THE RESOURCES AGENCY OF CALIFORNIA

Department of Water Resources

BULLETIN No. 115

YUBA AND BEAR RIVERS BASIN INVESTIGATION

APRIL 1964

HUGO FISHER
Administrator
The Resources Agency of California

EDMUND G. BROWN
Governor
State of California

WILLIAM E. WARNE
Director
Department of Water Resources

Yuba River Basin looking east. Daguerre Point Dam is at right center of picture. Cordua-Hallwood Canal traverses foreground. Marysville Dam would reach for two miles across the Yuba River between Browns Valley Ridge and McCartie Hill about one and one-half miles upstream from Daguerre Point Dam. McCartie Hill is just beyond the right edge of the picture. The foot of the Browns Valley Ridge is visible at left center.

State of California

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GOVERNOR OF
CALIFORNIA

HUGO FISHER
ADMINISTRATOR
RESOURCES AGENCY

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THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
1120 N. STREET, SACRAMENTO

February 18, 1964

Honorable Edmund G. Brown, Governor
and Members of the Legislature
of the State of California

Gentlemen:

I have the honor to transmit herewith Bulletin No. 115, "Yuba and Bear Rivers Basin Investigation." This report sets forth the results of a comprehensive basinwide water resources investigation which was originally initiated under the California Water Development Program of 1956. It contains a coordinated plan aimed at eventual full and comprehensive development of the land and water resources of the Yuba and Bear Rivers Basin and contiguous lands dependent on the basin for water supply. A large part of the information developed during this investigation has been utilized by local public agencies in furtherance of water development. It is envisioned that this report will serve as a valuable guide to those interested in the future development of the Yuba and Bear Rivers Basin.

Sincerely yours,

William E. Warne

Director

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

EDMUND G. BROWN, Governor
HUGO FISHER, Administrator, The Resources Agency of California
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Executive Secretary

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ACKNOWLEDGEMENT

Valuable assistance and data used in the investigation were contributed by agencies of the federal government, the State of California, cities, counties, public and private agencies and individuals. This cooperation is gratefully acknowledged.

Special mention is made of the helpful cooperation of the following:

Bureau of Reclamation, United States Department of the Interior

Corps of Engineers, United States Army

Department of Fish and Game, State of California

Yuba County Water Agency

Nevada Irrigation District

THE SACRAMENTO UNION Wed., Oct. 19, 1960

Nevada Irrigation Unit Asks Big Project OK

WASHINGTON (AP)—Nevada Irrigation District at Grass Calif., Tuesday applied to the Federal Power Commission for a proposed $36,825,000 hydroelectric project in the Califo… of Sierra, Nevada, and Placer. …e proposed Yuba-Bear River …opment would have a total … capa… of 59,100 killo-watts in two powerho… It would be located … Fork of the North … Middle Yuba Rive… of Middle Yuba … Creek, South Yuba … River.

The district w… …erated …

Voters in Yuba Okeh Water Issue 12 to 1

…cent of Yuba County's eligible … ers turned out Tuesday to give the $185,000,000 revenue bond proposal of the Yuba County Water Agency an almost 12 to 1 margin of approval, …

Placer OKs Bonds for Water Plan

By VALLEY NEWS SERVICE

AUBURN—By a vote of nearly 25 to one, Placer County voters Tuesday approved a $140,000,000 revenue bond issue that will finance construction of a vast network of irrigation reservoirs and power houses on the upper American and Rubicon Rivers.

The vote was 7,423 in favor … 296 opposed.

It was one of … outs of vo…

THE SACRAMENTO BEE Page C5 Thursday, August 31, 1961

Browns Valley Board Awards Dam Contract

BROWNS VALLEY, Yuba Co.—Directors of the Browns Valley Irrigation District have awarded a contract for construction of the district's Virginia Ranch Dam project to the firm of … Burrough… …illiams and …mont, San … firm was …3.05 mil-

…uesday …e firm …sso- …utter …on- …l to …vo

Board Lets Bear River Dam

The board of the South Sutter Water District Monday, authorized engineers to advertize for bids for the construction of a diversion tunnel, inlet and outlet works, spillway, dam, and access road, and conveyance and distribution canal, of proposed Camp Far West Project.

The dam is located on the Bear … …ximately 7 miles East …fornia.

CHAPTER I. INTRODUCTION

The above newspaper headlines, relating to five separate water development projects, appeared within a recent interval of less than two years. They testify to the intensive interest of local agencies in the development of new water supplies to satisfy local requirements. Four of the projects are now under construction and when completed, will develop for beneficial uses a large portion of the waters of the Yuba, Bear, and American Rivers.

Water supplies available for irrigation and domestic use in the foothill regions of the Yuba-Bear Area are now being fully utilized. On the valley floor, current pumping from ground water storage exceeds recharge to the basin, resulting in a continual lowering of ground water elevations over the past ten years. The need to develop additional water supplies is evident and faces nearly every agricultural region of the Yuba-Bear Area. These water supplies must be developed if the economic growth of the area is to keep pace with other competitive areas of the State and nation.

A market for additional water supplies, and the recent enactment of federal and state legislation to provide loans to local agencies at low interest rates, have made several local projects financially feasible for the first time. Other projects which will further develop the hydroelectric power potential are utilizing this source of project revenues as a means of establishing feasibility. It is essential that local projects do not preclude or make infeasible the eventual optimum development of the basin's water and land use potential. Basinwide planning such as conducted by the department provides the means of assuring that individual projects are in fact a desirable increment leading toward full and comprehensive basin development.

During the course of this investigation plans were evaluated from the viewpoint of the public's interest.

In addition to new water supplies and hydroelectric power, consideration was given to flood control, recreation, and fish and wildlife in the overall pattern of development. Furthermore, there is a need, relative to the selection of additional units of the State Water Resources Development System as contemplated in the California Water Resources Bond Act, to ascertain whether or not the opportunity exists, after satisfying local requirements, to construct facilities which will enable further export of water from the Sacramento-San Joaquin Delta.

Authorization for Investigation

The Department of Water Resources initiated an investigation of the Yuba and Bear Rivers Basin under the California Water Development Program of 1956. Work accomplished during the first year consisted mainly of the formulation of a preliminary plan, subsequently included in Bulletin No. 3, "The California Water Plan."

Legislative sanction for a more intensive investigation was given in the spring of 1957 under the provisions of Resolution Chapter 296, Statutes of 1957. This resolution requested the Department of Water Resources:

> " ... to expedite the ... feasibility investigation and the formulation of plans for the full development of the Yuba and Bear Rivers under the ... California Water Development Program."

The Legislature took further action with respect to the area in 1958 when it passed concurrent resolutions which requested the Department of Water Resources to:

> " ...ₒ conduct ... investigations ... and prepare plans and estimates, for a flood control dam on the Yuba River in the vicinity of Parks Bar Bridge in Yuba County, to be constructed in cooperation with the United States, and to report thereon to the Legislature upon the convening of the 1959 Regular Session..." (Calif. Stats. 1958, First Ex. Sess. Res. Chs. 77, 83.)

These studies were completed and the results reported to the Legislature through a letter to Senator E. C. Johnson, Tenth Senatorial District, on June 5, 1959.

Ample funds were made available by the Legislature during the initial years of the investigation to proceed with feasibility studies of a multipurpose project on the lower Yuba River. However, funds requested by the department beginning in fiscal year 1959, to extend the investigation at the same level for upstream portions of the Yuba and Bear Rivers Basin, were reduced by the Legislature. Although the reduction in funds resulted in less intensive studies of the upstream area, the net effect was one of degree. The results of the investigation of the Yuba-Bear Area presented in this report provide reliable data and guidance for future water development.

Objective of Investigation

The objective of this investigation was to formulate a comprehensive plan for basinwide development to meet projected water requirements to year 2020. Selection of a major, multipurpose project on the lower Yuba River was of initial concern to fulfill the requirements of water resource development including flood control and possible export of water to the Delta under the State Water Resource Development System.

Scope of Investigation

Under the authorizing legislation, the department was requested to expedite the investigation of the Yuba and Bear Rivers. Studies under this authorization commenced in July 1957. The initial period of the investigation was devoted mainly to the collection of data necessary to proceed with a full basin study.

Six major storage sites on the Yuba River were explored in considerable detail during the period 1957 through 1959. Further study of the Marysville site was conducted in 1961. Results of geologic investigations conducted at these sites nave been compiled in the form of office reports. Geologic exploration in conjunction with studies of projects in areas of local development were conducted primarily at the reconnaissance level.

All available flow measurements and reservoir operation records were collected and utilized in a study of the water supply of the Yuba and Bear Rivers Basin and adjacent areas. Monthly unimpaired flows were determined at gaging stations and potential dam and diversion sites throughout the area of investigation. The results of the study were compiled in an office report, entitled "Unimpaired Streamflow - Yuba and Bear Rivers."

Land use and land classification surveys were available for most of the foothill and mountainous regions of the Yuba-Bear Area from a 1957 survey conducted as part of a statewide program. For the Valley Floor Service Area, data collected in 1954 as part of Bulletin No. 58, "Northeastern Counties Investigation," were adjusted to fit the new service area boundaries. Surveys of the small, remaining, peripheral areas were conducted to complete the coverage of the study area. These surveys provided the basis for estimates of present and future water requirements.

Evaluation of the recreational potential of New Bullards Bar and Marysville Reservoirs was made during the course of the investigation, and office reports prepared.

The Department of Fish and Game, by service agreement with the department, conducted studies of streamflow requirements necessary to sustain fishlife or enhance existing habitat below proposed projects.

Engineering designs and estimates of cost were made for various sizes of projects under consideration. These estimates, together with estimates of project benefits, were utilized in economic sizing studies. Reservoir operation studies were conducted to determine project yields of hydroelectric power and water.

An analysis was made of economic conditions within the various water service areas, including the derivation of payment capacity for agricultural water and the benefits which would accrue to the areas from the various uses of project water.

Related Investigations and Reports

During the course of this investigation, both the Corps of Engineers and the Bureau of Reclamation were also engaged in relatively limited investigations of the Yuba River. The Corps of Engineers had as its objective the review of its "Comprehensive Report on Sacramento-San Joaquin Basin Streams" for the purpose of determining the advisability of modifying recommendations contained therein with respect to the Bullards Bar Project on the North Yuba River. This entailed consideration of multipurpose projects at other sites on the Yuba River as well as at Bullards Bar. The Bureau of Reclamation was endeavoring to select and evaluate an initial multipurpose project on the Yuba River. Because of the more or less parallel investigations of the state and these federal agencies, close liaison was maintained during the planning period to exchange information and avoid duplication of costly field work to the maximum extent possible.

A considerable amount of information relevant to the Yuba-Bear Area is available in previous bulletins of the Department of Water Resources, and in reports and documents of other agencies. A bibliography of publications utilized during the course of this investigation is presented following the main text of this bulletin.

Area of Investigation

The area of investigation, shown on Plate 1, "Location of Yuba-Bear Area," comprises the watersheds of the Yuba and Bear Rivers, and adjacent lands in the foothills and on the Sacramento valley floor which depend to varying degrees upon these sources for present and future water supplies. The boundary, proceeding clockwise, is defined by the Feather River on the west; South Honcut Creek, a segment of the Yuba-Butte county line, and the Feather River watershed divide on the north; the Truckee River watershed divide on the east; the American River watershed divide, changing to the North Fork of the American River on the southeast; and the Sacramento county line on the south. This boundary embraces an area of about 2,635 square miles, or 10 percent of the entire Sacramento River drainage basin.

Seven counties are represented within the area of investigation, including all of Yuba County, large portions of Nevada, Sierra, Placer, and Sutter Counties, and smaller portions of Plumas and Butte Counties.

General Description of the Area

The area under investigation is situated on the western slope of the Sierra Nevada northeast of Sacramento. Elevations range from about 20 feet near the Feather River to over 9,000 feet at the crest of the Sierra Nevada. The valley floor is a flat, nearly treeless plain which slopes gradually upward to the east, blending into rolling foothills with scattered oaks. With increase in elevation, the oak growth becomes denser, gradually merging with conifer forests which cover the mountains to the east. At the higher elevations the conifer forests are broken by the bare granitic peaks of the Sierra Divide.

Major streams of the basin, rising in the flatter granitic and lava basins near the summit, soon drop steeply to the west through deep, precipitous canyons before gradually decreasing in slope as they pass through the foothill regions and across the valley floor. These steep canyons afford poor sites for reservoirs, and consequently existing and proposed storage projects are confined primarily to the higher elevations or the foothill regions.

The Yuba River has its beginning near the crest of the Sierra Nevada and drains about 1,358 square miles of the western slope before entering the Feather River at Marysville. The principal tributaries are the North Yuba River with a drainage area of 488 square miles; the Middle Yuba River with a drainage area of 212 square miles; the South Yuba River with a drainage area of 352 square miles; Deer Creek with a drainage area of 90 square miles; and French Dry Creek with a drainage area of 108 square miles. The major tributary is the North Yuba River which contributes about 46 percent of the total natural flow originating above the base of the foothills.

The Bear River drains a narrow basin which tapers almost to a point between the Yuba and American River watersheds near Emigrant Gap. As is typical of the rivers which pass through the central mountain region, it drops rapidly through a steep-sided canyon before emerging into the foothill region and then travels westerly across the valley floor to join the Feather River three miles above Nicolaus. The drainage area above Highway 99E aggregates 292 square miles. Dry Creek, a tributary which drains a portion of the foothill region north of the Bear River, and which is generally considered as a separate stream, joins the Bear River a short distance above the mouth.

Several minor streams including Coon Creek, Doty Ravine, Auburn Ravine, and Pleasant Grove Creek, originate in the foothills south of the Bear River. These streams contribute relatively small amounts of runoff and are usually nearly dry by late summer.

Geology

The Yuba and Bear Rivers Basin lies largely within the Sierra Nevada geomorphic province. It is bounded on the west by the alluvial deposits of the Sacramento Valley. Uplift and westward tilting of the huge Sierra Nevada fault block has caused the westerly flowing Yuba and Bear Rivers to cut deep canyons through the metamorphic and granitic bedrock and the overlying volcanic rocks.

A generalized, eastward geologic traverse along the Yuba River, from its confluence with the Feather River at Marysville to the peaks of the Sierra Nevada divide, encounters several distinct geologic formations. Roughly, these include from elevations 20 to 150 feet, 10 miles of Recent and Pleistocene alluvial deposits; from elevations 150 to 1,500 feet, 20 miles of largely Mesozoic metavolcanic rocks and Mesozoic granitic rocks; from elevations 1,500 to 4,000 feet, 30 miles of largely Paleozoic metasedimentary rocks and Mesozoic granitic rocks, capped with Tertiary volcanics and gravels; and from elevations 4,000 to 7,500 feet, 10 miles of Mesozoic granitic rocks overlain by Tertiary volcanics and Pleistocene glacial deposits.

Two major zones of Mesozoic ultrabasic or serpentine rocks traverse the watershed in a direction generally parallel with the crest of the Sierra Nevada. One zone of serpentine up to four miles in width cuts through the center of the drainage basins, being intersected by the North Yuba River at Goodyears Bar, by the Middle Yuba River near Moore's Flat, by the South Yuba River east of Washington, and by the Bear River east of Dutch Flat. This stratum is generally softer and more easily eroded than adjoining strata, and through it the canyons are on a flatter gradient and wider than in the rocks above and below. The other zone of discontinuous bodies of serpentine strikes near the confluences of the Yuba River and its main tributaries.

Several large fault systems traverse the Yuba and Bear Rivers Basin in a northwest-southeast direction, especially along the zones of ultrabasic rocks or serpentine. The Melones fault zone is the major fault system in the area. Seismicity in this region is classed as low to moderate. The region, based on interpretation of the instrumental earthquake record since 1934, is relatively quiet seismically. During this 27-year period, 1934-1961, there were no recorded epicenters of Richter Magnitude 4 and above in the area of investigation. Strong motion and sensitive seismic instrument records are not available in the area to determine horizontal and/or vertical acceleration values for use in design.

The portion of the Yuba-Bear Area in the Sacramento Valley is underlain by unconsolidated deposits of Teritary and Quaternary age. These materials consist principally of sand, gravel, silt, and clay, and contain usable quantities of ground water having generally satisfactory quality.

Soils

Soils of the Yuba-Bear Area can be systematically arranged or classified into three rather broad groups: (1) recent alluvial soils; (2) older alluvial or valley filling soils; and (3) residual or upland soils. Soils representing each of these major groups can be found in most any locality within the area of investigation, but even within one grouping the members may vary so tremendously in their agricultural value that a detailed analysis would be required to delineate them.

The type of parent rock materials from which the soils of the area of investigation were formed occur in north-south zones running parallel to the main axis of the Sierra Nevada uplift. These zones afford a rather effective way of describing the characteristics of the service areas and the agricultural or other potential uses of the lands and soils therein. These zones are described below.

The valley floor zone comprises all the lands lying between the Feather River on the west and an imaginary line beginning in the south near Loomis, running north through

Lincoln and ending on South Honcut Creek some 20 miles northeast of Marysville. The soils of this zone are of recent and older alluvial origin. They were formed from the outwash material of the many creeks and rivers that transect the area and are characteristically quite mixed as to their parent rock source material.

Some local flooding is found on the recent alluvial soils in the vicinity of Coon Creek, Secret, and Auburn Ravines. A considerable acreage of both young and older valley fill type soils have been dredged for gold. The resultant mined area is generally a jumbled pile of loose, water-polished rock, although in some areas leveling and the addition of topsoil have created irrigable land. By and large these areas are not suitable for further irrigation development.

Soil profile development is quite variable among the alluvial soils found in the valley floor zone, ranging from smooth or gently undulating hardpan soils of a generally uniform nature to deep, permeable recent alluvial soils. In one sector, immediately north of Roseville and extending nearly to Lincoln, the uniformity of this alluvial belt is broken by an area of very shallow and rocky soils. These soils were formed over the remnant of an ancient tuffaceous volcanic mudflow. Lack of soil depth, generally less than one foot, and extreme rockiness render these soils for the most part unsuitable for agricultural development.

The recent alluvial soils have been planted for the most part in high-yielding deciduous orchard. The land parcels not in orchard will probably be similarly developed in the near future. The fine-textured and somewhat shallow hardpan lands, however, are now only partially developed to irrigated agriculture. Due to shallow depth, fine textures, or other limited conditions, most of the developed lands in this category are being utilized for production of rice, various field crops, or dry-farmed grain.

The second major soil zone, the intermediate, comprises a narrow band running north and south immediately east of the valley floor zone. This zone is located on the westerly edge of the foothills up to an elevation of about 1,000 feet. The zone is made up primarily of residual soils formed from granitic parent rock. There are a few small parcels of granitic, recent alluvial soil bordering some of the tributary streams. The zone begins immediately west of Folsom Lake and sweeps north through Penryn to the Gold Hills region and north to the Bear River. North of the Bear River this belt is quite spotty and localized and of little agricultural importance.

Many large granitic rock outcroppings are apparent throughout the intermediate zone; however, the soils are relatively deep even in close proximity to the rock outcroppings. The profiles are rather sandy and friable at the surface, grading into clay loam subsoils. At depths from three to five feet, the granitic parent material is usually encountered. These soils are quite rapidly drained on sloping lands, but water tends to pond in any draw or depression. An attempt is made to compensate for poor drainage in swales and draws by planting these areas to pears. Immediately above the swales and draws, the land is planted to and highly adapted for plum and peach production.

The upland zone occupies the medium elevations of the foothills from about 1,000 to 2,500 feet. In general, the east-west width varies from 10 to 40 miles. The widest point in the zone runs from Camp Far West Reservoir to Chicago Park. The soils are primarily residual, derived from basic igneous and metavolcanic parent rock. In much of the zone, the soils are shallow and rocky.

By and large, the crop adaptability of the lands in the upland zone is better directed toward the planting of perennials such as pasture or deciduous orchard.

The mountain zone lies from above 2,500 feet to the crest of the Sierra Nevada. With the exception of a few scattered parcels of recent alluvium in a few rather isolated valleys, the major soil bodies are restricted to the tops of several long, rather gently sloping, finger-like ridges. The soils are typically deep, rather rocky, reddish-brown in color, and clay loam in texture. The native vegetation is a luxuriant cover of mixed coniferous forest. A large acreage of high water table irrigated pasture exists in this zone. These pasture parcels are generally adjacent to a creek or stream from which irrigation water is naturally or artificially wild-flooded across the land. These meadows have been grazed extensively since the opening of the national forests by the Taylor Grazing Act.[1/]

Climate

The climate of the Yuba-Bear Area varies from a hot Savannah type on the valley floor to an Alpine type at the higher elevations in the Sierra Nevada.

On the valley floor, there are approximately 300 frost-free days beginning in February and continuing through November. Occasional frosts occur during December and January, but severe freezes and prolonged cold spells are rare. The annual average rainfall is about 19 inches, largely from rainstorms during the late fall, winter, and early spring months.

In the foothills and lower mountainous areas, the summer months are slightly cooler than the valley floor area and are generally dry except for occasional ineffective showers from the latter part of June through the first part of September. The spring and fall seasons are also cooler than the valley floor, but there is a considerable increase in the amount of rainfall especially above an elevation of 1,000 feet. Rains beneficial to the growth and development

1/ (48 Stat. 1269, 43 U.S.C. Sec. 315-315r, 1958 ed.)

of various crops are a common occurrence during the spring and fall months.

The winters vary considerably according to elevation. In the areas below an elevation of 1,000 feet, snow storms of any magnitude are rare, although frosts are frequent. The growing season normally exceeds 250 days and approaches 270 days in the lower regions. Above the 1,000-foot contour, snow and colder weather increase in frequency and intensity with increased elevation. Historical data indicate the average annual temperature decreases about 3 degree for each 1,000-foot increase in elevation. The growing season ranges from 250 days at the lower elevation to about 150 days in the higher areas near the 2,700-foot elevation. Rainfall amounts to about 25 inches at the 500-foot contour and increases to as much as 50 inches at about 2,700 feet elevation.

More detailed information on the climate of the Yuba-Bear Area is available in an office report prepared by the department entitled "Climatology of the Yuba-Bear Area."

Economic Activities

The economy of the area of investigation is based primarily on activities relating to its soil, timber, and mineral resources. The relative importance of these resources in the economy has, however, changed markedly over the years since about 1845, the beginning of farming in the area. Most recently, use of the mountainous regions for recreation has become of increasing importance in the overall economic picture.

Soon after the discovery of gold in 1848, hydraulic gold mining became the leading activity. Production, however, was curtailed sharply in 1893 by the passage of the California Debris Commission Act,[1/] and is now confined primarily to dredging of the Yuba River channel near Browns Valley. Since mining first began in the area, the Yuba River has produced more gold than any other river in the United States. The current fixed price has relegated gold mining to a secondary position. Authorities agree that an increase in price would re-establish gold mining as a leading activity. During 1959, the value of all minerals mined was about $6,000,000.

With the curtailment of gold mining in 1893, agriculture again assumed a leading role in the economy, a position which it has continued to maintain to the present time. The present value of all agricultural products from the area is in the order of $40,000,000 per year.

