D. Edmonston, State Engineer, Walter W. Weir, Division of Soils, University of California; Robert A. Gardner, Division of Soil Survey, U. S. Department of Agriculture; and Ralph C. Cole, Branch of Operation and Maintenance, U. S. Bureau of Reclamation, were designated by their respective organizations to constitute a Board for the review of a classification of the lands of Calaveras and Tuolumne Counties as to their suitability for irrigation. The field examination was made on September 18, 19, and 20, 1950, followed by an office conference on September 21, 1950. During these investigations the Board was accompanied by John W. Shannon and Roy N. Haley of the Division of Water Resources, who had conducted the field work and made the classification which was being reviewed. The findings of this Board are set forth in the following paragraphs.

DISCUSSION OF STANDARDS

The land classification standards as given in the typewritten report, "Land Classification Standards and Criteria, Survey of Mountainous Areas, Calaveras and Tuolumne Counties," by Mr. Shannon were carefully reviewed prior to the inspection of the mapping. In these investigations the paramount considerations were: first, whether or not the standards were adequate to cover all land which could be considered suitable for irrigation in these counties, and second, whether or not the lands were mapped in compliance with the classification standards set up.

During the course of the field inspection it was observed:

(1) In the field mapping both loose rock and rock outcroppings were considered, whereas the specifications in Table 1 of "Land Classification Standards and Criteria, Survey of Mountainous Areas, Calaveras and Tuolumne Counties," mention loose rock only. It is agreed that both of these items should be considered in the classification.

(2) In mapping Class 4(3) lands wherever depth of soil is the limiting factor, stoniness sufficient to slightly reduce productivity and interfere with cultural practices is permitted as inclusions within the land class, whereas when the soils are deep and slope is the important factor in the delineation, stoniness to moderately reduce productivity and interfere with cultural practices is permitted as an inclusion. In the specifications (Table 1) a moderate amount of stoniness is permitted in all of Class 4(3) lands. It is agreed that less stoniness should be permitted where the soils are shallow.

(3) Class 4-P as mapped permits of slopes up to the maximum of Class 4(3) and stoniness only to the maximum of Class 4(2). The major criteria in this class is the extreme shallowness of the soil. The specifications are indefinite in this respect and should be more specifically defined.

In order to more carefully check the minimum standards for Class 4(3) and 4-P the Storie Index for the minimum requirements for each was computed and was found to range between 17 and 20 per cent. It was concluded that this value represents the extreme lower limits of lands that can be considered suitable for irrigation.

All other land classes mapped within the area are considered properly defined. The board also considers that all land classes suitable for irrigation are included within the land classes used in this survey.

CONSIDERATION OF MAPPING

The field mapping was done on contact prints of aerial photographs of scale 1 to 20,000. Land classification areas were delineated in the field according to field observations of topography, depth of soil, and stoniness and rockiness. These field observations were later checked in the field office by stereoptic observations particularly for slope, stoniness, and rockiness. The mapping was done on a reconnaissance basis, each mapper covering about 6 to 8 square miles per day.

It was observed that there were instances where small tracts of lands suitable for irrigation but isolated by extensive areas of land not suitable for irrigation were not mapped out. Likewise there were small bodies of land not suitable for irrigation that were included in large areas of lands suitable for irrigation. This is what would be expected on this type of survey. More precise separations could only be accomplished by mapping in greater detail. It is believed, however, that greater detail in mapping would not materially alter the acreage of land suitable for irrigation for each county from that found by this survey.

The field inspections revealed that the mapping was done consistent with the specifications established with the exceptions noted above, and that these exceptions more properly define these classes than do the specifications presented in the report.

In considering the classification and mapping in these two counties special attention was paid to the following areas for each of which a brief discussion is given of the soil conditions and mapping problems encountered.

1. Keystone Area

In the Keystone area the soils are in the main relatively shallow and rocky with considerable complexity of relief patterns. These soils are in the main of the Dorado and Auburn soil series. The Dorado soils are relatively shallow having been formed on metamorphosed sedimentary rock materials. The soils of the Auburn series are formed on metamorphosed igneous rocks, particularly amphybolite schist. The very limited acreage now irrigated in this area is devoted to irrigated pasture, with yields being fair to poor.

2. Jamestown and Chinese Camp Area

Here the soils are also mainly of the Dorado and Auburn soil series, and the conditions are similar to those described for the Keystone area. There is probably a slight increase in the acreage under irrigation in this area.

3. Groveland Area

In the Groveland area the soils are of good depth, usually four feet or more to bedrock. They are largely from basic igneous rocks and may be classified as members of the Aiken series. The mapping problems in this area consisted largely in mapping out areas of favorable topography. Most of the exclusions consist of areas with very complex relief patterns or with slopes that are so steep that they were not considered favorable for irrigation. There is only a very small amount of irrigation in the Groveland area.

4. Standard, Tuolumne Area

The soils here are derived mainly from granitic rock sources, and they consist mostly of soils of the Sierra, Cuyamaca, and Holland series. The Sierra soils are red; the Cuyamaca soils have pale surface soils with redder subsoils; and the Holland soils are brown or greyish-brown. In general, the soils are deep, and the mapping problems consist largely of mapping suitable topography for irrigation. In this locality the slopes are complex and there are some very steep slopes. The irrigated crops in this area consist largely of apples. There is also a little irrigated pasture. Production appears to be only fair in this locality.

5. Sonora, Columbia, and Murphy Areas

In this area there are considerable outcroppings of limestone. The soils are rather shallow and are derived from the limestone. Also in this locality are rather shallow rocky soils, red in color, derived from basic igneous rocks probably closely associated with soils of the Auburn series. In this area there are some alluvial soils on the stream bottoms. Most of the mapping problems in the Sonora, Columbia, and Murphy areas are involved in rough complex slopes and shallow and stony soils. There are some apples and irrigated pasture in this area, most of the apples being in the vicinity of Murphy and largely on stream bottom lands rather than on the upland soils.

6. Sheep Ranch, Angels Camp Area

In this area the soils are derived largely from metamorphosed sedimentary rocks, but the soils are deeper than those listed for the Keystone and Chinese Camp areas. These soils consist largely of those comprising the Sites series, but there are also some soils of the Aiken series. These lie at higher elevations around Averys.

In this particular district we made special observations at Ariola Ranch, west of Frogtown, where gravity irrigation is in use on relatively steep slopes for irrigated pasture. The soils are members of the Sites series, and the area was classified as 4(3). This particular pasture looked good.

7. Mountain Ranch and Railroad Flat Areas

The soils in this area are mainly of the Sites series having medium depth and complex slopes. There are also some alluvial soils along the stream bottoms. Irrigated pasture, walnuts, and apples are grown in this area. Although some of the trees appear to be very productive there is a great difference in sizes of trees throughout the orchards, giving these orchards a spotty appearance. The one exception was the Mountain Ranch orchard where the trees appeared to be making good growth and were relatively uniform in size. This orchard is on alluvial soils, Class 2. There are rather extensive clearings of land now in progress in the vicinity of Mountain Ranch.

8. West Point Area

This area consists largely of soils derived from granitic rocks. The soils are largely of the Sierra and Cuyamaca series. In this area the soils are deep. Mapping problems consisted largely of separating lands of suitable topography. In many areas the slopes are very complex. The crops in this area are mainly walnuts, some of which are irrigated and some are grown without irrigation. Although the trees on the irrigated areas look better than those which are not irrigated there is considerable spottiness in all the orchards. The total area in crops is small.

9. Mokelumne Hill, San Andreas

This area consists largely of shallow soils formed on slates largely of the Mariposa series. Irrigated areas consist mainly of irrigated pasture with a small amount of fruit in the vicinity of Mokelumne Hill. Although the slopes in this area are not overly steep the topography is very irregular. There is a great amount of rockiness and stoniness with a considerable amount of slate outcroppings.

10. Salt Springs Valley

Salt Springs Valley contains considerable alluvial stream bottom land which is classified mainly as Class 2. These areas are suitable for irrigation for fruit, pasture, and other forage crops. The upland soils in the Salt Springs area are very shallow, although the slopes are not excessive. The principal soils series are the Amador, White Rock, and related series. The Amador soils are formed on rocks consisting largely of rhyolite tuffs. These soils have favorable macro-relief, but are cut up with hogwallow micro-relief. They are also very shallow and because of the acidic nature of the parent rocks they have a low nutrient level, and are not very productive. Soils of the White Rock series are formed from light colored slates. These soils are extremely shallow and are likewise relatively infertile. Areas of both Amador and White Rock series are mapped as Class 4-P suitable only for irrigated pasture.

11. Milton-Valley Springs Area

In this area there are also considerable acreages of alluvial soils similar to the Salt Springs Valley area and also extensive areas of soils of the Amador series which have the same adaptability as those described in the Salt Springs area. In addition to these soils there are some soils of the Whitney, Auburn, and Pentz series. Attention was called to several areas in which old and fairly good olive orchards occur. For the most part these olive orchards are on soils of the Whitney and Auburn series. Both of these soils are much better adapted to these crops than are the Amador and Pentz soils. The Amador and Pentz soils are much more extensive in area. As a matter of fact most of the Whitney and Auburn soils of this area which have topography suitable for irrigation are planted to olives. In general, the Pentz soils have rough topography. They are represented by the "haystack mountain" type of topography which is so conspicuous in this area. The Amador soils occupy lower lying positions. The Whitney soils are formed on brown sandstones and conglomerates and are of medium depths. Also in this area are some old valley terraces consisting mostly of soils of the Redding series. These soils have gravelly and cobbly surface textures and have hardpans at relatively shallow depths. Although suited for irrigated pasture, they are not suitable for fruit.

In summary it is felt that the specifications used for this survey are adequate to cover all lands which can be considered suitable for irrigation. It is felt that the mapping has been consistent with the mapping standards established. In the lower portions of both Calaveras and Tuolumne Counties most of the 4-P lands have relatively favorable topography. The slopes usually are less than 20 per cent with the majority of areas averaging not over 15 per cent in slope. Because of the infertility of some of the soils of this area, particularly those derived from the Amador and White Rock series, it is felt that some of the mapping is probably a little too generous, and some of these areas mapped as 4-P might better have been mapped as Class 6.

At the higher elevations throughout the two counties the main consideration was relief involving mainly complexity of slopes, and here the classification and mapping are entirely adequate and satisfactory. Throughout the entire review of the field mapping we did not encounter any area of significant size where it was felt the mapping was too severe or where lands should be raised to a higher class.

/s/ WALTER W. WEIR
University of California

/s/ ROBERT A. GARDNER
U. S. Department of Agriculture

/s/ RALPH C. COLE
U. S. Bureau of Reclamation

APPENDIX L

RECORDS OF APPLICATION OF WATER ON SELECTED PLOTS AND WATERSHEDS IN AND ADJACENT TO PLACER COUNTY

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RECORDS OF APPLICATION OF WATER ON SELECTED PLOTS AND WATERSHEDS IN AND ADJACENT TO PLACER COUNTY

APPLICATION OF GROUND WATER TO REPRESENTATIVE CROPS IN AND ADJACENT TO PLACER COUNTY, 1949, 1950, AND 1951

Crop	Season	Map number	Well number	Method of irrigation	Soil type	Area, in acres	Total depth of applied water, in inches
PLACER COUNTY							
Almonds	1949	1	10N/5E-11G1	Flooding	Loam	17	4.6
	1949	2	10N/5E-12R1	Sprinkler	Sandy loam	19	12.3
	1949	3	10N/6E-9D1	Sprinkler	Sandy loam	15	16.4
	1950	3	10N/6E-9D1	Sprinkler	Sandy loam	15	17.0
	1951	3	10N/6E-9D1	Sprinkler	Sandy loam	15	10.5
			Weighted mean depths:	1949 11.0 inches (0.9 foot) 1950 17.0 inches (1.4 feet) 1951 10.5 inches (0.9 foot) 1949-50 12.0 inches (1.0 foot)			
Ladino clover (seed)	1949	4	13N/5E-25H1 13N/6E-30M1	Border check	Loam	160	46.0
	1950	5	10N/5E-9L1	Sprinkler	Loam	115	44.0
	1950	6	10N/6E-16D1	Sprinkler	Sandy loam	58	25.4
	1950	7	12N/5E-5R1	Contour check	Loam	175	37.9
	1950	4	13N/5E-25H1 13N/6E-30M1	Border check	Loam	140	50.0
	1951	5	10N/5E-9L1	Sprinkler	Loam	63	38.0
	1951	6	10N/6E-16D1	Sprinkler	Sandy loam	58	23.4
	1951	7	12N/5E-5R1	Contour check	Loam	172	37.4
	1951	8	12N/5E-18J1	Border check	Loam	68	43.0
	1951	9	12N/5E-21A1	Border check	Sandy loam	57	33.5
	1951	10	13N/5E-24A1	Border check	Sandy loam	56	30.0
			Weighted mean depths:	1949 46.0 inches (3.8 feet) 1950 41.3 inches (3.4 feet) 1951 35.2 inches (2.9 feet) 1949-50 39.4 inches (3.3 feet)			
Pasture	1950	11	11N/5E-7R1	Contour check	Loam	101	51.0
	1950	12	11N/5E-29K1 11N/5E-29K2	Border check	Sandy loam	160	43.3
	1950	13	11N/6E-17J1	Contour check	Sandy loam	40	60.1
	1950	14	12N/5E-2B1	Border check	Loam	50	68.8
	1950	15	12N/5E-19C1	Border check	Loam	85	47.3
	1950	16	13N/5E-33L1	Border check	Loam	92	48.6
	1950	17	13N/6E-28N1 33C1, 33K1, 33M1, 33M2	Border check	Sandy loam	303	43.5
	1951	11	11N/5E-7R1	Border check	Loam	97	55.7
	1951	12	11N/5E-29K1 11N/5E-29K2	Border check	Sandy loam	185	52.0
	1951	13	11N/6E-17J1	Contour check	Sandy loam	40	60.5
	1951	14	12N/5E-2B1	Border check	Loam	50	65.0
	1951	18	12N/5E-12C1	Contour check	Sandy loam	80	14.5*
	1951	19	12N/5E-19D1	Border check	Loam	75	68.8
	1951	20	12N/5E-30A1	Border check	Loam	56	37.0
	1951	21	12N/6E-19A2	Border check	Sandy loam	29	96.3
	1951	22	12N/6E-21J1 21L1, 21N1, 27D1, 28A1, 28B1	Border check	Loam	465	24.0
	1951	23	13N/5E-2Q1	Sprinkler	Sandy loam	60	25.0
	1951	24	13N/5E-23P1	Border check	Loam	30	55.7
	1951	25	13N/5E-23R2	Border check	Loam	40	72.0
	1951	17	13N/6E-28N1 33C1, 33K1, 33M1, 33M2	Border check	Sandy loam	381	39.0
			Weighted mean depths:	1950 47.6 inches (4.0 feet) 1951 41.7 inches (3.5 feet) 1950-51 43.8 inches (3.6 feet)			
			Ladino clover (seed) and Pasture-Weighted mean depths:	1949 46.0 inches (3.8 feet) 1950 45.4 inches (3.8 feet) 1951 40.1 inches (3.3 feet) 1949-51 42.4 inches (3.5 feet)			
Rice	1949	26	11N/5E-17H1	Contour check	Sandy loam	120	48.0
	1949	27	11N/5E-19A1 11N/5E-19H1	Contour check	Sandy loam	160	74.0
	1949	28	11N/5E-31A1	Contour check	Sandy loam	50	55.5
	1950	29	11N/5E-6A1	Contour check	Loam	156	78.7
	1950	30	11N/5E-G1	Contour check	Loam	90	56.4
	1950	31	11N/5E-7L1	Contour check	Sandy loam	51	100.0
	1950	32	11N/5E-14P1 11N/5E-14P2	Contour check	Loam	74	69.9

APPLICATION OF GROUND WATER TO REPRESENTATIVE CROPS IN AND ADJACENT TO PLACER COUNTY, 1949, 1950, AND 1951—Continued

Crop	Season	Map number	Well number	Method of irrigation	Soil type	Area, in acres	Total depth of applied water, in inches
PLACER COUNTY (Continued)							
Rice (continued)	1950	33	11N/5E-19J1	Contour check	Loam	82	72.0
	1950	34	11N/5E-19P1	Contour check	Loam	155	62.0
	1950	35	11N/5E-28P1	Contour check	Loam	80	66.2
	1950	36, 37	11N/5E-29A1	Contour check	Sandy loam	140	47.5
			29G1, 29H1				
	1950	28	11N/5E-31A1	Contour check	Sandy loam	92	63.3
	1950	38	12N/5E-3A1	Contour check	Loam	96	63.0
	1950	39	12N/5E-4J1	Contour check	Loam	171	43.4
	1950	40	12N/5E-6R1	Contour check	Loam	60	*130.1
	1950	41	12N/5E-13A1	Contour check	Sandy loam	85	49.0
	1950	42	12N/5E-14L1	Contour check	Sandy loam	200	45.0
	1950	43	12N/6E-28M1	Contour check	Loam	172	58.0
			12N/6E-29G1				
	1951	44	10N/5E-3N1	Contour check	Loam	92	99.9
	1951	45	10N/5E-10J1	Contour check	Sandy loam	41	80.0
	1951	46	10N/5E-11E1	Contour check	Loam	65	56.0
	1951	47	11N/5E-3H1	Contour check	Sandy loam	85	51.7
	1951	48	11N/5E-4P1	Contour check	Gravelly loam	153	32.9
	1951	29	11N/5E-6A1	Contour check	Loam	106	57.7
	1951	30	11N/5E-6G1	Contour check	Loam	106	53.7
	1951	31	11N/5E-7F1	Contour check	Sandy loam	127	91.0
			11N/5E-7L1				
	1951	49	11N/5E-8Q1	Contour check	Loam	180	61.1
			11N/5E-16D1				
	1951	50	11N/5E-10L1	Contour check	Sandy loam	78	34.9
	1951	51	11N/5E-15G2	Contour check	Loam	60	45.6
	1951	52	11N/5E-18H1	Contour check	Sandy loam	144	39.6
	1951	33, 27	11N/5E-19A1	Contour check	Loam	250	60.6
			19H1, 19J1				
	1951	53	11N/5E-28C1	Contour check	Loam	50	66.0
	1951	35	11N/5E-28P1	Contour check	Loam	80	44.9
	1951	36	11N/5E-29A1	Contour check	Sandy loam	80	69.0
	1951	37	11N/5E-29H1	Contour check	Sandy loam	31	72.6
	1951	41	12N/5E-13A1	Contour check	Sandy loam	97	46.0
	1951	54	12N/5E-17A1	Contour check	Loam	312	78.5
			17B1, 17C1				
	1951	15	12N/5E-19C1	Contour check	Loam	74	72.5
	1951	55	12N/5E-20A1	Contour check	Loam	222	72.9
			12N/5E-20H1				
	1951	56	12N/5E-21B1	Contour check	Loam	80	50.2
	1951	57	13N/5E-10K1	Contour check	Loam	151	77.0
			13N/5E-10P1				
	1951	58	13N/5E-22C1	Contour check	Sandy loam, loam	450	57.5
			22P1, 27C1, 27F1				
			Weighted mean depths:	1949 61.7 inches (5.1 feet)			
				1950 59.3 inches (4.9 feet)			
				1951 61.9 inches (5.2 feet)			
				1949-51 61.1 inches (5.1 feet)			
Vineyard	1949	59	10N/5E-12E1	Sprinkler	Loam	18	4.0
	1949	2	10N/5E-12R1	Sprinkler	Sandy loam	40	4.2
			Weighted mean depth:	1949 4.1 inches (0.34 foot)			
SUTTER COUNTY							
Pasture	1951	60	11N/4E-1F1	Border check	Loam	38	47.0
	1951	61	11N/4E-2H1	Border check	Loam	31	48.5
	1951	62	11N/4E-10A1	Border check	Loam	231	51.3
			10A2, 10C2, 10H1				
	1951	63	11N/4E-12F1	Border check	Loam	23	36.5
	1951	64	11N/4E-12J2	Border check	Loam	64	31.4
	1951	65	11N/4E-12Q1	Border check	Loam	47	40.8
	1951	66	11N/4E-12R1	Border check	Loam	79	32.6
	1951	67	12N/4E-10A1	Border check	Loam	78	65.4
	1951	68	12N/4E-11H1	Border check	Loam	24	70.9
	1951	69	12N/4E-13C1	Border check	Loam	200	40.5
			12N/4E-13F1				
	1951	70	12N/4E-25C1	Border check	Loam	158	37.6
			12N/4E-25F1				
	1951	71	12N/4E-25M1	Border check	Loam	64	36.0
	1951	72	12N/4E-36P1	Border check	Loam	56	31.0
	1951	16	13N/5E-33L1	Border check	Loam	102	69.5
			13N/5E-33P1				
			Weighted mean depth:	1951 45.6 inches (3.8 feet)			

APPLICATION OF GROUND WATER TO REPRESENTATIVE CROPS IN AND ADJACENT TO PLACER COUNTY, 1949, 1950, AND 1951—Continued

Crop	Season	Map number	Well number	Method of irrigation	Soil type	Area, in acres	Total depth of applied water, in inches
SUTTER COUNTY (Continued)							
Rice	1951	73	11N/4E-2G1	Contour check	Loam	76	73.0
	1951	74	11N/4E-2K1	Contour check	Loam	69	83.5
	1951	75	11N/4E-11K1	Contour check	Loam	65	82.3
	1951	76	11N/4E-11N1	Contour check	Loam	95	53.6
	1951	77	11N/4E-13M2	Contour check	Sandy loam	100	56.4
	1951	78	11N/4E-14B1	Contour check	Sandy loam	60	127.5
	1951	79	11N/4E-14D1	Contour check	Sandy loam	65	91.2
	1951	80	11N/4E-23J1	Contour check	Loam	120	75.0
	1951	81	12N/4E-2B1 13N/4E-35Q1	Contour check	Loam	153	102.0
	1951	82	12N/4E-3A1 12N/4E-3A2	Contour check	Loam	90	113.5
	1951	83	12N/4E-3R1	Contour check	Loam	80	56.5
	1951	84	12N/4E-10C1	Contour check	Loam	107	46.5
	1951	85	12N/4E-13R1	Contour check	Loam	201	41.4
	1951	86	12N/4E-15E1 15N1, 15P1	Contour check	Loam	207	156.3
	1951	87	12N/4E-24A1	Contour check	Loam	112	46.4
	1951	88	12N/4E-34C1 34K1, 34L1	Contour check	Loam	116	161.9
	1951	89	12N/4E-36Q1	Contour check	Loam	102	78.5
	1951	90	13N/4E-35A1 13N/4E-35H1	Contour check	Loam	320	52.3
	1951	91	13N/4E-36J1	Contour check	Loam	129	48.3
	1951	92	13N/5E-28N1	Contour check	Sandy loam	108	75.0
	1951	93	13N/5E-30J1 30L1, 30R1	Contour check	Loam	342	58.7
	1951	94	13N/5E-33M1	Contour check	Sandy loam	140	43.4
			Weighted mean depth: 1951 75.3 inches (6.3 feet)				

* Omitted from weighted mean.