Although agriculture is the leading activity on an overall basis, logging and the manufacture of lumber constitute the leading industry in many localized areas of the Yuba and Bear Rivers Basin. The annual cut in the forested areas is in the order of 340,000,000 board feet.

1/ (27 Stat. 507, 33 U.S.C., Sec. 661-685, 1958 ed.)

Other industrial establishments are engaged in food processing, the manufacture of clay tile, and a variety of small enterprises.

No reliable estimates are available concerning income derived from recreational activities in the area. However, these activities encompass hunting, fishing, camping, snow sports, and virtually all other types of general outdoor recreation. Facilities to provide accommodations and services for vacationists and sportsmen are available throughout the area. The area also contains many historical attractions associated with the early gold mining days, and these, too, attract many visitors.

History of Water Development

The history of water development in the area begins with the discovery of gold in 1848. Early operations were generally confined to areas along the natural watercourses, and development usually consisted of little more than a timber-crib dam to divert the water to the workings. Later, as mining spread to the slopes and broad ridges between the rivers, it became necessary to build ditches and flumes to provide an adequate supply of water for mining operations. With the advent of hydraulic mining with its tremendous thirst for water, it became necessary to construct even more elaborate works reaching to the higher elevations in order to provide an adequate supply of water. A notable example is the long since abandoned Milton Ditch on the San Juan Ridge which conveyed water diverted from the Middle Yuba River near Milton to the vast placer workings on the ridge, where millions in gold were recovered from the face of the earth by washing with hydraulic monitors. Debris from this type of operation was carried by the rivers to the Sacramento Valley, resulting in the enactment of the California Debris Commission Act in 1893 which prohibited the dumping of debris from hydraulic mines into navigable streams. It has been estimated that 700,000,000 cubic yards of material was carried downstream by the Yuba River, raising its bed above the level of the surrounding countryside in the reach between the base of the foothills and the mouth. Due to the prohibitive cost of preventing movement of debris downstream, virtually all hydraulic mining in the area ceased.

In an effort to control movement of debris, Bullards Bar Dam was constructed on the North Yuba River in 1924. It was later acquired by the Pacific Gas and Electric Company and is now used to store water for power generation and irrigation to the extent of its limited capacity.

Daguerre Point Dam, on the lower main stem of the Yuba River, is an earlier example of a debris storage barrier. It is estimated that approximately 20 million cubic yards of mining debris have been retained by this structure. For the past 50 years the structure has also been used to divert irrigation water to the lands of the Hallwood Irrigation Company and the Cordua Irrigation District on the Sacramento valley floor. Englebright Dam, constructed by the federal government in 1941 in an unsuccessful effort to re-establish hydraulic mining, is now used mainly for power generation.

With the decline of hydraulic mining, the existing water companies turned their attention to the sale of irrigation water to farm users. However, the demand for irrigation water was unfortunately small, and many companies were driven out of business. Many of the works on the headwaters of the Middle and South Yuba Rivers and other streams of the area, built by companies long since vanished, have been incorporated into the present-day facilities of the Nevada Irrigation District and the Pacific Gas and Electric Company.

In more recent years, the increased demand for irrigation water has resulted in the construct of several reservoirs by local agencies. Projects by the Nevada Irrigation District include Bowman Reservoir, built in 1927, followed in 1928 by Milton Diversion Reservoir and Lake Combie. Scotts Flat Reservoir on Deer Creek was constructed in 1949. The Camp Far West Irrigation District constructed Camp Far West Reservoir in 1928 to serve a small area on the valley floor adjacent to the Bear River.

CHAPTER II. WATER SUPPLY

Except for a relatively small import from the American River Basin, precipitation is the only source of water supply to the Yuba and Bear Rivers.

Winter rains, followed by melting snow, gradually increase the runoff of the Yuba River from early fall to the middle of spring when snowmelt produces the peak seasonal runoff. From late spring through the summer, streamflow rapidly drops off to a minimum in September.

Runoff of the Bear River differs from the Yuba River in that the seasonal runoff closely resembles the rainfall pattern. Maximum flows in the Bear River usually occur in February and March.

Under current conditions of basin development, the diversion of both regulated and unregulated streamflow is the chief source of water for irrigation and domestic purposes. On the valley floor, the available surface water supplies are supplemented by extensive pumping from the ground water basin.

The interbasin transfer of water in the area of investigation is of particular significance. Water supplies developed in the headwaters of the Middle and South Yuba Rivers are transported to the Bear River and thence into the foothill area south of the Bear River. A portion of this water ultimately is diverted into the American River above Folsom Reservoir. Interbasin transfer of water is further discussed under heading of "Imports and Exports."

In this chapter, the water supply of the Yuba-Bear Area is considered and evaluated under the general headings "Precipitation," "Runoff," "Ground Water," "Water Quality," and "Floods and Flood Flows."

Precipitation

Winter storms moving in from the Pacific Ocean deposit relatively light precipitation as they cross the floor of the Central Valley. As they are lifted and cooled in their passage over the Sierra Nevada they lose moisture at increasing rates. The quantity of precipitation, therefore, generally increases with elevation. Before reaching the highest levels of the watershed, however, the amount of precipitation tends to decrease because most of the available moisture has been removed from the rain-bearing clouds. This decrease is illustrated on Plate 2, "Lines of Equal Mean Seasonal Precipitation." For purposes of this report, the 50-year period from July 1905 through June 1955 has been used to calculate mean[1/] seasonal[2/] precipitation.

1/ A "mean period" is a period of time chosen to represent conditions of water supply or climate over a long period of years. The "mean" is an arithmetical average.

2/ A precipitation season extends from July 1 through June 30.

Precipitation Stations and Records

There are 99 precipitation stations in or adjacent to the area of investigation with continuous records of 10 years or longer. Most of these records have been published by the U.S. Weather Bureau or are available from the Department of Water Resources. This information has been tabulated and relevant data summarized in a departmental office report, "Climatology of the Yuba-Bear Area," which is available to those interested. Tabulations of station names, locations, and related information have been omitted from this report.

Precipitation Characteristics

In common with other areas of California, the most obvious characteristic of the precipitation is its seasonal occurrence. Virtually no rainfall is to be expected in the summer months except from occasional thunderstorms which occur more often in the mountains than on the valley floor. The monthly distribution of precipitation varies considerably from season to season, but the months from December through March usually account for more than two-thirds of the seasonal total. Mean monthly distribution of precipitation, at stations considered to be representative of the valley floor and foothill service areas, is presented in Table 1. Probably the most important characteristic of the precipitation is that it generally falls as snow at altitudes above

TABLE 1

MEAN MONTHLY DISTRIBUTION OF PRECIPITATION
AT REPRESENTATIVE STATIONS IN WATER SERVICE AREAS
(Based on records for the 50-year period 1905-06 to 1954-55)

Month	Precipitation in inches and percent of seasonal total					
	Marysville		Auburn		Grass Valley	
	Inches	Percent	Inches	Percent	Inches	Percent
July	0.00	0.0	0.00	0.0	0.04	0.1
August	0.02	0.1	0.01	0.0	0.04	0.1
September	0.23	1.1	0.33	0.9	0.50	0.9
October	0.94	4.6	1.58	4.6	2.49	4.7
November	2.16	10.7	3.41	9.8	5.57	10.5
December	3.99	19.6	5.99	17.2	9.19	17.2
January	4.05	19.9	7.45	21.4	10.80	20.3
February	3.63	17.9	6.30	18.1	9.33	17.5
March	2.88	14.2	5.34	15.3	8.09	15.2
April	1.42	7.0	2.75	7.9	4.25	8.0
May	0.76	3.7	1.25	3.6	2.18	4.1
June	0.24	1.2	0.43	1.2	0.77	1.4
TOTALS	20.32	100.0	34.82	100.0	53.25	100.0

5,500 feet. This, in effect, provides a natural storage reservoir to sustain the streamflow well into the summer months. Another characteristic of the precipitation is its extreme variability from season to season. For example, Nevada City received about 17 inches in 1863-64 and over 117 inches in 1867-68.

Quantity of Precipitation

As stated previously, the quantity of precipitation at various locations in the Yuba-Bear Area is available from U.S. Weather Bureau and department records. These records served as the basis for plotting lines of equal mean seasonal precipitation, or isohyets, shown on Plate 2. By measuring the areas between isohyets, the weighted mean seasonal depth and the total quantity of precipitation was determined. The mean seasonal precipitation on the Yuba and Bear Rivers watersheds above the valley floor was determined to be about 5,000,000 acre-feet. On the valley floor, the mean seasonal precipitation amounts to about 600,000 acre-feet.

Runoff

For purposes of this report, the 50-year mean period, 1906-07 through 1955-56, was selected as the basis for calculating the unimpaired runoff1/ of the Yuba and Bear Rivers. The seasonal unit runoff of the Yuba River Basin above the valley floor was found to average about 2,000

1/ Unimparied runoff is the flow of a stream as it would be if unaltered by upstream diversion, storage, import, export, or change in upstream consumptive use caused by development. Also referred to herein as natural runoff.

acre-feet per square mile. Both the North and South Yuba Rivers have a natural runoff of about 2,200 acre-feet per square mile of drainage area; the Middle Yuba River has about 1,800 acre-feet per square mile; and Deer Creek about 1,200 acre-feet per square mile. The high unit runoff from the watershed of the North Yuba River is attributable to the heavy precipitation. High unit runoff from the watershed of the South Yuba River results not only from heavy precipitation but also from the large areas of barren rock in the upper watershed. The watershed of the Bear River contributes about 1,100 acre-feet per season of natural runoff per square mile of drainage area.

Stream Gaging Stations and Records

Available records of measured runoff of the principal streams in the Yuba and Bear Rivers Basin were considered to be sufficient in number, period of record, and reliability to serve the purposes of this investigation. Table 2 lists the pertinent stream gaging stations, drainage areas, calculated total and unit natural runoff and periods of record. Locations of these stations are shown on Plate 2. The reference numbers shown in Table 2 correspond to the numbering system originated for purposes of this investigation.

Most of the records of measured streamflow and diversions in the area have been published in the Water Supply Papers of the U.S. Geological Survey. Other records

TABLE 2

ESTIMATED MEAN SEASONAL NATURAL RUNOFF, DRAINAGE AREA, UNIT RUNOFF, AND PERIOD OF RECORD AT SELECTED GAGING STATIONS IN THE YUBA AND BEAR RIVERS BASIN

Gage ref. no.	Station	Natural runoff, in acre-feet	Drainage area, in sq. mi.*	Unit runoff, in acre-feet per sq. mi.	Period of record
	MAIN YUBA RIVER AND DEER CREEK				
34	Yuba River at Smartville	2,336,000	1,198.8	1,900	1903-41
33	Deer Creek near Smartville	105,000	84.3	1,200	1935-
30	Yuba River at Englebright Dam	2,231,000	1,107.3	2,000	1941-
	NORTH YUBA RIVER				
13	North Yuba River below Bullards Bar Dam	1,066,000	488.3	2,200	1908-21, 39, 1942-
8	North Yuba River below Goodyears Bar	541,000	249.5	2,200	1930-37 1938-
3	North Yuba River near Sierra City	179,000	94.1	1,900	1911-13, 1923-44
	MIDDLE YUBA RIVER				
19	Middle Yuba River near North San Juan	367,000	201.8	1,800	1900, 1910-41
18	Oregon Creek near North San Juan	58,300	34.4	1,700	1910-
17	Middle Yuba River above Oregon Creek	303,000	161.7	1,900	1941-
15	Middle Yuba River at Milton	80,400	39.7	2,000	1926-34, 1936-
	SOUTH YUBA RIVER				
26	South Yuba River near Washington	534,000	197.4	2,700	1942-53, 1956-
25	Canyon Creek below Bowman Lake	90,100	28.6	3,200	1927-
24	South Yuba River at Langs Crossing	346,000	119.8	2,900	1933-
22	South Yuba River near Cisco	140,000	51.5	2,700	1942-

TABLE 2 (continued)

Gage ref. no.	Station	Natural runoff, in acre-feet	Drainage area, in sq. mi.*	Unit runoff, in acre-feet per sq. mi.	Period of record
	(FRENCH) DRY CREEK				
47	Dry Creek at Virginia Ranch	77,900	71.4	1,100	1948-
46	Dry Creek near Brownsville	24,900	20.4	1,200	1948-
	BEAR RIVER				
43	Bear River near Wheatland	330,000	292.0	1,100	1928-
38	Bear River near Colfax	143,000	105.1	1,400	1911-1938

*Department of Water Resources measurements.

were obtained from the Pacific Gas and Electric Company and the Nevada Irrigation District. These records formed the basis of a study to determine the monthly streamflow of the Yuba and Bear Rivers and minor streams within the area of investigation as would have occurred under natural conditions. Results of this study are compiled in an office report designated as Appendix A to this bulletin. These flows were used in determining the monthly impaired runoff[1/] at the diversion and storage sites considered in this investigation.

Runoff Characteristics

Runoff from the Yuba and Bear Rivers Basin is derived largely from snowmelt; consequently, the major portion generally occurs during the late spring and early summer months. Discharge of the Yuba and Bear Rivers stream system varies widely from month to month and from season to season. The minimum flow of record at Smartville on the Yuba River was about 6 second-feet on September 23, 1941; the maximum instantaneous peak flow was about 161,500 second-feet on December 23, during the 1955 flood. On a mean seasonal[2/] basis, the unimpaired flow of the Yuba River at Smartville has been calculated to be 2,336,000 acre-feet;

1/ The impaired runoff is the flow of a stream as it would be under a given state of upstream development.
2/ A runoff season extends from October 1 through September 30.

but the minimum flow, in 1923-24, was only 714,000 acre-feet. The flow during the maximum season of record, 1906-07, has been calculated to have been 4,544,000 acre-feet. Similarly, for the Bear River near Wheatland, the mean seasonal unimpaired flow has been calculated at 330,300 acre-feet, with minimum and maximum seasonal flows of 68,000 and 776,000 acre-feet occurring in 1923-24 and 1906-07, respectively. Seasonal flows of the Yuba River at Smartville and Bear River near Wheatland are presented in Table 3.

Quantity of Runoff

A prime requirement in the formulation of water development projects is reliable estimates of the water supply. Accordingly, considerable study was made of the basin runoff. Short-period gaging station records were correlated with those of longer duration, and flows were estimated at selected ungaged locations. Unimpaired runoff from ungaged watersheds was based on the drainage area and mean seasonal precipitation.

Under natural conditions, the North Yuba River would contribute about 46 percent of the mean seasonal runoff above the Smartville gage, Middle Yuba River would contribute about 16 percent, South Yuba River about 31 percent, Deer Creek about 4.5 percent; and the remainder, about 2.5 percent, would flow from intermediate drainage.

TABLE 3

RECORDED, COMPUTED, AND ESTIMATED NATURAL SEASONAL RUNOFF
OF YUBA RIVER AT SMARTVILLE AND BEAR RIVER NEAR WHEATLAND

(in acre-feet)

Season	Recorded runoff at Smartville	Estimated and computed natural runoff at Smartville	Recorded runoff near Wheatland	Estimated and computed natural runoff near Wheatland
1906-07	4,457,100	4,544,000		775,600
1907-08	1,594,100	1,691,000		203,500
1908-09	3,877,800	3,968,000		550,000
1909-10	2,667,900	2,756,000		270,200
1910-11	3,508,200	3,606,000		565,300
1911-12	1,128,900	1,209,000		125,200
1912-13	1,397,200	1,492,000		132,000
1913-14	2,865,300	3,061,000		496,000
1914-15	2,500,200	2,690,000		428,200
1915-16	3,091,500	3,300,000		578,900
1916-17	2,306,500	2,530,000		335,800
1917-18	1,141,200	1,348,000		123,300
1918-19	1,739,900	1,976,000		312,700
1919-20	1,084,000	1,298,000		108,700
1920-21	2,873,300	3,084,300		488,400
1921-22	2,725,700	3,024,900		459,900
1922-23	1,804,900	2,093,100		397,300
1923-24	442,600	713,600		67,900
1924-25	1,850,600	2,136,000		287,500
1925-26	1,381,900	1,559,700		262,900
1926-27	3,222,600	3,510,300		553,300
1927-28	2,185,300	2,442,100		320,000
1928-29	697,500	1,099,700	103,000	125,400
1929-30	1,429,300	1,842,300	355,100	216,000
1930-31	428,900	741,500	145,100	73,000
1931-32	1,730,600	2,178,200	233,800	248,800
1932-33	796,800	1,187,700	50,600	121,800
1933-34	720,300	1,055,100	125,800	121,300
1934-35	1,865,100	2,324,200	354,400	355,900
1935-36	2,196,900	2,667,100	461,600	429,600
1936-37	1,528,400	1,887,400	256,000	324,600
1937-38	3,590,700	3,859,400	575,000	567,400
1938-39	644,700	950,300	85,200	119,500
1939-40	2,488,800	2,864,200	410,500	401,000

TABLE 3 (continued)

Season	Recorded runoff at Smartville	Estimated and computed natural runoff at Smartville	Recorded runoff near Wheatland	Estimated and computed natural runoff near Wheatland
1940-41	2,687,400	3,122,600	504,400	480,900
1941-42	2,940,700	3,398,800	515,600	501,500
1942-43	2,716,600	3,126,600	493,600	463,100
1943-44	1,020,100	1,390,200	148,900	188,200
1944-45	1,693,400	2,108,000	314,000	287,000
1945-46	1,982,100	2,397,900	368,300	316,700
1946-47	978,600	1,362,800	150,900	168,400
1947-48	1,554,900	2,018,800	207,900	220,700
1948-49	1,112,400	1,501,000	197,000	214,800
1949-50	1,807,500	2,238,600	255,200	269,400
1950-51	3,095,600	3,576,300	645,300	597,200
1951-52	3,651,900	4,136,300	623,100	605,900
1952-53	2,127,700	2,529,600	257,100	259,300
1953-54	1,538,400	1,958,500	251,000	264,700
1954-55	903,600	1,364,500	123,200	172,900
1955-56	3,421,600	3,875,100	582,800	558,300
Mean for 50-year period	-	2,335,900	-	330,300

Imports and Exports

There are no present imports into the Yuba River Basin. Most of the water exported from the basin is diverted from the headwaters of the Middle and South Yuba Rivers into the Bear River watershed through facilities of the Nevada Irrigation District and the Pacific Gas and Electric Company. An average of about 380,000 acre-feet of water is exported annually in this manner. Of this amount, about 50,000 acre-feet is returned to the Yuba River Basin for power generation and irrigation along the ridge between the South Yuba and Bear Rivers. About 310,000 acre-feet of the remainder is conveyed through the Drum System of the Pacific Gas and Electric Company for power, irrigation, and domestic purposes in the area south of the Bear River. The balance enters the Bear River, from which it is rediverted into the Boardman Canal for power, irrigation, and domestic purposes on the Colfax Divide and in the vicinity of Auburn. In addition to the above, the recently completed South Fork Feather River Project of the Oroville-Wyandotte Irrigation District will utilize an average of about 50,000 acre-feet of water each year diverted from Slate Creek, a tributary to the North Yuba River.

About 20,000 acre-feet of water has been diverted each season from the North Yuba River at Colgate to Browns Valley Irrigation District. With the construction of the

Virginia Ranch Project, the diversion will be reduced to 2,500 acre-feet per season.

Below Smartville, the amount of water diverted each season to serve lands on the valley floor has increased over the years from 130,000 acre-feet in 1949-50 to over 200,000 acre-feet in 1958-59. Recent diversions have averaged about 160,000 acre-feet per season.

Present imports to the Bear River watershed are made primarily near the headwaters, although some irrigation return flow does enter the basin from the ridge between the South Yuba and Bear Rivers. Net imports from the Yuba River average about 335,000 acre-feet per year. An additional average of 8,000 acre-feet per year enters from the American River Basin by way of the Lake Valley Pipeline.

Exports from the Bear River Basin are made through the conveyance facilities of the Pacific Gas and Electric Company and the Nevada Irrigation District, for use in the area south and west of Auburn. These exports include nearly all of the water imported to the basin near the headwaters, plus diversions of the natural flow for irrigation and domestic purposes in the foothill region west of Auburn. Total diversions from the basin average about 340,000 acre-feet per year.

Present Impaired Flow

The net effect of present upstream uses and diversions of water from the Yuba and Bear Rivers Basin has been to deplete the streamflow at the base of the foothills, during recent years, by an average of about 440,000 acre-feet per year. This amount is essentially the depletion of the Yuba River at Smartville; the average depletion of the Bear River above the Wheatland gage is minor.

For the Yuba River, additional depletions, in an average amount of about 50,000 acre-feet per year, now result from the diversion of Slate Creek through the facilities of the Oroville-Wyandotte Irrigation District. The Virginia Ranch Project of Browns Valley Irrigation District, now under construction, will impair the flow of French Dry Creek by an average amount of about 30,000 acre-feet per year. Increases in depletions can be anticipated as projects are constructed to serve irrigable lands within the basin and contiguous upstream areas dependent thereon for a water supply. These future depletions will be counter-balanced to some extent by increased runoff resulting from changed land use and from return flow. The effect on firm yield of downstream projects will be relatively small due to the nominal quantities of water naturally available for diversion during the critical period. It is therefore anticipated that these future uses will not seriously deplete the present streamflow, after accounting for diversions from Slate Creek. Hence, the present impaired flow, adjusted for diversions from Slate Creek and French Dry Creek, was used with confidence in estimating the water supplies available for development by a major project on the lower Yuba River.

Ground Water

Under a cooperative arrangement made with the State in 1948, the U.S. Geological Survey undertook as its first activity a detailed study of the geological features of the ground water basins of the Sacramento Valley, the results of which are published in U.S. Geological Survey Water Supply Paper 1497. The first stage of this study was a determination of the storage capacity of the near-surface water-bearing deposits in the valley, the results of which are included as Appendix D in State Water Resources Board Bulletin No. 1. Additional information applicable to the Valley Floor Service Area of the Yuba and Bear Rivers has been amassed in the course of various investigations by the State, the Geological Survey, and others. State Water Resources Board Bulletin No. 6, "Sutter-Yuba County Investigation," and Bulletin No. 10, "Placer County Investigation," contain information which is particularly applicable to this investigation. Geologic study of this area by the Department of Water Resources is continuing as part of the coordinated statewide planning program. Since this report does not deal in detail with conjunctive operation of surface and ground water storage reservoirs, only generalized data, much of which have been extracted from previous investigations and reports, is presented herein for informational purposes.

Location

Ground water underlies virtually all of the Valley Floor Service Area, the limits of the basin being determined by the extent of the underlying water-bearing materials, which, in the Yuba-Bear Area, terminate on the east at a line approximated by the 200-foot contour. Certain areas within the basin do not, however, produce water of usable quality and must therefore be excluded.

Soils

Most of the soils of the ground water basin are classified as old alluvium, with smaller bodies of younger alluvium occurring in rather narrow bands along the major stream channels. In general, the old alluvial soils are underlain with hardpan at depths ranging from a few inches to several feet. Drainage varies in these hardpan areas from fair to poor, with the topography ranging from hogwallow to undulating or rolling. The old alluvial soils lying at the lower elevations of the service area are characterized by smooth and nearly level topography. Virtually all of the old alluvial soils are of medium texture.

Geology

Geologic units in the valley floor area range in age from pre-Cretaceous metamorphic and igneous rocks of the Sierra Nevada block to Recent alluvium still being deposited. The rocks may be divided into two general categories: (1) the Sierra Nevada basement complex which extends beneath the Sacramento Valley, and (2) the marine and continental sediments which overlie the basement in the Sacramento Valley. The usable water-bearing deposits are contained in the upper part of the sediments of the Sacramento Valley; the deeper marine sediments contain water of poor quality.

The oldest water-bearing materials, Tertiary in age, are volcanic rock, derived from the Sierra Nevada. These materials consist of tuff-breccia of mudflow origin and interbedded volcanic sands and gravels. The tuff-breccia is relatively impermeable and yields little water. However, the volcanic sands and gravels are moderately permeable and are important aquifers near Marysville, Wheatland, and Beale Air Force Base.

Overlying these volcanic materials are old alluvial deposits belonging to the Laguna formation and related continental sediments. These deposits form the dissected uplands along the valley margin and extend westward beneath younger alluvium. The Laguna deposits consist of clay, silt, and cemented sand and gravel up to 350 feet thick. Many wells are located in these deposits, but yields are low to moderate.

Intermediate alluvial deposits of the Victor formation, up to 100 feet thick, overlie the Laguna deposits in the low plains. The Victor formation is the most permeable alluvial deposit in the area. It is generally perm able throughout; in some places, highly permeable lenses of sand and gravel provide large supplies of water to irrigation wells.

Recent alluvium, defined as those materials undergoing deposition, may be divided into two categories: (1) flood-basin deposits, and (2) stream channel deposits. Flood-basin deposits consist of an accumulation of relatively impermeable clays and silts which have been laid down by overflow water of the rivers. Generally, the flood-basin deposits produce little water. Stream channel deposits of the major streams contain well sorted sands and gravels to depths of 125 feet. Wells in these coarse deposits are highly productive.

Ground Water Hydrology

Replenishment to the ground water of the Valley Floor Service Area presently occurs through infiltration of rainfall, subsurface inflow, percolation from surface streams, and infiltration from the unconsumed portion of applied irrigation waters. Water level contours suggest that considerable ground water recharge is contributed by the Yuba River and lesser amounts by the Bear River. Other sources of recharge by stream seepage are from the Feather River and from minor streams of the area. For the most part, free ground water exists throughout present zones of pumping, but locally there appear to be instances of confinement in certain depth zones. Natural movement of ground water is in a general westerly direction throughout most of the area. However, pumping has created certain depressions in the water table toward which ground water flows from all sides.

Specific Yield and Ground Water Storage Capacity. 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 the total volume of saturated soil, and is commonly expressed as a percentage. The ground water storage capacity is then determined as a product of the area, depth, and specific yield. Table 4 summarizes this information for the Valley Floor Service Area, together with other pertinent data. The specific yield is shown to average about six percent for the service area as a whole.

The total ground water storage capacity in the 20-foot to 200-foot depth zone is about 3,650,000 acre-feet, of which about 1,750,000 acre-feet is available in the first 80 feet. However, not all of this storage capacity is usable, due primarily to quality considerations. Recent

TABLE 4

ESTIMATED SPECIFIC YIELD, AND GROUND WATER STORAGE CAPACITY OF VALLEY FLOOR GROUND WATER BASIN

(Compiled from data in USGS Water Supply Paper 1497)

Unit	Area, in acres	Weighted average specific yield, in percent				Weighted average gross storage capacity, in acre-feet			
		Depth of zone from ground surface, in feet				Depth of zone from ground surface, in feet			
		20-50	50-100	100-200	20-200	20-50	50-100	100-200	20-200
North of Yuba River to South Honcut Creek	49,770	9.0	8.3	5.5	6.9	135,000	207,000	274,000	616,000
South of Yuba River to Bear River	89,150	8.1	7.5	6.3	6.9	217,000	334,000	562,000	1,113,000
South of Bear River in Sutter County	85,830	6.4	5.8	5.6	5.8	165,000	249,000	481,000	895,000
South of Bear River in Placer County	108,470	5.2	5.0	5.4	5.3	169,000	271,000	586,000	1,026,000
Total Area	333,220	6.8	6.4	5.7	6.1	686,000	1,061,000	1,903,000	3,650,000

estimates indicate that approximately 96 percent, or about 3,500,000 acre-feet, of the total ground water storage capacity could be used to a depth of 200 feet, with no impairment of quality.

Ground Water Levels

The Department of Water Resources has measured water levels at a series of control wells throughout the Sacramento Valley during the fall of most years from 1929 through 1940, and each year from 1947 to date. These data, together with measurements collected by other agencies, are published through 1958 in Bulletin No. 77-58, the first of an annual series of bulletins designed to present information on ground water conditions in Central and Northern California.

These data are utilized in the preparation of maps showing lines of equal depths to ground water. In order to estimate the magnitude of the average overpumping on the ground water basin, these maps were used to determine the change in depths to ground water over a selected period of time. A map was then drawn showing lines of equal change in elevation of the ground water during the selected period, fall of 1953 to fall of 1960. Average rainfall during this period closely approximates the 50-year mean precipitation, and changes in depths to ground water for this period are therefore believed to be a true reflection of current overpumping of the ground water basin. Plate 3, "Lines of Equal Change in Ground Water Level, 1953-1960," presents these data graphically. By planimetering the area between the lines of equal change, the weighted average change in elevation of water levels was estimated for each unit of the valley floor ground water basin. The results of these estimates are presented in Table 5.

Change in Ground Water Storage

In an area of free ground water, the volume of soil dewatered or resaturated over a period of time, when multiplied by the specific yield, measures the change in ground water storage during that time. Changes in ground water storage were estimated for each unit of the valley floor area by multiplying changes in elevation of ground water by the area of each unit and by the weighted average of specific yield found by the U.S. Geological Survey for the depth interval in which dewatering occurred. The results of these estimates are presented in Table 5.

Yield of Wells

Irrigation in many portions of the Valley Floor Service Area is, at present, dependent entirely on pumping from the ground water basin. Yield of wells therefore becomes an important and, in some small areas, the determining factor in the development of these lands for irrigated

TABLE 5

ESTIMATED WEIGHTED AVERAGE CHANGE IN FALL
GROUND WATER ELEVATION AND GROUND WATER STORAGE
OF VALLEY FLOOR GROUND WATER BASIN

Unit	Area, in acres	Weighted average change in ground water elevation, fall 1953 to fall 1960, in feet	Weighted average specific yield of unwatered zone, in percent	Change in ground water storage, fall 1953 to fall 1960 in acre-feet
North of Yuba River to S. Honcut Creek	49,770	- 6.5	9.0	- 29,000
South of Yuba River to Bear River	89,150	-17.7	8.1	-128,000
South of Bear River in Sutter County	85,830	- 8.3	6.4	- 46,000
South of Bear River in Placer County	108,470	-21.5	5.0	-117,000
TOTAL	333,220			-320,000

agriculture. Fortunately, throughout most of the area, adequate agricultural wells can generally be obtained.

Yield of wells in the Yuba-Bear Area was analyzed by the U.S. Geological Survey and the department, utilizing data obtained from well pumping tests by the Pacific Gas and Electric Company and the department. Results of this analysis are summarized in Table 6, which shows average values of yield and specific capacity in various units of the valley floor area. The term "specific capacity" refers to the number of gallons per minute which can be produced by pumping a well so as to create one foot of drawdown. The term "drawdown" refers to the lowering of the water level in a well caused by pumping. The "yield factor" reflects the production of water per foot of well depth and is determined by multiplying the specific capacity by 100 and dividing by the depth of the well, in feet. The yield factor thus affords an approximate measure of the average permeability of the saturated materials penetrated by the well, although it should be noted that the values computed in this manner presume that depth to static ground water level was the same for all wells tested. Data were not available to enable computation of "yield factor for saturated thickness."

Although wells of adequate capacity can generally be obtained in all portions of the ground water basin, a comparison of the average yield factors in Table 6 reveals

TABLE 6

MEASURED YIELD OF WELLS IN
VALLEY FLOOR GROUND WATER BASIN

Unit	Number of wells tested	Average discharge, in gallons per minute	Average specific capacity, in gallons per foot of drawdown	Average depth of wells, in feet	Average yield factor
North of Yuba River to South Honcut Creek	28	838	60	201	29.8
South of Yuba River to Bear River	109	846	48	292	16.7
South of Bear River in Sutter County	104	960	47	324	14.7
South of Bear River in Placer County	13	752	35	486	7.3

that it is generally necessary to drill wells to greater depths in Placer County than elsewhere in the basin to obtain equivalent yields.

<u>Ground Water Pumping</u>

As previously stated, a detailed study of ground water was beyond the scope of this investigation. Sufficient data were available, however, as a result of continuing programs conducted by the department together with information published by other agencies, to enable a study of the use of ground water in the Yuba-Bear valley floor area, and to evaluate the effect of this use on the underlying storage basin.

A study of probable ground water utilization in the valley floor area, during the period 1954 through 1960, indicated gross ground water pumping for irrigation of about 98,000 acres averaged about 420,000 acre-feet per season. During the same period, as shown in Table 5, there was a depletion of ground water storage of 320,000 acre-feet, or an average depletion of 46,000 acre-feet per season. Based on these estimates, it is concluded that approximately 350,000 acre-feet per season could be pumped from the ground water basin under present (1961) conditions of development without further lowering of ground water levels. Increased use of surface water in the area would contribute additional recharge to the basin and thereby permit an increase in the use of ground water or raise the water table in pumping depressions.

Water Quality

In formulating water development projects, water quality is a significant factor with respect to the beneficial uses for which the water will be developed.

Samples from surface waters within the area of investigation were collected and analyzed during the period of April 1958 through March 1960. To supplement data collected for this investigation, analyses were also obtained from the department's surface water quality monitoring program and evaluated to provide a history of water quality on a number of the basin streams.

Although no ground water samples were collected during this survey, analyses from the ground water monitoring system were utilized to determine quality conditions of subsurface resources. Criteria used in the quality of surface and ground water are listed in Appendix C.

Sources of Pollution

Surface water quality problems in the Yuba and Bear Rivers Basin are minor. Two possible sources of water quality impairment are known to exist in the area of investigation: disposal of industrial wastes, and disposal of domestic or municipal wastes.

Industrial. Industrial wastes in the Yuba-Bear Area include drainage and discharge to surface waters from mining operations and lumbering industries.

Discharge from the few mines presently in operation and the drainage and leaching from abandoned mines do not at present significantly impair water quality. However, an increase in discharges to the streams from expanded mining operations could cause quality impairment unless suitable controls were imposed.

Wastes from 15 lumbering industries presently appear to be the most serious source of possible degradation to streams in the area. Ponds used by lumber mills, for storage and handling of logs, discharge a toxic tannic acid waste. Under present conditions, properly enforced regulations on waste dischargers keep these wastes from becoming a detriment to water quality and it can be anticipated that the Water Pollution Control Board will continue to maintain rigid controls on future lumbering wastes.

Municipal. Discharges from several small rural, urban, and resort communities impose a waste loading to surface waters in the Yuba and Bear drainage basins.

The Grass Valley sewage treatment plant, discharging to Wolf Creek and thence to the Bear River, released average daily flows of 1.74 MGD and 2.20 MGD in 1959-60 and 1960-61, respectively, with a biochemical oxygen demand (BOD) of only 8 ppm. The cities of Auburn and Nevada City presently discharge between 0.50 and 0.70 MGD with an even lower BOD. As of this date, there are no other sewage flows greater than 0.50 MGD.

Due to adequate treatment of domestic sewage wastes, water quality degradation from these sources has been prevented.

Quality Characteristics

The quality of all natural surface waters is dependent upon climatic, hydrologic, and geologic factors. The physical and chemical properties of the Yuba and Bear Rivers are discussed below.

Physical. At present the physical quality in streams of the Yuba and Bear drainage basins is very good. The only variations observed are seasonal. During high flow periods water quality is generally better than during low flow periods.

In Table 7, ranges are presented which show recent conditions near the mouth of the Yuba and Bear Rivers.

All streams within the basin exhibit the same physical characteristics; no cases were observed where the values shown were exceeded. No color, taste, or odor problems have been observed in any surface waters within the basins.

TABLE 7

PHYSICAL QUALITY OF YUBA AND BEAR RIVER WATER
(1951 through 1960)

Constituents	Yuba River		Bear River	
	Maximum	Minimum	Maximum	Minimum
Temperature, °F.	83	38	82	46
Dissolved oxygen, mg/L	14.5	7.4	12.1	7.3
Dissolved oxygen, % sat.	132	84	106	68
Turbidity, mg/L	220	0	3,400	0
pH	8.0	6.6	7.9	7.3

Chemical. The dissolved and suspended minerals in the Yuba and Bear Rivers derive from the natural process of water moving over the surface of the watershed.

Table 8 lists the major chemical constituents observed in the Yuba and Bear Rivers. All cations and anions are now shown. Only those which best characterize the water are tabulated.

Tributary streams in the basins have chemical characteristics similar to those of the Yuba and Bear Rivers.

Ground Water Quality

Very few waste discharges to land within the Yuba-Bear Area are large enough to cause quality degradation by percolation through the soil. In special instances very local problems could arise, for instance, where a specific discharger might obtain his supply from a ground water source near a waste discharge. In such a case a cross-connection could occur through the permeable soil formations between the discharge and supply points.

TABLE 8

CHEMICAL CHARACTER OF YUBA AND BEAR RIVERS

Constituents	Yuba River		Bear River	
	Maximum	Minimum	Maximum	Minimum
Conductance, micromhos	204	44	513	84
Hardness, mg/L	96	18	180	34
Total dissolved solids, mg/L	141	30	334	56
Sodium, percent	19	9	37	12
Calcium, mg/L	19	5	35	8
Magnesium, mg/L	6	1	23	3
Bicarbonate, mg/L	96	23	213	30

Ground waters in the study area range from good to excellent mineral quality except for a few localized areas. Total dissolved solids in most areas are less than 300 ppm. Scattered locations in Yuba County and areas near Sheridan and Lincoln are underlain by more highly mineralized waters which may include connate waters from the Ione formation. These waters have up to 2,000 ppm TDS, high chlorides, boron, sulfates, and sodium, and are unsatisfactory for most uses.

Water Quality Effects on Project Development

Physical. New storage reservoirs always present a potential for taste and odor problems because of the decomposition of organic material as the reservoir is filled. In a number of western states, taste and odor problems occurred in reservoirs near wooded areas principally from the decay of vegetation. Decay of vegetation creates a source of food for aglae. Recent investigations of the by-products generated by the decay of leaves show a startling increase in the production of phenolic tastes and odors from such decay.

Adequate attention to clearing and grubbing of reservoir sites should minimize the problems associated with organic decomposition of vegetation.

Chemical. In general, a reservoir has an averaging effect on mineral quality. Maximums and minimums of concentrations are smoothed out, so that water of more uniform mineral quality results in the reservoir and downstream releases.

There are substantial beneficial effects of a reservoir on a water's chemical quality. Runoff during above-normal flows is generally of better mineral quality and much of this water is stored in the pool for later release. The relative volume of poorer quality water stored during the low-flow period of the year is usually small by comparison.

Since, even under the most adverse conditions, mineral quality of present waters in the Yuba and Bear Rivers is suitable for most beneficial uses, water discharged from reservoirs impounding annual flows should be of slightly better quality than the average of present waters.

Floods and Flood Flows

Maximum flood flows of the Yuba and Bear Rivers and their tributaries generally occur between the months of November and April. The largest floods often occur between November and January as the result of direct runoff from intense precipitation, increased occasionally by runoff from snowmelt. Snowmelt plays a more important role in the makeup of floods occurring after January. The lower portions of the Yuba and Bear River watersheds do not generally accumulate snow cover; consequently, runoff from these drainage areas varies more directly with precipitation.

The earliest recorded flood flows in the Yuba River Basin were measured in the Yuba River at Smartville commencing with the water year 1903-04. The larger floods of recent times have occurred during the winters of 1903-04, 1906-07, 1908-09, 1927-28, 1937-38, 1940-41, 1950-51, 1955-56, and 1957-58.

Major Flood-Producing Storms

The storms which have produced the major recorded floods of the Yuba River are briefly described below.

The March 1907 storm was preceded by extensive new snow cover. Heavy rainfall from the storm and unusually rapid snowmelt resulted in record floods.

The January 1909 storm was continuous throughout the month. Temperatures were above normal and heavy snowmelt contributed to the flood conditions.

The March 1928 flood was produced by unusually heavy rainfall at the higher elevations, accompanied by above-normal temperatures. The storm occurred during the end of a warm, dry season.

The December 1937 storm was one of the greatest of record in Northern California. The extreme floods in the Yuba River were the combined result of a persistent pressure gradient, southwest winds of near gale velocities, and high moisture content of the surrounding air mass. Heavy rainfall occurred in a comparatively short period of time.

The November 1950 flood was the result of a series of storms formed by strong currents of very warm, moist air. Heavy runoff from already saturated watershed areas resulted.

The December 1955 storm, probably the most extreme in recent history, was principally the result of a very large, warm, moisture-laden air mass over Northern California. The excessively heavy rainfall occurred over a 5-day period.

Magnitude of Floods

The December 1955 flood peaks on the majority of the streams in the Yuba River system generally exceeded any previously recorded flows. However, maximum peak discharges at a few stream gaging stations did not occur during this flood. Peak flows were recorded or were estimated to have occurred during the March 1928 flood on Downie River at Downieville and Canyon Creek below Bowman Lake. The maximum peak flood flow on the South Yuba River near Cisco was measured during the November 1950 flood.

Table 9 shows the estimated instantaneous peak flow and the 1-, 3-, and 5-day volumes of selected floods at various dam and diversion sites in the Yuba River Basin. It should be noted that a number of the peak flows at the Parks Bar damsite exceeded those at the Marysville damsite downstream. The apparent explanation is that the peak flow is reduced by the change in channel width and stream gradient and by the difference in time of concentration at the two stations.

TABLE 9

ESTIMATED FLOOD FLOWS
AT
SELECTED DAM SITES

Dam site	Stream	Drainage area in /: square miles	Instantaneous peak, in second-feet: 20-year	Instantaneous peak, in second-feet: December 1955	Instantaneous peak, in second-feet: 100-year	1-day volume, in acre-feet: 20-year	1-day volume, in acre-feet: December 1955	1-day volume, in acre-feet: 100-year	3-day volume, in acre-feet: 20-year	3-day volume, in acre-feet: December 1955	3-day volume, in acre-feet: 100-year	5-day volume, in acre-feet: 20-year	5-day volume, in acre-feet: December 1955	5-day volume, in acre-feet: 100-year
Indian Valley	North Yuba River	271	34,200	28,200	53,300	46,000	44,100	72,300	103,000	102,000	166,000	117,000	128,000	184,000
New Bullards Bar	North Yuba River	486	61,000	70,000	87,000	79,000	113,000	115,000	179,000	254,000	269,000	218,000	318,000	346,000
Hour House Diversion	Middle Yuba River	14[illegible]	19,700	25,300	30.800	27,400	36,700	43,100	62,500	85,200	100,000	71,800	101,000	113,000
Log Cabin Diversion	Oregon Creek	50	4,640	4,990	6,550	6,210	6,330	9,030	14,400	15,500	21,800	17,900	19,100	28,300
Freemans Crossing	Middle Yuba River	197	25,[illegible]	32,200	39,700	35,800	45,800	55,600	81,700	107,000	130,000	95,400	128,000	148,000
Parks Bar	Yuba River	1209	151,000	167,000	236,000	211,000	268,000	331,000	463,000	599,000	741,000	547,000	727,000	862,000
Dry Creek Auxiliary	French Dry Creek	52	11,4[illegible]	10,400	14,300	11,500	11,600	13,[illegible]	22,900	23,700	27,900	33,300	39,600	43,200
Marysville	Yuba River	1325	141,000	210,000	219,000	205,000	269,000	322,000	463,000	596,000	741,000	494,000	734,000	777,000

CHAPTER III. LAND AND WATER USE

The present pattern of land use in the Yuba-Bear Area is predominantly agricultural, with urban and urban-related development occupying little more than one percent of the total area. Gross acreage devoted to irrigated agriculture occupies about 10 percent of the total area, and dry-farmed lands another 4 percent. The balance is dominantly forest land and undeveloped valley and foothill land.

Agricultural development in the Yuba-Bear Area is said to have begun about 1845, and shortly thereafter received stimulus from the influx of settlers associated with the gold rush era. Development was largely restricted to the growing of dry-farmed grain crops and livestock raising. By 1865, a large portion of the valley floor was given over to the production of wheat. Irrigation developed slowly, but it is probable that the first lands on the east side of the Sacramento Valley to receive irrigation water were near the confluence of Honcut Creek and Feather River. Diminishing profits from dry land grain farming, together with the development of more satisfactory pumps, gave impetus to the increase in irrigated acreage after 1910. Irrigation in the foothill regions became practical on a limited scale through utilization of ditches originally constructed for hydraulic mining. The transition from dry-farming to irrigated cropping

Dry range and irrigated pasture -
Grass Valley Service Area

"...only about 40 percent of foothill lands classified as irrigable are expected to be under irrigation by 2020."

has continued to this time, and now amounts to a gross area of 167,000 acres.

In the valley floor area, rice, pasture, and deciduous fruits and nuts account for the major portion of the present irrigated acreage, with field, truck, and alfalfa crops accounting for a smaller but important portion of the remainder. In addition to irrigated acreage, there are about 52,000 acres of dry-farmed hay, grain, fallow, and idle land.

Agriculture in the foothill regions is primarily a cattle grazing operation, with deciduous orchard second in importance. The majority of the orchard land is located in the vicinity of Chicago Park and Auburn.

It is expected that land use for irrigated agriculture will continue to increase during the next 50 years, with a marked increase in the number of small noncommercial holdings, referred to herein as residential farms. In the valley floor area, it is anticipated that irrigable lands will be fully utilized by the end of this century, and that urban encroachment on these lands will reduce the irrigated acreage after that time.

Irrigation development in the foothill regions is expected to occur more slowly, governed in some areas by the lack of existing irrigation development and/or the cost of developing new water supplies. Overall, only about 40 percent of foothill lands classified as irrigable are expected to be under irrigation by 2020.

The nature and extend of present and probable future land use in the Yuba-Bear Area, and the water requirements associated with these lands are discussed in this chapter. In connection with this discussion, the following terms are used as defined.

<u>Water Use</u> - This term is used in a broad sense to include any employments of water by nature or man, either consumptive or nonconsumptive, as well as irrecoverable losses of water incidental to such employment.

<u>Consumptive Use of Water</u> - The water consumed by vegetative growth in transpiration and building of plant tissues, and water evaporated from adjacent soil, from water surfaces, and from foliage. Also, water similarly consumed and evaporated by urban and nonvegetative types of land use.