APPLICATION OF WATER ON SELECTED FOOTHILL PLOTS IN PLACER COUNTY, 1950

Crop	Elevation, in feet	Map number	Method of irrigation	Area in acres	Water applied: Total amount, in acre-feet	Water applied: Depth, in inches	Drainage and estimated use by native vegetation, in acre-feet	Water retained: Total amount, in acre-feet	Water retained: Depth, in inches
Mixed orchard	400	95	Sprinkler	46	159	41	7	152	40
	400	96	Sprinkler	42	122	35	2	120	34
	600	97	Sprinkler	18	49	33	not known	--	--
	1,200	98	Sprinkler	52	330	76	not known	--	--
	1,200	99	Furrow	84	278	40	not known	--	--
	1,250	100	Sprinkler	37	127	41	not known	--	--
			Weighted mean depth of applied water: 45.8 inches (3.8 feet)						
Mixed orchard and pasture	400	101	Sprinkler	34	138	49	14	124	44
Pasture	1,150	102	Flood from contour ditch	62	398	77	56	342	66
	1,250	103	Sprinkler	37	35	11	not known	--	--
	1,300	104	Flood	54	230	51	25	205	46
			Weighted mean depth of applied water: 52.0 inches (4.3 feet)						
Pears	2,300	105	Sprinkler	10	25	30	0	25	30

APPLICATION OF WATER ON PORTION OF EDEN VALLEY WATERSHED, PLACER COUNTY, 1951

WATER USE STUDY "A"

Location: T. 14 N., R. 9 E., M. D. B. & M., portions of Sections 16 and 21
Average elevation: 2,350 feet
Drainage area: 384 acres

Irrigated lands: 113 acres
Tules and brush: 11 acres

(In acre-feet)

Period	Regulated inflow to irrigated lands	Rainfall on watershed	Total inflow	Outflow	Water retained in watershed	Regulated water retained in watershed
5-1 to 5-31	58	114	172	65	107	18*
6-1 to 6-30	56		56	21	35	35
7-1 to 7-31	58		58	15	43	43
8-1 to 8-31	58		58	11	47	47
9-1 to 9-30	56		56	9	47	47
5-1 to 9-30	286	114	400	121	279	190
Less applied water consumed by tules and brush (estimated)						44
Applied water retained by irrigated lands						146
Average retention of applied water by irrigated lands					1.3 feet 15.5 inches	

* Estimated from daily records of inflow, outflow, and precipitation.

NOTES:

The inflow stations for this study consisted of 15 diversions from the Boardman Canal regularly measured by the Pacific Gas and Electric Company. The outflow station consisted of a water stage recorder on a drain, installed, rated, and operated during the study by the Division of Water Resources.

The orchards in this watershed vary in size of trees from large to small. The side slopes are on about an eight per cent grade. Hillside native vegetation is pine forest and manzanita brush.

APPLICATION OF WATER IN PENRYN VALLEY, PLACER COUNTY, 1951

WATER USE STUDY "B"

Location: T. 11 N., R. 7 E., M. D. B. & M., portions of Sections 3, 4, 5, 8, 9, and 17; T. 12 N., R. 7 E., M. D. B. & M., portions of Sections 26, 27, 28, 32, 33, and 34

Average elevation: 500 feet
Drainage area: 6,025 acres
Irrigated lands: 3,240 acres
Tules and brush: 1,020 acres

(In acre-feet)

Period	Regulated inflow to irrigated lands	Rainfall on watershed	Total inflow	Outflow	Water retained in watershed	Regulated water retained in watershed
5-1 to 5-31	1,786	748	2,534	505	2,029	1,236*
6-1 to 6-30	2,325		2,325	95	2,230	2,230
7-1 to 7-31	2,631		2,631	95	2,536	2,536
8-1 to 8-31	2,719		2,719	111	2,608	2,608
9-1 to 9-30	2,311		2,311	250	2,061	2,061
5-1 to 9-30	11,772	748	12,520	1,056	11,464	10,671
Less applied water consumed by tules and brush (estimated)						4,080
Applied water retained by irrigated lands						6,591
Average retention of applied water by irrigated lands					2.0 feet 24.4 inches	

* Estimated from daily records of inflow, outflow, and precipitation.

NOTES:

Inflow stations for this study were at the head of the Antelope Canal and on the Red Ravine Canal at the Southern Pacific Railway crossing. The outflow stations were on Antelope Creek near Rocklin, and wastes from the Antelope Canal at Clover Valley Reservoir and at the end of the canal. All stations were installed, rated, and operated by the Division of Water Resources.

The lower three-fourths of Penryn Valley has a slope of about one per cent and the upper fourth has a slope of about four per cent. Orchards vary from very good to poor. Hillside native vegetation is oak and brush.

APPLICATION OF WATER ON SAILOR RAVINE WATERSHED, PLACER COUNTY, 1951

WATER USE STUDY "C"

Locotion: T. 13 N., R. 7 E., M. D. B. & M., portions of Section 36;
T. 13 N., R. 8 E., M. D. B. & M., portions of Section 31

Average elevotion: 1,500 feet
Droinoge area: 360 acres
Irrigoted londs: 209 ocres
Tules ond brush: 16 acres

(In acre-feet)

Period	Regulated inflow to irrigated lands	Rainfall on watershed	Total inflow	Outflow	Water retained in watershed	Regulated water retained in watershed
5-1 to 5-31	96	98	194	71	123	36*
6-1 to 6-30	158		158	48	110	110
7-1 to 7-31	164		164	50	114	114
8-1 to 8-31	164		164	51	113	113
9-1 to 9-30	158		158	61	97	97
5-1 to 9-30	740	98	838	281	557	470
Less applied water consumed by tules and brush (estimated)						64
Applied water retained by irrigated lands						406
Average retention of applied water by irrigated lands					2.0 feet 23.4 inches	

* Estimated from daily records of inflow, outflow, and precipitation.
NOTES:
The inflow stations for this study consisted of 3 Nevada Irrigation District diversion boxes on the Vernon Extension Canal and Roehr Pipe Line, regularly measured by the District. The outflow station consisted of a water stage recorder on Sailor Ravine below the Francis Ranch, installed, rated, and operated by the Division of Water Resources.
This watershed is characterized by excellent orchards, which are mostly cover-cropped, and have slopes averaging about six per cent. Hillside native vegetation is mostly oak.

APPLICATION OF WATER ON SHIRLAND DITCH WATERSHED, PLACER COUNTY, 1951

WATER USE STUDY "D"

Locotion: T. 12 N., R. 8 E., M. D. B. & M., portions of
Sections 27, 28, 33, and 34

Average elevotion: 1,050 feet
Drainage oreo: 1,325 ocres
Irrigated londs: 687 ocres
Tules ond brush: 121 acres

(In ocre-feet)

Period	Regulated inflow to irrigated lands	Rainfall on watershed	Total inflow	Outflow	Water retained in watershed	Regulated water retained in watershed
5-1 to 5-31	228	361	589	128	461	104*
6-1 to 6-30	465		465	81	384	384
7-1 to 7-31	482		482	56	426	426
8-1 to 8-31	434		434	59	375	375
9-1 to 9-30	415		415	105	310	310
5-1 to 9-30	2,024	361	2,385	429	1,956	1,599
Less applied water consumed by tules and brush (estimated)						484
Applied water retained by irrigated lands						1,115
Average retention of applied water by irrigated lands					1.6 feet 19.5 inches	

* Estimated from daily records of inflow, outflow, and precipitation.
NOTES:
The inflow station for this study was located on the Shirland Ditch at its head. The outflow stations were located on Mormon Creek above the South Canal and on the Shirland Drain near Scott's Corner. The stations were installed, rated, and operated by the Division of Water Resources.
The lands irrigated in this watershed are on eight per cent or steeper slopes. Hillside native vegetation is mostly oak and brush with scattered pine.

APPENDIX M

RESERVOIR YIELD STUDIES

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RESERVOIR YIELD STUDIES

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, JACKSON MEADOWS RESERVOIR

(In acre-feet)

Storage capacity: 45,000 acre-feet | Seasonal yield: 45,100 acre-feet

Season	Water supply				Distribution of water supply					Diversion to Milton-Bowman Conduit*
	Storage, October 1	Estimated runoff, Middle Fork Yuba River at dam site	Diversion from Haypress Creek	Total inflow	Evaporation	Fish release	Yield	Spill	Storage, September 30	
920-21	0	80,900	36,400	117,300	1,700	3,600	41,700	34,700	35,600	76,400
21-22	35,600	88,200	35,900	124,100	1,700	3,600	45,100	72,300	37,000	97,400
22-23	37,000	62,800	24,500	87,300	1,700	3,600	45,100	37,600	36,300	82,700
23-24	36,300	17,200	7,200	24,400	1,200	3,600	45,100	0	10,800	45,100
24-25	10,800	68,200	22,100	90,300	1,700	3,600	45,100	16,900	33,800	62,000
925-26	33,800	47,000	16,200	63,200	1,700	3,600	45,100	15,700	30,900	60,800
26-27	30,900	111,100	38,100	149,200	1,800	3,600	45,100	92,600	37,000	120,300
27-28	37,000	72,300	25,900	98,200	1,700	3,600	45,100	50,700	34,100	95,800
28-29	34,100	35,100	12,700	47,800	1,600	3,600	45,100	0	31,600	45,100
29-30	31,600	68,100	21,800	89,900	1,700	3,600	45,100	36,100	35,000	81,200
930-31	35,000	23,100	8,800	31,900	1,200	3,600	45,100	0	17,000	45,100
31-32	17,000	76,700	26,000	102,700	1,600	3,600	45,100	32,600	36,800	77,700
32-33	36,800	43,100	12,700	55,800	1,600	3,600	45,100	7,300	35,000	52,400
33-34	35,000	35,200	11,100	46,300	1,700	3,600	45,100	300	30,600	45,400
34-35	30,600	66,700	25,500	92,200	1,700	3,600	45,100	36,700	35,700	81,800
Average		59,700	21,700	81,400	1,600	3,600	44,900	28,900		71,300

Yield plus spill up to capacity of conduit.

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, LAKE VALLEY RESERVOIR

(In acre-feet)

Storage capacity: 41,000 acre-feet | Seasonal yield: 103,800 acre-feet

Season	Water supply						Distribution of water supply				
	Storage, October 1	Estimated runoff, North Fork of North Fork American River	Diversion from Fordyce Lake	Diversion from Rattlesnake Creek	Diversion from South Fork Yuba River	Total inflow	Evaporation	Fish release	Yield	Spill*	Storage, September 30
920-21	0	10,100	57,100	7,600	70,300	145,100	900	1,200	100,400	15,000	27,600
21-22	27,600	10,500	57,100	3,200	43,800	114,600	900	1,200	103,800	6,700	29,600
22-23	29,600	8,500	57,100	4,600	52,100	122,300	900	1,200	103,800	17,500	28,500
23-24	28,500	1,700	54,000	4,100	23,900	83,700	700	1,200	103,800	0	6,500
24-25	6,500	8,200	57,100	6,100	61,400	132,800	900	1,200	103,800	6,900	26,500
925-26	26,500	4,600	56,400	4,500	46,200	111,700	900	1,200	103,800	9,900	22,400
26-27	22,400	12,200	59,400	7,100	80,200	158,900	900	1,200	103,800	44,200	31,200
27-28	31,200	8,000	58,700	3,000	51,800	121,500	900	1,200	103,800	24,400	22,400
28-29	22,400	3,700	54,000	6,400	38,200	102,300	800	1,200	103,800	0	18,900
29-30	18,900	5,900	58,600	5,000	60,100	129,600	900	1,200	103,800	16,400	26,200
930-31	26,200	2,200	54,000	4,800	28,900	89,900	800	1,200	103,800	0	10,300
31-32	10,300	8,300	56,100	4,800	57,400	126,600	900	1,200	103,400	4,100	27,300
32-33	27,300	4,100	55,600	4,000	41,700	105,400	900	1,200	103,800	500	26,300
33-34	26,300	3,600	54,000	6,700	41,900	106,200	900	1,200	103,800	4,000	22,600
34-35	27,600	8,500	57,100	4,300	50,400	120,300	900	1,200	103,800	11,500	25,500
Average		6,700	56,400	5,100	49,900	118,100	900	1,200	103,500	10,700	

Maximum diversions into Lake Valley Reservoir would not be made when reservoir spills.

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, CISCO RESERVOIR

(In ocre-feet)

Storoge copocity: 100,000 acre-feet

Seasonol yield: 145,800 ocre-feet

Season	Water supply				Distribution of water supply					Release to Spaulding Power House No. 1*
	Storage, October 1	Estimated runoff, South Fork Yuba River at dam site	Diversion from Fordyce Lake	Total inflow	Evaporation	Fish release	Yield	Spill	Storage, September 30	
1920-21	0	160,700	57,100	217,800	1,500	7,200	139,100	0	70,000	145,800
21-22	70,000	153,700	57,100	210,800	1,700	7,200	145,800	51,200	74,900	151,200
22-23	74,900	124,800	57,100	181,900	1,700	7,200	145,800	28,100	74,000	151,200
23-24	74,000	44,600	54,000	98,600	1,100	7,200	145,800	0	18,500	145,800
24-25	18,500	138,100	57,100	195,200	1,500	7,200	145,800	0	59,200	145,800
1925-26	59,200	94,000	56,400	150,400	1,600	7,200	145,800	0	55,000	145,800
26-27	55,000	190,000	59,400	249,400	1,800	7,200	145,800	71,700	77,900	151,200
27-28	77,900	145,000	58,700	203,700	1,700	7,200	145,800	63,500	63,400	155,700
28-29	63,400	81,800	54,000	135,800	1,400	7,200	145,800	0	44,800	145,800
29-30	44,800	125,900	58,600	184,500	1,700	7,200	145,800	4,000	70,600	148,100
1930-31	70,600	54,500	54,000	108,500	1,200	7,200	145,800	0	24,900	145,800
31-32	24,900	156,800	56,100	212,900	1,600	7,200	145,800	11,100	72,100	148,100
32-33	72,100	90,500	55,600	146,100	1,500	7,200	145,800	0	63,700	145,800
33-34	63,700	76,400	54,000	130,400	1,400	7,200	145,800	0	39,700	145,800
34-35	39,700	151,600	57,100	208,700	1,600	7,200	145,800	24,400	69,400	148,100
Average		119,200	56,400	175,600	1,500	7,200	145,400	16,900		148,000

* Yield plus spill up to capacity of conduit.

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, ROLLINS RESERVOIR

(In ocre-feet)

Storage copocity: 70,000 ocre-feet including 5,000 acre-feet for debris staroge

Seasonal yield: 271,500 ocre-feet

Season	Water supply				Distribution of water supply				
	Storage, October 1	Estimated runoff, Bear River at dam site	Inflow from Drum System*	Total inflow	Evaporation	Yield	Spill	Storage, September 30	Deficiency, in percent
1920-21	0	250,200	178,200	428,400	2,300	259,400	127,800	38,900	
21-22	38,900	224,500	144,100	368,600	2,300	271,500	93,800	39,900	
22-23	39,900	187,700	151,200	338,900	2,500	271,500	60,700	44,100	
23-24	44,100	33,200	84,400	117,600	400	156,300	0	5,000	**42.6
24-25	5,000	138,000	154,700	292,700	2,500	228,400	19,400	47,400	**15.9
1925-26	47,400	125,100	133,500	258,600	1,500	268,900	0	35,600	**1.0
26-27	35,600	270,500	126,500	397,000	2,700	271,500	93,400	65,000	
27-28	65,000	169,300	213,000	382,300	2,700	272,200	102,400	70,000	
28-29	70,000	64,400	183,800	248,200	1,200	271,500	15,500	30,000	
29-30	30,000	106,700	260,300	367,000	2,700	271,500	62,900	59,900	
1930-31	59,900	33,100	178,800	211,900	1,100	262,800	2,900	5,000	3.2
31-32	5,000	130,600	156,800	287,400	1,800	243,300	0	47,300	10.6
32-33	47,300	64,400	175,900	240,300	1,100	271,500	0	15,000	
33-34	15,000	62,600	207,200	269,800	1,200	271,500	0	12,100	
34-35	12,100	178,500	225,800	404,300	2,700	266,700	78,300	68,700	1.8
Average		135,900	171,600	307,500	1,900	257,200	43,800		

* Record of Drum Canal plus Lake Valley Pipe Line minus Boardman Diversion minus spill to Towle Canal.
** Bowman Reservoir and conduits, constructed in 1927, would have reduced these deficiencies.

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, FRENCH MEADOWS RESERVOIR

(In acre-feet)

torage capacity: 74,000 acre-feet

Seasonal yield: 64,000 acre-feet

Season	Water supply				Distribution of water supply				Release to Deep Canyon Power House*
	Storage, October 1	Estimated runoff, Middle Fork American River at dam site	Diversion from Duncan Creek	Total inflow	Evaporation	Yield	Spill	Storage, September 30	
920-21	0	121,500	26,200	147,700	2,000	59,500	32,500	53,700	72,800
21-22	53,700	124,200	23,300	147,500	2,000	64,000	79,500	55,700	83,700
22-23	55,700	112,000	23,000	135,000	2,000	64,000	66,200	58,500	84,000
23-24	58,500	26,800	4,000	30,800	2,000	64,000	0	23,300	64,000
24-25	23,300	124,900	19,600	144,500	2,000	64,000	44,800	57,000	79,200
925-26	57,000	54,400	11,000	65,400	2,000	64,000	6,600	49,800	70,600
26-27	49,800	130,100	24,800	154,900	2,000	64,000	80,500	58,200	81,700
27-28	58,200	87,800	20,200	108,000	2,000	64,000	48,700	51,500	79,300
28-29	51,500	49,000	9,800	58,800	2,000	64,000	0	44,300	64,000
29-30	44,300	70,200	14,700	84,900	2,000	64,000	10,100	53,100	70,400
930-31	53,100	29,700	5,200	34,900	2,000	64,000	0	22,000	64,000
31-32	22,000	109,400	19,100	128,500	2,000	64,000	27,400	57,100	73,200
32-33	57,100	54,900	10,200	65,100	2,000	64,000	2,300	53,900	66,300
33-34	53,900	43,500	8,700	52,200	2,000	64,000	0	40,100	64,000
34-35	40,100	100,600	18,300	118,900	2,000	64,000	36,400	56,600	77,100
Average		82,600	15,900	98,500	2,000	63,700	29,000		72,900

Yield plus spill up to capacity of conduit.