<u>Applied Water</u> - The water delivered to a farmer's headgate in the case of irrigation use, or to a domestic connection, in the case of urban use, or its equivalent. It does not include direct precipitation.

<u>Irrigation Efficiency</u> - The ratio of the amount of the consumptive use of applied irrigation water to the total amount of such applied water, commonly expressed as a percentage.

Water Requirement - The amount of water, exclusive of precipitation, needed to provide for all beneficial uses and for losses incidental to such uses.

Present - This term is used generally in reference to land use conditions prevailing during 1954 through 1961.

Residential Farm - A relatively large homesite, located in a rural environment, of which a portion is devoted to irrigated agriculture.

Water Service Areas

To facilitiate the study of local water resource development, the area of investigation was divided into seven water service areas. Boundaries of these areas were determined primarily by topographic features, and with consideration of present and future sources of water supply, and are delineated on Plate 4, "Water Service Areas."

The Valley Floor Service Area includes all lands below the 200-foot contour except for the portion of Nevada Irrigation District in Placer County extending below this elevation. Brownsville Service Area, situated between the Yuba River and South Honcut Creek, is bounded on the northeast by the divide between French Dry Creek and the North

Yuba River, which is also the approximate limit of lands suited to irrigated agriculture in contrast to lands best suited to continued forest use. San Juan Ridge Service Area occupies the ridge between the Middle and South Yuba Rivers and terminates on the east at an arbitrary line drawn to include all lands suited to irrigated agriculture. Grass Valley Service Area is situated between the South Yuba River and Bear River and is bounded on the west by the 200-foot elevation contour and on the east by the Nevada Irrigation District boundary. The Auburn Foothills Service Area comprises the foothill area between the Bear River and the Sacramento county line, terminating on the east at an arbitrary line defined in part by the Bear River Canal, and by ridges separating the Bear River, Coon Creek, and American River watersheds. The Colfax Ridge Service Area includes most of the ridge separating the Bear and American Rivers, except at the higher elevations where it is confined to the Bear River side of the ridge. The remaining portion of the Yuba-Bear Area is designated as the Mountain Service Area. A breakdown of the water service areas by counties is presented in Table 10.

Existing Water Supply Agencies

The agricultural regions of the Yuba-Bear Area are extensively organized into various types of legal entities, which exist for the purpose of supplying water for

TABLE 10

WATER SERVICE AREAS BY COUNTIES

(Areas in acres)

County	Water Service Areas							Total
	Valley Floor	Browns-ville	San Juan Ridge	Grass Valley	Auburn Foothills	Colfax Ridge	Mountain	
Butte	-	899	-	-	-	-	287	1,186
Nevada	-	-	37,632	211,309	-	-	263,373	512,314
Placer	106,744	-	-	-	174,649	60,984	11,462	353,779
Plumas	-	-	-	-	-	-	11,794	11,794
Sierra	-	-	-	-	-	-	309,400	309,400
Sutter	85,242	-	-	-	-	-	-	85,242
Yuba	167,598	128,058	-	41,857	-	-	73,892	411,405
TOTAL	359,614	128,957	37,632	253,166	174,649	60,894	670,208	1,685,120

irrigation and domestic uses to members within their respective service areas. These entities range from water agencies with countywide responsibilities for water supply development, to water and irrigation districts and companies which serve defined areas. At the present time (1963), there are 15 active agencies represented in the area of investigation, not including 2 county water agencies, and 5 reclamation districts located along the Feather River. Two agencies, the Natomas Central Mutual Water Company and the San Juan Suburban Water District, also serve areas in Sacramento County. The locations of the various agencies are shown on Plate 5, "Location of Existing Water Service Agencies."

Although it was beyond the scope of this investigation to consider in detail the service areas of existing water agencies in the Yuba-Bear Area on an individual basis, information relating to these agencies was utilized in making projections of future land use and in estimating supplemental water requirements in the larger water service areas. A brief account of the various agencies which exist in the area of investigation follows.

Browns Valley Irrigation District is located in Yuba County northeast of Marysville, and was organized in 1881. The major towns in the district are Browns Valley and Loma Rica. The district contains 42,000 acres, of which 13,444 acres are classified as irrigable land. In 1960, 3,450 acres were reported irrigated. The North Yuba River has been the principal source of water supply. The district is now constructing Virginia Ranch Dam on French Dry Creek, which will enable 7,200 acres of additional lands to be brought under irrigation in the near future. The current assessments of water tolls in the district amount to $18 per miners-inch.

Cordua Irrigation District is located in Yuba County northeast of Marysville, and was organized in 1919. There are no towns in the district. Of a total of 7,638 acres in the district, 5,111 acres were reported irrigated in 1960. In addition, water was supplied for the irrigation of 1,071 acres outside the district. Water supply is obtained by direct diversion from the Yuba River. The current annual rate for water is $1.25 an acre for irrigated pasture and $3.00 an acre for rice. There is also an assessment of $3.07 per $100 of assessed valuation, which has the effect of making the overall annual cost of water on irrigated pasture approximately $2.00 an acre and $3.75 an acre for rice.

Hallwood Irrigation Company was organized in 1910 as a private nonprofit organization. It is located north of and adjacent to Marysville in Yuba County. There are no towns in the service area. The main crops grown on the irrigated lands are pasture and rice. Of a total of 11,000 acres in the company's service area, approximately 7,200 acres were irrigated in 1956. An annual fee of $3 an acre is charged for water regardless of the particular crop and its water requirement.

Camp Far West Irrigation District was organized in 1924 for the purpose of improving water conditions in an area of some 4,100 acres. The district is located in Yuba and Placer Counties east of the town of Wheatland, and has about 2,600 acres classified as irrigable. Alfalfa, field crops and deciduous orchard are the principal crops grown. Prior to construction of enlarged Camp Far West Reservoir on the Bear River by South Sutter Water District, water supplies were developed in the district's Camp Far West Reservoir, which had a capacity of about 5,000 acre-feet. The district will now receive a firm supply of 12,000 acre-feet per year from the new reservoir.

South Sutter Water District, which was formed in 1959, is situated in Sutter and Placer Counties due east of Nicolaus. The major towns are East Nicolaus and Pleasant Grove. It contains approximately 55,000 acres, of which 51,350 acres are considered irrigable. The acreage irrigated in 1956 amounted to 20,955 acres, utilizing water obtained for the most part from the ground water basin. Enlarged Camp Far West Reservoir will supplement the district's existing ground water supply. The principal crops presently grown within the district are rice, irrigated pasture, and legume seeds, whereas 20 years ago the lands were devoted to dry-farmed grain and pasture.

Plumas Mutual Water Company, which was organized about 1918, is located in southwest Yuba County, south of

Marysville. Prior to the flood in 1955, the company was charging $3.50 an acre for water, but extensive flood damage necessitated an increase to recover the cost of repairs. Charges have since varied to cover operating expenses. The company presently irrigates some 1,210 acres with water pumped from the Feather River.

Sheridan County Water District is located in Placer County northwest of Lincoln. The district at one time considered developing a water supply from the Yuba River but the plan was abandoned and the district is now inactive.

The Natomas Central Mutual Water Company serves water to an area of 23,145 acres in Sutter and Placer Counties situated to the north of North Sacramento. The company was incorporated in July 1921. The Sacramento River is the primary source of water supply with the remaining supplies coming from irrigation wells and drains.

Yuba County Water District is located immediately north of Browns Valley Irrigation District in Yuba County and was organized in July 1952. The major towns in the district are Challenge, Dobbins, Rackerby, Brownsville, and Strawberry Valley. The district encompasses a gross area of about 120,000 acres of which about 22,600 acres are classified as suitable for irrigated agriculture. Lands presently irrigated amount to less than 600 acres, most of which are in the Lake Mildred-Los Verjeles Ditch service area.

Wheatland Water District, located in southern Yuba County, was organized in 1949 for the purpose of supplying water to about 12,780 acres of irrigable land within the district. There are no towns within its boundaries. Due to both technical and financial limitations the district is not operating as a water supplying agency. The Yuba River has been considered as the diversion source. However, some 7,000 acres are being irrigated by privately owned and operated pumping installations. The area is faced with a serious overdraft situation. About 1,100 acres within the Wheatland Water District situated northwest of the town of Wheatland was reorganized in 1958 into the Johnson Rancho County Water District.

San Juan Ridge County Water District was formed in December 1958 for the purpose of developing a surface water supply primarily for irrigation. It is located in northern Nevada County adjacent to the town of North San Juan. The area consists of 7,500 acres located on a ridge between the Middle and South Yuba Rivers. A gross area of some 5,000 acres has been classified as irrigable. The present water supply consists of diversions from small creeks and springs, and is used primarily for the irrigation of 300 acres of pasture.

French Corral County Water District was formed in December 1959, and includes 900 acres of land in northwest

Nevada County north of the town of French Corral. About 800 acres are considered to be irrigable land. The land was previously included in the San Juan Ridge Water Users Association until the association dissolved about 1926. Since that time the area has been served through a lease agreement with the San Juan Ridge Canal System. Water deliveries are presently made to the district through a reclaimed mining ditch from a diversion on Shady Creek. Consideration has been given to the construction of a dam on Shady Creek to provide about 100 acre-feet of water. Existing Pine Grove Reservoir provides about 150 acre-feet of water.

The agricultural development in the area is mostly dry land pasture. The main use of the presently diverted water is for household purposes. The water users are presently charged $0.20 per acre-inch to cover the maintenance of the system.

Nevada Irrigation District was organized in August 1921 with the primary purpose of supplying water for irrigation and domestic uses. The district is located in southern Nevada County and northern Placer County east of Marysville. The main towns in the area are Grass Valley and Nevada City. Diversions are made from the Yuba and Bear Rivers and Deer Creek.

The initial area of the district contained about 202,000 acres. In the years following, however, that portion of Placer County adjacent to Nevada County desired to join the district and in December 1926 the electorate voted approval for the annexation of about 66,000 additional acres for a present total of 268,000 acres. Of this area, 100,000 acres are classified as irrigable. In 1960, some 74,253 acre-feet of water were diverted for irrigation on 18,880 acres. Water was also sold outside the district for irrigation on an additional 1,957 acres. Irrigated pasture and deciduous orchard are the main irrigated crops. A fee of $0.33 per miner's inch per day is charged for water.

The San Juan Suburban Water District provides water service for irrigation and urban use to an area in Placer County east of Roseville, and to adjoining areas in Sacramento County to the south. The American River is the source of water supply, with delivery made to the district at Folsom Dam.

The Pacific Gas and Electric Company provides treated and untreated water to the Colfax Ridge area and to a large area of the foothills northeast of Roseville. The rates for untreated irrigation water vary according to the season and quantity provided. The seasonal irrigation rate between May 1 and September 30 is $55 per miner's inch. Between October 1 and April 30, the rates are $8 for the first miner's inch and $0.33 per miner's inch per day for additional quantities. A metered rate is also quoted but the amount of water sold in this manner constitutes a minor portion of the sales. Treated urban water is priced on a decreasing sliding scale which amounts to about $7 per household per month.

In addition to the above, two agencies exist in the area of investigation whose responsibilities are county-wide in scope; namely, Placer County Water Agency and Yuba County Water Agency. These agencies were created by the California State Legislature through adoption of the Placer County Water Agency Act[1/] in 1957, and the Yuba County Water Agency Act[2/] in 1959. Under these acts, an agency, in addition to the usual powers and functions of such an entity, is empowered to make water available for any present or future beneficial use of the lands or inhabitants of the agency and develop incidental hydroelectric power for market at wholesale rates as a means of assistance in financing the construction, operation, and maintenance of its projects for the control, conservation, diversion, and transmission of water.

At the present time, Placer County Water Agency is proceeding with construction of the Middle Fork American River Project, which will supply water to the foothill and valley floor regions of western Placer County.

The Yuba County Water Agency is proceeding with plans to construct the New Bullards Bar Project on the Yuba River, which will provide new water supplies for the valley floor region in that county.

1/ Calif. Stats. 1957, Ch. 1234, p. 2519.
2/ Calif. Stats. 1959, Ch. 788, p. 2780.

Land Use

As the first step in evaluating water requirements in the Yuba-Bear Area, land use and land classification surveys were conducted in the foothill and mountainous regions during the summer of 1957. For the valley floor area, older data collected in 1954 as part of Bulletin No. 58, "Northeastern Counties Investigation," were adjusted to fit the new service area boundaries in Yuba and Sutter Counties. The Placer County portion was surveyed in 1961. Based on the land use and classification data, forecasts were made of the probable nature and extent of future land use.

Present Pattern of Land Use

Land use data collected between 1954 and 1957 are considered herein to represent present conditions of development, and were used to determine the type, location, and areal extent of irrigated and dry-farmed lands, recreational developments, and urban areas. A summary of the results of these surveys is presented in Table 11.

Irrigated Lands. Irrigated lands include all agricultural lands to which water is applied, excluding natural precipitation or water from other natural sources not induced by irrigation. The acreages reported are gross determinations without any reductions for roads, farmsteads, irrigation features, or other types of nonirrigated inclusions within the land parcels that were too small to delineate within the

TABLE 11

PRESENT PATTERN OF LAND USE
BY WATER SERVICE AREAS AND COUNTIES

(in acres)

Land Use Type	Valley Floor: North of Yuba River: Yuba	Valley Floor: Yuba River to Bear River: Yuba	Valley Floor: Yuba River to Bear River: Yuba (Beale AFB)	Valley Floor: Yuba River to Bear River: Sutter	Valley Floor: Yuba River to Bear River: Placer	Valley Floor: Yuba River to Bear River: Subtotal	Valley Floor: South of Bear River: Placer	Valley Floor: South of Bear River: Sutter	Valley Floor: South of Bear River: Subtotal	Valley Floor: Total	Brownsville: Butte	Brownsville: Yuba	Brownsville: Total
Irrigated Lands													
Alfalfa	1,653	2,794		6		2,800	623	3,421	4,044	8,497			
Pasture	8,026	12,985	35		29	13,049	5,522	8,204	13,726	34,801		3,000	3,000
Hay and Grain	195									195			
Misc. Field	1,265	2,302		168	349	2,819	623	2,542	3,165	7,249			
Misc. Truck	2,667	1,777		45		1,822		1,202	1,202	5,691			
Deciduous Orchard	5,102	4,608		432	60	5,100	912	4,097	5,009	15,211			
Subtropical Orchard	65	189				189	41	25	66	320		467	467
Vineyard							97		97	97			
Rice	10,142	9,432	44	—	—	9,476	4,060	23,789	27,849	47,467	—	—	—
Total Irrigated	29,115	34,087	79	651	438	35,255	11,878	43,280	55,158	119,528		3,467	3,467
Dry Farmed Lands		14	535	32	126	707	51,884		51,884	52,591		131	131
Natural Meadow												467	467
Recreational and Parks							168		168	168		29	29
Urban	1,069	2,939				2,939	3,497	112	3,609	7,617		260	260
Native Vegetation	29,848	52,731	17,181	35	911	70,858	37,872	41,132	79,004	179,710	899	123,704	124,603
TOTAL	60,032	89,771	17,795	718	1,475	109,759	105,299	84,524	189,823	359,614	899	128,058	128,957

TABLE 11 (continued)

PRESENT PATTERN OF LAND USE
BY WATER SERVICE AREAS AND COUNTIES

(in acres)

	San Juan Ridge	Grass Valley				Auburn Foothills	Colfax Ridge	Mountain							
Land Use Type	Nevada	Yuba	Yuba Beale AFB	Nevada	Total	Placer	Placer	Yuba	Plumas	Sierra	Nevada	Placer	Butte	Total	Grand Total
Irrigated Lands															
Alfalfa						228									8,725
Pasture	404	286		9,332	9,618	14,132	174	229		118	30			377	62,506
Hay and Grain	2					48		5						5	250
Misc. Field				6	6	138									7,393
Misc. Truck				36	36	130				1				1	5,858
Deciduous Orchard	8			942	942	16,861	454	17		27				44	33,520
Subtropical Orchard		97		4	101	276									1,164
Vineyard				18	18	17									132
Rice															47,467
Total Irrigated	414	383		10,338	10,721	31,830	628	251		146	30			427	167,015
Dry Farmed Land	136	62		549	611	5,057	332	39		33	13			85	58,943
Natural Meadow	73			274	274	63	149	27	4	1,962	2,082	169		4,244	5,270
Recreational and Parks				77	77	187	51	69	6	600	600	229		1,504	2,016
Urban	127	40		2,916	2,956	4,356	530	124	63	269	170			626	16,472
Native Vegetation	36,882	25,486	15,886	197,155	238,527	133,156	59,204	73,382	11,721	306,390	260,478	11,064	287	663,322	1,435,404
TOTAL	37,632	25,971	15,886	211,309	253,166	174,649	60,894	73,892	11,794	309,400	293,373	11,462	287	670,208	1,685,120

mapping scale. Previous studies have indicated that in intensively irrigated regions, nonirrigated inclusions within various land parcels are closely related to the type of crop grown. It would be necessary to reduce rice acreages, where the plantings are normally large, by about 4.5 percent and deciduous orchard, where plantings are normally smaller, by about 7.5 percent in order to determine a net cropped acreage.

Within the irrigated category, by reference to Table 11, it can be observed that pasture and rice compose the largest crop acreages. In years previous to the 1957 field survey, more acres of pasture than the 62,000 reported were irrigated within the area of investigation. The cutback in acreage is attributable in large part to a lowering of the price received for beef cattle. Rice acreages as shown are probably high for Sutter and Yuba Counties since the survey data were collected during the summer of 1954, and rice quotas were initiated in the years that followed.

Pears, plums, and peaches comprise the majority of the deciduous orchard acreages and represent about 14 percent of the irrigated crop pattern. The miscellaneous deciduous category was used to identify those orchards that had either interplantings or mixtures of different trees too complex to delineate separately, or were of minor importance from an acreage standpoint. The latter category was composed of such tree crops as walnuts, nectarines, cherries, and almonds.

Dry-Farmed Lands. At the times of the various land use surveys, there were approximately 64,200 acres of land that were supporting dry-farmed crops, were fallow or idle, or were being used in direct association with agriculture. The largest use was for about 29,500 acres of dry-farmed barley and wheat, grown for the most part on the rolling hardpan lands north of Roseville.

Approximately 5,300 acres of natural meadow was found in the Yuba-Bear Area, most of which are receiving a natural water supply from springs, small streams, or from seeps originating along various canals or irrigation ditches. The grazing value of these meadows is generally a function of the climatic variations occurring from year to year. Most of the natural meadows were found in the higher more mountainous sections of the area of investigation.

Other Land Uses. This category includes urban and urban-related land uses, recreational lands, and native vegetation. The urban acreages reported include land areas occupied by cities, towns, or other significant urban-associated land types included in the standard land use legend. These include urban residential, commercial, industrial, or military types. Approximately 16,500 acres of urban land use acreages were mapped within the area of investigation. Scattered residential areas must have been at least one home per two acres in density and be at least five homes in a group in order to be considered developed urban. This density would be equivalent to about two persons per acre.

Recreational classes were composed of recreational residential, recreational commercial, campgrounds, and various park types. The majority of the recreational classes, totaling about 2,000 acres, were found to occur in the Mountain Service Area. All other land uses not described above were designated as being native vegetation. The majority of the acreage mapped as native vegetation was rough, steep, and broken mountainous land, although irrigable lands not presently irrigated were also included in the native vegetation category.

Potential Pattern of Land Use

The development of any given land area to a certain pattern of use is governed by several factors. Factors such as soil type, topography, climate, and geographic location, do not change or change only slightly over a period of time. Others, such as an increase or a shift in population, economic conditions, and governmental controls can and do change significantly over a period of time and are the governing factors affecting projection of land use into the future. For the purpose of projections made under this investigation, the following general assumptions were used:

1. The price-cost relationship for agricultural commodities will resemble those prevailing for the period of 1952-56.

2. A relatively high level of employment and consumption will prevail during the period of the economic analysis.

3. Population will continue to grow, increasing to an estimated 420 million in the United States and 56 million in California by the year 2020.

4. Irrigation water in sufficient quantity and of adequate quality will be available by 1970 at a cost that does not prohibit irrigation development as projected herein.

5. Land, as a scarce resource, will increase in importance and the various service areas considered herein will at least sustain the present comparative advantages with respect to crops grown in competing areas.

6. The future economic development in the various service areas will attain, as a minimum, the level of the projected growth.

7. There will be no disruption of world trade by the outbreak of major hostilities or by the imposition of trade barriers not presently in existence.

8. Production controls presently imposed by the government on the selected representative crops projected in this study will eventually be withdrawn or modified to the extent that they will not restrict future development to a greater degree than anticipated in making the projections.

9. The prevailing supply of ground water, present surface diversions, and project-developed water will contribute their designated yields to the total available water in the respective areas.

10. The efficiency in the use of irrigation water will increase through improved irrigation practices.

11. Urban land use will follow the current pattern with the cities spreading onto lands deemed suitable for subdivision and industrial purposes with consideration given to existing transportation routes and accessibility of land.

12. Water under nonproject conditions will be diverted from the least intensive use to more intensive uses to meet demands imposed by increasing population.

13. Virginia Ranch and enlarged Camp Far West Projects are considered herein as existing developments for analysis purposes.

Present and Projected Population. Projections of population to the year 2020 for the Yuba-Bear Area were made through utilization of available studies of historical and projected populations for regions and counties of the State. Estimates of future population within the various service areas by decades to year 2020 were determined after careful analysis of present growth trends adjusted to reflect economic factors, topography, climate, geographical location, and other factors pertinent to the Yuba-Bear Area. The present population distribution was based upon a study of the results of the 1960 census of population. Table 12 presents total historical and projected population including urban, residential farm, and rural, for the various water service areas to year 2020.

Land Use Groups. The location and extent of irrigable lands in the Yuba-Bear Area were determined by field surveys which grouped all lands into appropriate

TABLE 12

HISTORICAL AND PROJECTED POPULATION

Subdivision	Year 1940	1950	1960	1970	1980	1990	2000	2010	2020
Valley Floor Service Area									
North of Yuba River	7,570	9,258	11,425	15,000	19,500	25,600	33,000	43,000	55,000
Yuba River to Bear River	6,928	12,138	19,405	25,400	32,900	42,500	55,500	72,500	95,000
South of Bear River	10,087	13,253	18,900	26,650	40,800	62,900	92,100	129,800	185,000
Valley Floor Total	24,585	34,649	49,730	67,050	93,200	131,000	180,600	245,300	335,500
Foothill Service Areas									
Brownsville	1,767	2,189	2,219	2,300	2,700	3,400	5,000	7,500	10,000
San Juan Ridge	830	582	397	375	550	900	1,550	2,775	5,000
Grass Valley	17,342	17,789	18,436	19,600	22,600	28,100	35,350	45,000	57,250
Auburn Foothills	15,499	24,068	31,679	44,600	64,000	90,300	118,500	144,800	178,000
Colfax Ridge	2,583	3,681	4,009	4,700	5,850	7,150	8,400	9,600	10,900
Foothill Total	38,021	48,309	56,740	71,575	95,700	129,850	168,800	209,675	252,150
Mountain Service Area	2,721	2,141	1,848	1,875	2,300	3,150	4,300	5,575	7,350
GRAND TOTAL	65,327	85,099	108,318	140,500	191,200	264,000	353,700	460,550	595,000
Cities									
Marysville	6,646	7,826	9,553						
Nevada City-Grass Valley	8,146	7,788	7,229						
Auburn	4,013	4,653	5,586						
Roseville	6,653	8,723	13,421						

classifications according to their suitability for future development to irrigated agriculture or continued forest use. Urban and recreational lands were classified only to the extent of present use. Each land use group is discussed under the following designations:

(1) Irrigable agricultural lands
(2) Irrigable forest lands
(3) Urban lands
(4) Recreational lands
(5) All other lands.