SEASONAL SUMMARY OF MONTHLY YIELD TO FORESTHILL DIVIDE FROM FRENCH MEADOWS-PAGGE CONDUIT

(In acre-feet)

Season	Water supply					Distribution of water supply		
	Release from French Meadows Reservoir	Diversion from Deep and Lost Canyons	Diversion from Secret Canyon	Diversion from Eldorado and Bullion Creeks	Total	Conduit losses	Release to Foresthill Divide	Remainder to Pagge Reservoir
920-21	72,800	56,300	17,200	12,600	158,900	8,000	17,500	133,400
21-22	83,700	48,500	13,300	11,200	156,700	7,800	17,500	131,400
22-23	84,000	50,300	15,300	11,300	160,900	8,100	17,500	135,300
23-24	64,000	8,500	2,400	1,400	76,300	3,900	17,500	54,900
24-25	79,200	44,600	13,500	9,900	147,200	7,500	17,500	122,200
925-26	70,600	23,000	6,800	4,800	105,200	5,300	17,500	82,400
26-27	81,700	66,200	20,300	14,400	182,600	9,100	17,500	156,000
27-28	79,300	43,100	10,100	8,200	140,700	7,100	17,500	116,100
28-29	64,000	20,300	6,000	4,400	94,700	4,800	17,500	72,400
29-30	70,400	31,200	9,500	6,900	118,000	5,900	17,500	94,600
930-31	64,000	10,900	3,200	2,200	80,300	4,100	17,500	58,700
31-32	73,200	47,100	14,300	10,600	145,200	7,300	17,500	120,400
32-33	66,300	21,000	6,300	4,400	98,000	5,100	17,500	75,400
33-34	64,000	18,100	5,300	3,800	91,200	4,500	17,500	69,200
34-35	77,100	46,100	13,300	10,400	146,900	7,400	17,500	122,000
Average	72,900	35,700	10,500	7,800	126,900	6,400	17,500	102,900

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, BIG RESERVOIR

(In acre-feet)

Storage capacity: 2,200 acre-feet

Seasonal yield: 1,500 acre-feet

Season	Water supply		Distribution of water supply				Deficiency, in per cent
	Storage, October 1	Estimated runoff, North Fork Forbes Creek at dam site	Evaporation	Yield	Spill	Storage, September 30	
1920-21	0	2,900	100	1,500	0	1,300	
21-22	1,300	3,000	100	1,500	1,200	1,500	
22-23	1,500	2,500	100	1,500	1,000	1,400	
23-24	1,400	600	100	1,500	0	400	
24-25	400	2,900	100	1,500	300	1,400	
1925-26	1,400	1,300	100	1,500	100	1,000	
26-27	1,000	3,100	100	1,500	1,100	1,400	
27-28	1,400	2,300	100	1,500	1,000	1,100	
28-29	1,100	1,100	100	1,500	0	600	
29-30	600	1,600	100	1,500	0	600	
1930-31	600	700	100	1,200	0	0	20
31-32	0	2,500	100	1,400	0	1,000	7
32-33	1,000	1,200	100	1,500	0	600	
33-34	600	1,100	100	1,500	0	100	
34-35	100	2,600	100	1,500	0	1,100	
Average		2,000	100	1,500	300		

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, SUGAR PINE RESERVOIR

(In acre-feet)

Storage capacity: 10,000 acre-feet

Seasonal yield: 7,200 acre-feet

Season	Water supply				Distribution of water supply				Deficiency, in percent
	Storage, October 1	Estimated runoff, Shirttail Creek at dam site	Release and spills from Big Reservoir	Total inflow	Evaporation	Yield	Spill	Storage, September 30	
1920-21	0	12,000	1,500	13,500	300	7,000	0	6,200	3
21-22	6,200	12,300	2,700	15,000	400	7,200	6,600	7,000	
22-23	7,000	10,400	2,500	12,900	400	7,200	5,200	7,100	
23-24	7,100	2,400	1,500	3,900	300	7,200	0	3,500	
24-25	3,500	11,700	1,800	13,500	400	7,200	2,700	6,700	
1925-26	6,700	5,500	1,600	7,100	400	7,200	500	5,700	
26-27	5,700	12,800	2,600	15,400	400	7,200	6,700	6,800	
27-28	6,800	9,500	2,500	12,000	400	7,200	5,000	6,200	
28-29	6,200	4,400	1,500	5,900	300	7,200	0	4,600	
29-30	4,600	6,600	1,500	8,100	300	7,200	0	5,200	
1930-31	5,200	3,000	1,200	4,200	200	7,200	0	2,000	
31-32	2,000	10,100	1,400	11,500	300	7,200	0	6,000	
32-33	6,000	5,100	1,500	6,600	300	7,200	0	5,100	
33-34	5,100	4,300	1,500	5,800	200	7,200	0	3,500	
34-35	3,500	10,800	1,500	12,300	400	7,200	1,700	6,500	
Average		8,100	1,800	9,900	300	7,200	1,900		

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, PAGGE RESERVOIR

(In acre-feet)

Storage capacity: 69,000 acre-feet | Seasonal yield: 90,000 acre-feet

Season	Water supply					Distribution of water supply				Release to Pickering Bar Power House*
	Storage, October 1	Estimated runoff, Pagge Creek at dam site	Inflow from French Meadows-Pagge Conduit	Spill, Sugar Pine Reservoir	Total inflow	Evaporation	Yield	Spill	Storage, September 30	
1920-21	0	9,600	133,400	0	143,000	1,300	82,700	9,400	49,600	92,100
21-22	49,600	9,900	131,400	6,600	147,900	1,300	90,000	55,800	50,400	115,600
22-23	50,400	8,300	135,300	5,200	148,800	1,400	90,000	56,800	51,000	121,300
23-24	51,000	2,000	54,900	0	56,900	1,000	90,000	0	16,900	90,000
24-25	16,900	9,400	122,200	2,700	134,300	1,300	90,000	8,800	51,100	98,800
1925-26	51,100	4,400	82,400	500	87,300	1,300	90,000	3,800	43,300	93,800
26-27	43,300	10,300	156,000	6,700	173,000	1,400	90,000	71,100	53,800	129,900
27-28	53,800	7,600	116,100	5,000	128,700	1,400	90,000	45,000	46,100	122,000
28-29	46,100	3,600	72,400	0	76,000	1,200	90,000	0	30,900	90,000
29-30	30,900	5,300	94,600	0	99,900	1,300	90,000	0	39,500	90,000
1930-31	39,500	2,400	58,700	0	61,100	1,000	90,000	0	9,600	90,000
31-32	9,600	8,100	120,400	0	128,500	1,200	90,000	0	46,900	90,000
32-33	46,900	4,000	75,400	0	79,400	1,200	90,000	0	35,100	90,000
33-34	35,100	3,500	69,200	0	72,700	1,000	90,000	0	16,800	90,000
34-35	16,800	8,700	122,000	1,700	132,400	1,300	90,000	9,000	48,900	99,000
Average		6,500	102,900	1,900	111,300	1,200	89,500	17,300		100,200

* Yield plus spill up to capacity of conduit.

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, FORBES RESERVOIR, FORESTHILL DIVIDE PROJECT

(In acre-feet)

Storage capacity: 5,300 acre-feet | Seasonal yield: 7,100 acre-feet

Season	Water supply				Distribution of water supply				Deficiency, in per cent	Surplus diverted to Big Reservoir
	Storage, October 1	Estimated runoff, Forbes Creek	Diversion from Bullion Creek	Total inflow	Evaporation	Yield	Spill	Storage, September 30		
1920-21	0	4,100	12,900	17,000	300	6,800	8,200	1,700	4	8,200
21-22	1,700	4,200	11,700	15,900	300	7,100	8,500	1,700		8,500
22-23	1,700	3,400	12,000	15,400	200	7,100	8,000	1,800		7,200
23-24	1,800	700	2,900	3,600	100	5,300	0	0	25	0
24-25	0	3,300	12,900	16,200	200	6,600	8,100	1,300	7	8,100
1925-26	1,300	1,900	6,400	8,300	200	7,100	2,100	200		2,100
26-27	200	5,000	14,700	19,700	200	6,800	11,500	1,400	4	10,700
27-28	1,400	3,200	11,000	14,200	200	7,100	7,600	700		6,500
28-29	700	1,500	5,100	6,600	200	7,000	0	0	1	0
29-30	0	2,400	7,200	9,600	200	6,500	2,100	800	8	2,100
1930-31	800	900	3,600	4,500	100	5,200	0	0	27	0
31-32	0	3,400	11,200	14,600	200	6,600	6,400	1,400	7	6,400
32-33	1,400	1,700	5,900	7,600	200	7,100	500	1,200		500
33-34	1,200	1,500	5,000	6,500	200	7,100	400	0		400
34-35	0	3,400	11,000	14,400	200	6,600	6,400	1,200	7	6,400
Average		2,700	8,900	11,600	200	6,700	4,600			4,500

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, ENLARGED BIG RESERVOIR, FORESTHILL DIVIDE PROJECT

(In acre-feet)

Storage capacity: 6,500 acre-feet

Seasonal yield: 7,200 acre-feet (remainder credited to Sugar Pine Reservoir)

Season	Water supply					Distribution of water supply				Deficiency, in percent
	Storage, October 1	Estimated runoff, tributary Forbes Creek	Diversion from Bullion Creek		Total inflow	Evaporation	Yield	Spill	Storage, September, 30	
			Regular	Spill						
1920-21	0	2,800	17,000	8,200	28,000	300	8,500	16,700	2,500	3
21-22	2,500	2,900	15,500	8,500	26,900	300	8,800	17,700	2,600	
22-23	2,600	2,400	16,000	7,200	25,600	300	8,800	16,300	2,800	
23-24	2,800	500	3,800	0	4,300	200	6,900	0	0	22
24-25	0	2,200	17,200	8,100	27,500	200	8,200	17,100	2,000	7
1925-26	2,000	1,300	8,400	2,100	11,800	200	8,800	4,300	500	
26-27	500	3,300	19,600	10,700	33,600	300	8,700	22,900	2,200	1
27-28	2,200	2,200	14,600	6,500	23,300	200	8,800	15,300	1,200	
28-29	1,200	1,000	6,700	0	7,700	200	8,700	0	0	1
29-30	0	1,600	9,600	2,100	13,300	200	8,000	3,700	1,400	9
1930-31	1,400	600	4,700	0	5,300	100	6,600	0	0	25
31-32	0	2,300	14,900	6,400	23,600	300	8,100	13,000	2,200	8
32-33	2,200	1,100	7,800	500	9,400	300	8,800	700	1,800	
33-34	1,800	1,000	6,600	400	8,000	200	8,800	500	300	
34-35	300	2,300	14,600	6,400	23,300	300	8,500	12,900	1,900	3
Average		1,800	11,800	4,500	18,100	200	8,400	9,400		

SEASONAL SUMMARY OF MONTHLY YIELD STUDY, SUGAR PINE RESERVOIR, FORESTHILL DIVIDE PROJECT

(In acre-feet)

Storage capacity: 17,000 acre-feet

Seasonal yield: 10,400 acre-feet

Season	Water supply					Distribution of water supply				Deficiency, in percent
	Storage, October 1	Estimated runoff, North Shirttail Canyon below Big Reservoir	Diversion from Big Reservoir	Spill from Big Reservoir	Total inflow	Evaporation	Yield plus diversion from Big Reservoir	Spill	Storage, September 30	
1920-21	0	7,800	1,600	16,700	26,100	500	9,900	3,800	11,900	5
21-22	11,900	8,000	1,600	17,700	27,300	500	10,400	16,300	12,000	
22-23	12,000	6,500	1,600	16,300	24,400	500	10,400	13,600	11,900	
23-24	11,900	1,300	1,200	0	2,500	300	10,400	0	3,700	
24-25	3,700	6,300	1,600	17,100	25,000	500	10,400	5,900	11,900	
1925-26	11,900	3,500	1,600	4,300	9,400	400	10,400	0	10,500	
26-27	10,500	9,400	1,600	22,900	33,900	500	10,400	21,600	11,900	
27-28	11,900	6,100	1,600	15,300	23,000	400	10,400	13,400	10,700	
28-29	10,700	2,800	1,600	0	4,400	300	10,400	0	4,400	
29-30	4,400	4,500	1,600	3,700	9,800	300	10,400	0	3,500	
1930-31	3,500	1,700	1,200	0	2,900	100	6,300	0	0	39
31-32	0	6,400	1,500	13,000	20,900	500	9,700	0	10,700	7
32-33	10,700	3,100	1,600	700	5,400	400	10,400	0	5,300	
33-34	5,300	2,800	1,600	500	4,900	200	10,000	0	0	4
34-35	0	6,500	1,600	12,900	21,000	500	9,800	0	10,700	6
Average		5,100	1,600	9,400	16,100	400	10,000	5,000		

YIELD STUDY

CAMP FAR WEST RESERVOIR

(In acre-feet)

Capacity: 104,000 acre-feet | Yield: 90,000 acre-feet

Season	November—May			June—October							Spill, end of May	Deficiency, in percent
	Runoff	Demand, 30% of annual demand	Storage, end of May	Demand, 70% of annual demand	Apparent storage, end of October	Apparent deficiency, end of October	Average summer storage	Evaporation	Storage, end of October	Deficiency, end of October		
920-21	467,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	336,000	
21-22	409,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	312,800	
22-23	364,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	267,800	
23-24	23,000	27,000	30,800	63,000	----	32,200	----	----	0	32,200	0	35.8
24-25	239,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	108,000	
925-26	223,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	116,800	
26-27	450,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	353,800	
27-28	296,000	27,000	104,000	63,000	41,000		72,500	6,200	34,800	----	199,800	
28-29	112,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	15,800	
29-30	355,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	258,800	
930-31	145,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	48,800	
31-32	234,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	137,800	
32-33	51,000	27,000	58,800	63,000	----	4,200	27,300	3,100	0	7,300	0	8.1
33-34	126,000	27,000	99,000	63,000	36,000	----	67,500	5,800	30,200	----	0	
34-35	354,000	27,000	104,000	63,000	41,000	----	72,500	6,200	34,800	----	253,200	
Average	256,000	27,000		63,000							160,600	

YIELD STUDY

COON CREEK RESERVOIR PLUS NOVEMBER THROUGH APRIL COMBIE-OPHIR DIVERSION OF 100 SECOND-FEET

(In acre-feet)

Capacity: 59,000 acre-feet | Yield: 56,000 acre-feet

Season	November—May				June—October							Spill, end of May	Deficiency, in percent
	Estimated runoff	Diversion	Demand, 30% of annual demand	Storage, end of May	Demand, 70% of annual demand	Apparent storage, end of October	Apparent deficiency, end of October	Average summer storage	Evaporation	Storage, end of October	Deficiency, end of October		
920-21	44,600	35,700	16,800	59,000	39,200	19,800	----	39,400	2,500	17,300	----	4,500	
21-22	40,000	35,700	16,800	59,000	39,200	19,800	----	39,400	2,500	17,300	----	17,200	
22-23	33,500	35,700	16,800	59,000	39,200	19,800	----	39,400	2,500	17,300	----	10,700	
23-24	5,900	35,700	16,800	42,100	39,200	2,900	----	22,500	1,800	1,100	----	0	
24-25	24,600	35,700	16,800	44,600	39,200	5,400	----	25,000	2,000	3,400	----	0	
925-26	22,300	35,700	16,800	44,600	39,200	5,400	----	25,000	2,000	3,400	----	0	
26-27	48,200	35,700	16,800	59,000	39,200	19,800	----	39,400	2,500	17,300	----	11,500	
27-28	30,200	35,700	16,800	59,000	39,200	19,800	----	39,400	2,500	17,300	----	7,400	
28-29	11,500	35,700	16,800	47,700	39,200	8,500	----	28,100	2,100	6,400	----	0	
29-30	19,000	35,700	16,800	44,300	39,200	5,100	----	24,700	2,000	3,100	----	0	
930-31	5,900	35,700	16,800	27,900	39,200	----	11,300	8,300	900	0	12,200	0	21.8
31-32	23,300	35,700	16,800	42,200	39,200	3,000	----	22,600	1,800	1,200	----	0	
32-33	11,500	35,700	16,800	31,600	39,200	----	7,600	12,000	1,200	0	8,800	0	15.7
33-34	11,200	35,700	16,800	30,100	39,200	----	9,100	10,500	1,100	0	10,200	0	18.2
34-35	31,800	35,700	16,800	50,700	39,200	11,500	----	31,100	2,200	9,300	----	0	
Average	24,200	35,700	16,800		39,200							3,400	

YIELD STUDY

DOTY RAVINE RESERVOIR PLUS NOVEMBER THROUGH APRIL DIVERSION FROM AUBURN RAVINE CANAL

(In acre-feet)

Capacity: 32,000 acre-feet — Yield: 28,000 acre-feet

Season	November—May				June—October							Spill, end of May	Deficiency, in percent
	Estimated runoff	Diversion	Demand, 20% of annual demand	Storage, end of May	Demand, 80% of annual demand	Apparent storage, end of October	Apparent deficiency, end of October	Average summer storage	Evaporation	Storage, end of October	Deficiency, end of October		
1920-21	14,200	23,000	5,600	31,500	22,400	9,100	----	20,300	3,000	6,100	----	100	
21-22	17,700	23,000	5,600	31,500	22,400	9,100	----	20,300	3,000	6,100	----	4,700	
22-23	10,500	23,000	5,600	31,500	22,400	9,100	----	20,300	3,000	6,100	----	2,500	
23-24	2,000	23,000	5,600	25,500	22,400	3,100	----	14,300	2,300	800	----	0	
24-25	7,800	23,000	5,600	26,000	22,400	3,600	----	14,800	2,400	1,200	----	0	
1925-26	7,000	23,000	5,600	25,600	22,400	3,200	----	14,400	2,300	900	----	0	
26-27	15,200	23,000	5,600	31,500	22,400	9,100	----	20,300	3,000	6,100	----	2,000	
27-28	9,500	23,000	5,600	31,500	22,400	9,100	----	20,300	3,000	6,100	----	1,500	
28-29	3,600	23,000	5,600	27,100	22,400	4,700	----	15,900	2,500	2,200	----	0	
29-30	6,000	23,000	5,600	25,600	22,400	3,200	----	14,400	2,300	900	----	0	
1930-31	1,900	23,000	5,600	20,200	22,400	----	2,200	9,000	1,600	----	3,800	0	13.6
31-32	7,300	23,000	5,600	24,700	22,400	2,300	----	13,500	2,200	100	----	0	
32-33	3,600	23,000	5,600	21,100	22,400	----	1,300	9,900	1,700	----	3,000	0	10.7
33-34	3,500	23,000	5,600	20,900	22,400	----	1,500	9,700	1,700	----	3,200	0	11.4
34-35	10,000	23,000	5,600	27,400	22,400	5,000	----	16,200	2,500	2,500	----	0	
Average	7,700	23,000	5,600		22,400							700	

YIELD STUDY

LINCOLN RESERVOIR PLUS NOVEMBER THROUGH APRIL DIVERSION FROM AUBURN RAVINE CANAL

(In acre-feet)

Capacity: 15,000 acre-feet — Seasonal yield: 17,500 acre-feet

Season	November-May				June-October							Spill, end of May	Deficiency, in percent
	Estimated runoff	Diversion	Demand, 20% of annual demand	Storage, end of May	Demand, 80% of annual demand	Apparent storage, end of October	Apparent deficiency, end of October	Average summer storage	Evaporation	Storage, end of October	Deficiency, end of October		
1920-21	52,550	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	43,050	
21-22	49,910	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	40,410	
22-23	39,380	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	29,880	
23-24	7,020	9,000	3,500	12,520	14,000		1,480	5,520	875	----	2,355	0	13.5
24-25	28,970	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	18,470	
1925-26	26,220	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	16,720	
26-27	56,710	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	47,210	
27-28	35,520	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	26,020	
28-29	13,520	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	4,020	
29-30	22,360	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	12,860	
1930-31	6,960	9,000	3,500	12,460	14,000	----	1,540	5,400	870	----	2,410	0	13.8
31-32	27,390	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	17,890	
32-33	13,520	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	4,020	
33-34	13,160	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	3,660	
34-35	37,400	9,000	3,500	15,000	14,000	1,000	----	7,500	1,000	----	----	27,900	
Average	28,710	9,000	3,500		14,000							19,470	

YIELD STUDY

AUBURN RAVINE RESERVOIR PLUS NOVEMBER THROUGH APRIL SPILL FROM WISE POWER HOUSE

(In acre-feet)

Capacity: 11,700 acre-feet | Yield: 13,000 acre-feet

Season	November—May				June—October							Spill, end of May	Deficiency, in percent
	Estimated runoff	Diversion	Demand, 20% of annual demand	Storage, end of May	Demand, 80% of annual demand	Apparent storage, end of October	Apparent deficiency, end of October	Average summer storage	Evaporation	Storage, end of October	Deficiency, end of October		
1920-21	21,700	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	17,600	
21-22	19,400	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	15,800	
22-23	16,100	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	12,500	
23-24	3,000	10,000	2,600	10,900	10,400	500	----	5,700	600	----	100	0	0.8
24-25	11,800	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	7,700	
1925-26	10,800	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	7,200	
26-27	23,300	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	19,700	
27-28	14,600	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	11,000	
28-29	5,500	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	1,900	
29-30	9,200	10,000	2,600	11,500	10,400	1,100		6,300	600	500	----	5,600	
1930-31	2,800	10,000	2,600	10,700	10,400	300	----	5,500	500	----	200	0	1.5
31-32	11,200	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	7,100	
32-33	5,500	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	1,900	
33-34	5,400	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	1,800	
34-35	15,300	10,000	2,600	11,500	10,400	1,100	----	6,300	600	500	----	11,700	
Average	11,700	10,000	2,600		10,400							8,100	

YIELD STUDY

WHITNEY RANCH RESERVOIR PLUS NOVEMBER THROUGH APRIL DIVERSION FROM AUBURN RAVINE

(In acre-feet)

Capacity: 10,300 acre-feet | Yield: 9,500 acre-feet

Season	November—May				June—October							Spill, end of May	Deficiency, in percent
	Estimated runoff	Diversion	Demand, 20% of annual demand	Storage, end of May	Demand, 80% of annual demand	Apparent storage, end of October	Apparent deficiency, end of October	Average summer storage	Evaporation	Storage, end of October	Deficiency, end of October		
1920-21	3,000	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	2,100	
21-22	3,000	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	2,200	
22-23	3,900	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	3,100	
23-24	200	11,000	1,900	9,400	7,600	1,800	----	5,600	2,200	0	600	0	6.3
24-25	3,100	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	2,200	
1925-26	2,700	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	1,900	
26-27	2,800	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	2,000	
27-28	800	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	0	
28-29	1,000	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	200	
29-30	1,900	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	1,100	
1930-31	700	11,000	1,900	9,900	7,600	2,300	----	6,100	2,300	0	----	0	
31-32	1,800	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	900	
32-33	1,000	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	200	
33-34	1,600	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	800	
34-35	3,200	11,000	1,900	10,000	7,600	2,400	----	6,200	2,300	100	----	2,400	
Average	2,000	11,000	1,900		7,600							1,300	

YIELD STUDY

CLOVER VALLEY RESERVOIR PLUS NOVEMBER THROUGH APRIL DIVERSION FROM AUBURN RAVINE

(In acre-feet)

Capacity: 21,600 acre-feet

Seasonal yield: 22,000 acre-feet

Season	November-May				June-October							Spill, end of May	Deficiency, in percent
	Estimated runoff	Diversion	Demand, 20% of annual demand	Storage, end of May	Demand, 80% of annual demand	Apparent storage, end of October	Apparent deficiency, end of October	Average summer storage	Evaporation	Storage, end of October	Deficiency, end of October		
1920-21	2,700	22,000	4,400	20,300	17,600	2,700	----	11,500	900	1,800	----	0	
21-22	2,400	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	500	
22-23	2,000	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	1,100	
23-24	400	22,000	4,400	20,800	17,600	3,200	--	12,000	900	2,300	----	0	
24-25	1,500	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	100	
1925-26	1,800	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	900	
26-27	2,900	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	2,000	
27-28	1,800	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	2,000	
28-29	700	22,000	4,400	21,100	17,600	3,500	----	12,300	900	2,600	----	0	
29-30	1,200	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	100	
1930-31	400	22,000	4,400	20,800	17,600	3,200	----	12,000	900	2,300	----	0	
31-32	1,400	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	0	
32-33	700	22,000	4,400	21,100	17,600	3,500	----	12,300	900	2,600	--	0	
33-34	700	22,000	4,400	20,900	17,600	3,300	----	12,100	900	2,400	----	0	
34-35	1,900	22,000	4,400	21,300	17,600	3,700	----	12,500	900	2,800	----	600	
Average	2,000	22,000	4,400		17,600							500	

APPENDIX N

ESTIMATES OF COST

TABLE OF CONTENTS

ESTIMATED COST OF JACKSON MEADOWS DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 6,024 feet, U. S. G. S. datum
Elevation of spillway crest: 6,010 feet
Height of dam to spillway crest, above stream bed: 145 feet

Capacity of reservoir to spillway crest: 45,000 acre-feet
Capacity at spillway with 4-foot freeboard: 19,000 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$20,000	
Stripping and preparation of foundation	54,500 cu.yd.	$2.00	109,000	
Embankment				
Impervious zone	446,000 cu.yd.	0.95	423,700	
Pervious zone	1,012,200 cu.yd.	0.50	506,100	
Grouting		lump sum	58,500	$1,117,300
Spillway				
Excavation	179,000 cu.yd.	3.00	537,000	
Concrete	1,625 cu.yd.	40.00	65,000	
Reinforcing steel	122,000 lb.	0.15	18,300	620,300
Outlet Works				
Excavation	4,650 cu.yd.	4.00	18,600	
Concrete				
Structure	50 cu.yd.	100.00	5,000	
Pipe encasement	1,100 cu.yd.	30.00	33,000	
Reinforcing steel	105,000 lb.	0.15	15,800	
Steel pipe, 60-inch diameter	160,000 lb.	0.30	48,000	
Valves		lump sum	55,500	175,900

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Reservoir				
Land and improvements			none	
Public utilities		lump sum	$75,000	
Clearing	900 ac.	$200.00	180,000	$255,000
Subtotal				$2,168,500
Administration and engineering, 10%				216,800
Contingencies, 15%				325,300
Interest during construction				81,300
TOTAL				$2,791,900
Annual Costs				
Interest, 3%				$83,800
Amortization, 0.887%				24,800
Replacement, 0.07%				2,000
Operation and maintenance				7,000
General expense, 0.32%				8,900
TOTAL				$126,500

ESTIMATED COST OF HAYPRESS DIVERSION AND TUNNEL

(Based on prices prevailing in April, 1953)

Elevation of crest of weir: 6,265 feet, U. S. G. S. datum
Height of weir above stream bed: 12 feet
Capacity of weir with 7-foot head: 10,000 second-feet

Capacity of diversion tunnel: 350 second-feet
Length of diversion tunnel: 3 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Unwatering weir site		lump sum	$2,000	
Excavation	900 cu.yd.	$4.00	3,600	
Concrete	1,380 cu.yd.	40.00	55,200	
Reinforcing steel	83,000 lb.	0.15	12,500	
Gates and trashrack		lump sum	5,100	$78,400
Diversion Tunnel				
Excavation, tunnel portal	12,000 cu.yd.	3.00	36,000	
Tunnel				
Concrete-lined, 7-foot diameter	0.6 mi.	1,100,000	660,000	
Unlined, 8.3-foot diameter	2.4 mi.	600,000	1,440,000	
Rights of way	20 ac.	50.00	1,000	2,137,000
Subtotal				$2,215,400

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$221,500
Contingencies, 15%			332,300
Interest during construction			83,100
TOTAL			$2,852,300
Annual Costs			
Interest, 3%			$85,600
Amortization, 0.887%			25,300
Replacement, 0.07%			2,000
Operation and maintenance			1,000
General expense, 0.32%			9,100
TOTAL			$123,000

ESTIMATED COST OF LAKE VALLEY DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 5,870 feet, U. S. G. S. datum
Elevation of crest of spillway: 5,863 feet
Height of dam to spillway crest, above stream bed: 150 feet

Capacity of reservoir to spillway crest: 41,000 acre-feet
Capacity of spillway with 4-foot freeboard: 3,500 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Unwatering dam site		lump sum	$5,000	
Stripping and preparation of foundation	111,300 cu.yd.	$2.00	222,600	
Excavation for embankment				
Impervious	866,000 cu.yd.	0.80	692,800	
Pervious	1,650,000 cu.yd.	0.75	1,237,500	
Embankment				
Impervious	753,100 cu.yd.	0.25	188,300	
Pervious	1,720,000 cu.yd.	0.17	292,400	
Drilling grout holes	6,600 lin.ft.	3.00	19,800	
Pressure grouting	4,400 cu.ft.	4.00	17,600	$2,676,000
Spillway				
Excavation	26,000 cu.yd.	3.00	78,000	
Concrete	310 cu.yd.	40.00	12,400	
Reinforcing steel	23,000 lb.	0.15	3,500	93,900
Outlet Works				
Excavation	87,500 cu.yd.	1.50	131,200	
Concrete				
Pipe encasement	2,000 cu.yd.	30.00	60,000	
Structural	30 cu.yd.	90.00	2,700	
Reinforcing steel	206,000 lb.	0.15	30,900	
Steel pipe	131,000 lb.	0.25	32,700	
Trashrack steel	4,900 lb.	0.25	1,200	
High-pressure slide gate 4' x 5'	1 ea.	lump sum	33,600	
Capital Costs—Continued				
Outlet Works—Continued				
Hollow jet valve, 24-inch diameter	1 ea.	lump sum	$5,400	$297,700
Reservoir				
Land	480 ac.	$300.00	144,000	
Public utilities	none			
Clearing	150 ac.	400.00	60,000	204,000
Subtotal				$3,271,600
Administration and engineering, 10%				327,200
Contingencies, 15%				490,800
Interest during construction				98,100
TOTAL				$4,187,700
Annual Costs				
Interest, 3%				$125,600
Amortization, 0.887%				37,100
Replacement, 0.07%				2,900
Operation and maintenance				66,000
General expense, 0.32%				13,400
TOTAL				$245,000

ESTIMATED COST OF LAKE FORDYCE DIVERSION CONDUIT

(Based on prices prevailing in April, 1953)

Elevation of flume invert at point of diversion: 6,361 feet, U. S. G. S. datum
Elevation of flume at tunnel: 6,326 feet
Capacity of flume: 100 second-feet

Elevation of tunnel invert at inlet: 6,326 feet
Elevation of tunnel outlet: 6,300 feet
Length of tunnel: 1.14 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Flume				
Inlet structure		lump sum	$2,000	
Flume, 6.4-foot diameter	2.8 mi.	$97,200	272,200	
Right of way				
Land	17.3 ac.	50.00	900	
Clearing	17.3 ac.	150.00	2,600	
Transition at tunnel		lump sum	2,000	$279,700
Tunnel				
8.3-foot diameter tunnel				
Unlined	1.03 mi.	560,000	576,800	
Lined	0.11 mi.	810,000	92,000	668,800
Subtotal				$948,500
Administration and engineering, 10%				94,900
Contingencies, 15%				142,300
Interest during construction				14,200
TOTAL				$1,199,900
Annual Costs				
Interest, 3%				$36,000
Amortization, 0.887%				10,600
Replacement				
Flume, 1.0%				3,500
Tunnel, 0.02%				200
Operation and maintenance				
Flume, 1.0%				3,500
Tunnel, 0.05%				400
General expense, 0.32%				3,800
TOTAL				$58,000

ESTIMATED COST OF RATTLESNAKE DIVERSION CONDUIT

(Based on prices prevailing in April, 1953)

Elevation of conduit invert, at headworks: 5,930 feet, U. S. G. S. datum
Elevation of flume at siphon: 5,910 feet, U. S. G. S. datum
Capacity of conduit: 100 second-feet
Elevation of siphon invert at outlet: 5,900 feet, U. S. G. S. datum
Length of flume: 1.51 miles
Length of siphon: 0.42 mile

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	110 cu.yd.	$5.00	$600	
Concrete				
Weir	116 cu.yd.	35.00	4,100	
Sluice box	45 cu.yd.	90.00	4,100	
Reinforcing steel	10,000 lb.	0.15	2,100	
Trashrack	2,000 lb.	0.25	500	
3½′ x 3½′ head gate		lump sum	1,000	
2′ x 2′ sluice gate		lump sum	600	$13,000
Conduit				
Flume	1.51 mi.	132,000	199,300	
Siphon, 4-foot diameter	.42 mi.	316,800	133,100	
Transitions		lump sum	3,000	
Rights of way				
Land	12 ac.	50.00	600	
Clearing	12 ac.	150.00	1,800	337,800
Subtotal				$350,800

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$35,100
Contingencies, 15%			52,600
Interest during construction			5,300
TOTAL			$443,800
Annual Costs			
Interest, 3%			$13,300
Amortization, 0.887%			3,900
Replacement, 1.0%			4,400
Operation and maintenance			
Flume, 1%			4,400
Siphon, 0.5%			2,200
General expense, 0.32%			1,400
TOTAL			$29,600

ESTIMATED COST OF SOUTH FORK YUBA RIVER DIVERSION CONDUIT

(Based on prices prevailing in April, 1953)

Elevation of conduit invert, at headworks: 5,950 feet, U. S. G. S. datum
Elevation of canal at tunnel entrance: 5,890 feet, U. S. G. S. datum
Elevation of tunnel exit: 5,875 feet, U. S. G. S. datum
Capacity of conduit: 200 second-feet to elevation 5,900 feet and 300 second-feet beyond this point
Length of conduit: 6.5 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	100 cu.yd.	$5.00	$500	
Concrete				
Weir	250 cu.yd.	35.00	8,700	
Sluice box	45 cu.yd.	90.00	4,000	
Reinforcing steel	15,000 lb.	0.15	2,200	
Trashrack	2,000 lb.	0.25	500	
5′ x 5′ slide gate		lump sum	1,200	
2′ x 2′ sluice gate		lump sum	600	$17,700
Conduit				
Flume				
300 second-foot capacity	1.8 mi.	180,000	320,000	
200 second-foot capacity	3.7 mi.	94,600	350,000	
Transitions		lump sum	3,000	
Tunnel, 8.7-foot diameter	1.0 mi.	580,000	580,000	
Rights of way				
Land	34 ac.	50.00	1,700	
Clearing	34 ac.	150.00	5,100	1,259,800
Subtotal				$1,277,500

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$127,800
Contingencies, 15%			191,600
Interest during construction			19,200
TOTAL			$1,616,100
Annual Costs			
Interest, 3%			$48,500
Amortization, 0.887%			14,300
Replacement			
Flume, 1%			16,200
Tunnel, 0.02%			300
Operation and maintenance			
Flume, 1%			16,200
Tunnel, 0.05%			800
General expense, 0.32%			5,200
TOTAL			$101,500

ESTIMATED COST OF LAKE VALLEY PIPE LINE

(Based on prices prevailing in April, 1953)

Elevation of pipe line at inlet: 5,750 feet, U. S. G. S. datum
Elevation of pipe line at terminus: 5,700 feet, U. S. G. S. datum

Capacity of pipe line: 200 second-feet
Length of pipe line: 2.0 miles

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Steel pipe, 5.5 foot dia.	2.0 mi.	$215,000	$430,000		Interest, 3%			$17,200
60-inch butterfly valve	1 ea.	lump sum	17,500		Amortization, 0.887%			5,100
					Replacement, 1%			5,700
Rights of way					Operation and maintenance			2,900
Land	14 ac.	100.00	1,400		General expense, 0.32%			1,800
Clearing	14 ac.	100.00	2,800		TOTAL			$32,700
Subtotal				$451,700				
Administration and engineering, 10%				45,200				
Contingencies, 15%				67,800				
Interest during construction				8,500				
TOTAL				$573,200				

ESTIMATED COST OF LAKE VALLEY POWER HOUSE

(Based on prices prevailing in April, 1953)

Elevation of penstock inlet: 5,700 feet, U. S. G. S. datum
Elevation of power house tailrace: 5,025 feet, U. S. G. S. datum

Capacity of penstock: 200 second-feet
Length of penstock: 0.7 mile

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Power house, 17,500 kilowatts, single unit plant		lump sum	$1,250,000		Interest, 3%			$62,700
					Amortization, 0.887%			18,500
Penstock	0.7 mi.	$565,000	396,000		Replacement, 1.2%			25,100
					Insurance, 0.12%			2,500
Rights of way					Operation and maintenance			70,000
Land	5 ac.	100.00	500		General expenses, 0.32%			6,700
Clearing	5 ac.	200.00	1,000		TOTAL			$185,500
Subtotal				$1,647,500				
Administration and engineering, 10%				164,800				
Contingencies, 15%				247,100				
Interest during construction				30,900				
TOTAL				$2,090,300				

ESTIMATED COST OF CISCO DAM AND RESERVOIR

(Bosed on prices prevoiling in April, 1953)

Elevotion of crest of dom: 5,840 feet, U. S. G. S. dotum
Elevotion of crest of spillwoy: 5,828 feet
Height of dom to spillwoy crest, obove streom bed: 238 feet

Copocity of reservoir to crest of spillwoy: 100,000 ocre-feet
Copocity of spillwoy with 4-foot freeboord: 15,000 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$50,000	
Stripping and preparation of foundation	54,500 cu.yd.	$2.10	114,400	
Embankment				
Dumped rock	2,397,900 cu.yd.	1.80	4,316,200	
Placed rock	176,300 cu.yd.	8.00	1,410,400	
Concrete				
Slab and cutoff	17,000 cu.yd.	30.00	510,000	
Reinforcing steel	2,500,000 lbs.	0.15	375,000	
Drilling grout holes	5,840 lin.ft.	3.50	20,400	
Pressure grouting	2,920 cu.ft.	4.00	11,700	$6,808,100
Spillway				
Excavation	24,400 cu.yd.	5.00	122,000	
Concrete	600 cu.yd.	35.00	21,000	
Reinforcing steel	45,000 lbs.	0.15	6,700	149,700
Outlet Works				
Excavation				
Tunnel	6,100 cu.yd	50.00	305,000	
Tunnel portals and approach	10,000 cu.yd.	3.00	30,000	
Concrete				
Tunnel lining	1,600 cu.yd.	35.00	56,000	
Structural	850 cu.yd.	60.00	51,000	
Reinforcing steel	85,000 lbs.	0.15	12,700	
Trashrack steel	13,900 lbs.	0.25	3,500	
Steel pipe, 60-inch diameter	195,800 lbs.	0.25	48,900	
Steel supports and timber		lump sum	62,400	
High-pressure slide gate 4′ x 4′		lump sum	25,000	
Hollow jet valve, 48-inch diameter		lump sum	14,400	608,900

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Reservoir				
Land and improvements		lump sum	$885,000	
Public utilities				
Telephone lines and cables		lump sum	491,300	
Power line		lump sum	500,000	
U. S. Highway 40				
Highway	6 mi.	$200,000	1,200,000	
Bridges	2 ea.	100,000	200,000	
Clearing	940 ac.	200.00	188,000	$3,464,300
Subtotal				$11,031,000
Administration and engineering, 10%				1,103,100
Contingencies, 15%				1,654,700
Interest during construction				330,900
TOTAL				$14,119,700
Annual Costs				
Interest, 3%				$423,600
Amortization, 0.887%				125,200
Replacement, 0.07%				9,900
Operation and maintenance				12,500
General expense, 0.32%				45,200
TOTAL				$616,400

ESTIMATED COST OF FORDYCE DIVERSION CONDUIT

(Bosed on prices prevoiling in April, 1953)

Elevotion of flume invert ot point of diversion: 6,361 feet, U. S. G. S. dotum
Elevotion of flume ot tunnel: 6,326 feet
Copocity of flume: 100 second-feet

Elevotion of tunnel invert ot inlet: 6,326 feet
Elevation of tunnel outlet: 6,300 feet
Length of tunnel: 1.14 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Flume				
Inlet structure		lump sum	$2,000	
Flume, 6.4-foot diameter	2.8 mi.	$97,200	272,200	
Right of way				
Land	17.3 ac.	50.00	900	
Clearing	17.3 ac.	150.00	2,600	
Transition at tunnel		lump sum	2,000	$279,700
Tunnel				
8.3-foot diameter tunnel				
Unlined	1.03 mi.	560,000	576,800	
Lined	0.11 mi.	810,000	92,000	668,800
Subtotal				$948,500
Administration and engineering, 10%				94,900
Contingencies, 15%				142,300
Interest during construction				14,200
TOTAL				$1,199,900

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$36,000
Amortization, 0.887%			10,600
Replacement			
Flume, 1.0%			3,500
Tunnel, 0.02%			200
Operation and maintenance			
Flume, 1.0%			3,500
Tunnel, 0.05%			400
General expense, 0.32%			3,800
TOTAL			$58,000

ESTIMATED COST OF WOODCHUCK DAM AND RESERVOIR

(Based on prices prevailing in July, 1953)

Elevation of crest of dam: 6,300 feet, U. S. G. S. datum
Elevation of crest of spillway: 6,290 feet
Height of dam to spillway crest, above stream bed: 50 feet

Capacity of reservoir to crest of spillway: 1,475 acre-feet
Capacity of spillway with 4-foot freeboard: 6,200 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$25,000	
Stripping and preparation of foundation	2,500 cu.yd.	$3.00	7,500	
Embankment				
Placed rock	4,470 cu.yd.	8.00	35,800	
Dumped rock	42,230 cu.yd.	0.50	21,100	
Drilling grout holes	4,980 lin.ft.	4.00	19,900	
Pressure grouting	3,320 cu.ft.	4.00	13,300	
Slab concrete	820 cu.yd.	50.00	41,000	
Reinforcing steel	106,200 lbs.	0.15	15,900	$179,500
Spillway				
Excavation, rock	49,300 cu.yd.	3.00	147,900	
Concrete	370 cu.yd.	40.00	14,800	
Reinforcing steel	27,800 lbs.	0.15	4,200	166,900
Outlet Works				
Excavation, rock	600 cu.yd.	5.00	3,000	
Compacted backfill	430 cu.yd.	4.00	1,700	
Concrete, structural	130 cu.yd.	100.00	13,000	
Steel pipe	9,870 lbs.	0.25	2,500	
Reinforcing steel	13,000 lbs.	0.15	2,000	
Trashrack steel	2,130 lbs.	0.25	500	
Circular slide gates, 48-inch diameter	2 ea.	500.00	1,000	
Gate controls	1 ea.	700.00	700	24,400