(1) Irrigable Agricultural Lands. Irrigable agricultural lands were mapped in accordance with established departmental criteria. Since it is the physical characteristics of the land and the inherent conditions of the soil itself that directly affect the suitability of land for irrigation development, these were the basic factors considered in undertaking the field land classification survey. The character of the soil was established by examination of road cuts and material from numerous test holes, together with observation of the type and quality of native vegetation and crops being grown. Representative slopes throughout the area were measured with a clinometer, and other conditions were observed. By giving consideration to all these factors, the appropriate classification for each parcel of land was determined.

Topographic characteristics of irrigable agricultural lands are identified in the tables of this bulletin by the following symbols:

V - These lands are level or slightly sloping and vary from smooth to hummocky or gently undulating relief. The maximum allowable slope is 6 percent for smooth, reasonably large-sized bodies lying in the same plane. As the relief increases and becomes more complex, lesser slopes are limiting. These lands are suitable for all climatically adapted crops.

H - These are lands with greater slope and/or relief than those of the V class. They vary from smooth to moderately rolling or undulating relief. The maximum allowable slope is 20 percent for smooth, reasonably large-sized bodies lying in the same plane. As the relief increases and becomes more complex, lesser slopes are limiting.

M - These are lands with greater slope and/or relief than those of the H class. They vary from smooth to steeply rolling or undulating relief. The maximum allowable slope is 30 percent for smooth, reasonably large-sized bodies lying in the same plane. As the relief increases and becomes more complex, lesser slopes are limiting.

Lands classified under the above symbols have soil with medium to deep effective root zones, are permeable throughout, and are free of salinity, alkalinity, rock, or other conditions which would limit crop adaptability. Limitations on the suitability of V, H, and M lands for the growing of all climatically adapted crops are identified by use of the following subsymbols:

w - Indicates the presence of a high water table, which in effect limits the present crop adaptability of these lands to pasture crops. Drainage and a change in irrigation practices would be required to affect the crop adaptability.

h - Indicates very heavy textures, which made these lands best suited for production of shallow-rooted crops.

l - Indicates fairly coarse textures and low moisture holding capacities, which in general make these lands unsuited for the production of shallow-rooted crops because of the frequency of irrigations required to supply the water needs of such crops.

p - Indicates shallow depth of the effective root zone, which limits use of these lands to shallow-rooted crops.

r - Indicates the presence of rock on the surface or within the plow zone in sufficient quantity to prevent use of the land for cultivated crops.

(2) Irrigable Forest Lands. These are presently forested lands subject to forest management, which meet the requirements for irrigable land but which, because of climatic conditions and physiographic position, are better suited for timber production or some type of forest management program rather than for irrigated agriculture.

(3) Urban Lands. Lands classified in the urban category were delineated only to the extent of their present growth. Predictions as to future urban encroachment in a given area was determined on an acre per capita basis. Agricultural land classification was utilized to indicate the probable future location, type, and density of urban areas as indicated by the slope, soil, and cover characteristics of a given area. The physical environment within any given area was evaluated to indicate probable trends as to the nature of urban growth, whether to dense urban complexes or moving toward a lower density suburban residential type of development.

(4) Recreational Lands. Within the broader designation of recreational lands, major recreational categories were delineated dependent on their water use under the categories recreational residential, recreational commercial, campgrounds, and parks. Predictions as to the probable location and extent of future growth of recreational lands were not made. Lands suitable for recreational use adjacent to proposed reservoirs are generally not in conflict with other potential land uses. In cases where recreational development might occur on irrigable lands, the water requirement would generally be less due to the lower unit requirement for recreation.

(5) All Other Lands. This category includes all lands which fail to meet the requirements of any of the above classes.

Classification of lands of the Yuba-Bear Area into the five categories described above, and the distribution of these lands within the counties and water service areas, are presented in Table 13.

Based on the foregoing, projections of future land use patterns for irrigated agriculture, residential farms, and urban areas, were made for each water service area by decades from year 1970 to year 2020. For each of the water services areas, projections were first made of the anticipated development to irrigated agriculture. These projections were

TABLE 13

CLASSIFICATION OF LANDS
BY WATER SERVICE AREAS AND COUNTIES

(in acres)

Land Class	Valley Floor										Brownsville		
	North of Yuba River	Yuba River to Bear River					South of Bear River						
	Yuba	Yuba	Yuba (Beale AFB)	Sutter	Placer	Subtotal	Placer	Sutter	Subtotal	Total	Butte	Yuba	Total
Agricultural													
V	16,556	25,662	1,628	617	434	28,341	5,615	26,928	32,543	77,440		787	787
Vw	31	50				50				81		522	522
Vr												22	22
Vl	590	1,267		65	479	1,811	218	383	601	3,002			
Vp	28,085	45,683	8,748			54,431	68,389	48,220	116,609	199,125		72	72
Vh							6	6,202	6,208	6,208			
H	31	51				51	493		493	575		3,638	3,638
Hp	7,363	4,386	6,515			10,901	22,247	49	22,296	40,560		8,814	8,814
Hr												3,222	3,222
Hpr	539									539		3,134	3,134
M												3,382	3,382
Mp	223	86	11			97	531		531	851		11,824	11,824
Mr												2,458	2,458
Mpr	147	33				33	2		2	182		3,890	3,890
Subtotal	53,565	77,218	16,902	682	913	95,715	97,501	81,782	179,283	328,563		41,765	41,765
Urban	1,069	2,939				2,939	3,497	112	3,609	7,617		260	260
Recreational							168		168	168		530	530
Forest lands											755	7,827	8,582
Nonirrigable lands	5,398	9,614	893	36	562	11,105	4,133	2,630	6,763	23,266	144	77,676	77,820
TOTAL	60,032	89,771	17,795	718	1,475	109,759	105,299	84,524	189,823	359,614	899	128,058	128,957

TABLE 13 (continued)

CLASSIFICATION OF LANDS
BY WATER SERVICE AREAS AND COUNTIES

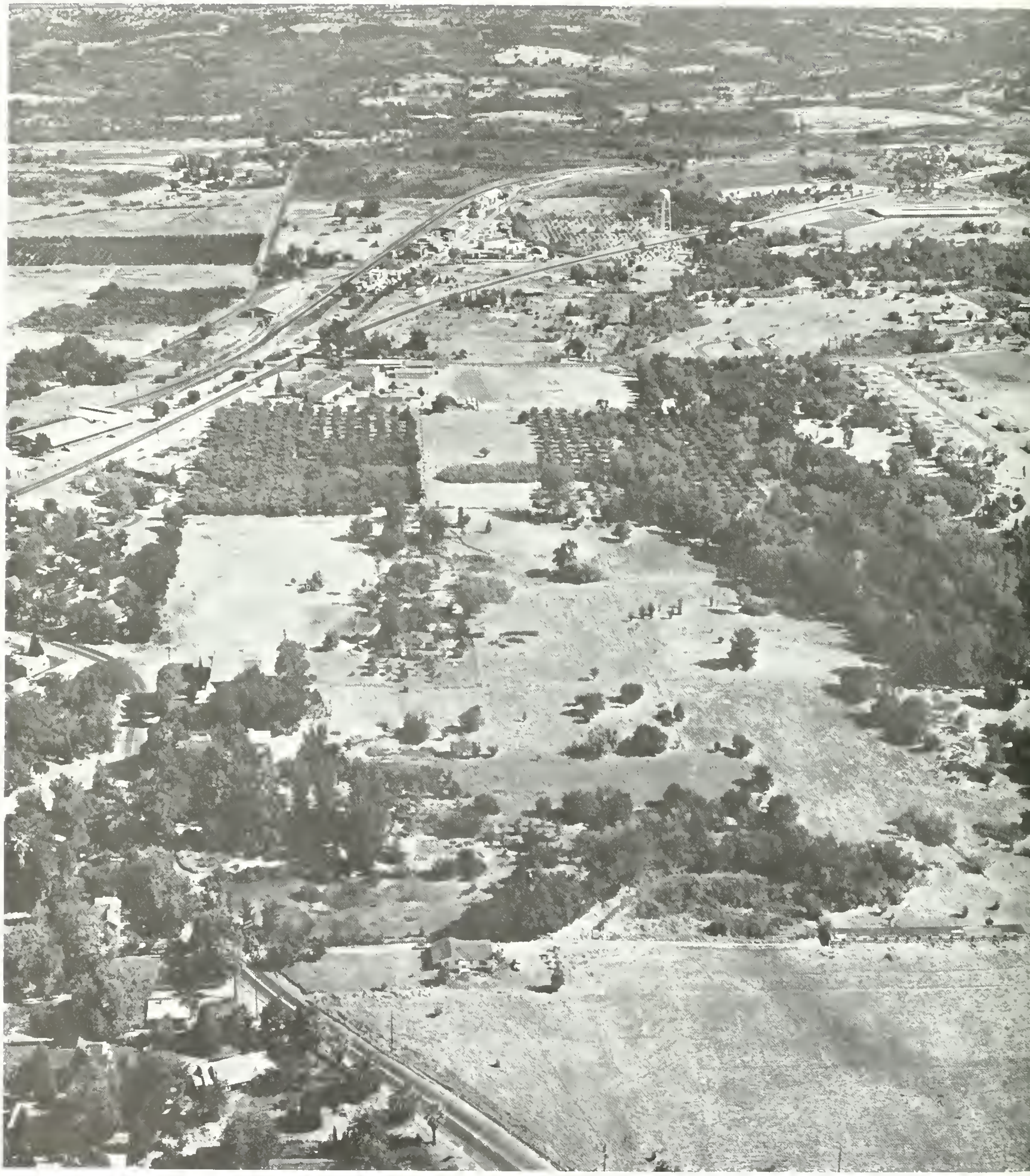
(in acres)

Land Class	San Juan Ridge	Grass Valley				Auburn Foothills	Colfax Ridge	Mountain						
	Nevada	Yuba	Yuba (Beale AFB)	Nevada	Total	Placer	Placer	Yuba	Plumas	Sierra	Nevada	Placer	Butte	Total
Agricultural														
V	130	118	180	2,173	2,471	5,609	76	8						8
Vw	79			288	288	63	146	32	4	2,037	2,081	174		4,328
Vr				50	50	2,271								
Vl		6			6	121								
Vp		57	46	282	385	7,916	7							
Vh														
H	1,654	98	31	15,792	15,921	8,158	2,158	422	22	157	182			783
Hp		5,827	8,037	19,322	33,186	55,173				9				9
Hr	23	11	29	360	400	859				18	32			50
Hpr	579	1,572	1,073	6,475	9,120	5,357	11							
M	3,028			24,304	24,304	6,344	6,280	831	41	325	658			1,855
Mp	611	4,270	2,723	27,008	34,001	28,140	562			3	49			52
Mr	12	24		414	438	106	42							
Mpr	483	2,388	1,394	9,410	13,192	7,009	9							
Subtotal	6,599	14,371	13,513	105,878	133,762	127,126	9,291	1,293	67	2,549	3,002	174		7,085
Urban	127	40		2,916	2,956	4,356	530	124	63	269	170			626
Recreational				139	139	1,860	3,482	2,432	300	4,357	3,223	1,337		11,649
Forest Lands	3,407			3,674	3,674		4,160	13,101	609	19,525	62,170	442	204	96,051
Nonirrigable Lands	27,499	11,560	2,373	98,702	112,635	41,307	43,431	56,942	10,755	282,700	194,808	9,509	83	554,797
TOTAL	37,632	25,971	15,886	211,309	253,166	174,649	60,894	73,892	11,794	309,400	263,373	11,462	287	670,208

governed by factors and assumptions previously presented in this chapter.

Farm population was determined on the basis of the manpower requirement necessary to successfully manage the acreages of the crop pattern projected. The balance of the projected service area population was then distributed between dense urban and residential farms upon consideration of such factors as quantity of available land, accessibility to urban areas, general climatic and topographic characteristics, and existing urban and residential farm development applicable to each service area.

The majority of residential farm growth is expected to take place in the foothill areas. In general, 40 to 60 percent of the total future population in these areas is expected to reside on residential farms. The ownership of land and acreage irrigated was assumed to range from a home with only normal landscaping occurring on a half acre of land or less, up to ownership of 30 acres of irrigated land. Families were assumed to average three persons per unit on the valley floor, and 2.7 persons per unit in the foothills. As indicated by the current increases in residential farm development throughout the lower elevation foothill lands of the Sierra Nevada, recognition of this type of land use was considered essential in this investigation.



Urban and Residential Farm Development - Auburn Foothills Service Area. Loomis and vicinity looking north depicting type of development prevalent in the foothill regions.

No attempt was made to project future areas of recreational and park development. Present recreational and park lands, due to their relatively low unit water use, normally met by small localized development, were included in future nonwater service area.

A summary of land use projections for year 2020 is presented in Table 14.

Water Use

At the present time, water use in the Yuba-Bear Area is confined to the irrigation of crops and to urban use, and for the generation of hydroelectric power. There are no major reservoirs existing in the area which were planned solely, or in part, for the purpose of recreation, or to provide controlled stream releases for fishery enhancement. Most reservoirs in the area are, however, open to public use for fishing and boating.

Under existing development, there are approximately 750,000 acre-feet of water per year applied to the land for irrigation of crops or for urban use in the Yuba-Bear Area. This use is expected to double in the next 50 to 60 years. Some of this water is first used for the production of hydroelectric energy at 12 powerplants in the Yuba-Bear Area. Utilization of the waters of the Yuba and Bear Rivers for the generation of hydroelectric power will increase substantially in the future with the addition of new and enlarged powerplants

TABLE 14

PROJECTED 2020 PATTERN OF LAND USE
BY WATER SERVICE AREAS
(in acres)

Land use type	Water service areas: Valley floor: North of Yuba River	Valley floor: Yuba River to Bear River 1/	Valley floor: South of Bear River: Placer County	Valley floor: South of Bear River: Sutter County	Valley floor: South of Bear River: Subtotal	Valley floor: Total	Browns-ville	San Juan Ridge	Grass Valley	Auburn Foothills	Colfax Ridge	Mountain	Grand total
Irrigated agriculture													
Decid. orchard	12,000	19,000	4,000	16,000	20,000	51,000	1,000	1,200	7,300	18,640	600		79,740
Subtrop. orchard	1,000	1,500				2,500	2,000			3,600			8,100
Misc. truck	2,250	3,000	600	9,000	9,600	14,850							14,850
Misc. field	4,000	5,000	10,000	9,000	19,000	28,000				2,700			30,700
Alfalfa	1,000	900		1,140	1,140	3,040				2,000			5,040
Rice	10,000	12,000	14,000	27,500	41,500	63,500							63,500
Pasture	12,450	19,700	32,000	9,060	41,060	73,210	10,700	300	26,500	20,360	500	500	132,070
Double crop	(1,200)	(1,600)	(2,100)	(3,600)	(5,700)	(8,500)							(8,500)
Total net irrigated	42,700	61,100	60,600	71,700	132,300	236,100	13,700	1,500	33,800	47,300	1,100	500	334,000
Residential farms	2,600	4,750	5,550	2,500	8,000	15,350	5,130	2,460	17,790	26,350	2,100		69,180
Urban	6,490	11,590	19,500	3,010	22,510	40,590	770	300	8,260	27,700	1,530	2,500	81,650
Total water service area	51,790	77,440	85,600	77,210	162,810	292,040	19,600	4,260	59,850	101,350	4,730	3,000	484,830
Total nonwater service area	8,240	32,320 2/	19,700	7,310	27,010	67,570	109,360	33,370	193,320	73,300	56,160	667,210	1,200,290
TOTAL GROSS AREA	60,030	109,760	105,300	84,520	189,820	359,610	128,960	37,630	253,170	174,650	60,890	670,210	1,685,120

1/ Includes Sutter and Placer Counties north of Bear River
2/ Includes 17,800 acres in Beale Air Force Base

presently proposed for construction. It is currently anticipated that there will be an increase in the installed generating capacity of the basin from about 157,000 kilowatts to about 551,000 kilowatts.

Reservoirs planned for construction in the near future will rectify many cases of stream neglect through the controlled release of water for fishery preservation or enhancement. In addition, provisions for recreational use at and near reservoirs is becoming a major consideration in the planning of water projects, stimulated in part by the availability of recreational grants under the Davis-Grunsky Act. It is expected that in the future, recreation will become a major nonconsumptive use of water in the Yuba-Bear Area.

Unit Use of Water

The second step in evaluation of water requirements involved determination of unit values of water use for each of the major types of land use existing and projected for the Yuba-Bear Area.

Values of unit use of water are of two types, determined on separate but closely related bases. The first type of unit use is the consumptive use of applied water, which is the water actually consumed by the particular type of land use to which it is applied. The second type of unit use is the applied water requirement and it includes, in addition to actual consumptive use of applied water, the additional water necessary to allow for application losses inherent in the utilization of water. The amount of this loss is a measure of the efficiency of the particular type of water use involved. These aspects of water use are discussed below under separate headings.

Unit Consumptive Use of Applied Water. The units of consumptive use of applied water utilized in this report are expressed in feet of depth per season for irrigated crops. For each crop, the unit value of consumptive use of applied water is the same as that presented in State Water Resources Board Bulletin No. 2, "Water Utilization and Requirements of California," June 1955. These values must be considered as approximate until such time as results are obtained from long-term field studies directed to such measurements which are underway in several areas of the Sacramento Valley. Findings resulting from these studies may occasion a modification of the consumptive use of applied water values and irrigation efficiencies utilized for this report.

Unit values for consumptive use in urban areas and for residential farms were not computed. Total amounts of consumptive use were based on a percentage of the delivery requirement.

Efficiency Factors. The term "irrigation efficiency" as used herein, indicates the percent of applied water which is consumptively utilized by evaporation and transpiration processes. The unconsumed portion percolates to depths below the root zone and accumulates as reusable ground water and/or contributes to surface and subsurface drainage away from the area of application.

It is noted that the irrigation efficiencies shown in Table 15, comprise a single value for each crop under present land use conditions. The present efficiency figures for the various crop types were obtained from irrigation application data collected within the Yuba-Bear Area. Under future conditions, the efficiencies vary according to crop and soil or land class characteristics, the latter of which are segregated into four groups. Projected irrigation efficiency values were based on averages considered attainable in the area taking into consideration soil textures, soil depth, relief, irrigation frequencies and duration, and method of application.

Soil characteristics of the lands in Group "A" in Table 15 are typified by the conditions found on class V lands. These soils have a relatively high moisture retention, smooth topography, and deep profiles for plant root development. Highest irrigation efficiencies can be attained on these lands due to rapid infiltration and the reduction in the frequency of irrigation applications.

Group "B" lands exhibit markedly different soil conditions. However, these lands were grouped together because they are considered to possess similar irrigation efficiencies. Land classes in this group were Vp, Vl, and Vh.

TABLE 15

ESTIMATED IRRIGATION EFFICIENCY AND
UNIT IRRIGATION REQUIREMENT

Foothill Service Areas[1/]

Crop	Irrigation efficiency by land class[2/] (in percent)					Unit seasonal consumptive use of applied water (in feet)	Unit seasonal irrigation requirement (in feet)				
	Present	Projected					Present	Future			
		A	B	C[3/]	D[3/]			A	B	C	D
Alfalfa hay	65	75	65	70	--	2.3	3.5	3.1	3.5	3.3	-
Pasture	50	70	60	70	60	2.2	4.4	3.1	3.7	3.1	3.7
Deciduous orchard	55	70	65	70	60	1.3	2.4	1.9	2.0	1.9	2.2
Subtropical orchard	55	70	65	70	60	1.4	2.5	2.0	2.2	2.0	2.3
Misc. field crops[4/]	60	70	65	--	--	1.0	1.7	1.4	1.5	-	-

TABLE 15 (continued)

Valley Floor Service Area

Crop	Irrigation efficiency by land class[2] (in percent)					Unit seasonal consumptive use of applied water (in feet)	Unit seasonal irrigation requirement (in feet)				
	Present	Projected					Present	Future			
		A	B	C[3]	D[3]			A	B	C	D
Alfalfa hay	65	75	70	70	--	2.3	3.5	3.1	3.3	3.3	-
Pasture	60	70	60	70	60	2.6	4.3	3.7	4.3	3.7	4.3
Deciduous orchard	55	70	65	70	60	1.6	2.9	2.3	2.5	2.3	2.7
Subtropical orchard	55	70	65	70	60	1.7	3.1	2.4	2.6	2.4	2.8
Rice	60	--	70	--	--	4.1	6.5	-	6.0	-	-
Misc. field crops[4]	65	75	70	--	--	1.6	2.5	2.1	2.3	-	-
Misc. truck crops	65	75	70	--	--	0.8	1.2	1.1	1.1	-	-
Tomatoes	65	75	65	--	--	2.2	3.4	2.9	3.4	-	-

1/ Composed of Auburn Foothills, Brownsville, Colfax Ridge, Grass Valley, and San Juan Ridge Service Areas. Units of use taken from Bulletin 2, Subunit 26.

2/ Letters refer to the following land classification groupings: (A) V; (B) Vr, Vl, Vp, Vh; (C) H, Hr, M; (D) Hp, Hpr, Mp, Mpr.

3/ Efficiency obtained by assuming sprinkler irrigation.

4/ Miscellaneous field crops are composed of milo, sugar beets, dry field beans.

The Vp lands have dense clay or hardpan subsoil layers that restrict root penetration and moisture retention while the Vl lands have low moisture retention due to coarse texture. The Vh land class was included in Group "B" because nearly all of these fine-textured clay basin soils are currently being utilized exclusively for rice production and will probably remain in that land use in the future. Since irrigation efficiency on rice was assumed to be similar to those obtainable for other crops on Vp and Vl land classes, it appeared to be repetitious to create a special group for rice.

Group "C" lands exhibit gently to moderately rolling topography and deep, permeable soils with a favorable moisture retention. These lands differ from Group "A" land topographically and also in that irrigation application is considered to be largely by sprinkler. Crop adaptability on these lands is generally restricted to deep-rooting deciduous orchard and higher yielding pasture crops.

Group "D" lands are rolling to steeply sloping, with soils that are generally quite shallow, more or less rocky, and exhibit rather low moisture retention. Irrigation on these lands would generally be restricted to pasture or a limited selection of deciduous orchard crops. Due to low moisture retention and the difficulties encountered in irrigating rolling, rather broken lands, the irrigation efficiency would be markedly lower.

Urban water use efficiency for purposes of this investigation was estimated to be 50 percent for all areas.