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Reservoir				
Land	100 ac.	National Forest	none	
Highway relocation	2 mi.	$20,000	$40,000	
Clearing reservoir lands	60 ac.	50.00	3,000	$43,000
Subtotal				$413,800
Administration and engineering, 10%				41,400
Contingencies, 15%				62,100
Interest during construction				6,200
TOTAL				$523,500
Annual Costs				
Interest, 3%				$15,700
Amortization, 0.887%				4,600
Replacement, 0.07%				400
Operation and maintenance				300
General expense, 0.32%				1,700
TOTAL				$22,700

ESTIMATED COST OF RATTLESNAKE DIVERSION CONDUIT

(Based on prices prevailing in April, 1953)

Elevation of conduit invert, at headworks: 6,253 feet, U. S. G. S. datum
Elevation of flume, at penstock: 6,248 feet

Capacity of flume: 160 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Inlet structure		lump sum	$2,000	
Flume, 8.9-foot diameter	1.0 mi.	$76,600	76,600	
Right of way				
Land	6 ac.	50.00	300	
Clearing	6 ac.	150.00	900	
Transition to penstock		lump sum	2,000	$81,800
Subtotal				$81,800
Administration and engineering, 10%				8,200
Contingencies, 15%				12,300
Interest during construction				1,200
TOTAL				$103,500

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$3,100
Amortization, 0.887%			900
Replacement, 1%			1,000
Operation and maintenance			1,000
General expense, 0.32%			300
TOTAL			$6,300

ESTIMATED COST OF CISCO POWER HOUSE NO. 1

(Based on prices prevailing in April, 1953)

Elevation of penstock inlet: 6,248 feet, U. S. G. S. datum
Length of penstock: 1,400 feet
Diameter of penstock: 5 feet to 4.75 feet

Elevation of tailrace: 5,828 feet
Installed capacity: 5,000 kilowatts

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Penstock, 5-foot diameter	1,400 lin.ft.	$67.00	$93,800		Interest, 3%			$28,600
Power house, 5,000 kilowatts, single unit		lump sum	650,000	$743,800	Amortization, 0.887%			8,300
Subtotal				$743,800	Replacement, 1%			9,500
Administration and engineering, 10%				74,400	Insurance, 0.12%			1,100
Contingencies, 15%				111,600	Operation and maintenance			37,500
Interest during construction				22,300	General expense, 0.32%			3,000
TOTAL				$952,100	TOTAL			$88,000

ESTIMATED COST OF CISCO RESERVOIR TUNNEL

(Based on prices prevailing in April, 1953)

Elevation of power tunnel, at inlet: 5,588 feet, U. S. G. S. datum
Elevation of power tunnel, at outlet: 5,531 feet

Length of tunnel: 3.6 miles
Capacity of tunnel: 200 second-feet

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Tunnel					Interest, 3%			$80,500
Unlined, 8.3-foot diameter	3.2 mi.	$550,000	$1,760,000		Amortization, 0.887%			23,800
Lined, 7.0-foot diameter	0.4 mi.	810,000	324,000		Replacement, none			
4′ x 4′ high pressure slide gate		lump sum	21,600		Operation and maintenance, 0.05%			1,300
Valve chamber		lump sum	15,000	$2,120,600	General expense, 0.32%			8,600
Subtotal				$2,120,600	TOTAL			$114,200
Administration and engineering, 10%				212,100				
Contingencies, 15%				318,100				
Interest during construction				31,800				
TOTAL				$2,682,600				

ESTIMATED COST OF CISCO POWER HOUSE NO. 2

(Bosed on prices prevailing in April, 1953)

Elevation of penstock inlet: 5,531 feet, U. S. G. S. dotum
Elevation of power house tailrace: 5,025 feet
Capacity of penstock: 300 second-feet

Length of penstock: 0.6 mile
Installed capacity: 28,000 kilowatts

Item	Quantity	Unit price	Cost	
Capital Costs				
Power house, 28,000 kilowatts, single unit plant		lump sum	$2,000,000	
Penstock	3,200 lin.ft.	$250.00	800,000	
Surge tank		lump sum	130,000	
Right of way				
Land	7.4 ac.	100.00	700	
Clearing	7.4 ac.	200.00	1,500	$2,932,200
Subtotal				$2,932,200
Administration and engineering, 10%				293,200
Contingencies, 15%				439,800
Interest during construction				55,000
TOTAL				$3,720,200

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$111,600
Amortization, 0.887%			33,000
Replacement			
Power plant, 1.2%			32,300
Penstock, 1.0%			10,900
Insurance, power plant, 0.12%			3,200
Operation and maintenance			
Power plant			103,000
Penstock			1,400
General expense, 0.32%			11,900
TOTAL			$307,300

ESTIMATED COST OF ROLLINS DAM AND RESERVOIR

(Bosed on prices prevailing in April, 1953)

Elevotion of crest of dam: 2,185 feet, U. S. G. S. datum
Elevation of crest of spillway: 2,170 feet
Height of dom to spillwoy crest, above stream bed: 220 feet

Capacity of reservoir to crest of spillway: 70,000 ocre-feet
Capacity of spillway with 6.25-foot freeboard: 35,000 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and eare of stream		lump sum	$433,000	
Stripping and preparation of foundation	151,000 cu.yd.	$0.50	75,500	
	32,000 cu.yd.	1.10	35,200	
Excavation for embankment				
From borrow pits	1,140,000 cu.yd.	0.35	399,000	
From tailings	1,367,500 cu.yd.	0.30	410,000	
Embankment				
Impervious, borrow	1,140,000 cu.yd.	0.20	228,000	
Pervious, tailing	1,367,500 cu.yd.	0.15	205,500	
Pervious, salvage	442,000 cu.yd.	0.20	88,400	
Riprap	49,500 cu.yd.	3.00	148,500	
Drilling grout holes	13,200 lin.ft.	4.00	52,800	
Pressure grouting	13,200 eu.ft.	4.00	52,800	$2,128,700
Spillway				
Excavation				
Common	32,000 eu.yd.	0.50	32,000	
Rock, general	97,600 eu.yd.	1.00	97,600	
Rock, shape	24,400 cu.yd.	3.00	73,200	
Concrete				
Weir	900 cu.yd.	35.00	31,500	
Lining	10,000 cu.yd.	35.00	350,000	
Cutoff wall	325 eu.yd.	8.00	2,600	
Reinforeing steel	816,000 lb.	0.14	114,000	
Approach excavation				
Soil	62,000 cu.yd.	0.45	27,900	
Roek, shape	50,000 cu.yd.	2.75	137,500	
Rock, general	200,000 cu.yd.	1.00	200,000	1,066,300
Outlet Works				
Baekfill plug (concrete)	88 cu.yd.	30.00	2,600	
Steel pipe	279,000 lb.	0.25	69,800	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works—Continued				
Reinforeing steel				
Butterfly valve, 60″	10,000 lb.	$1.75	$17,500	
Hollow jet valve, 48″	27,000 lb.	0.60	5,400	
Trashrack	10,000 lb.	0.20	2,000	
				$97,300
Reservoir				
Land and improvements				
Land	500 ac.	40.00	20,000	
Cabins	18 ea.	2,000	36,000	
Public utilities		lump sum	31,000	
Clearing	900 ac.	200.00	180,000	267,000
Subtotal				$3,559,300
Administration and engineering, 10%				355,900
Contingencies, 15%				533,900
Interest during construction				133,000
TOTAL				$4,582,100
Annual Costs				
Interest, 3%				$137,500
Repayment, 0.887%				40,600
Replacement, 0.07%				3,200
Operation and maintenanee				9,500
General expense, 0.32%				14,700
TOTAL				$205,500

ESTIMATED COST OF CHICAGO PARK CANAL DIVERSION

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 2,720 feet, U. S. G. S. datum
Elevation of crest of overpour to side channel: 2,718 feet, U. S. G. S. datum

Height of dam to crest, above stream bed: 20 feet
Elevation of flowline of side channel at canal intake: 2,707 feet, U. S. G. S. datum

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Stripping and preparation of foundation				
Gravel	1,000 cu.yd.	$1.00	$1,000	
Rock	325 cu.yd.	8.50	2,600	
Concrete	1,010 cu.yd.	35.00	35,350	
Radial gate and hoist, 20′ x 7′	2 ea.	7,300	14,600	$53,600
Side Channels and Headworks				
Excavation				
Rock	17,000 cu.yd.	3.00	51,000	
Semistructural concrete	1,100 cu.yd.	60.00	66,000	
Reinforcing steel	110,000 lb.	0.15	16,500	
Slide gate, 5′ x 5′	2 ea.	1,000	2,000	135,500
Subtotal				$189,100

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$18,900
Contingencies, 15%			28,400
Interest during construction			3,500
TOTAL			$239,900
Annual Costs			
Interest, 3%			$7,200
Amortization, 0.887%			2,130
Replacement, 0.07%			200
General expense, 0.32%			770
Operation and maintenance, 1%			2,400
TOTAL			$12,700

ESTIMATED COST OF CHICAGO PARK CANAL

(Based on prices prevailing in April, 1953)

Elevation of canal invert at point of diversion: 2,707 feet, U. S. G. S. datum
Elevation of canal at penstack: 2,690 feet, U. S. G. S. datum

Capacity of canal: 700 second-feet
Length of canal: 5.75 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Excavation				
Earth	25,000 cu.yd.	$0.35	$8,800	
Soft rock	50,000 cu.yd.	3.00	150,000	
Canal				
Concrete	12,450 cu.yd.	75.00	930,000	
Reinforcing	124,500 lb.	0.15	185,000	
Wasteways	5	1,000	5,000	
Rights of way				
Land	50 ac.	100.00	5,000	
Clearing	50 ac.	200.00	10,000	
Subtotal				$1,293,800

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$129,400
Contingencies, 15%			194,100
Interest during construction			24,200
TOTAL			$1,641,500
Annual Costs			
Interest, 3%			$49,450
Amortization, 0.887%			14,600
Replacement, 1%			16,400
Operation and maintenance, 1%			16,400
General expense, 0.32%			5,250
TOTAL			$102,100

ESTIMATED COST OF CHICAGO PARK POWER HOUSE

(Based on prices prevailing in April, 1953)

Elevation of penstock inlet: 2,690 feet, U. S. G. S. datum
Elevation of power house tailrace: 2,220 feet, U. S. G. S. datum
Capacity of penstock: 700 second-feet
Length of penstock: 0.38 mile

Item	Quantity	Unit price	Cost	
Capital Costs				
Power house, 25,000 kilowatt, single unit plant		lump sum	$1,950,000	
Penstock	0.38 mi.	$1,030,000	392,000	
Rights of way				
Land	5 ac.	100.00	500	
Clearing	5 ac.	300.00	1,500	
Subtotal				$2,344,000
Administration and engineering, 10%				234,400
Contingencies, 15%				351,600
Interest during construction				44,000
TOTAL				$2,974,000

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$89,200
Amortization, 0.887%			26,400
Replacement			
Penstock			5,000
Power house			30,000
Insurance, 0.12%			3,600
Operation and maintenance			
Penstock			1,110
Power house			77,500
General expense, 0.32%			9,500
TOTAL			$242,300

ESTIMATED COST OF FRENCH MEADOWS DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 5,220 feet, U. S. G. S. datum
Elevation of crest of spillway: 5,210 feet
Height of dam to spillway crest, above stream bed: 200 feet
Capacity of reservoir to crest of spillway: 74,000 acre-feet
Capacity of spillway with 4-foot freeboard: 17,400 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$25,000	
Stripping and preparation of foundation	52,000 cu.yd.	$2.00	104,000	
Embankment				
Dumped rock	1,043,000 cu.yd.	2.35	2,451,000	
Placed rock	122,000 cu.yd.	8.00	976,000	
Concrete	20,080 cu.yd.	30.00	602,400	
Reinforcing steel	1,763,000 lbs.	0.15	264,500	
Grouting		lump sum	126,000	$4,548,900
Spillway				
Excavation	45,500 cu.yd.	3.00	136,500	
Concrete	530 cu.yd.	40.00	21,200	
Reinforcing steel	53,000 lbs.	0.15	8,000	165,700
Outlet Works				
Excavation				
Tunnel portal	12,500 cu.yd.	3.00	37,500	
Tunnel	2,080 cu.yd.	45.00	93,600	
Concrete				
Tunnel lining	910 cu.yd.	40.00	36,400	
Structures	230 cu.yd.	100.00	23,000	
Reinforcing steel	23,000 lbs.	0.15	3,500	
Steel pipe	88,000 lbs.	0.25	22,000	
Valves and trashrack		lump sum	110,000	326,000

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Reservoir				
Land and improvements			$5,400	
Public utilities		lump sum	212,000	
Clearing	1,010 ac.	$150.00	151,500	$368,900
Subtotal				$5,409,500
Administration and engineering, 10%				541,000
Contingencies, 15%				811,400
Interest during construction				101,500
TOTAL				$6,863,400
Annual Costs				
Interest, 3%				$206,000
Amortization, 0.887%				60,900
Replacement, 0.07%				4,800
Operation and maintenance				9,500
General expense, 0.32%				22,000
TOTAL				$303,200

ESTIMATED COST OF DUNCAN CREEK DIVERSION AND CONDUIT

(Bosed an prices prevoiling in April, 1953)

Elevation af crest af weir: 5,415 feet, U. S. G. S. datum
Height of weir above streom bed: 25 feet
Drainage area, above diversion warks: 9.0 square miles
Copocity af weir with 11-faat head: 7,000 secand-feet

Length af weir: 30 feet
Capacity of diversian canduit: 100 secand-feet
Length af diversion conduit: 2.8 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	200 cu.yd.	$5.00	$1,000	
Concrete	840 cu.yd.	50.00	42,000	
Reinforcing steel	84,000 lbs.	0.20	16,800	
Gates and trashrack		lump sum	4,000	$63,800
Conduit				
Canal, concrete-lined	2.4 mi.	32,000	76,800	
Tunnel, unlined, 8.2-foot diameter	0.4 mi.	750,000	300,000	
Access road and clearing	3.0 mi.	30,000	90,000	
Rights of way		none		466,800
Subtotal				$530,600

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$53,100
Contingencies, 15%			79,600
Interest during construction, none			
TOTAL			$663,300
Annual Costs			
Interest, 3%			$19,900
Amortization, 0.887%			5,900
Replacement, 0.02%			100
Operation and maintenance			600
General expense, 0.32%			2,100
TOTAL			$28,600

ESTIMATED COST OF FRENCH MEADOWS-DEEP CANYON CONDUIT

(Bosed an prices prevailing in April, 1953)

Elevatian af tunnel inlet: 5,035 feet, U. S. G. S. datum
Elevotian af tunnel autlet: 4,910 feet

Capacity of conduit: 200 secand-feet
Length of conduit: 6.02 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Conduit				
Tunnel, unlined, 8.3-foot diameter	4.5 mi.	$600,000	$2,700,000	
Tunnel, lined, 7.0-foot diameter	1.1 mi.	1,150,000	1,265,000	
Siphon, steel pipe, 7.0-foot diameter	0.42 mi.	950,000	399,000	$4,364,000
Subtotal				$4,364,000
Administration and engineering, 10%				436,400
Contingencies, 15%				654,600
Interest during construction				163,700
TOTAL				$5,618,700

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$168,600
Amortization, 0.887%			49,800
Replacement, 0.02%			1,100
Operation and maintenance, 0.05%			2,800
General expense, 0.32%			18,000
TOTAL			$240,300

ESTIMATED COST OF DEEP CANYON POWER HOUSE

(Based on prices prevailing in April, 1953)

Elevation of penstock inlet: 4,910 feet, U. S. G. S. datum
Elevation of power house tailrace: 4,020 feet

Capacity of penstock: 200 second-feet
Length of penstock: 2,450 feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Penstock				
7.2 to 6.0-foot diameter	2,450 lin.ft.	$223.00	$546,000	
Access road	2 mi.	30,000	60,000	
Surge tank		lump sum	90,000	$696,000
Power House				
15,000-kilowatt, single unit plant	15,000 kw.	125.00	1,875,000	
Access road	3 mi.	80,000	240,000	2,115,000
Subtotal				$2,811,000
Administration and engineering, 10%				281,100
Contingencies, 15%				421,800
Interest during construction				105,400
TOTAL				$3,619,300

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$108,600
Amortization, 0.887%			32,200
Replacement			
Penstock, 1.00%			7,000
Power house, 1.20%			22,500
Surge tank, 1.00%			900
Insurance			3,300
Operation and maintenance			66,000
General expense, 0.32%			11,600
TOTAL			$252,100

ESTIMATED COST OF DEEP CANYON DIVERSION AND CONDUIT

(Based on prices prevailing in April, 1953)

Elevation of crest of weir: 4,020 feet, U. S. G. S. datum
Height of weir above stream bed: 20 feet
Drainage area, above the diversion works: 21.4 square miles
Capacity of weir with 15-foot head: 13,000 second-feet

Length of weir: 65 feet
Capacity of conduit: 400 second-feet
Length of conduit: 0.9 mile

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	200 cu.yd.	$5.00	$1,000	
Concrete	2,000 cu.yd.	50.00	100,000	
Reinforcing steel	200,000 lbs.	0.20	40,000	
Gates and trashrack		lump sum	5,400	$146,400
Conduit				
Tunnel, unlined, 9.0-foot diameter	0.6 mi.	650,000	390,000	
Tunnel, lined, 7.5-foot diameter	0.1 mi.	1,200,000	120,000	
Steel pipe, 7-foot diameter	0.2 mi.	320,000	64,000	574,000
Subtotal				$720,400

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$72,000
Contingencies, 15%			108,000
Interest during construction			27,000
TOTAL			$927,400
Annual Costs			
Interest, 3%			$27,800
Amortization, 0.887%			8,200
Replacement, 0.05%			500
Operation and maintenance			900
General expense, 0.32%			3 000
TOTAL			$40,400

ESTIMATED COST OF LOST CANYON DIVERSION AND TUNNEL

(Based on prices prevailing in April, 1953)

Elevation of crest of weir: 3,980 feet, U. S. G. S. datum
Height of weir above stream bed: 20 feet
Drainage area above diversion works: 1.9 square miles
Capacity of weir with 6-foot head: 1,900 second-feet

Length of weir: 30 feet
Capacity of conduit: 400 second-feet
Length of conduit: 1.3 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	100 cu.yd.	$5.00	$500	
Concrete	720 cu.yd.	50.00	36,000	
Reinforcing steel	72,000 lbs.	0.20	14,400	
Gates and trashrack		lump sum	5,400	
Access road	3 mi.	50,000	150,000	$206,300
Conduit				
Tunnel, unlined, 9.0-foot diameter	1.2 mi.	650,000	780,000	
Tunnel, lined, 7.5-foot diameter	0.1 mi.	1,200,000	120,000	900,000
Subtotal				$1,106,300

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$110,600
Contingencies, 15%			165,900
Interest during construction			41,500
TOTAL			$1,424,300
Annual Costs			
Interest, 3%			$42,700
Amortization, 0.887%			12,600
Replacement, 0.05%			700
Operation and maintenance			1,400
General expense, 0.32%			4,600
TOTAL			$62,000

ESTIMATED COST OF SECRET CANYON DIVERSION AND TUNNEL

(Based on prices prevailing in April, 1953)

Elevation of crest of weir: 3,955 feet, U. S. G. S. datum
Height of weir above stream bed: 20 feet
Drainage area above diversion works: 8.7 square miles
Capacity of weir with 6.6-foot head: 5,300 second-feet

Length of weir: 90 feet
Capacity of conduit: 450 second-feet
Length of conduit: 2.8 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	300 cu.yd.	$5.00	$1,500	
Concrete	1,650 cu.yd.	50.00	82,500	
Reinforcing steel	165,000 lbs.	0.20	33,000	
Gates and trashrack		lump sum	5,400	
Access road	2 mi.	40,000	80,000	$202,400
Conduit				
Tunnel, unlined, 9.4-foot diameter	2.5 mi.	680,000	1,700,000	
Tunnel, lined, 7.9-foot diameter	0.3 mi.	1,280,000	384,000	2,084,000
Subtotal				$2,286,400

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$228,600
Contingencies, 15%			342,900
Interest during construction			85,700
TOTAL			$2,943,600
Annual Costs			
Interest, 3%			$88,300
Amortization, 0.887%			26,100
Replacement, 0.05%			1,500
Operation and maintenance			2,900
General expense, 0.32%			9,400
TOTAL			$128,200

ESTIMATED COST OF EL DORADO CREEK DIVERSION AND TUNNEL

(Based on prices prevailing in April, 1953)

Elevation of crest of weir: 3,890 feet, U. S. G. S. datum
Height of weir above stream bed: 30 feet
Drainage area above diversion works: 4.9 square miles
Capacity of weir with 11.2-foot head: 3,900 second-feet

Length of weir: 30 feet
Capacity of diversion conduit: 500 second-feet
Length of conduit: 1.8 miles

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	200 cu.yd.	$5.00	$1,000	
Concrete	1,200 cu.yd.	50.00	60,000	
Reinforcing steel	120,000 lbs.	0.20	24,000	
Gates and trashrack		lump sum	5,400	
Access road	1.5 mi.	40,000	60,000	$150,400
Conduit				
Tunnel, unlined, 10.0-foot diameter	1.6 mi.	750,000	1,200,000	
Tunnel, lined, 8.5-foot diameter	0.2 mi.	1,400,000	280,000	
Access road	1 mi.	40,000	40,000	1,520,000
Subtotal				$1,670,400