Unit Delivery Requirements. The unit irrigation delivery requirements shown in Table 15 were obtained by dividing the unit seasonal consumptive use of applied water by the estimated irrigation efficiency.

The estimated irrigation delivery requirement values are average values, and actual use will vary from year to year depending upon rainfall distribution and other climatic conditions. Also, for any particular year, areawide water use is influenced by other variable factors such as the cost of water, market fluctuations in prices received for crops, low crop yields caused by disease or insect damage, and the personal inclinations of the individual irrigator. Unit irrigation requirements are an estimate of the depth of water which it is believed is needed to satisfactorily bring the crops to maturity under average conditions.

Water delivery requirements for urban areas were computed on a per capita basis rather than on a unit area basis, as data providing measured quantities of water assignable to a known population were found to be more available and reliable than estimates of water use assigned to various urban land uses on an acreage basis. A value of 260 gallons per capita per day was used in all water service areas for present and future development to year 2020.

Water requirements for residential farm use consist of internal or household uses normally associated with urban residential areas plus an external use for irrigation of smalll sized parcels of home gardens, pastures, and orchards. An average delivery requirement of 3.0 acre-feet per acre was used for residential farms.

Consumptive Use of Applied Water

Estimates were made of present and future consumptive use of applied water within the various water service areas of the investigation. The estimates for irrigated agriculture were derived by applying unit values of consumptive use of applied water as shown in Table 15 to present and estimated future patterns of agricultural land use. In determining the amount of applied water consumptively used on presently irrigated lands, it was assumed that all crops were presently receiving a full water supply.

Consumptive use of applied water in municipal and industrial areas, for purposes of this investigation, was estimated as 50 percent of the total delivery requirement. This low percentage is due to the relatively high proportion of the total delivery requirement necessary for nonconsumptive purposes, and the lack of reuse prevalent in urban areas. On residential farms, which may be considered as partially suburban and partially noncommercial agriculture, it was envisioned that with the small size land parcels involved and the ability to exercise strict water control, the consumptive use would be approximately 80 to 85 percent of the delivery requirement.

A summary of estimated present and year 2020 mean seasonal consumptive use of applied water is presented in Table 16.

Water Delivery Requirements

Water delivery requirements as considered herein were confined to those associated with consumptive use by crops, urban and residential farm uses, and nonconsumptive requirements for hydroelectric power generation, recreation, and fish and wildlife.

In this bulletin, water delivery requirements were evaluated at the farm headgate for irrigation use, and to the domestic connection in the case of urban use. They do not include conveyance losses encountered in delivery of the water to the user, or account for reuse of applied water within the service area. Present and year 2020 water delivery requirements for each service area are presented in Table 17. Under applicable headings in Chapter V, water delivery requirements by decades are presented in conjunction with projects formulated to meet future needs.

Water requirements for recreation and fisheries preservation were considered in connection with reservoir storage capacity and water surface area at minimum pool,

TABLE 16

ESTIMATED PRESENT AND YEAR 2020
MEAN SEASONAL CONSUMPTIVE USE OF APPLIED WATER
(in acre-feet)

Water Service Area	Present			Year 2020			
	Irrigated agriculture 1/	Urban	Total	Irrigated agriculture	Residential farm	Urban	Total
Valley Floor							
North of Yuba River	82,200	1,450	83,650	108,280	6,500	7,400	122,180
Yuba River to Bear River	95,770	2,180	97,950	150,520	11,830	12,050	174,400
South of Bear River	175,030	2,130	177,160	364,760	20,000	25,560	410,320
Subtotal	353,000	5,760	358,760	623,560	38,330	45,010	706,900
Brownsville	7,250	60	7,310	27,640	13,850	450	41,940
San Juan Ridge	380	20	400	2,220	6,150	150	8,520
Grass Valley	22,520	1,610	24,130	67,690	44,820	4,840	117,350
Auburn Foothills	54,130	2,900	57,030	85,660	65,880	19,540	171,080
Colfax Ridge	970	300	1,270	1,880	5,250	1,080	8,210
Mountain 2/							
Total	438,250	10,650	448,900	808,650	174,280	71,070	1,054,000

1/ Includes residential farm use
2/ Not computed. Estimated to aggregate less than 2,000 acre-feet in year 2020.

TABLE 17

ESTIMATED PRESENT AND YEAR 2020 MEAN SEASONAL
DELIVERY REQUIREMENTS FOR WATER
(in acre-feet)

Water Service Area	Present			Year 2020			
	Irrigated agriculture 1/	Urban	Total	Irrigated agriculture	Residential farm	Urban	Total
Valley Floor							
North of Yuba River	131,950	2,900	134,850	163,560	7,800	14,800	186,160
Yuba River to Bear River	154,590	4,350	158,940	228,500	14,200	24,100	266,800
South of Bear River	280,480	4,260	284,740	550,000	24,000	51,120	625,120
Subtotal	567,020	11,510	578,530	942,060	46,000	90,020	1,078,080
Brownsville	14,370	110	14,480	45,760	15,390	900	62,050
San Juan Ridge	760	40	800	3,450	7,380	300	11,130
Grass Valley	44,820	3,220	48,040	106,310	53,370	9,660	169,340
Auburn Foothills	104,500	5,800	110,300	137,820	79,050	39,090	255,960
Colfax Ridge	1,860	600	2,460	2,720	6,300	2,160	11,180
Mountain 2/							
Total	733,330	21,280	754,610	1,238,120	207,490	142,130	1,587,740

1/ Includes residential farms
2/ Not estimated

and stream releases below proposed projects. Detailed studies necessary to evaluate the optimum storage capacity for recreation and reservoir fishery were beyond the scope of this investigation. Minimum storage capacities, where not determined by other considerations, were selected largely on the basis of engineering judgment. More detailed studies of individual projects would be necessary in order to recommend minimum storage requirements adequate to maintain an established reservoir fishery under maximum drawdown conditions, and to optimize benefits from recreational use.

Stream release requirements below proposed projects for preservation of fish and wildlife were studied by the Department of Fish and Game. Recommendations for stream releases are presented in Appendix B.

CHAPTER IV. PLANNING CRITERIA AND CONSIDERATIONS

This chapter presents and discusses some of the more important legal considerations and policies governing water development planning in California as they are considered to apply to the area under investigation, and to an export project on the Yuba River. The chapter also includes and presents certain basic engineering and economic data and assumptions used in the studies and not presented elsewhere in the report.

Legal Aspects

The principal legal aspects of water development planning in the area under investigation are those relating to water rights, the County of Origin Law, and the Watershed Protection Act. In the formulation and analysis of projects, full consideration is given to the effects of prior water rights and the influence of these laws.

Water Rights

Adequate appropriative water rights are a necessary prerequisite to the construction of any water development project, whether large or small, which involves a storage or direct diversion of surface water for use on nonriparian land. Prior to December 19, 1914, the effective date of the Water Commission Act, (now codified in the Water Code) rights by appropriation could be initiated by the diversion and beneficial use of water and the priority could be preserved by recording a notice with the county recorder. Since that date, initiation of appropriative rights has been made by filing an application with the State Water Rights Board, or one of its predecessor agencies. If unappropriated water is available and other requirements are met, a permit is issued, and after the application of the water to the contemplated beneficial use is completed, the right is confirmed by a license. The priority of the right is the date on which the application is filed.

Recent applications for major appropriations of water have been made by the Yuba County Water District, Yuba County Water Agency, Browns Valley Irrigation District, Nevada Irrigation District, Oroville-Wyandotte Irrigation District, Johnson Rancho County Water District, South Sutter Water District, San Juan Ridge County Water District, the California Department of Water Resources, and others. Some of these applications are mutually conflicting. The applications by the Department of Water Resources have been made pursuant to Section 10500 of the Water Code and are not subject to the requirement of diligence. This, in effect, holds the water in public trust for future use. Further discussion of water rights and a summary of the more significant applications on file with the State Water Rights Board, pertinent to this investigation, is given in Appendix D.

In formulating the plans for a major project on the Yuba River, it was assumed that the present impaired flow of the Yuba River at the Smartville gage reflects present upstream consumptive uses and is, therefore, in a sense, the measure of the rights to such uses. Existing power rights above the Smartville gage were respected by making allowance for either the acquisition of existing power facilities or by making releases of water to these facilities in accordance with historic records. Below the Smartville gage, existing rights were recognized by making "mandatory" releases to the river sufficient in quantity and time to meet present diversion requirements from the Yuba and Feather Rivers as well as ground water recharge from the Yuba River channel.

County of Origin Law and Watershed Protection Act

These laws can best be understood in the light of the physical situation with which they were designed to deal. The physical problem is brought about by the maldistribution of the water supplies of the State both as to place and time of occurrence. The records indicate that approximately 70 percent of these water supplies originate in the area north of the latitude of Sacramento; conversely, it is estimated that approximately 70 percent of the ultimate need for water will occur south of that latitude. Hence, water must be transferred from north to south. In addition, practically all of the precipitation occurs in the winter and

and spring months and the resultant runoff must be stored in reservoirs in order to make it available for irrigation use during the summer and fall months. Furthermore, there are wet years during which water must be stored for use during dry years.

The physical problems associated with the maldistribution of the water supplies can be rectified by the construction of engineering works. These problems, however, are often rendered more complex by the need to consider and resolve other important factors which may be associated with the development. As an example, the need to transfer water from north to south has caused concern, in areas of water surplus, that the remaining supplies will be inadequate for the future requirements of these areas. This concern has resulted in enactment of the "County of Origin Law" which offers some protection to areas of water surplus.

The so-called County of Origin Law, now Section 10505 of the Water Code, places a restriction on the State in assigning or releasing any water rights applications filed by the State in furtherance of a general plan to develop the State's water supplies. Section 10505 of the Water Code provides as follows:

> "10505. No priority under this part shall be released nor assignment made of any application that will, in the judgment of the commission, deprive the county in which the water covered by the application originates of any such water necessary for the development of the county."

This protection has three principal limitations: first, it is only effective as to applications of the State; second, it is dependent upon periodic relief by the Legislature from the usual requirements of diligence which apply to all other applications; and third, it applies only to water originating within a county.

Subsequently, the Legislature passed the so-called Watershed Protection Act as part of the Central Valley Project Act. These provisions restrict the operators of the Central Valley Project by requiring that no watershed wherein the water originates, or no area immediately adjacent thereto which could be conveniently served with water, shall be deprived of necessary water by the project. These provisions constitute Sections 11460-11463 of the Water Code, supplemented by Section 11128. The most significant of these Sections, 11460, reads as follows:

> "11460. In the construction and operation by the department of any project under the provisions of this part, a watershed or area wherein water originates, or an area immediately adjacent thereto which can conveniently be supplied with water therefrom, shall not be deprived by the department directly or indirectly of the prior right to all of the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein."

While in one sense broader than the County of Origin Law, the Watershed Protection sections are also restrictive in their protection in that they apply only to the operators of the Central Valley Project.

Policy Assumptions

The major policy assumptions governing water development planning for this report are the "Basin Water Development Concept" and, as it relates to exports of water from the Yuba River, the more recent "Delta Pool Concept." Other important policy assumptions relate to the "Reimbursable and Nonreimbursable Costs." These matters are considered in this section.

Basin Water Development Concept

The essence of this concept is that water developments to satisfy immediate needs shall not preclude or make infeasible the eventual and reasonable optimum development of a basin's water and land use potential. This implies that good reservoir sites should not be pre-empted by inadequate use or lack of provision for full future use. The areas of water use are extended, under this concept, to include contiguous areas dependent upon a particular basin for their future water supplies. The concept must be applied with good judgment and within the limitations of sound economic principles; otherwise, further water development in California might be effectively impeded. The basin concept is considered to be one of the fundamental principles underlying formulation of The California Water Plan. However, the physical works of that plan have never been subjected to full tests of engineering and economic feasibility, and therefore serve only as a broad general guide for basin planning. The detailed plans resulting from investigations such as conducted herein will provide the basis for amending The California Water Plan insofar as physical works in a particular area are concerned.

Delta Pool Concept

The Delta of the Sacramento-San Joaquin Rivers is considered, in The California Water Plan, to be the focal point towards which all surplus waters of Northern California will be directed. The plan of operating the Delta through the "pooling" of waters, which now or in the future will flow into it, is known as the "Delta Pool Concept." This concept involves the utilization of surplus waters in the Delta which now waste to the ocean, and from time to time, supplementing the exportable water through development of other surface water resources, primarily from the North Coastal Area. The pooling concept obviates the need for identifying each acre-foot of water in the Delta with its source of origin, thereby permitting the emphasis on planning to be placed upon the works required to serve the areas of deficiency with an adequate supply of water at the time when it is needed and in an economic manner. Inherently, as part of this concept, it is the responsibility of the State to provide for replenishment of the Delta supply when and as needed. The Delta Pool Concept recognizes that works such as described in this report, providing water primarily for local use, may tend to diminish the supplies available for export from the Delta.

Reimbursable and Nonreimbursable Costs

The state policy with respect to repayment of project costs is assumed to generally parallel current federal practices, except that costs allocated to irrigation are repayable with full interest. In general, the costs of all project functions, except flood control and certain aspects of fisheries, wildlife, and recreation, are assumed to be fully reimbursable. Reimbursable costs associated with fisheries, wildlife, and recreational functions are assumed to be limited to operation and maintenance of special facilities added to and included in the project for enhancement of these purposes, but not otherwise required for operation of the project.

Engineering Considerations

This section summarizes the various engineering considerations and standards used or considered in sizing, designing, and estimating the cost of projects, the components thereof, and the alternatives thereto. The material is arranged under separate headings but not necessarily in the order of consideration in the studies.

Water Demand Schedules

The demands for water from a project often vary considerably from month to month and among the several purposes for which the project is planned. These demands are not only important as a factor in fixing conduit sizes but sometimes have a considerable influence on project yield. These demand characteristics are briefly discussed below and summarized in Table 18.

Irrigation. Most of the water requirements for irrigation are concentrated in the summer months. These demands usually follow a rather inflexible pattern from month to month, but experience has indicated that deficiencies can be endured on occasion without serious results. For the valley floor and foothill service areas, a maximum seasonal deficiency in project water deliveries of 35 percent was assumed, with an aggregate deficiency of not more than 100 percent during the critical period 1927-28 through 1933-34. It is to be noted that this deficiency can be mitigated to a considerable extent in the valley floor service area by the use of ground water.

Urban and Domestic. These uses of water occur throughout the year with the summer month demands averaging about three times the demands of the winter months. From the standpoint of annual requirements, the demands for urban and domestic water amounts to about as much per acre as the average application requirements for irrigation.

TABLE 18

MONTHLY WATER REQUIREMENTS
IN PERCENT OF SEASONAL DEMAND

Month	Irrigation use: Valley Floor	Irrigation use: Foothills 1/	Irrigation use: San Juan Ridge	Residential farm use	Urban use
January	0	0	0	1	5
February	0	0	0	1	4
March	1	0	0	1	5
April	5	9	0	4	6
May	15	11	5	8	8
June	19	20	22	21	13
July	23	24	31	28	15
August	20	21	26	24	14
September	14	13	14	8	11
October	3	2	2	2	8
November	0	0	0	1	6
December	0	0	0	1	5
TOTAL	100	100	100	100	100

1/ All areas except San Juan Ridge

It is expected that urban demands in the valley floor service area will continue to be met by pumping from the ground water basin. In the foothill areas, allowance was made for urban demand in project operation schedules where applicable.

Conveyance Losses

Conveyance losses are defined as the water lost in transit between the point of diversion and the place of use. Although some loss of water occurs in all types of conduits, no loss has been assumed in this report for conduits serving powerplants. Seepage losses from unlined canals excavated through earth materials constitute the principal conveyance loss. In estimating amount of conveyance loss, consideration was given to length of canal, records of historic losses in existing canals, and the possibility of canal improvement under future development. In general, estimates of loss for present development range from 15 to 30 percent of the amount diverted. Continuing improvement under future development would result in decreasing losses by an estimated 5 to 10 percent.

Stream Percolation. For purposes of this investigation, an average release of 5,000 acre-feet per month was made to the main stem of the Yuba River in order to compensate for the normal percolation loss from the lower Yuba River channel. It is realized that percolation to ground water from stream channels is dependent upon many factors; but the rate assumed is considered to be reasonably conservative, substantiated to a degree by a study of streamflow depletion occurring on the main stem Yuba River.

Reuse of Applied Water

Within the area of investigation there is and will continue to be reuse of applied water which is not consumptively used. Return flow from irrigation applications and domestic use will find its way into streams and drainage courses where, in some cases, it will be available for rediversion and reapplication. In some instances return flow will be used within the same service area in which it originates. On the valley floor it will be most desirable to utilize return flows in order to minimize drainage problems that would otherwise develop.

The reuse of return flow can best be explained by the following examples:

If a service area has a delivery requirement of 100,000 acre-feet, an irrigation efficiency of 65 percent, and there is no opportunity for reuse, it is then necessary to formulate a project to develop 100,000 acre-feet plus an additional amount -- say 20 percent or 20,000 acre-feet -- to allow for conveyance losses. Of the 120,000 acre-feet developed, only 65,000 acre-feet will be consumptively used during the irrigation process and 55,000 acre-feet will be return flow and conveyance losses. Of the 55,000 acre-feet, some portion -- say 25 percent or 14,000 acre-feet -- will be consumptively lost to native vegetative growth. The remaining 41,000 acre-feet will be available for recapture at some point below the service area and reapplied.

Taking the same service area and assuming that one half of the lands can reuse water from the other half, then the following analysis would apply. For half of the lands 60,000 acre-feet would be developed (50,000 for delivery and 10,000 for conveyance loss) and 32,500 acre-feet would be consumptively used for crops. Of the return flow of 27,500 acre-feet, 6,900 acre-feet would be lost to native vegetation and 20,600 acre-feet would be available for reuse. For the other half of the service area it would therefore only be necessary to develop an additional 39,400 acre-feet. From the second half of the service area there would still be 20,600 acre-feet available for reuse in a downstream area.

Hydroelectric Power

The energy generation capability of hydroelectric power facilities in an adverse water year determines the dependable capacity of the plant. In an adverse year, substantially all of the system hydroelectric capacity is operated in the peak of the load, and production of certain minimum amounts of energy by each plant is required to make the plant capacity useful in supplying that segment of the load to which it is assigned.

The required monthly distribution of the energy generation also has an important effect upon dependable capacity of the hydroelectric plant. Generally speaking, energy requirements of the power load are larger in the summer time than in the winter time. Primarily on this account, energy generation for each kilowatt of hydroelectric dependable capacity must be larger in the summer months. The following adverse year monthly kilowatt-hours per kilowatt of dependable capacity corresponding to an annual capacity factor of 30 percent were used by the department for the reservoir operation studies and the sizing of power facilities.

Month	Kilowatt hours per kilowatt	Capacity factor, %
January	150	20
February	140	21
March	170	23
April	190	26
May	220	30
June	260	36
July	330	44
August	330	44
September	250	35
October	220	30
November	200	28
December	170	23
ANNUAL	2,630	30

Water Temperature Considerations

The water temperatures in reservoirs are a function of size, depth, surface area, relationship and magnitude of inflow and outflow, and many other factors. Virtually no data were available during the course of study which could be applied to the reservoirs of the Yuba and Bear Rivers for the prediction of water temperatures.

For rice crops and certain species of anadromous fish, water temperatures are of particular concern. The ideal water temperature for production of rice is 70° to 75° F. Ideal water temperature for propagation of salmon and steelhead range from 42° to 56° F. Temperatures in excess of 57° F. cannot be tolerated during the spawning season. Some control of water temperatures may be achieved by withdrawing the water from the reservoirs at different levels. Fortunately, the water requirements for the two purposes cited are not mutually conflicting with respect to time of use.

Reservoir Evaporation Rates

For purposes of this report, annual net evaporation from water surfaces was computed at the rate of 2.2 acre-feet per acre for the lower elevation foothill reservoirs, and 1.7 acre-feet per acre for intermediate basin reservoirs. The net evaporation from reservoirs at the higher altitudes of the basin varies between 1.1 and 1.2 acre-feet per acre. These values were computed as the difference between natural evapotranspiration losses and evaporation from water surfaces.

Operation of Reservoirs for Flood Control

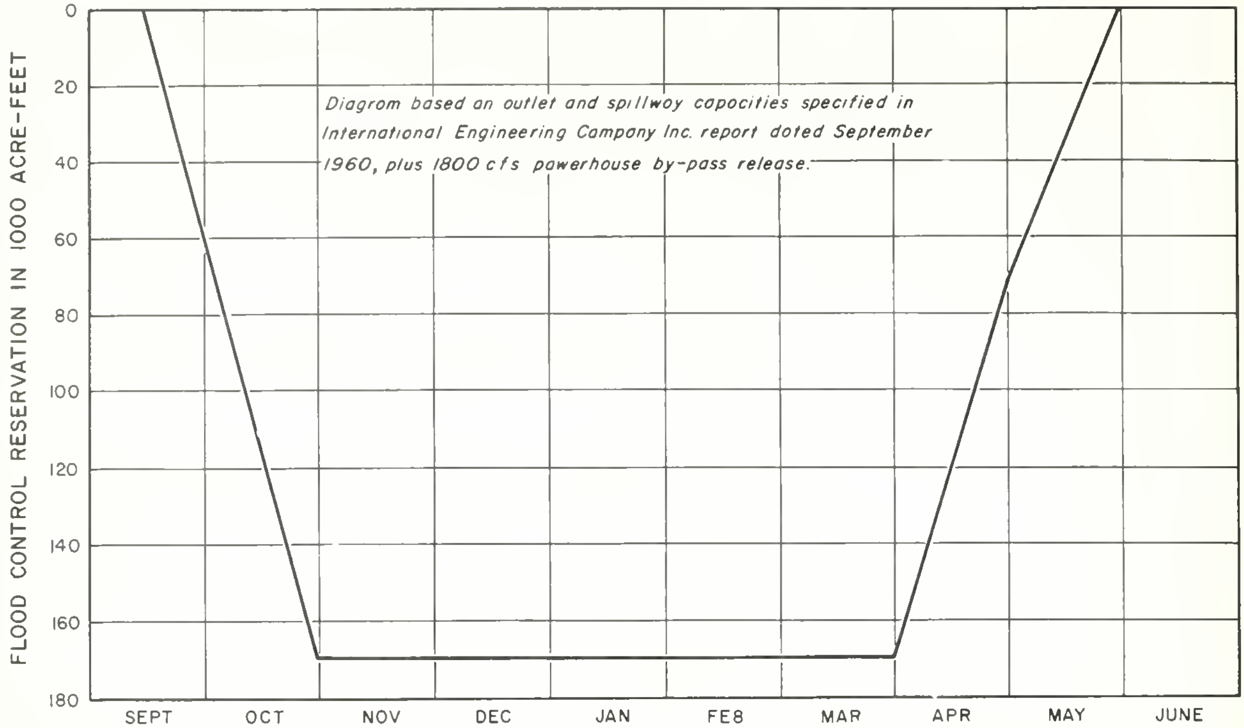
The basic criteria for operation of reservoirs on the Yuba River for flood control were established by the Sacramento District, Corps of Engineers, U. S. Army. The degree of control is predicated on limiting the flow in the Yuba River at Marysville to 120,000 second-feet under standard project flood conditions.