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$167,000
Contingencies, 15%			250,500
Interest during construction			62,600
TOTAL			$2,150,500
Annual Costs			
Interest, 3%			$64,500
Amortization, 0.887%			19,100
Replacement, 0.05%			1,100
Operation and maintenance			2,200
General expense, 0.32%			6,900
TOTAL			$93,800

ESTIMATED COST OF BULLION CREEK DIVERSION AND CONDUIT

(Based on prices prevailing in April, 1953)

Elevation of crest of weir: 3,828 feet, U. S. G. S. datum
Height of weir above stream bed: 20 feet
Drainage area behind diversion works: 1.6 square miles
Capacity of weir with 5-foot head: 1,080 second-feet

Length of weir: 30 feet
Elevation of conduit inlet: 3,818 feet
Elevation of conduit outlet: 3,660 feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Works				
Excavation	200 cu.yd.	$5.00	$1,000	
Concrete	690 cu.yd.	50.00	34,500	
Reinforcing steel	69,000 lbs.	0.20	13,800	
Gates and trashrack		lump sum	5,400	
Access road	1 mi.	40,000	40,000	$94,700
Conduit				
Canal, lined	0.9 mi.	164,000	147,600	
Flume	0.7 mi.	316,000	221,200	
Tunnel, unlined, 10.0-foot diameter	2.4 mi.	750,000	1,800,000	
Tunnel, lined, 8.5-foot diameter	0.2 mi.	1,400,000	280,000	
Access road	2 mi.	30,000	60,000	2,508,800
Subtotal				$2,603,500
Administration and engineering, 10%				260,400
Contingencies, 15%				390,500
Interest during construction				97,600
TOTAL				$3,352,000

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$100,600
Amortization, 0.887%			29,700
Replacement			
Diversion, 0.07%			100
Canal, 0.02%			100
Tunnel, 0.02%			500
Flume, 1.00%			2,700
Operation and maintenance			
Flume, canal, and diversion, 1%			5,800
Tunnel, 0.05%			1,300
General expense, 0.32%			10,800
TOTAL			$151,600

ESTIMATED COST OF FORESTHILL CANAL

(Based on prices prevailing in April, 1953)

Elevotian af inlet: 3,660 feet, U. S. G. S. dotum
Slope of canal: 13.5 feet per mile
Velocity: 6 feet per second

Capacity of canal: 75 second-feet
Length of canal: 7.6 miles
Type: Tropezoidal section, shotcrete-lined

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Excavation	32,200 cu.yd.	$0.75	$24,200		Interest, 3%			$8,200
Road embankment	32,200 cu.yd.	0.25	8,000		Amortization, 0.887%			2,400
Shotcrete lining	56,100 sq.yd.	3.00	168,000		Operation and maintenance, 1%			2,700
Main road crossing	2	lump sum	2,400		General expense, 0.32%			900
Minor road crossing	4	lump sum	2,800					
Right of way	30 ac.	100.00	3,000		TOTAL			$14,200
Clearing	30 ac.	200.00	6,000					
Stream crossing	6	lump sum	4,200	$218,600				
Subtotal				$218,600				
Administration and engineering, 10%				21,900				
Contingencies, 15%				32,800				
Interest during construction, none								
TOTAL				$273,300				

ESTIMATED COST OF SUGAR PINE CANAL

(Bosed on prices prevailing in April, 1953)

Elevotion of inlet: 3,660 feet, U. S. G. S. datum
Elevotion of outlet: 3,657 feet
Length of conol: 0.7 mile

Type of canal: Tropezoidol section, shatcrete-lined
Slope of canol: 4.3 feet per mile
Capacity of canol: 500 second-feet

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Canal, lined	0.7 mi.	$164,000	$114,800	$114,800	Interest, 3%			$4,400
					Amortization, 0.887%			1,300
Subtotal				$114,800	Replacement, 0.02%			none
Administration and engineering, 10%				11,500	Operation and maintenance, 1%			1,500
Contingencies, 15%				17,200	General expense, 0.32%			500
Interest during construction				4,300	TOTAL			$7,700
TOTAL				$147,800				

ESTIMATED COST OF PAGGE RESERVOIR TUNNEL

(Bosed on prices prevailing in April, 1953)

Elevation of tunnel inlet: 3,657 feet, U. S. G. S. dotum
Elevotion of tunnel outlet: 3,640 feet

Copocity of tunnel: 500 second-feet
Length of tunnel: 0.8 mile

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Tunnel, unlined, 10.0-foot diameter	0.7 mi.	$750,000	$525,000		Interest, 3%			$26,800
Tunnel, lined, 8.5-foot diameter	0.1 mi.	1,400,000	140,000		Amortization, 0.887%			7,900
Access roads	1.0 mi.	30,000	30,000	$695,000	Replacement, 0.02%			200
Subtotal				$695,000	Operation and maintenance, 0.05%			400
					General expense, 0.32%			2,900
Administration and engineering, 10%				69,500	TOTAL			$38,200
Contingencies, 15%				104,300				
Interest during construction				26,100				
TOTAL				$894,900				

ESTIMATED COST OF PAGGE DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 3,650 feet, U. S. G. S. datum
Elevation of crest of spillway: 3,640 feet
Height of dam to spillway crest, above stream bed: 280 feet

Capacity of reservoir to spillway crest: 69,000 acre-feet
Capacity of spillway with 4-foot freeboard: 4,400 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$5,000	
Stripping and preparation of foundation	100,200 cu.yd.	$2.00	200,400	
Embankment				
Impervious	976,000 cu.yd.	0.75	732,000	
Pervious	1,815,000 cu.yd.	2.40	4,356,000	
Auxiliary dam	41,400 cu.yd.	1.00	41,400	
Grouting		lump sum	30,400	$5,365,200
Spillway				
Excavation	53,800 cu.yd.	1.50	80,700	
Concrete	110 cu.yd.	40.00	4,400	
Reinforcing steel	11,000 lbs.	0.20	2,200	87,300
Outlet Works				
Excavation	3,800 cu.yd.	5.00	19,000	
Concrete				
Pipe encasement	1,640 cu.yd.	30.00	49,200	
Structural	450 cu.yd.	100.00	45,000	
Steel pipe	410,000 lbs.	0.25	102,500	
Valves and trashrack		lump sum	46,000	261,700

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Reservoir				
Land	Federally owned			
Public utilities		lump sum	$80,000	
Clearing	630 ac.	$200.00	126,000	$206,000
Subtotal				$5,920,200
Administration and engineering, 10%				592,000
Contingencies, 15%				888,000
Interest during construction				222,000
TOTAL				$7,622,200
Annual Costs				
Interest, 3%				$228,700
Amortization, 0.887%				67,600
Replacement, 0.07%				5,300
Operation and maintenance				9,400
General expense, 0.32%				24,400
TOTAL				$335,400

ESTIMATED COST OF SUGAR PINE DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 3,650 feet, U. S. G. S. datum
Elevation of spillway crest: 3,641 feet
Height of dam to spillway crest, above stream bed: 131 feet

Capacity of reservoir to spillway crest: 10,000 acre-feet
Capacity of spillway with 4-foot freeboard: 4,600 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$5,000	
Stripping and preparation of foundation	103,900 cu.yd.	$1.50	155,900	
Embankment				
Impervious	507,200 cu.yd.	0.75	380,400	
Pervious	126,800 cu.yd.	2.00	254,000	
Riprap	22,200 cu.yd.	2.50	55,500	$850,800
Spillway				
Excavation	70,000 cu.yd.	0.50	35,000	35,000
Outlet Works				
Excavation	2,200 cu.yd.	5.00	11,000	
Concrete				
Pipe encasement	1,060 cu.yd.	30.00	31,800	
Structural	110 cu.yd.	100.00	11,000	
Steel pipe	229,200 lbs.	0.25	57,300	
Reinforcing steel	127,800 lbs.	0.15	19,200	
Valves and trashrack		lump sum	38,400	168,700

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Reservoir				
Land	Federally owned			
Highway relocation	2-mile dirt road	$10,000	$20,000	
Forbes campground		lump sum	5,000	
Clearing	220 ac.	200.00	44,000	$69,000
Subtotal				$1,123,500
Administration and engineering, 10%				112,400
Contingencies, 15%				168,500
Interest during construction				42,100
TOTAL				$1,446,500
Annual Costs				
Interest, 3%				$43,400
Amortization, 0.887%				12,800
Replacement, 0.07%				1,000
Operation and maintenance				2,000
General expense, 0.32%				4,600
TOTAL				$63,800

ESTIMATED COST OF IOWA HILL CANAL

(Based on prices prevailing in April, 1953)

Elevation of crest of weir: 3,446 feet, U. S. G. S. datum
Height of weir crest above stream bed: 5 feet
Slope: 5 feet per mile
Velocity: 2.6 feet per second

Capacity of canal: 15 second-feet
Length of canal: 6.8 miles
Type: Trapezoidal section, shotcrete-lined
Acreage served: 1,760 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion structure				
Stripping	50 cu.yd.	$1.00	$50	
Reinforced concrete	28 cu.yd.	50.00	1,400	
Reinforcing steel	2,800 lbs.	0.15	420	
Steel frame for flashboards	3,460 lbs.	0.30	1,010	
Timber flashboards	300 bd.ft.	0.40	120	$3,000
Conduit				
Excavation	17,730 cu.yd.	0.75	13,300	
Trimming	42,560 sq.yd.	0.30	12,770	
Concrete				
Shotcrete	42,560 sq.yd.	3.50	148,970	
Inlet structure	4 cu.yd.	50.00	200	
Reinforcing steel	400 lbs.	0.15	60	
Headgate, 4′ x 5′		lump sum	500	
Right of way	20 ac.	100.00	2,000	
Clearing of right of way	20 ac.	200.00	4,000	181,800
Subtotal				$184,800
Capital Costs—Continued				
Administration and engineering, 10%			$18,500	
Contingencies, 15%			27,700	
Interest during construction, none				
TOTAL			$231,000	
Annual Costs				
Interest, 3%			$6,900	
Amortization, 0.887%			2,100	
Replacement, 0.02%			100	
General expense, 0.32%			700	
Operation and maintenance, 1%			2,300	
TOTAL			$12,100	

ESTIMATED COST OF IOWA HILL PUMPING PLANT AND PIPE LINE

(Based on prices prevailing in April, 1953)

Intake elevation: 3,515 feet, U. S. G. S. datum
Pumping plant capacities:
1st stage: 16 second-feet
2nd stage: 10 second-feet
3rd stage: 3 second-feet

Gross seasonal diversion: 5,000 acre-feet
Acreage served: 2,000 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Pump, motor, and electrical equipment	1 ea.	$8,150	$8,150	
Pump, motor, and electrical equipment	1 ea.	7,710	7,710	
Pump, motor, and electrical equipment	1 ea.	3,200	3,200	
Steel pipe				
14-inch	570 lbs.	0.25	140	
12-inch	9,760 lbs.	0.25	2,430	
6-inch	7,000 lbs.	0.25	1,740	
Excavation for pipe trench	670 cu.yd.	0.75	500	
Backfill for pipe trench	580 cu.yd.	0.50	290	
Pump and motor houses	3 ea.	1,480	4,440	$28,600
Subtotal				$28,600
Capital Costs—Continued				
Administration and engineering, 10%			$2,900	
Contingencies, 15%			4,300	
Interest during construction			200	
TOTAL			$36,000	
Annual Costs				
Interest, 3%			$1,100	
Amortization, 0.887%			300	
Replacement, 1.20%			400	
Insurance, 0.12%			100	
General expense, 0.32%			100	
Electric energy (9 mills/KWH)			17,600	
TOTAL			$19,600	

ESTIMATED COST OF PAGGE-PICKERING BAR CONDUIT

(Based on prices prevailing in April, 1953)

Elevation of conduit inlet: 3,400 feet, U. S. G. S. datum
Elevotian of conduit outlet: 3,390 feet

Copocity of conduit: 300 secand-feet
Length af conduit: 0.83 mile

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Conduit, steel pipe, 72-inch diameter	4,400 lin.ft.	$72.00	$316,800		Interest, 3%			$13,200
Valves		lump sum	24,600	$341,400	Amortization, 0.887%			3,900
Subtotal				$341,400	Replacement, 1%			4,400
Administration and engineering, 10%				34,100	Operation and maintenance, $0.0125 per square foot			1,000
Contingencies, 15%				51,200	General expense, 0.32%			1,400
Interest during construction				12,800	TOTAL			$23,900
TOTAL				$439,500				

ESTIMATED COST OF SUGAR PINE-PICKERING BAR CONDUIT

(Based on prices prevailing in April, 1953)

Elevotion of canduit inlet: 3,515 feet, U. S. G. S. dotum
Elevotion of canduit outlet: 3,390 feet

Copocity of conduit: 300 second-feet
Length of conduit: 0.34 mile

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Conduit, steel pipe, 72-inch diameter	1,800 lin.ft.	$72.00	$129,600		Interest, 3%			$6,000
Valves		lump sum	24,600	$154,200	Amortization, 0.887%			1,800
Subtotal				$154,200	Replacement, 1%			2,000
Administration and engineering, 10%				15,400	Operation and maintenance, $0.0125 per square foot			500
Contingencies, 15%				23,200	General expense, 0.32%			600
Interest during construction				5,800	TOTAL			$10,900
TOTAL				$198,600				

ESTIMATED COST OF PICKERING BAR TUNNEL

(Based on prices prevailing in April, 1953)

Elevation of tunnel inlet: 3,390 feet, U. S. G. S. dotum
Elevation of tunnel outlet: 3,366 feet

Capacity of tunnel: 300 second-feet
Length of tunnel: 1.7 miles

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Annual Costs**			
Tunnel, lined, 7-foot diameter	1.7 mi.	$920,000	$1,564,000	$1,564,000	Interest, 3%			$60,400
					Amortization, 0.887%			17,900
Subtotal				$1,564,000	Replacement, 0.02%			400
Administration and engineering, 10%				156,400	Operation and maintenance, 0.05%			1,000
Contingencies, 15%				234,600	General expense, 0.32%			6,400
Interest during construction				58,700	TOTAL			$86,100
TOTAL				$2,013,700				

ESTIMATED COST OF PICKERING BAR POWER HOUSE

(Based on prices prevailing in April, 1953)

Elevation of penstock inlet: 3,366 feet, U. S. G. S. datum
Elevation of power house tailrace: 1,486 feet

Capacity of penstock: 300 second-feet
Length of penstock: 0.91 mile

Item	Quantity	Unit price	Cost	
Capital Costs				
Power plant				
44,000 kilowatts, single unit plant	44,000 kw.	$96.00	$4,224,000	
Access road	4.2 mi.	100,000	420,000	
Clearing	5 ac.	200.00	1,000	$4,645,000
Penstock				
6.5 feet to 5 feet varying diameter	4,800 lin.ft.	230.00	1,105,000	
Surge tank		lump sum	150,000	
Access road	2 mi.	50,000	100,000	1,355,000
Subtotal				$6,000,000
Administration and engineering, 10%				$600,000
Contingencies, 15%				900,000
Interest during construction				225,000
TOTAL				$7,725,000

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$231,800
Amortization, 0.887%			68,500
Replacement			
Penstock, 1.00%			11,100
Power house, 1.20%			63,400
Surge tank, 1.00%			1,500
Insurance, 0.12%			5,100
Operation and maintenance			111,100
General expense, 0.32%			24,700
TOTAL			$517,200

ESTIMATED COST OF FORBES DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 4,010 feet, U. S. G. S. datum
Elevation of crest of spillway: 4,000 feet
Height of dam to spillway crest, above stream bed: 135 feet

Capacity of reservoir to crest of spillway: 5,300 acre-feet
Capacity of spillway with 4-foot freeboard: 2,200 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$1,000	
Stripping and preparation of foundation				
Common	76,000 cu.yd.	$1.00	76,000	
Embankment				
Impervious fill	210,000 cu.yd.	0.65	136,000	
Pervious fill	446,000 cu.yd.	0.75	335,000	
Drilling grout holes	10,800 lin.ft.	4.00	43,200	
Pressure grouting	5,400 cu.ft.	4.00	21,600	$612,800
Spillway				
Excavation				
Common	7,490 cu.yd.	2.00	15,000	
Concrete				
Weir	70 cu.yd.	50.00	3,500	
Lining	90 cu.yd.	40.00	3,600	
Reinforcing steel	7,000 lb.	0.20	1,400	23,500
Outlet Works				
Excavation				
Common	213 cu.yd.	2.00	400	
Rock, trench and structures	213 cu.yd.	6.00	1,300	
Concrete				
Backfill	100 cu.yd.	35.00	3,500	
Structural	19 cu.yd.	100.00	1,900	
Reinforcing steel	15,000 lb.	0.20	3,000	
Steel pipe	27,300 lb.	0.30	8,200	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works—Continued				
Trashrack steel	1,500 lb.	$0.50	$800	
Butterfly valve, 12-inch diameter	2 ea.	1,200	2,400	
Hollow jet valve, 12-inch diameter	1 ea.	1,000	1,000	$22,500
Reservoir				
Clearing	100 acres	150.00	15,000	15,000
Subtotal				$673,800
Administration and engineering, 10%				67,400
Contingencies, 15%				101,100
Interest during construction				12,600
TOTAL				$854,900
Annual Costs				
Interest, 3%				$25,700
Repayment, 0.887%				7,600
Replacement, 0.07%				600
Operation and maintenance				1,100
General expense, 0.32%				2,700
TOTAL				$37,700

ESTIMATED COST OF ENLARGED MORNING STAR DAM AND BIG RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 4,118 feet, U. S. G. S. datum
Elevation of crest of spillway: 4,108 feet
Height of dam to spillway crest, above stream bed: 82 feet

Capacity of reservoir to crest of spillway: 6,500 acre-feet
Capacity of spillway with 4-foot freeboard: 1,800 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$5,000	
Stripping and preparation of foundation				
Common	131,000 cu.yd.	$1.00	131,000	
Embankment				
Impervious fill	831,400 cu.yd.	0.60	498,800	
Facing, dumped rock	34,500 cu.yd.	2.00	69,000	
Drilling grout holes	9,600 lin.ft.	4.00	38,400	
Pressure grouting	4,800 cu.ft.	4.00	19,200	$761,400
Spillway				
Excavation				
Common	6,700 cu.yd.	2.00	13,400	
Concrete				
Weir and control section	191 cu.yd.	40.00	7,600	
Reinforcing steel	19,100 lb.	0.20	3,800	24,800
Outlet Works				
Excavation				
Common	284 cu.yd.	1.00	300	
Rock	284 cu.yd.	6.00	1,700	
Concrete				
Backfill	146 cu.yd.	35.00	5,100	
Structural	24 cu.yd.	100.00	2,400	
Reinforcing steel	19,950 lb.	0.20	4,000	
Steel pipe	26,000 lb.	0.30	7,800	
Operating mechanism		lump sum	700	
Control lines	250 lb.	3.00	800	
Trashrack steel	1,500 lb.	0.50	800	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works—Continued				
Butterfly valves, 12-inch diameter	2 ea.	$1,200	$2,400	
Hollow jet valve, 12-inch diameter	1 ea.	1,000	1,000	$27,000
Reservoir				
Clearing	110 ac.	250.00	27,500	27,500
Subtotal				$840,700
Administration and engineering, 10%				84,000
Contingencies, 15%				126,000
Interest during construction				15,800
TOTAL				$1,066,500
Annual Costs				
Interest, 3%				$32,000
Repayment, 0.887%				9,500
Replacement, 0.07%				800
Operation and maintenance				1,300
General expense, 0.32%				3,400
TOTAL				$47,000

ESTIMATED COST OF SUGAR PINE DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 3,680 feet, U. S. G. S. datum
Elevation of crest of spillway: 3,670 feet
Height of dam to spillway crest, above stream bed: 160 feet

Capacity of reservoir to crest of spillway: 17,000 acre-feet
Capacity of spillway with 4-foot freeboard: 4,600 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$10,000	
Stripping and preparation of foundation				
Common	84,000 cu.yd.	1.50	126,000	
Embankment				
Impervious fill	1,100,000 cu.yd.	0.75	825,000	
Pervious fill, rockfill	208,000 cu.yd.	1.40	291,000	
Riprap	26,600 cu.yd.	3.00	79,800	$1,331,800
Auxiliary Dam				
Stripping	5,000 cu.yd.	2.00	10,000	
Earthfill	53,000 cu.yd.	1.00	53,000	63,000
Spillway				
Excavation				
Common	18,200 cu.yd.	2.00	36,400	
Concrete				
Cutoff wall	228 cu.yd.	35.00	8,000	
Reinforcing steel	22,800 lb.	0.20	4,500	48,900
Outlet Works				
Excavation				
Common	140 cu.yd.	1.50	260	
Trench	900 cu.yd.	10.00	9,000	
Concrete				
Backfill	600 cu.yd.	30.00	18,000	
Structural, inlet and outlet	50 cu.yd.	90.00	4,500	
Reinforcing steel	69,000 lb.	0.15	10,350	
Steel pipe	85,900 lb.	0.25	21,475	
Trashrack steel	11,800 lb.	0.25	2,950	
Butterfly valve, 30-inch diameter	2 ea.	3,500	7,000	
Capital Costs—Continued				
Outlet Works—Continued				
Hydraulic control lines	375 ft.	$3.00	$1,125	
Control house		lump sum	600	
24″ x 24″ slide gate	1 ea.	600.00	600	
36″ x 30″ slide gate	2 ea.	1,000	2,000	
Needle valve, 36-inch diameter	1 ea.	8,000	8,000	$85,860
Reservoir				
Land, private	100 ac.	$50.00	$5,000	
federal	300 ac.	none	none	
Highway relocation	2 mile dirt road	10,000	20,000	
Forbes Campground		lump sum	5,000	
Clearing	325 ac.	200.00	65,000	95,000
Subtotal				$1,624,600
Administration and engineering, 10%				162,500
Contingencies, 15%				243,750
Interest during construction				30,500
TOTAL				$2,061,400
Annual Costs				
Interest, 3%				$61,800
Repayment, 0.887%				18,300
Replacement, 0.07%				1,500
Operation and maintenance				3,400
General expense, 0.32%				6,600
TOTAL				$91,600