The standard project flood varies for each reservoir site and depends upon the drainage basin characteristics above the site. It generally ranges in peak and volume from 40 to 60 percent of the probable maximum flood and may have a frequency of occurrence of once in 100 years or more. The reserved flood control storage space in a reservoir is determined by routing the standard project flood through it, with concurrent releases and downstream flood accretions limited to 120,000 second-feet at Marysville. Because of high downstream runoff, the standard project flood on the Yuba River cannot be controlled by storage on the North Yuba River alone. Therefore, unless all of the required flood control storage is concentrated in a single reservoir on the main stem of the river, a combination of reservoirs is required to achieve full standard project flood protection.

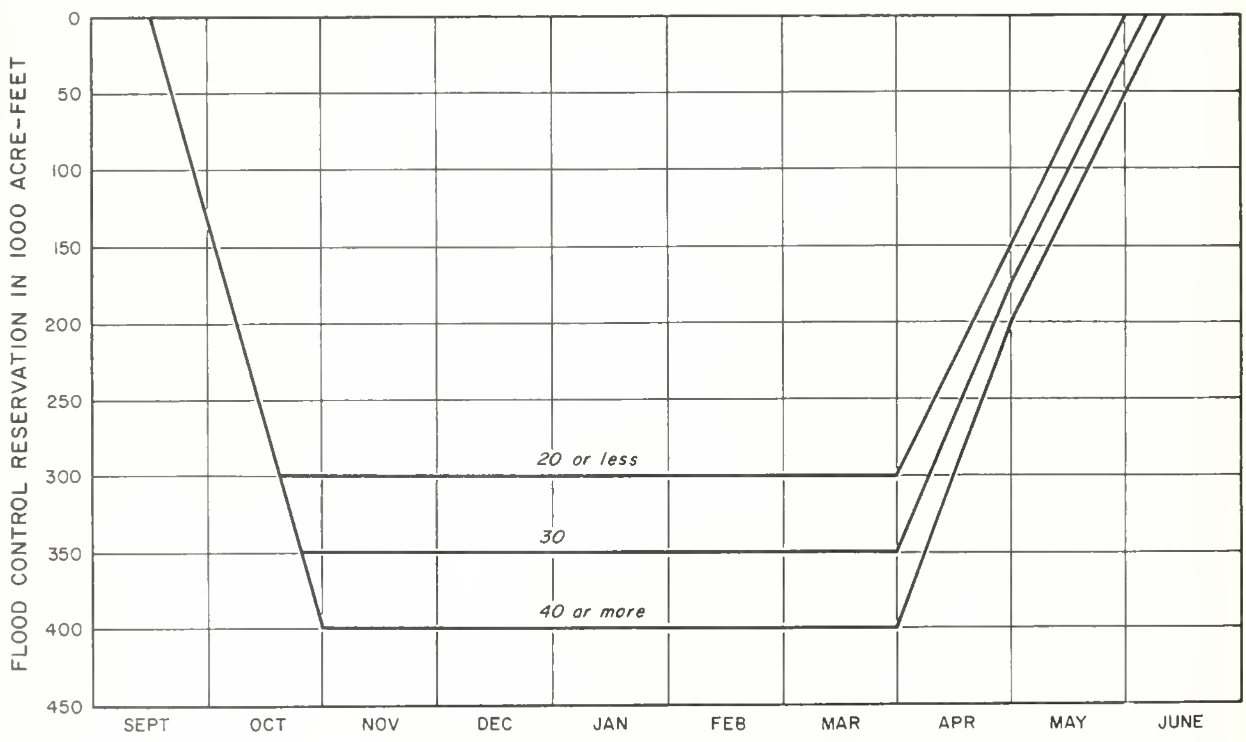
The following data apply to standard project flood control storage requirements on the Yuba River:

Single Reservoir Project	Storage (acre-feet)	Release (cfs)
Marysville, or Parks Bar with connected storage on French Dry Creek	400,000	120,000
Dual Reservoir Project		
New Bullards Bar	170,000	50,000
Marysville or Parks Bar with connected storage on French Dry Creek	260,000	120,000

Having established the basic requirement for flood control in a single reservoir and in a combination of reservoirs, the Corps of Engineers prepared preliminary operating diagrams for use in routing the actual inflow, as it would occur under project conditions, through the reservoirs. The diagram for a single main stem reservoir takes into account the antecedent precipitation as an index of the flood-producing potential, with the required flood storage space for a given month adjusted accordingly. Figure 1 is an illustration of the preliminary flood control diagrams for New Bullards Bar Reservoir and for a single reservoir located on the main stem Yuba River. For a combination New Bullards Bar and main stem reservoir project, 80 percent of the flood reservation maintained in the upstream reservoir can be credited to the storage reservation requirement for a single main stem reservoir.



NEW BULLARDS BAR RESERVOIR



YUBA RIVER MAIN-STEM RESERVOIR

NOTES:

1. *Parameter value is preceeding 60-day precipitation in percent of normal annual precipitation.*
2. *When empty space in any reservoir is less than required, water shall be released as rapidly as possible without causing flows in Yuba River at Marysville to exceed 120,000 c.f.s., and without changing releases more than 10,000 c.f.s. in any 2-hour period.*
3. *Required space in main-stem reservoir may be reduced by about 80 percent of the space provided at New Bullards Bar Reservoir up to 170,000 acre-feet.*
4. *Data furnished by Sacramento District, Corps of Engineers, U.S. Army.*

Figure I, PRELIMINARY FLOOD CONTROL DIAGRAMS

Economic Considerations

The principal economic studies conducted to evaluate the possibilities for developing the water resources of the Yuba-Bear Area were: (1) evaluation of present or preproject economic conditions; (2) determination of payment capacity for irrigation water; (3) projection of future land and water use needs; (4) determination of project benefits that would accrue from the construction and operation of proposed projects; (5) project formulation and evaluation studies to determine the size and economic justification of the potential projects.

Payment Capacity

Payment capacity represents the maximum ability of the bulk of the water users to pay for irrigation water delivered to the farm headgate. This ability to pay is determined in the amount of farm income retained by the farmer after paying all farm production costs except the cost of water. The weighted average payment capacity for irrigation water on a per acre and per acre-foot basis for the projected crop pattern in each service area is as follows:

	Per acre	Per acre-foot
Valley Floor	$34.50	$ 8.70
Brownsville	15.80	4.65
San Juan Ridge	45.60	19.80
Grass Valley	17.30	5.45
Auburn Foothills	36.80	12.40
Colfax Ridge	40.50	17.70

Preliminary determination of payment capacity for water, together with estimates of the cost of developing water supplies, is one of the previously mentioned factors considered in projecting future land use patterns.

Project Benefits

Benefits of the projects considered herein would accrue primarily from irrigation and urban water supplies, production of hydroelectric energy, flood control, increased recreational opportunities, and fish and wildlife enhancement.

In determining project benefits, long-term projections were made of agricultural development, recreational use, and population growth and distribution. The projections of population were distributed within the various service areas in accordance with other existing and projected developments with consideration given to the probability of further agricultural, recreational, and urban and suburban developments oriented to the natural resources of the area. Projections of population, and of agricultural development, are contained in Chapter III.

Agricultural Benefits. The agricultural benefits for representative crops were evaluated on a per acre basis by determining the gross income that would be realized after deducting all estimated farm costs except land and water costs. The benefits would be the difference, therefore, between the returns to land and water with and without a water supply project, but they primarily would be dependent upon the net gain to land due to the project and to the resulting crop pattern.

The historical agricultural crop prices and yields used in the economic analysis were based on weighted average prices and yields reported in the annual reports of the Agricultural Commissioners in the respective counties for the base period 1952-56, inclusive. In general, the price and yield trends for the period of analysis were utilized with the application of judgment to obtain reasonable projections for prices and yields. The projected prices would represent the net amount received by the producer at the point of delivery. In the case where historical prices or yields were not in agreement with the accepted figures in the industry, or where exceptional years were noted, adjustments to the prices and/or yields were made.

Crop production costs, consisting of fixed and variable costs together with a management charge, also were computed for the base period. The variable costs would be base costs incurred in production and are commonly called operating expenses. These expenses include costs of labor, fuel, repairs, and materials. Fixed costs would include interest, depreciation, taxes, and general expense. Management charge would be the allowance made for farm management, but it would not include labor costs. The foregoing costs were computed using the following assumptions: (1) hourly farm wages would be $1 and $1.25 for unskilled and skilled labor, respectively; (2) average inventory values would equal 50 percent of the original investment costs; (3) the interest rate would be 5 percent per annum; and (4) allowances would be made for depreciation on such items as buildings, irrigation facilities, and operating equipment.

Urban Benefits. In evaluating benefits that would accrue from the urban use of water, the concept of vendibility, limited by the next least costly alternative source, was used. Benefits were determined on the basis of the value of untreated water delivered to a central distribution agency.

Residential Farm Benefits. The benefits attributable to the use of project water on residential farms are considered as a composite value based on the anticipated uses of the water. The water used to irrigate the agricultural portion provides a benefit equivalent to the average for commerical agriculture in the same general area. Similarly, the portion utilized as domestic water provides the same average benefit as the water provided for urban uses. Therefore, the benefit per acre was computed as the weighted average value based on the respective uses of the project water.

Hydroelectric Power Benefits. These benefits were measured in terms of the cost of producing power by the most likely alternative source, in this case, a privately financed steam-electric plant located in the Delta. Emphasis was placed on estimating the market for, and the value of, hydroelectric power since these factors are of primary importance in forecasting future revenues attributable to any power project. A general description of the factors considered and the results obtained are presented below.

Northern and Central California were selected as the power market area. The anticipated magnitude and characteristics of future power demand in this area were related to the estimated generating resources available to meet this demand. The area load and resource projections were analyzed to ascertain the proper relationship between dependable generating capacity and the average annual energy generated for the powerplants to be added by the projects considered herein. Power revenues were estimated after the magnitudes of the dependable capacity and average annual energy generation were determined.

It was concluded from detailed technical studies that future power requirements of Northern and Central California, based on anticipated population growth and annual energy use per capita, would provide a ready market for hydroelectric energy generated by the projects considered herein.

The value of hydroelectric power from the projects considered herein was estimated to be $23.30 per kilowatt year of dependable capacity and 3.0 mills per kilowatt-hour. These figures are based on the cost of producing equivalent power in a modern steam-electric plant, with suitable adjustments for transmission cost and losses as shown in Appendix F.

Flood Control Benefits. Flood control benefits that would accrue to New Bullards Bar and Marysville Reservoirs were estimated by Sacramento District, Corps of Engineers, U. S. Army. Values quoted herein are average annual equivalent benefits from the proposed lower Yuba River Project following construction of Oroville Reservoir.

Recreational and Fish and Wildlife Benefits. The recreational benefits that would accrue as a result of water project developments would be measured by comparing the estimated future recreational activity in the area with and without the project. For the purpose of this investigation, recreational benefits analyses were limited to studies of the proposed lower Yuba River Project. These studies were limited to water-associated recreational activities. Important factors to be considered in determining benefits include trends in population growth and distribution, improved mobility because of better roads and transportation facilities, location of areas from which visitors would come, increased leisure time and physiological need for outdoor recreation, existing recreational opportunities and facilities in the area, possible development of new types of outdoor recreational activity, and attractiveness of the area in relation to rival or competing areas.

Streams affected by all projects considered were investigated by the Department of Fish and Game. Present use was determined by sampling surveys, interviews, and by counts of angling intensity and distribution. A report containing recommendations regarding streamflows and the probable effects of proposed developments upon the fish and wildlife resources of the Yuba and Bear Rivers Basin, prepared by the Department of Fish and Game, is included herein as Appendix B.

Project Formulation and Evaluation

Preliminary project formulation and evaluation studies were conducted to determine the proper size and the economic justification of the potential projects. Each project was selected and sized to provide the most economical method of accomplishing its purpose and to provide maximum net benefits. The optimum development of the projects considered herein is that size of project at which the incremental benefits equal the incremental costs. The value of the benefits utilized in the sizing studies was limited to primary tangible irrigation, domestic, and hydroelectric power benefits. The costs used in the sizing studies included all project capital costs, and costs for operation, maintenance, and replacement.

Economic Justification. A project may be considered economically justified if the benefits that accrue therefrom are in excess of the costs incurred in its design, construction, operation and maintenance. Moreover, each separate segment or purpose of a multipurpose project must provide benefits at least equal to its cost. The comparison of benefits and costs of a project commonly is expressed as a benefit-cost ratio. This ratio should not be the only criterion, since it does not adequately reflect many project intangible benefits or detriments which may be significant.

In making economic justification analyses of potential projects for the purposes of the investigation, only tangible primary benefits were utilized. A tangible benefit is one that adequately can be expressed in monetary terms, whereas an intangible benefit, although real, cannot be so measured. A primary benefit is the net gain or value realized directly from the project. A secondary benefit is the net gain or value added, over and above the values of the primary benefits, as a result of economic activities induced by or resulting from the project.

CHAPTER V. PLANS FOR DEVELOPMENT

Increasing demands for water service in the Yuba-Bear Area will be associated closely with the growing population and with a change from present-day dry-farm operations to irrigated agriculture, brought about by the availability of low cost water from projects planned for near future construction. At the present time, dry-farmed lands comprise about one-fourth of the developed land in the Yuba-Bear Area.

Projects formulated under this investigation were designed to provide supplemental water supplies adequate for future needs as projected to year 2020. For the foothill areas, plans for development consist for the most part of relatively small single and dual purpose water supply projects to serve local areas. Hydroelectric power production was included where feasible. Recreation as a primary purpose was not considered in the formulation of these projects, although consideration was given to requirements for recreation purposes, such as adequate minimum pools in reservoirs and stream releases for fishery preservation.

Plans for development of surplus flows of the lower Yuba River are multipurpose in concept and are designed to develop the water and power resources, provide flood control, and maintain or enhance the recreational and fisheries potential.

Individual projects as proposed herein were conceived as part of a coordinated basinwide plan of development with recognition of the need for water in various part of the Yuba-Bear Area, and the necessity for obtaining optimum development of the available water supply. Consideration was also given to the export of surplus water from the Yuba River to the Delta.

In the ensuing presentation, the following terms are used as defined below.

Project Yield - The maximum sustained rate of draft from a reservoir that could be maintained through a critically deficient water supply period to meet a given demand for water with a permissible deficiency.

Effective Project Yield - The amount of water developed by a project which is delivered to the farm headgate to meet a given demand, plus the amount of reuse of this water within the project service area which becomes available as the result of return flow. In this report is is assumed that the initial delivery, and also the amount that becomes available for reuse at a lower elevation can be measured, and is therefore a suitable basis for determining average cost of project water.

Dependable Capacity - The load carrying ability of a powerplant that is always available for the time interval and period specified, when related to the characteristic of the load to be supplied. Dependable capacity is fixed primarily by the rate at which power can be produced under conditions of minimum head resulting from maximum reservoir drawdown, or maximum tail-water elevation, and the amounts of energy that can be produced during specified periods of time under the most adverse conditions. Certain and definite amounts of energy must be produced if the capacity is to be considered usable to supply that portion of the load assigned to a particular powerplant or group of powerplants.

Capacity Factor - The ratio of the energy actually produced by a power generating plant in a given period of time to the energy than would be produced if operated at installed capacity throughout the period.

Payment Capacity - The ability of the bulk of the water users in a specific service area to pay for irrigation water, usually expressed in dollars per acre or dollars per acre-foot delivered at the farm headgate. Payment capacity is derived by deducting all fixed and variable costs, except the cost of water, from gross revenues.

Present Water Resource Development

The extent of present development of the surface water supply of the Yuba and Bear Rivers varies widely among the major streams of the basin. The South Yuba River above Spaulding Dam has reached virtually complete development from a practical standpoint through the efforts of the Pacific Gas and Electric Company and its predecessors. The North Yuba

River on the other hand, with nearly one-half the entire runoff of the Yuba River system, is only slightly developed. Nearly all of the major watercourses in the basin contain storage or diversion projects which provide varying degrees of development.

A high degree of development of the subsurface water supply in the Yuba-Bear Area has been reached. In the valley floor region, pumping from the ground water reservoir has exceeded recharge for the past ten years.

About 40 percent of the presently irrigated lands in the Yuba-Bear Area receive water supplies from surface sources. The remaining lands, nearly all of which are within the Valley Floor Service Area, are served by pumping from the ground water basin.

Present water supply development in the various water service areas is described in the following sections and is shown in blue on Plate 6, "Plans for Development."

Valley Floor Service Area

Two projects constitute the major surface water development in the Valley Floor Service Area. The joint facilities of Cordua Irrigation District and Hallwood Water Company provide service to about 14,000 acres of land north of the Yuba River. Works consist of a main canal originating at Daguerre Point Dam on the Yuba River, and associated distribution facilities within the service area. Diversions have averaged about 160,000 acre-feet annually in recent years, including some for the purpose of flooding duck club lands in late fall. The amount of water diverted by the two agencies varies from year to year and is dependent upon the availability of flow in the river. However, some incidential regulation is afforded through the operation of Bullards Bar and Englebright Reservoirs by the Pacific Gas and Electric Company.

The construction of an enlarged Camp Far West Reservoir on the Bear River to increase the storage capacity from 5,000 to 103,500 acre-feet is presently underway by South Sutter Water District. The new reservoir will yield 78,500 acre-feet annually for use in the South Sutter Water District, as well as provide a firm irrigation supply of 12,000 acre-feet per season to Camp Far West Irrigation District.

As previously stated in Chapter II, a study of probable ground water utilization in the valley floor area indicates that about 98,000 acres of agricultural land are presently irrigated by pumping from the ground water basin. The water demand for these lands, together with urban uses, amount to about 420,000 acre-feet annually.

Brownsville Service Area

Agricultural water service in the Brownsville Service Area is confined mainly to lands within the Browns Valley Irrigation District. Existing district works consist of the

Browns Valley Ditch and extensions which convey water from the head of the Colgate Penstock to areas of water use. Annual diversions have averaged about 21,000 acre-feet in recent years.

Virginia Ranch Dam (Merle Collins Reservoir) on French Dry Creek, under construction by the district, will supplement the existing water supply by about 32,000 acre-feet per year. Irrigation releases from the reservoir will be made both to the stream for later diversion, and to the transmountain diversion tunnel for conveyance to the adjacent watershed to the west. The present distribution system will be augmented by the construction of new canals and rehabilitation and enlargement of existing canals where necessary. Present diversions from the head of the Colgate Penstock will be reduced and the water allowed to pass through the Colgate and Narrows Powerplants for the generation of power, for which the Pacific Gas and Electric Company will pay $62,000 annually to the district under a long-term agreement. When the need arises, most of the water will be recaptured near Daguerre Point by pumping from the Yuba River into a new canal serving the lower elevation lands within the district. Pacific Gas and Electric Company maintains Lake Francis on Dobbins Creek near Colgate to augment the water supply for Browns Valley Ditch and thereby reduces the need for releases from Colgate power system during dry periods.

Other water supply facilities for irrigation in the Brownsville Service Area are the privately owned Lake Mildred and the Los Verjeles Ditch. The reservoir, located on French Dry Creek about 2 miles above Merle Collins Reservoir has a usable storage capacity of about 1,500 acre-feet. Water released from storage is rediverted from French Dry Creek into the Los Verjeles Ditch and conveyed to areas of use.

The Yuba County Water District will soon have available 3,700 acre-feet of water, less conveyance losses, delivered via the Forbestown Ditch to New York Creek. The water will be delivered on an irrigation schedule under agreement with Oroville-Wyandotte Irrigation District from their South Fork Project on the Feather River.

San Juan Ridge Service Area

Lands devoted to irrigated agriculture on the San Juan Ridge aggregate little more than 400 acres under present conditions of development. Water supply development is essentially an individual effort and consists mainly of direct diversion or pumping from small streams originating on the ridge.

Grass Valley Service Area

Water supplies for irrigation in the Grass Valley Service Area are provided through the facilities of the Nevada Irrigation District. The district provides service for irrigation of about 10,000 acres of land in Nevada County, and in addition, sells water on an availability basis for use outside the district, primarily in the vicinity of Smartville in Yuba County.

Major water development facilities consist of Scotts Flat Reservoir on Deer Creek with a storage capacity of about 26,300 acre-feet, and a complex network of canals and ditches which distribute the water to areas of use. Water supply for the area comes from the natural flow of Deer Creek, largely supplemented by water delivered through the South Yuba Canal, and from the Yuba and Bear Rivers.

Water supplies delivered through the South Yuba Canal are developed in district facilities located in the mountainous regions of the Yuba River Basin, and are described in a later section. The South Yuba Canal terminates at Deer Creek Forebay, from which canal deliveries are released through the Deer Creek Penstock and Powerplant, works of the Pacific Gas and Electric Company. Deliveries have averaged about 52,000 acre-feet annually in recent years. From the powerplant the water enters Deer Creek and is available for diversion to the Cascade and Snow Mountain Ditches above Scotts Flat Reservoir, or flows into the reservoir for re-regulation and storage for use downstream. Water released from storage enters Deer Creek Diversion Reservoir from which releases can be made into the D-S Canal or to the stream for diversion at lower elevations.

The Excelsior Ditch, which serves lower elevation lands within the district, diverts from the South Yuba River about two miles above Highway 49 bridge and terminates at Deer Creek. An average of about 20,000 acre-feet of water annually are diverted into the ditch for local service, and to the extent that supplies are available, for use on lands outside the district. Deliveries outside the district are made through the China Ditch system, which originates on Deer Creek below the terminus of Excelsior Ditch, and extends to the vicinity of Smartville and Timbuctoo. Diversions to China Ditch average about 12,000 acre-feet of water annually.

Present development utilizing water supplies from the Bear River is limited to works for pumping from Lake Combie into a small ditch serving the La Mar Flat area north of the reservoir, and the Magnolia Ditch which receives water by siphon across the Bear River from the Gold Hill Canal. A total of about 600 acres are presently served by these works.

Auburn Foothills Service Area

A number of water service agencies, organized for the purpose of providing water for irrigation and domestic use, are found within the Auburn Foothills Service Area. Those providing water primarily for agricultural use are the Nevada Irrigation District and the Pacific Gas and Electric Company, while the remaining agencies provide service primarily of a municipal and suburban-residential nature.

The Nevada Irrigation District includes about 66,500 acres within the service area, of which about 16,000 acres are presently irrigated. Remaining irrigated lands within the service area, totaling approximately 16,000 acres, receive water supplies for the most part through the facilities of the Pacific Gas and Electric Company.

Works of the Nevada Irrigation District consist of a canal system for distribution of water supplies diverted from the Bear River and from the natural flow of small streams originating in the area. Deliveries from the Bear River are made through the Gold Hill Canal of 100 second-foot capacity, and through the Bear River Canal of the Pacific Gas and Electric Company. Water supplies are developed in district works near the headwaters of the Yuba River and are conveyed to the Bear River through the joint facilities of the district and the Pacific Gas and Electric Company, described in a following section. These water supplies are augmented by storage in Combie Reservoir, which has a capacity of about 9,000 acre-feet. Releases from Combie Reservoir are to the Bear River for diversion into the Gold Hill Canal.