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ESTIMATED COST OF DIVERSION AND SUPPLY CANALS, FORESTHILL DIVIDE PROJECT

(Based on prices prevailing in April, 1953)

Item	Quantity	Unit price	Cost	
Capital Costs				
Secret Canyon Canal				
Canal	2,700 lin.ft.	$6.00	$16,200	
Diversion	1 ea.	lump sum	11,600	$27,800
Black Canyon Canal				
Canal	7,400 lin.ft.	6.00	44,400	
	22,400 lin.ft.	2.45	54,900	
	58,300 lin.ft.	2.00	116,600	
Diversion	1 ea.	lump sum	9,000	228,900
El Dorado Creek Canal				
Canal	22,400 lin.ft.	2.50	56,000	
	22,400 lin.ft.	2.00	44,800	
Diversion	1 ea.	lump sum	11,600	112,400
Bullion Creek Canal				
Canal	42,200 lin.ft.	2.25	118,200	
	31,700 lin.ft.	2.00	63,400	
Diversion	1 ea.	lump sum	5,800	187,400
Forbes Reservoir Canal				
Canal	4,700 lin.ft.	4.10	19,300	
	4,700 lin.ft.	4.00	18,800	
	38,000 lin.ft.	3.90	148,200	
Road crossings	4 ea.	150.00	600	
Stream crossings	9 ea.	1,000	9,000	195,900
Big Reservoir Canal				
Canal	2,500 lin.ft.	4.00	10,000	
	22,000 lin.ft.	3.90	85,800	
Siphon	2,900 lin.ft.	20.00	58,000	
Road crossings	5 ea.	150.00	800	
Stream crossings	1 ea.	1,000	1,000	155,600

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Sugar Pine Reservoir Canal				
Canal	25,100 lin.ft.	$4.10	$102,900	
	20,100 lin.ft.	4.00	80,400	
	40,100 lin.ft.	3.90	156,400	
Siphon	4,500 lin.ft.	20.00	90,000	
Road crossings	8 ea.	150.00	1,200	
Stream crossings	8 ea.	1,000	8,000	$438,900
Subtotal				$1,346,900
Administration and engineering, 10%				134,700
Contingencies, 15%				202,000
Interest during construction				20,200
TOTAL				$1,703,800
Annual Costs				
Interest, 3%				$51,100
Amortization, 0.887%				15,000
Replacement, 0.50%				8,500
Operation and maintenance, 1%				17,000
General expense, 0.32%				5,500
TOTAL				$97,100

ESTIMATED COST OF FORESTHILL DIVIDE DISTRIBUTION SYSTEM

(Based on prices prevailing in April, 1953)

Distribution system: Unlined canals and ditches

Acreage served: 15,400 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Distribution system	15,400 ac.	$20.00	$308,000	$308,000
Subtotal				$308,000
Administration and engineering, 10%				30,800
Contingencies, 15%				46,200
Interest during construction				9,200
TOTAL				$394,200

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$11,800
Amortization, 0.887%			3,500
Operation and maintenance			
Ditch tender service, $0.55 per acre-foot			13,600
Maintenance charge, $0.40 per acre			6,200
District overhead, $0.50 per acre			7,700
TOTAL			$42,800

ESTIMATED COST OF CAMP FAR WEST DAM AND RESERVOIR

(Based on prices prevailing in April, 1952)

Elevation of crest of dam: 311 feet, U. S. G. S. datum
Elevation of crest of spillway: 300 feet
Height of dam to spillway crest, above stream bed: 155 feet

Capacity of reservoir to crest of spillway: 104,000 acre-feet
Capacity of spillway with 4-foot freeboard: 60,000 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$50,000	
Stripping and preparation of foundation	149,000 cu.yd.	$1.00	149,000	
Excavation for embankment				
From borrow pits	743,600 cu.yd.	0.65	483,300	
Stream bed gravel	1,243,100 cu.yd.	0.40	497,200	
Rock riprap	63,100 cu.yd.	2.00	126,200	
Embankment				
Common compacted	649,300 cu.yd.	0.25	162,300	
Pervious				
From excavation	1,055,600 cu.yd.	0.20	211,100	
From salvage	112,000 cu.yd.	0.30	33,600	
Sand and gravel filter	187,500 cu.yd.	0.50	93,800	
Rock riprap	63,100 cu.yd.	0.50	31,600	
Drilling grout holes	4,140 lin.ft.	3.00	12,400	
Pressure grouting	2,760 cu.ft.	4.00	11,000	$1,861,500
Spillway				
Excavation	200,000 cu.yd.	1.00	200,000	
Concrete	7,570 cu.yd.	35.00	265,000	
Reinforcing steel	559,400 lb.	0.15	83,900	548,900
Outlet Works				
Tunnel, 8-foot diameter	950 lin.ft.	200.00	190,000	
Portal, excavation	8,500 cu.yd.	2.00	17,000	
Concrete (intake, gate chamber, saddles, plug, and walkway)	280 cu.yd.	60.00	16,800	
Reinforcing steel	28,000 lb.	0.15	4,200	
Steel pipe, 66-inch diameter	210,000 lbs.	0.25	52,500	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works—Continued				
High-pressure 5′ x 5′ slidegate		lump sum	$25,000	
Stilling basin		lump sum	8,800	
Needle valve				
60-inch diameter		lump sum	27,500	
36-inch diameter		lump sum	10,000	
Venturi meter		lump sum	5,000	$356,800
Reservoir				
Private land	860 ac.	$54.00	$46,400	
Relocation of county road		lump sum	28,000	
Relocation of power line	2.3 mi.	30,000	69,000	$143,400
Subtotal				$2,910,600
Administration and engineering, 10%				291,100
Contingencies, 15%				436,600
Interest during construction				87,300
TOTAL				$3,726,100
Annual Costs				
Interest, 3%				$111,800
Amortization, 0.887%				33,100
Replacement, 0.07%				2,600
Operation and maintenance				12,500
General expense, 0.32%				11,900
TOTAL				$171,900

ESTIMATED COST OF BEAR RIVER CANAL

(Based on prices prevailing in April, 1952)

Elevation of stilling basin: 187 feet, U. S. G. S. datum
Elevation of division box: 183 feet

Capacity of canal: 400 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Canal				
Excavation	43,600 cu.yd.	$1.50	$65,400	
Compacted fill	40,000 cu.yd.	0.50	20,000	
Lining, shotcrete	24,000 cu.yd.	3.50	84,000	
Drainage structures	3 ea.	lump sum	1,500	$170,900
Division box				
Excavation	230 cu.yd.	3.00	700	
Concrete	87 cu.yd.	60.00	5,200	
Gates and trashracks	4 ea.	600.00	2,400	8,300
Rights of Way				
Land	18 ac.	50.00	900	
Clearing	18 ac.	100.00	1,800	
Fencing	3 mi.	1,500	4,500	7,200
Subtotal				$186,400

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$18,600
Contingencies, 15%			28,000
Interest during construction, none			
TOTAL			$233,000
Annual Costs			
Interest, 3%			$7,000
Amortization, 0.887%			2,100
Replacement, 0.50%			1,200
Operation and maintenance, 1.0%			2,300
General expense, 0.32%			700
TOTAL			$13,300

ESTIMATED COST OF SIPHON, CONDUIT, AND DISTRIBUTION SYSTEM FOR LANDS NORTH OF BEAR RIVER

(Based on prices prevailing in April, 1952)

Capacity of siphon: 200 second-feet
Length of siphon: 800 feet
Capacity of conduit, initial 2.9 miles: 200 second-feet
Capacity of conduit, remaining 0.8 mile: 100 second-feet
Distribution system: Unlined canals and ditches
Acreage served: 8,500 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Siphon				
Excavation, trench	3,000 cu.yd.	$3.00	$9,000	
Backfill				
Concrete	540 cu.yd.	35.00	18,900	
Earth	1,800 cu.yd.	1.00	1,800	
Steel pipe, 66-inch diameter	140,500 lb.	0.20	28,100	$57,800
Conduit				
Excavation	113,800 cu.yd.	0.50	56,900	
Trimming of canal	61,420 sq.yd.	0.30	18,400	
Compacted fill	16,780 cu.yd.	0.50	8,400	
Concrete				
Shotcrete	9,060 sq.yd.	3.50	31,700	
Flume intake and outlet	40 cu.yd.	50.00	2,000	
Road crossings	63 cu.yd.	50.00	3,200	
Flume footings	20 cu.yd.	80.00	1,600	
Parshall flume	15 cu.yd.	70.00	1,100	
Reinforcing steel	11,800 lbs.	0.15	1,800	
Timber				
Road crossings	6.37 MBM	350.00	2,200	
Flume substructure	14.1 MBM	400.00	5,600	
Flume, metal	300 lin.ft.	30.00	9,000	
Flume, hardware	1,690 lb.	1.00	1,700	
Rights of way	42 ac.	200.00	8,400	
Clearing	42 ac.	200.00	8,400	
Fencing	7.4 mi.	1,500	11,100	171,500
Subtotal				$229,300
Administration and engineering, 10%				22,900
Contingencies, 15%				34,400
Interest during construction, none				
TOTAL				$286,600

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Distribution System	8,500 ac.	$20.00	$170,000	$170,000
Subtotal				$170,000
Administration and engineering, 10%				17,000
Contingencies, 15%				25,500
Interest during construction, none				
TOTAL				$212,500
Annual Costs				
Siphon and Conduit				
Interest, 3%				$8,600
Amortization, 0.887%				2,500
Replacement, 0.50%				1,400
Operation and maintenance, 1.0%				2,900
General expense, 0.32%				900
TOTAL				$16,300
Distribution System				
Interest, 3%				$6,400
Amortization, 0.887%				1,900
Operation and maintenance				
Ditch tender service, $0.55 per acre-foot				16,500
Maintenance charge, $0.40 per acre				3,800
District overhead, $0.50 per acre				4,200
TOTAL				$32,800

ESTIMATED COST OF CONDUIT AND DISTRIBUTION SYSTEM FOR LANDS SOUTH OF BEAR RIVER

(Based on prices prevailing in April, 1952)

Capacity of conduit, initial 11.0 miles: 200 second-feet
Capacity of conduit, remaining 7.8 miles: 100 second-feet

Distribution system: Unlined canals and ditches
Acreage served: 8,500 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Conduit				
Excavation	311,360 cu.yd.	$0.50	$155,700	
Compacted fill	81,840 cu.yd.	0.50	40,900	
Trimming	330,210 sq.yd.	0.30	99,100	
Concrete				
Shotcrete	13,650 sq.yd.	3.50	47,800	
Flume transition structures	33 cu.yd.	50.00	1,700	
Road crossing	100 cu.yd.	50.00	5,000	
Substructure footings	20 cu.yd.	80.00	1,600	
Parshall flume	15 cu.yd.	70.00	1,100	
Siphon transition structure	30 cu.yd.	50.00	1,500	
Reinforcing steel	20,000 lbs.	0.15	3,000	
Timber				
Road crossings	12.5 MBM	350.00	4,400	
Flume substructure	11 MBM	400.00	4,400	
Flume, metal	420 lin.ft.	15.00	6,300	
Flume, hardware	1,320 lbs.	1.00	1,300	
Pipe, 48-inch corrugated metal	150 lin.ft.	20.00	3,000	
Jacking costs	100 lin.ft.	50.00	5,000	
Diversion dam at Markham Ravine		lump sum	1,500	
Rights of way	190 ac.	300.00	57,000	
Fencing	37.6 mi.	1,500	56,400	
Clearing	190 ac.	200.00	38,000	$534,700
Subtotal				$534,700
Administration and engineering, 10%				53,500
Contingencies, 15%				80,200
Interest during construction, none				
TOTAL				$668,400

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Distribution System	8,500 ac.	$20.00	$170,000	$170,000
Subtotal				$170,000
Administration and engineering, 10%				17,000
Contingencies, 15%				25,500
Interest during construction, none				
TOTAL				$212,500
Annual Costs				
Conduit				
Interest, 3%				$20,100
Amortization, 0.887%				5,900
Replacement, 0.50%				3,300
Operation and maintenance, 1.0%				6,700
General expense, 0.32%				2,200
TOTAL				$38,200
Distribution System				
Interest, 3%				$6,400
Amortization, 0.887%				1,900
Operation and maintenance				
Ditch tender service, $0.55 per acre-foot				16,500
Maintenance charge, $0.40 per acre				3,800
District overhead, $0.50 per acre				4,200
TOTAL				$32,800

ESTIMATED COST OF COON CREEK DAM AND RESERVOIR

(Bosed on prices prevailing in April, 1952)

Elevation of crest of dam: 560 feet, U. S. G. S. datum
Elevation of crest of spillway: 552 feet
Height af dom ta spillway crest, obave stream bed: 207 feet

Capacity of reservoir ta crest af spillway: 59,000 ocre-feet
Capacity of spillway with 4-foot freeboard: 14,000 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$5,000	
Stripping and preparation of foundation	304,200 cu.yd.	$1.50	456,300	
Excavation for embankment				
Impervious	903,900 cu.yd.	0.75	677,900	
Gravel	1,245,230 cu.yd.	0.75	933,900	
Embankment				
Impervious zone, compacted	786,040 cu.yd.	0.25	196,500	
Pervious zone				
From excavation	1,130,730 cu.yd.	0.20	226,100	
From salvage	128,300 cu.yd.	0.30	38,500	
Sand and gravel filter	115,500 cu.yd.	0.50	57,700	
Rock riprap (from salvage)	40,500 cu.yd.	0.50	20,300	
Drilling grout holes	8,400 lin.ft.	3.00	25,200	
Pressure grouting	5,600 cu.ft.	4.00	22,400	$2,659,800
Auxiliary Dams				
Stripping and preparation of foundation	55,260 cu.yd.	1.50	82,900	
Excavation for embankment				
From borrow pits	180,160 cu.yd.	0.75	135,100	
From quarry	251,410 cu.yd.	0.75	188,600	
Embankment				
Impervious zone	156,660 cu.yd.	0.25	39,200	
Pervious zone				
From excavation	176,510 cu.yd.	0.20	35,300	
From salvage	22,800 cu.yd.	0.30	6,800	
Sand and gravel filter	74,900 cu.yd.	0.50	37,400	
Rock riprap (from salvage)	17,900 cu.yd.	0.50	9,000	
Drilling grout holes	3,400 lin.ft.	3.00	10,200	
Pressure grouting	2,260 cu.ft.	4.00	9,000	553,500
Spillway				
Excavation				
Common	38,000 cu.yd.	1.50	57,000	
Rock	7,130 cu.yd.	5.00	35,700	
Concrete	7,130 cu.yd.	30.00	213,900	
Reinforcing steel	356,000 lbs.	0.15	53,400	360,000

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works				
Excavation	2,000 cu.yd.	$5.00	$10,000	
Concrete				
Trench backfill	1,000 cu.yd.	30.00	30,000	
Intake structure	50 cu.yd.	100.00	5,000	
Outlet structure	20 cu.yd.	100.00	2,000	
Reinforcing steel	110,000 lbs.	0.15	16,500	
Steel pipe, 48-inch diameter ¼-inch plate	127,500 lbs.	0.25	31,900	
High-pressure slide gates and controls, 30-inch diameter	2 ea.	lump sum	17,000	
Hollow jet valve, 42-inch diameter	1 ea.	lump sum	7,600	$120,000
Reservoir				
Land and improvements		lump sum	39,000	
Clearing	820 ac.	200.00	164,000	
Road relocation		lump sum	45,000	248,000
Subtotal				$3,941,300
Administration and engineering, 10%				394,100
Contingencies, 15%				591,200
Interest during construction				118,200
TOTAL				$5,044,800
Annual Costs				
Interest, 3%				$151,300
Amortization, 0.887%				44,700
Replacement, 0.07%				3,500
Operation and maintenance				8,500
General expense, 0.32%				16,100
TOTAL				$224,100

ESTIMATED COST OF COON CREEK DIVERSION, CONDUIT, AND DISTRIBUTION SYSTEM

(Based on prices prevailing in April, 1953)

Capacity of conduit: 100 second-feet
Length of conduit: 7.8 miles
Canal lined for first 0.5 mile

Distribution system: Unlined canals and ditches
Acreage served: 12,000 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Structure				
Stripping	320 cu.yd.	$0.50	$200	
Embankment	900 cu.yd.	0.50	400	
Timber, flashboards	1.2 MBM	250.00	300	
Crane for removing flashboards		lump sum	1,000	$1,900
Levee				
Stripping	1,500 cu.yd.	0.50	800	
Embankment	2,000 cu.yd.	0.50	1,000	
Concrete headwall and wing walls	22 cu.yd.	60.00	1,300	
Reinforcing steel	2,200 lbs.	0.15	300	
Headgate, 4′ x 5′		lump sum	500	3,900
Conduit				
Excavation	72,810 cu.yd.	0.50	36,400	
Compacted fill	32,740 cu.yd.	0.50	16,400	
Trimming	101,830 sq.yd.	0.30	30,500	
Concrete				
Shotcrete	5,330 sq.yd.	3.50	18,700	
Flume transition structures	16 cu.yd.	50.00	800	
Road crossings	60 cu.yd.	50.00	3,000	
Substructure footings	4 cu.yd.	80.00	300	
Siphon transition structure	30 cu.yd.	50.00	1,500	
Reinforcing steel	14,000 lb.	0.15	2,100	
Timber				
Road crossings	7.5 MBM	350.00	2,600	
Flume substructure	2.6 MBM	400.00	1,000	
Flume, metal	100 lin.ft.	15.00	1,500	
Flume, hardware	310 lb.	1.00	300	
Pipe, 48-inch corrugated metal	150 lin.ft.	20.00	3,000	
Jacking costs	100 lin.ft.	50.00	5,000	
Diversion dam at Markham Ravine		lump sum	1,500	
Rights of way	60 ac.	300.00	18,000	
Fencing	15.6 mi.	1,500	23,400	
Clearing	60 ac.	200.00	12,000	178,000
Subtotal				$183,800

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Administration and engineering, 10%				$18,400
Contingencies, 15%				27,600
Interest during construction, none				
TOTAL				$229,800
Distribution System	12,000 ac.	$20.00	$240,000	$240,000
Subtotal				$240,000
Administration and engineering, 10%				24,000
Contingencies, 15%				36,000
Interest during construction, none				
TOTAL				$300,000
Annual Costs				
Diversion and Conduit				
Interest, 3%				$6,900
Amortization, 0.887%				2,000
Replacement, 0.50%				1,100
Operation and maintenance, 1.0%				2,300
General expense, 0.32%				700
TOTAL				$13,000
Distribution System				
Interest, 3%				$9,000
Amortization, 0.887%				2,700
Operation and maintenance				
Ditch tender service, $0.55 per acre-foot				23,100
Maintenance charge, $0.40 per acre				4,800
District overhead, $0.50 per acre				6,000
TOTAL				$45,600

ESTIMATED COST OF DOTY RAVINE DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 340 feet, U. S. G. S. datum
Elevation of spillway crest: 330 feet
Height of dam to spillway crest, above stream bed: 105 feet

Capacity of reservoir to spillway crest: 32,000 acre-feet
Capacity of spillway with 4-foot freeboard: 10,800 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Main Dam and Saddle Dams				
Diversion and care of stream		lump sum	$5,000	
Stripping and preparation of foundation	224,000 cu.yd.	$1.50	336,000	
Excavation for embankment				
Impervious	965,300 cu.yd.	0.45	434,400	
Pervious	852,000 cu.yd.	0.60	511,200	
Embankment				
Impervious	819,300 cu.yd.	0.25	204,800	
Pervious	852,000 cu.yd.	0.20	170,400	
Pervious, salvage	225,000 cu.yd.	0.30	67,500	
Riprap	29,900 cu.yd.	2.50	74,800	$1,804,100
Spillway				
Excavation	79,700 cu.yd.	1.50	119,600	
Concrete	1,730 cu.yd.	35.00	60,600	
Reinforcing steel	130,000 lb.	0.15	19,500	199,700
Outlet Works				
Excavation	1,000 cu.yd.	5.00	5,000	
Concrete				
Pipe encasement	425 cu.yd.	30.00	12,800	
Structural	40 cu.yd.	90.00	3,600	
Reinforcing steel	50,600 lbs.	0.15	7,600	
Steel pipe, 48-inch diameter	61,200 lb.	0.25	15,300	
Butterfly valve, 36-inch diameter	2 ea.	6,000	12,000	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works—Continued				
Hollow jet valve, 36-inch diameter	1 ea.	$9,600	$9,600	
Trashrack steel	11,400 lbs.	0.25	2,900	
Control house		lump sum	2,000	$70,800
Reservoir				
Land and improvements		lump sum	222,000	
Public utilities		lump sum	30,500	
Clearing	400 ac.	400.00	160,000	412,500
Subtotal				$2,487,100
Administration and engineering, 10%				248,700
Contingencies, 15%				373,000
Interest during construction				93,300
TOTAL				$3,202,100
Annual Costs				
Interest, 3%				$96,100
Repayment, 0.887%				28,400
Replacement, 0.07%				2,200
Operation and maintenance				5,700
General expense, 0.32%				10,200
TOTAL				$142,600

ESTIMATED COST OF DOTY RAVINE DISTRIBUTION SYSTEM

(Based on prices prevailing in April, 1953)

Distribution system: Unlined canals and ditches

Acreage served: 6,000 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Distribution System	6,000 ac.	$20.00	$120,000	$120,000
Subtotal				$120,000
Administration and engineering, 10%				12,000
Contingencies, 15%				18,000
Interest during construction, none				
TOTAL				$150,000

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$4,500
Amortization, 0.887%			1,300
Operation and maintenance			
Ditch tender service, $0.55 per acre-foot			15,400
Maintenance charge, $0.40 per acre			2,400
District overhead, $0.50 per acre			3,000
TOTAL			$26,600

ESTIMATED COST OF DOTY RAVINE DIVERSION AND CANAL

(Based on prices prevailing in April, 1953)

Capacity of canal: 60 second-feet
Length of canal: 8 miles

Canal unlined

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost
Capital Costs					**Capital Costs—Continued**			
Diversion Structure					Administration and engineering, 10%			$3,000
Excavation	50 cu.yd.	$4.00	$200		Contingencies, 15%			4,500
Concrete	19 cu.yd.	100.00	1,900		Interest during construction			600
Reinforcing steel	1,900 lbs.	0.15	300		TOTAL			$38,400
Timber	0.3 MBM	325.00	100					
Hardware		lump sum	100	$2,600	**Annual Costs**			
Canal					Interest, 3%			$1,200
Excavation	32,800 cu.yd.	0.30	9,800		Amortization, 0.887%			300
Compaction	28,160 cu.yd.	0.25	7,000		Operation and maintenance, 1%			400
Trimming	86,350 sq.yd.	0.05	4,300		General expense, 0.32%			100
County road crossings	3 ea.	2,200	6,600	27,700	TOTAL			$2,000
Subtotal				$30,300				

ESTIMATED COST OF LINCOLN DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 245 feet, U. S. G. S. datum
Elevation of crest of spillway: 235 feet
Height of dam to spillway crest, above stream bed: 60 feet

Capacity of reservoir to crest of spillway: 15,000 acre-feet
Capacity of spillway with 5-foot freeboard: 18,500 second-feet

Item	Quantity	Unit price	Cost		Item	Quantity	Unit price	Cost	
Capital Costs					**Capital Costs—Continued**				
Dam					Reservoir				
Diversion and care of stream		lump sum	$5,000		Land and improvements		lump sum	$100,000	
Stripping and preparation of foundation	206,000 cu.yd.	$0.45	92,700		Road relocation	2 mi.	lump sum	50,000	
Embankment					Clearing reservoir lands	200 ac.	$50.00	10,000	$160,000
Impervious, borrow and fill	490,000 cu.yd.	0.60	294,000		Subtotal				$1,031,300
Pervious, quarry	428,000 cu.yd.	0.50	214,000		Administration and engineering, 10%				103,100
Riprap	15,000 cu.yd.	3.00	45,000	$650,700	Contingencies, 15%				154,700
Spillway					Interest during construction				19,300
Excavation					TOTAL				$1,308,400
Common	38,000 cu.yd.	0.50	19,000						
Rock	30,000 cu.yd.	1.00	30,000						
Concrete	3,450 cu.yd.	30.00	103,500						
Reinforcing steel	259,000 lbs.	0.15	38,900	191,400	**Annual Costs**				
Outlet Works					Interest, 3%				$39,300
Excavation					Repayment, 0.887%				11,600
Common	150 cu.yd.	0.50	70		Replacement, 0.07%				900
Rock	300 cu.yd.	2.50	750		Operation and maintenance				2,700
Concrete					TOTAL				$54,500
Backfill	291 cu.yd.	30.00	8,730						
Structural	10 cu.yd.	100.00	1,000						
Steel pipe	44,600 lbs.	0.25	11,150						
Reinforcing steel	30,000 lbs.	0.15	4,500						
High-pressure slide gates 30″ manual control	2 ea.	1,500	3,000	29,200					

ESTIMATED COST OF LINCOLN PROJECT DISTRIBUTION SYSTEM

(Based on prices prevailing in April, 1953)

Distribution system: Unlined canals and ditches

Acreage served: 3,700 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Distribution System	3,700 ac.	$20.00	$74,000	$74,000
Subtotal				$74,000
Administration and engineering, 10%				7,400
Contingencies, 15%				11,100
Interest during construction, none				
TOTAL				$92,500

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$2,800
Amortization, 0.887%			800
Operation and maintenance			
Ditch tender service, $0.55 per acre-foot			7,200
Maintenance charge, $0.40 per acre			1,500
District overhead, $0.50 per acre			1,900
TOTAL			$14,200

ESTIMATED COST OF AUBURN RAVINE DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 650 feet, U. S. G. S. datum
Elevation of spillway crest: 640 feet
Height of dam to spillway crest, above stream bed: 175 feet

Capacity of reservoir to spillway crest: 11,700 acre-feet
Capacity of spillway with 4-foot freeboard: 9,400 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Diversion and care of stream		lump sum	$5,000	
Stripping and preparation of foundation	110,500 cu.yd.	$1.50	165,800	
Excavation for embankment				
Impervious	664,700 cu.yd.	0.55	365,600	
Pervious, borrow	1,126,900 cu.yd.	0.60	676,100	
Embankment				
Impervious	578,000 cu.yd.	0.25	144,500	
Pervious	1,126,900 cu.yd.	0.20	225,400	
Pervious, salvage	31,900 cu.yd.	0.30	9,600	
Drilling grout holes	3,720 lin.ft.	3.00	11,200	
Pressure grouting	1,860 cu.ft.	4.00	7,400	
Riprap	36,200 cu.yd.	2.50	90,500	$1,701,100
Auxiliary Dam				
Stripping and preparation of foundation	700 cu.yd.	1.00	700	
Excavation for embankment	15,600 cu.yd.	0.55	8,600	
Embankment	13,600 cu.yd.	0.25	3,400	
Riprap	800 cu.yd.	2.50	2,000	14,700
Spillway				
Excavation	45,800 cu.yd.	1.50	68,700	
Concrete	1,349 cu.yd.	35.00	47,200	
Reinforcing steel	101,000 lbs.	0.15	15,200	
Spillway crossing		lump sum	1,200	132,300
Outlet Works				
Excavation	7,350 cu.yd.	2.50	18,400	
Concrete				
Structural	103 cu.yd.	90.00	9,300	
Pipe encasement	1,210 cu.yd.	30.00	36,300	
Reinforcing steel	135,800 lbs.	0.15	20,400	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works—Continued				
Steel pipe, 48-inch diameter	179,000 lbs.	$0.25	$44,800	
Trashrack steel	11,800 lbs.	0.25	3,000	
Butterfly valve, 30-inch diameter and actuators	2 ea.	4,000	8,000	
Needle valve, 36-inch diameter	1 ea.	lump sum	8,400	
Control house		lump sum	2,000	$150,600
Reservoir				
Land and improvements		lump sum	65,000	
Public utilities		lump sum	265,500	
Access road	1 mi.	25,000	25,000	
Clearing	337 ac.	285.00	96,000	451,500
Subtotal				$2,450,200
Administration and engineering, 10%				245,000
Contingencies, 15%				367,500
Interest during construction				36,800
TOTAL				$3,099,500
Annual Costs				
Interest, 3%				$93,000
Amortization, 0.887%				27,500
Replacement, 0.07%				2,200
Operation and maintenance				2,300
General expense, 0.32%				9,900
TOTAL				$134,900

ESTIMATED COST OF AUBURN RAVINE DISTRIBUTION SYSTEM

(Based on prices prevailing in April, 1953)

Distribution system: Unlined conols and ditches

Acreage served: 2,800 ocres

Item	Quantity	Unit price	Cost	
Capital Costs				
Distribution System	2,800 ac.	$20.00	$56,000	$56,000
Subtotal				$56,000
Administration and engineering, 10%				5,600
Contingencies, 15%				8,400
Interest during construction, none				
TOTAL				$70,000

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$2,100
Amortization, 0.887%			600
Operation and maintenance			
Ditch tender service, $0.55 per acre-foot			7,200
Maintenance charge, $0.40 per acre			1,100
District overhead, $0.50 per acre			1,400
TOTAL			$12,400

ESTIMATED COST OF WHITNEY RANCH DAM AND RESERVOIR

(Bosed on prices prevailing in April, 1953)

Elevotion of crest of dam: 200 feet, U. S. G. S. dotum
Elevotion of crest of spillwoy: 193 feet
Height of dam to spillwoy crest, above stream bed: 65 feet

Copocity of reservoir to spillwoy crest: 10,300 ocre-feet
Copocity af spillwoy with 4-foot freeboord: 4,400 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Unwatering and care of stream		lump sum	$2,000	
Stripping and preparation of foundation	125,900 cu.yd.	$1.00	125,900	
Excavation for embankment				
Impervious	529,100 cu.yd.	0.55	291,000	
Pervious	40,000 cu.yd.	0.60	24,000	
Embankment				
Impervious	460,100 cu.yd.	0.25	115,000	
Pervious	40,000 cu.yd.	0.20	8,000	
Pervious, salvage	146,000 cu.yd.	0.25	36,500	
Riprap	27,500 cu.yd.	2.50	68,800	
Drilling grout holes	8,000 lin.ft.	3.00	24,000	
Pressure grouting	4,000 cu.ft.	4.00	16,000	$711,200
Spillway				
Excavation	35,600 cu.yd.	1.50	53,400	
Concrete	180 cu.yd.	35.00	6,300	
Reinforcing steel	13,200 lb.	0.15	2,000	61,700
Outlet Works				
Excavation	400 cu.yd.	5.00	2,000	
Concrete				
Inlet structure	10 cu.yd.	90.00	900	
Pipe encasement	200 cu.yd.	30.00	6,000	
Reinforcing steel	21,000 lb.	0.15	3,200	
Trashrack steel	500 lb.	0.30	200	
Steel pipe, 24-inch diameter	14,100 lb.	0.25	3,600	
Gate valve, 24-inch diameter, hydraulic controls	1 ea.	lump sum	2,000	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Gate valve, 18-inch diameter, manual controls	2 ea.	lump sum	$1,000	
Control house		lump sum	2,000	$20,900
Reservoir				
Land	870 ac.	$60.00	52,200	
Improvements		lump sum	100,000	
Clearing	none			152,200
Subtotal				$946,000
Administration and engineering, 10%				94,600
Contingencies, 15%				141,900
Interest during construction				17,700
TOTAL				$1,200,200
Annual Costs				
Interest, 3%				$36,000
Amortization, 0.887%				10,600
Replacement, 0.07%				800
Operation and maintenance				2,300
General expense, 0.32%				3,800
TOTAL				$53,500

ESTIMATED COST OF AUBURN RAVINE DIVERSION AND CONDUIT

(Based on prices prevailing in April, 1953)

Capacity of conduit: 50 second-feet
Length of conduit: 12 miles

Canal unlined

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Structure				
Excavation	330 cu.yd.	$4.00	$1,300	
Concrete	152 cu.yd.	60.00	9,100	
Reinforcing steel	15,200 lb.	0.15	2,300	
Slide gates, 4' x 4'	5,000 lb.	0.60	3,000	$15,700
Conduit				
Excavation	33,400 cu.yd.	0.30	10,000	
Compaction	28,000 cu.yd.	0.25	7,000	
Trimming	100,000 sq.yd.	0.05	5,000	
County road crossings	2 ea.	2,500	5,000	
Farm road crossings	5 ea.	1,500	7,500	34,500
Subtotal				$50,200

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$5,000
Contingencies, 15%			7,500
Interest during construction, none			
TOTAL			$62,700
Annual Costs			
Interest, 3%			$1,900
Amortization, 0.887%			600
Operation and maintenance, 1%			600
General expense, 0.32%			200
TOTAL			$3,300

ESTIMATED COST OF WHITNEY RANCH DISTRIBUTION SYSTEM

(Based on prices prevailing in April, 1953)

Distribution system: Unlined canals and ditches

Acreage served: 2,000 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Distribution system	2,000 ac.	$20.00	$40,000	$40,000
Subtotal				$40,000
Administration and engineering, 10%				4,000
Contingencies, 15%				6,000
Interest during construction, none				
TOTAL				$50,000

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$1,500
Amortization, 0.887%			400
Operation and maintenance			
Ditch tender service, $0.55 per acre-foot			5,200
Maintenance charge, $0.40 per acre			800
District overhead, $0.50 per acre			1,000
TOTAL			$8,900

ESTIMATED COST OF CLOVER VALLEY DAM AND RESERVOIR

(Based on prices prevailing in April, 1953)

Elevation of crest of dam: 390 feet, U. S. G. S. datum
Elevation of crest of spillway: 380 feet
Height of dam to spillway crest, above stream bed: 120 feet

Capacity of reservoir to crest of spillway: 21,600 acre-feet
Capacity of spillway with 5-foot freeboard: 3,100 second-feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Dam				
Stripping and preparation of foundation	138,000 cu.yd.	$0.75	$103,500	
Embankment				
Impervious	890,000 cu.yd.	0.75	667,500	
Pervious	1,880,000 cu.yd.	0.70	1,316,000	
Drilling grout holes	8,700 lin.ft.	3.00	26,000	
Pressure grouting	11,000 cu.ft.	4.00	44,000	$2,157,000
Spillway				
Excavation				
Common	25,500 cu.yd.	0.50	12,800	
Rock	50,800 cu.yd.	2.00	101,600	
Concrete, lining	500 cu.yd.	35.00	17,500	
Reinforcing steel	36,700 lb.	0.15	5,500	137,400
Outlet Works				
Excavation				
Common	260 cu.yd.	0.50	100	
Rock	530 cu.yd.	2.00	1,100	
Concrete				
Backfill	230 cu.yd.	30.00	6,900	
Structural	50 cu.yd.	100.00	5,000	
Reinforcing steel	28,300 lb.	0.15	4,300	
Steel pipe	70,200 lb.	0.25	17,500	
Butterfly valve, 36-inch diameter	2 ea.	6,000	12,000	
Hollow jet valve, 42-inch diameter	1 ea.	10,500	10,500	

Item	Quantity	Unit price	Cost	
Capital Costs—Continued				
Outlet Works—Continued				
Trashrack steel	14,000 lb.	$0.25	$3,800	
Control house		lump sum	2,000	$63,200
Reservoir				
Land and improvements		lump sum	37,500	
Relocate telephone cable	2.9 mi.	lump sum	105,500	
Clearing reservoir lands	500 ac.	50.00	25,000	168,000
Subtotal				$2,525,600
Administration and engineering, 10%				252,600
Contingencies, 15%				378,800
Interest during construction				47,400
TOTAL				$3,204,400
Annual Costs				
Interest, 3%				$96,100
Repayment, 0.887%				28,400
Replacement, 0.07%				2,200
Operation and maintenance				5,000
TOTAL				$131,700

ESTIMATED COST OF CLOVER VALLEY DIVERSION AND CONDUIT

(Based on prices prevailing in April, 1953)

Capacity of conduit: 75 second-feet
Length of conduit: 15 miles

Canal unlined

Item	Quantity	Unit price	Cost	
Capital Costs				
Diversion Structure				
Excavation	100 cu.yd.	$4.00	$400	
Concrete	40 cu.yd.	60.00	2,400	
Reinforcing steel	4,000 lb.	0.15	600	
Slide gates, 4′ x 4′	5,000 lb.	0.60	3,000	$6,400
Auburn Ravine Siphon				
Welded steel pipe	140,000 lb.	0.30	42,000	42,000
Canal				
Excavation	230,000 cu.yd.	0.30	69,000	
Compaction	195,000 cu.yd.	0.25	48,800	
Trimming	85,000 sq.yd.	0.05	4,300	
County road crossings	8 ea.	6,000	48,000	
Farm road crossings	4 ea.	2,000	8,000	
Stream crossings	3 ea.	1,200	3,600	181,700
Clover Valley Tunnel				
Tunnel	1,800 lin.ft.	120.00	216,000	216,000
Subtotal				$446,100

Item	Quantity	Unit price	Cost
Capital Costs—Continued			
Administration and engineering, 10%			$44,600
Contingencies, 15%			66,900
Interest during construction			16,700
TOTAL			$574,300
Annual Costs			
Interest, 3%			$17,200
Amortization, 0.887%			5,100
Operation and maintenance, 1%			5,700
General expense, 0.32%			1,800
TOTAL			$29,800

ESTIMATED COST OF CLOVER VALLEY DISTRIBUTION SYSTEM

(Based on prices prevailing in April, 1953)

Distribution system: Unlined canals and ditches

Acreages served: 4,700 acres

Item	Quantity	Unit price	Cost	
Capital Costs				
Distribution System	4,700 ac.	$20.00	$94,000	$94,000
Subtotal				$94,000
Administration and engineering, 10%				9,400
Contingencies, 15%				14,100
Interest during construction, none				
TOTAL				$117,500

Item	Quantity	Unit price	Cost
Annual Costs			
Interest, 3%			$3,500
Amortization, 0.887%			1,000
Operation and maintenance			
Ditch tender service, $0.55 per acre-foot			12,100
Maintenance charge, $0.40 per acre			1,900
District overhead, $0.50 per acre			2,400
TOTAL			$20,900

ESTIMATED COST OF AUBURN RAVINE POWER DEVELOPMENT PROJECT

(Based on prices prevailing in April, 1953)

Elevation of forebay water surface: 875 feet, U. S. G. S. datum
Elevation of power house tailrace: 465 feet, U. S. G. S. datum

Capacity of penstock: 170 second-feet
Length of penstock: 4,590 feet

Item	Quantity	Unit price	Cost	
Capital Costs				
Power House				
10,000 kilowatt, single unit plant	10,000 kw.	$108.00	$1,080,000	
1,000 kilowatt generator	1,000 kw.	200.00	200,000	
Access road	1 mi.	80,000	80,000	
Clearing	5 ac.	200.00	1,000	$1,361,000
Penstock				
Penstock	2,060 lin.ft.	34.00	70,000	
	1,130 lin.ft.	55.00	62,200	
	720 lin.ft.	80.00	57,600	
	680 lin.ft.	87.00	59,200	
Anchors and piers				
Concrete	1,380 cu.yd.	50.00	69,000	
Reinforcing steel	104,000 lb.	0.15	15,600	
Butterfly valves	2 ea.	17,500	35,000	368,600
Forebay				
Excavation	297,300 cu.yd.	0.45	133,800	
Compacted fill	88,900 cu.yd.	0.85	75,600	
Outlet				
Pipe and valve	600 ft.	12.00	7,200	
Trashrack	7,000 lb.	0.15	1,100	
Concrete	1,300 cu.yd.	35.00	45,500	
Reinforcing steel	100,000 lb.	0.15	15,000	278,200
Conduit				
Intake		lump sum	5,000	
Canal	13,700 lin.ft.	11.00	150,700	155,700
Subtotal				$2,163,500
Administration and engineering, 10%				$216,400
Contingencies, 15%				324,500
Interest during construction				64,900
TOTAL				$2,769,300

Item	Quantity	Unit price	Cost	
Annual Costs				
Power House				
Interest, 3%			$52,300	
Amortization, 0.887%			15,500	
Replacement, 1.20%			20,900	
Operation and maintenance, $5.00 per kilowatt			55,000	
Insurance, 0.12%			2,100	
General expense, 0.32%			5,600	$151,400
Penstock				
Interest, 3%			14,200	
Amortization, 0.887%			4,200	
Replacement, 1.00%			4,700	
Operation and maintenance, $0.0125 per sq. ft.			2,100	
General expense, 0.32%			1,500	26,700
Forebay				
Interest, 3%			10,700	
Amortization, 0.887%			3,200	
Replacement, 0.02%			100	
Operation and maintenance, 0.5%			1,800	
General expense, 0.32%			1,100	16,900
Conduit				
Interest, 3%			6,000	
Amortization, 0.887%			1,800	
Replacement, 0.02%			100	
Operation and maintenance, 1%			2,000	
General expense, 0.32%			600	10,500
TOTAL				$205,500

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