The Pacific Gas and Electric Company provides water service to a large area south of Auburn Ravine. Water supplies are available from the Bear River as the result of headwater imports from the Yuba and American Rivers. The major portion of the water is diverted through the Bear River Canal, headworks of which are located on the left bank of the Bear River near Colfax. The canal, which has a capacity of about 490 second-feet, extends about 23 miles to the forebay and penstock of the Halsey Powerplant. After passing through the powerplant the water is conveyed about 6 miles to the Wise Forebay. Enroute the water is regulated in Rock Creek Reservoir, at which point deliveries of a portion of the supply belonging to the Nevada Irrigation District are released to Rock Creek. The balance of the water passes through the Wise Powerplant or is conveyed across Auburn Ravine for irrigation use in the company service area. Releases from the powerplant enter Auburn Ravine, The remaining portion of district water is delivered at this point and the balance is diverted into the South Canal for delivery to areas of use south of Auburn Ravine, or is spilled into the American River.

Additional water service to the area is provided by the company's Boardman Canal which diverts from the Bear River near Emigrant Gap and terminates near Roseville.

Colfax Ridge Service Area

The Boardman Canal, which traverses the entire length of the Colfax Ridge Service Area, is the only water supply facility of any extent in the area. Water supplies are provided for irrigation and for urban use along the ridge. Lands presently under irrigation aggregate slightly more than 600 acres.

Water supply is obtained from the natural flow of the Bear River augmented by releases from the Drum and South Yuba Canals to the river above the Boardman Canal headworks.

The canal diverts from the Bear River about one mile west of Emigrant Gap, and spills into Canyon Creek near Drum Forebay. Spill from the Boardman Canal and the Drum Forebay is diverted from Canyon Creek and conveyed in the Boardman-Towle Canal to the Alta Powerplant. After passing through the powerplant, the water may be spilled to the Bear River and diverted downstream at the intake to the Bear River Canal, or conveyed in the Boardman Canal down the ridge to areas of use in the vicinity of Colfax and Clipper Gap, and in the foothills southwest of Auburn.

Mountain Service Area

Except for the Slate Creek diversion feature of the Oroville-Wyandotte Irrigation District's South Fork Project on the Feather River, existing irrigation and hydroelectric power development in the Mountain Service Area is exclusively that of the Pacific Gas and Electric Company and the Nevada Irrigation District.

The Oroville-Wyandotte Irrigation District works consist of a diversion dam on Slate Creek, a tributary of the North Yuba River, and a tunnel extending from the diversion pool to Sly Creek Reservoir in the Feather River drainage basin. Diverted flows are used to supplement the runoff of the South Fork Feather River and its tributaries for the production of hydroelectric power and irrigation.

Bullards Bar Reservoir and power generation features comprise the only other development on the North Yuba River. Gross storage capacity of the reservoir is 31,500 acre-feet.

Present development by the Nevada Irrigation District and the Pacific Gas and Electric Company include works on the Middle Yuba River, Canyon Creek, South Yuba River, Bear River, and North Fork of North Fork American River. Under a joint project agreement between the two agencies, water supply developed by the district is utilized by the company for the generation of power, after which it is returned to the district at downstream points for irrigation use.

Nevada Irrigation District works, all of which are operated as part of the joint project, extend generally southward from the Middle Yuba River to Fuller Lake of the Pacific Gas and Electric Company. Features located on the Middle Yuba River are the Milton Diversion Dam and the headworks of the Milton-Bowman Conduit. Releases from the diversion pool into the conduit, which has a design capacity of 500 second-feet, are conveyed through 4.1 miles of pipeline and tunnel to Bowman Reservoir. This reservoir, located on Canyon Creek, a tributary to South Yuba River, has a storage capacity of 68,000 acre-feet. Several other reservoirs are located on Canyon Creek above Bowman Reservoir. Of these, French Lake is the largest with a storage capacity of 12,500 acre-feet. The controlled releases from Bowman Reservoir are conveyed southerly in the Bowman-Spaulding Conduit, 9 miles in length and of 230 second-foot capacity, to Fuller Lake on Jordan Creek. This reservoir, owned by Pacific Gas and Electric Company, has a capacity of 1,130 acre-feet. Flow in the Bowman-Spaulding Canal is augmented enroute by diversions from Texas and Fall Creeks into the canal. The Texas and Fall Creek diversion system, including the numerous small headwater lakes, are owned by the Pacific Gas and Electric Company and operated by the Nevada Irrigation District. The present contract between the district and the company requires that a total seasonal supply of 132,000 acre-feet of district water be delivered to the company at Fuller Lake. In addition, 3,500 acre-feet of company water from the Texas-Fall Creek system must be delivered each year. The district water, after being utilized for the generation of power in the company's powerplants, is returned below Deer Creek, Halsey and Wise Powerplants for irrigation use in the district's service areas in Nevada and Placer Counties.

Works of the Pacific Gas and Electric Company include Lake Van Norden, located near the headwaters of the South Yuba River, with a storage capacity of 5,900 acre-feet, and Fordyce, Meadow and Sterling Lakes on Fordyce Creek, a tributary of the South Yuba River, with an aggregate storage capacity of 53,000 acre-feet. The principal storage reservoir of the company is Lake Spaulding on the South Yuba River, with a storage capacity of 74,500 acre-feet. From Fuller Lake, previously mentioned, water delivered by the Nevada Irrigation District is conveyed by conduit to the company's Spaulding Powerplant No. 3 situated on the rim of Lake Spaulding, and then discharges to the reservoir.

Controlled releases from Lake Spaulding are made through Spaulding Powerplant No. 1, one of the two powerplants located just below the dam. Releases from the powerplant pass through Powerplant No. 2, or enter a tunnel leading to the Drum Canal. The Drum Canal, which has a capacity of 500 second-feet, passes from the South 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, terminating at the Drum Forebay. Releases through the Drum Powerplant enter an afterbay on the Bear River and then flow into a pressure tunnel leading to the Dutch Flat Powerplant. From the afterbay of Dutch Flat Powerplant, the released water is conveyed in the natural channel of the Bear River to the diversion headworks of the Bear River Canal, previously described.

The company's system also includes Lake Valley Reservoir located on the North Fork of North Fork American River, with a storage capacity of 8,100 acre-feet. Releases from the reservoir are conveyed to the Drum Canal by means of a conduit which joins the canal near Emigrant Gap. Some 13 other reservoirs owned by Pacific Gas and Electric Company are scattered throughout the watershed of the South Yuba River and the Texas and Fall Creek Basins.

Water released through Spaulding Powerplant No. 2 discharges into the South Yuba Canal and conveyed about 19 miles to Deer Creek Forebay, previously described. The canal has an initial capacity of 185 second-feet, reducing to a minimum of 125 second-feet enroute.

A summary of physical data relating to hydroelectric powerplants mentioned in the foregoing is presented in Table 19.

Formulation of Plans for a Multipurpose Project on the Lower Yuba River

Plans for a multipurpose project on the Lower Yuba River as formulated for Bulletin No. 3, "The California Water Plan," consisted of a complex of five reservoirs and associated hydroelectric power facilities located on the North, Middle, and main stem Yuba River, and an offstream storage reservoir located on Dry Creek to the south.

Storage on the North Yuba River under this plan was divided between a Wambo Reservoir of 62,000 acre-feet gross storage capacity and a New Bullards Bar Reservoir of 455,000 acre-feet gross storage capacity. Regulation of the Middle Yuba River was afforded by a Freemans Reservoir of 300,000 acre-feet gross storage capacity, to be constructed to the same normal pool elevation as New Bullards Bar

TABLE 19

HYDROELECTRIC POWERPLANTS IN THE YUBA-BEAR AREA

Name of plant	Type of unit	Number of units	Gross head (feet)	Design head (feet)	Maximum h.p. at design head	Name plate rating per unit (kw)	Total rated capacity (kw)	Year installed
Bullards Bar	VF	1	166	170	10,000	6,500	6,500	1924
Colgate	VF	1	820	728	35,000	24,000	24,000	1949
Narrows	VF	1	240	235	13,500	9,350	9,350	1942
Deer Creek	HI	1	837	760	7,500	5,500	5,500	1908
Spaulding No. 1	VF	1	197	197	10,000	6,400	6,400	1928
Spaulding No. 2	VF	1	344	335	5,300	3,370	3,370	1928
Spaulding No. 3 (Rim)	HF	1	318	306	8,000	6,300	6,300	1929
Alta	HI	2	648		3,000	1,000	2,000	1902
Drum	HI	2	1,374	1,330	17,000	12,000		1913
	HI	1	1,374	1,260	18,000	12,000	48,000	1922
	HI	1	1,374	1,280	18,000	12,000		1928
Dutch Flat	VF	1	643	496	29,000	22,000	22,000	1943
Halsey	HF	1	331	320	18,000	12,000	12,000	1916
Wise	HF	1	519	475	18,700	12,000	12,000	1917

VF - Vertical Francis
HI - Horizontal Impulse
HF - Horizontal Francis

Reservoir. A connecting tunnel would permit the operation of the two reservoirs as a single pool.

Downstream on the main stem, a Parks Bar Reservoir was proposed with a gross storage capacity of 243,000 acre-feet. Also included in the plan was a Waldo Reservoir on Dry Creek in Camp Beale to provide 300,000 acre-feet of offstream storage for Yuba River water diverted from existing Englebright Reservoir. Three new powerplants were included to develop the available head from Wambo Reservoir to below Parks Bar Reservoir.

More detailed studies of the Bulletin No. 3 plan conducted during the course of this investigation resulted in several modifications to the plan. Geologic exploration of the Freemans damsite revealed extensive stripping requirements associated with both the dam and the spillway. Subsequent investigation of alternatives to storage at the Freemans site resulted in the selection of a feeder conduit leading from the Middle Yuba River to a larger New Bullards Bar Reservoir which was sized to accommodate the increased inflow. Features of this conduit will be discussed later under heading of New Bullards Bar Unit.

Further investigation of the Wambo Reservoir revealed that the cost of developing the head available between Wambo and New Bullards Bar Reservoirs for hydroelectric power generation is greater than the benefits accruing from it, and therefore is an uneconomical increment of development.

Storage to afford comparable regulation of the North Yuba River can be obtained more economically at the New Bullards Bar site.

Analysis of two storage possibilities on the main stem Yuba River; namely, Marysville Reservoir and Parks Bar Reservoir, with interconnected storage on French Dry Creek, resulted in the small Parks Bar-Waldo Reservoir combination being eliminated in favor of storage at either of these other sites. The Marysville site, about 1.5 miles upstream from Daguerre Point Dam, is topographically suited for a reservoir with a capacity of up to 2 million acre-feet. At the Parks Bar site, supplemental storage capacity can be provided by an auxiliary dam on French Dry Creek to the north and the excavation of a connecting channel. Storage capacity up to 825,000 acre-feet can thus be obtained without interference with the Colgate Powerplant. The existing Englebright Dam would be inundated by a reservoir of this capacity.

During the course of these studies, several other alternative development possibilities were considered and evaluated in some detail before final project selection. These included:

1. A single large Narrows Reservoir on the main stem of the Yuba River, with dam located below existing Englebright Dam.

2. Alternative storage reservoirs on the main stem Yuba River to precede or follow upstream works.

a. A Long Bar Reservoir on Yuba River with dam located between the Marysville site and Parks Bar.

b. A Narrows Reservoir with interconnected offstream storage at Waldo Reservoir on Dry Creek.

3. Alternative storage reservoirs above Colgate to precede or follow downstream works.

a. A single large San Juan Reservoir, with dam located on North Yuba River below the confluence of Middle Yuba River.

b. A single large Wambo Reservoir, with dam located above the head of existing Bullards Bar Reservoir on North Yuba River.

c. A single large Indian Valley Reservoir, with dam located on North Yuba River near Highway 49 bridge crossing.

d. An Indian Valley-Wambo Reservoir combination.

e. An Indian Valley-New Bullards Bar Reservoir combination.

f. A New Bullards Bar-San Juan Reservoir combination.

4. Various combinations of upstream and downstream units to form a single integrated project, capable of accomplishing the required objectives, and in addition, susceptible to staging for construction to meet anticipated needs as they develop.

As planning studies and comparisons of alternatives progressed, it became evident that a dual reservoir project, consisting of (1) an upstream New Bullards Bar Reservoir with feeder diversions from the Middle Yuba River and Oregon Creek and associated power generation facilities, and (2) a downstream storage unit, would afford the most advantageous and economical water development. Alternative units for downstream storage would consist of (1) a Marysville Dam and Reservoir, or (2) a large Parks Bar Dam and Reservoir.

Either of these dual reservoir projects would conserve and develop new water supplies, develop the hydroelectric power potential of the Yuba River below New Bullards Bar Reservoir, provide for the control of floods, and enhance the recreation and fisheries potential of the area.

The Marysville site permits the development of a reservoir with a larger storage capacity than that available at the Parks Bar-Dry Creek site. The greater carry-over storage capacity, and the marginal feasibility of a dependable power installation below the dam due to the low average head available, would make possible the release of large quantities of water on a variable schedule to firm up the export supply from the Delta.

The Parks Bar Unit would include a powerplant at the base of the dam and would thereby further develop the power potential. As a consequence of release requirements for firm power generation, together with a smaller active storage capacity than the proposed Marysville Reservoir, no new water for export from the Delta would be realized.

In formulating the dual reservoir plans, it was anticipated that the combination upstream and downstream units would form a single integrated project that would be capable of accomplishing the desired objectives for multipurpose development on the river and, in addition, would be susceptible of staging for construction to meet anticipated needs as they develop.

In 1959, an act was passed by the California State Legislature creating the Yuba County Water Agency. The purpose of the agency is to coordinate development of the water resources of the county. Such development must conserve water for domestic, industrial, and irrigation uses; produce hydroelectric power; prevent flood damage; and enhance recreational activities. In that year, the agency retained International Engineering Company, Incorporated, (IECO) to prepare a master plan representing the most economical multipurpose development for maximum utilization of the water resources of Yuba County.

The plan for initial development formulated for the agency was essentially the same as the New Bullards Bar Unit of the lower Yuba River Project advocated by the State.

Subsequent studies conducted by the department and Yuba County Water Agency resulted in the following conclusions: (1) Supplemental water requirements in the Valley Floor Service Area could essentially be satisfied by the development of New Bullards Bar Reservoir and projects proposed by South Sutter Water District and Placer County Water Agency; (2) Reservoir storage on the main stem Yuba River, although currently required for vital flood protection, would not be justified until such time that additional water supplies were needed; and (3) The additional hydroelectric power developed below Englebright Dam is necessary to support local project financing from revenue bonds.

The New Bullards Bar-Marysville Project is considered to be the most practical multipurpose plan to maximize the development and utilization of the water resources of the lower Yuba River. Under this plan, the New Bullards Bar Unit would include the further development of the power drop available below Englebright Dam with the construction of a New Narrows Powerplant. Inasmuch as this plant would be subject to backwater from a future Marysville Reservoir, an agreement was reached between the department and the agency which in essence states that the agency will bear the cost for all damages and any loss of power head resulting from the construction of a Marysville Reservoir to a normal water surface elevation of 340 feet. A copy of this agreement is presented as Appendix H.

In light of the foregoing, physical features of the New Bullards Bar Unit described herein are for the agency plan as presented in their feasibility report dated January 1961 and the addendum thereto.

New Bullards Bar Unit

The new Bullards Bar Unit of the proposed lower Yuba River Project consists of six major related features

Englebright Dam and Narrows Powerplant on Yuba River. New Narrows Powerplant would be located on opposite bank.

which, for the sake of clarity, will be treated separately. The six features are:

1. Middle Yuba-Oregon Creek Diversion
2. New Bullards Bar Dam and Power Facilities
3. New Colgate Power Facilities
4. New Narrows Power Facilities
5. Timbuctoo Afterbay and Irrigation Diversion Weir
6. Irrigation canals and drainage facilities.

Portions of the following are taken directly from the IECO feasibility report and YCWA application for project license before the Federal Power Commission.

Middle Yuba-Oregon Creek Diversion. This feature consists of the Hour House and Log Cabin Diversion Dams and the Lohman Ridge and Camptonville Tunnels which will be used to divert and convey unregulated flows of Middle Yuba River and Oregon Creek into New Bullards Bar Reservoir.

Hour House Diversion Dam would be located on the Middle Yuba River about 6.5 miles upstream from the mouth of Oregon Creek. It would be of concrete arch construction with the central 315 feet of the dam formed as a spillway to permit unregulated passage of flood flows. Spillway capacity would be approximately 58,000 second-feet. One 18-inch diameter sluice pipe with valve would be provided to permit up to 50 second-feet stream releases for fish preservation below the dam. The dam would direct unregulated

Middle Yuba River water to Oregon Creek through the Lohman Ridge Tunnel.

The Lohman Ridge Tunnel would extend from the diversion pool behind Hour House Dam a distance of 19,700 feet to Oregon Creek. It would be of horseshoe section and have a capacity of 1,000 second-feet. The excavated section would be 14 feet in diameter and unlined or lined with concrete depending on the condition of the rock formations encountered.

Log Cabin Diversion Dam would be located on Oregon Creek about 3.5 miles upstream of its junction with the Middle Yuba River. It would be of concrete arch construction with the central 205 feet of the dam formed as a spillway to permit unregulated passage of flood flows. Spillway capacity would be approximately 12,000 second-feet. One 18-inch diameter sluice pipe with valve would be provided to permit up to 12 second-feet stream releases for fish preservation below the dam. The dam would divert imported Middle Yuba River water and unregulated flows of Oregon Creek through the Camptonville Tunnel to New Bullards Bar Reservoir.

Camptonville Tunnel would extend from the diversion pool behind Log Cabin Dam a distance of 6,750 feet to New Bullards Bar Reservoir. It would be of horseshoe section and have a capacity of 1,100 second-feet. The excavated section would be 15.5 feet in diameter and unlined or lined with concrete depending on condition of the rock formations encountered.

New Bullards Bar Dam and Power Facilities. This feature consists of the New Bullards Bar Dam, powerplant, outlet works, and spillway.

The dam would be located on the North Yuba River about 1.5 miles downstream from the existing Bullard Bars Dam and immediately upstream from the existing Colgate Diversion Dam. It would be of earthfill or concrete arch construction with a height above streambed of about 634 feet. Gross storage capacity of the reservoir would be 930,000 acre-feet at normal pool elevation of 1,955 feet. The following discussion relates to a dam of earthfill construction.

An inclined power tunnel would be located through the left abutment with intake invert at an elevation of 1,700 feet. It would be approximately 1,500 feet in length with a maximum capacity of 3,800 second-feet. The intake to the tunnel would be provided with conventional trashracks, a control gate and a set of stoplogs.

The spillway would be excavated through the ridge about 2,700 feet from the left abutment of the dam and discharge into Marys Ravine and then into the Middle Yuba River. Control would be provided by three 35-foot wide by 40-foot high tainter gates atop a concrete ogee weir with crest elevation 1,915 feet. Releases to maintain flood control reservation requirements would be made through two

15-foot by 15-foot outlets, regulated by top-sealing tainter gates, located near the base of the spillway dam. Total combined discharge capacity would be approximately 172,500 second-feet with reservoir at elevation 1,964 feet. A maximum flood control storage reservation of 170,000 acre-feet would be provided as specified by the U.S. Army Corps of Engineers.

A new powerplant would be located on the left bank adjacent to the toe of the dam. It would be the outdoor type with an installed capacity of 126,000 kilowatts provided by two generating units driven by Francis type turbines.

New Colgate Power Facilities. The main elements of this feature will be a diversion dam, power tunnel, surge shaft, two penstocks, and a powerplant.

The diversion dam would be located on the North Yuba River about 2,700 feet downstream of the toe of New Bullards Bar Dam. It would be of concrete gravity construction with overpour section and a height above streambed of about 50 feet. An 18-inch diameter outlet with regulating valve would be provided in the dam to release 5 second-feet of water for stream maintenance. This diversion dam would divert water released by the New Bullards Bar Powerplant into the existing and New Colgate Tunnels.

A new power tunnel of 2,600 second-foot capacity would extend from the diversion reservoir a distance of about

22,400 feet to the head of the New Colgate Penstock. It would be of horseshoe section with a diameter of 20 feet and would be unlined except where lining is required for support. The intake would be provided with trashrack and closure gate. A differential surge chamber would be constructed near the downstream end of the tunnel. A 12.5-foot diameter header located in the tunnel would extend approximately 250 feet to a wye where it would branch into two penstocks. The two penstocks, each 9.0 feet in diameter, would extend approximately 2,300 feet from the wye to the powerplant.

Due to construction of the New Bullards Bar Project, the existing Colgate Intake would be abandoned. A new intake would be provided and tied in with the existing tunnel by a new section of tunnel about 3,000 feet in length.

The New Colgate Powerplant would be located on the north bank of the Yuba River about 600 feet downstream of the existing Colgate Powerplant of the Pacific Gas and Electric Company. It would be the outdoor type with an installed capacity of 130,000 kilowatts provided by two generating units driven by Francis type turbines.

New Narrows Power Facilities. This feature consists of a New Narrows Power Tunnel and a New Narrows Powerplant. The powerplant would be located on the north bank of the Yuba River facing the existing Pacific Gas and Electric Company

Narrows Powerplant and about 1,200 feet downstream from Englebright Dam.

The tunnel, with a maximum capacity of 3,000 second-feet, would be 1,600 feet long between the intake and the head of the penstock. It would be of standard horseshoe section excavated to a diameter of 19 feet, and lined. The inlet would be provided with an emergency closure gate. The penstock would be 13.25 feet in diameter and extend for about 230 feet from the tunnel to the powerplant. A surge chamber would be excavated near the downstream end of the tunnel.

New Narrows Powerplant would be of the outdoor type with an installed capacity of 41,000 kilowatts in a single unit. A 66-inch bypass valve of the Howell-Bunger type would release water for irrigation purposes when the powerplant is not in operation. The powerplant would be designed so that the equipment is safe against flooding in the event the future Marysville Unit is constructed with a reservoir capacity of 1,000,000 acre-feet, corresponding to a normal pool elevation of 340 feet.

Timbuctoo Afterbay and Irrigation Diversion Weir. A Timbuctoo Afterbay Dam would be constructed on the Yuba River about one mile upstream from Parks Bar Bridge on State Highway 20. It would be of rockfill construction and provide about 5,500 acre-feet of active storage capacity for re-regulation of releases from the Narrows Powerplants.

Downstream at Marysville damsite, a low rockfill weir would be constructed to develop a diversion pool to an approximate elevation of 165 feet. Headworks for the proposed main canals, stream release outlet, fish ladders and screens would be located at the weir.

The diversion weir and afterbay dam would be interim facilities until construction of the Marysville Unit, which would replace the function of these facilities.

Irrigation and Drainage Facilities. The main canal systems would be located on both the north and south sides of the Yuba River. The North Canal would extend from the diversion weir northwest along the base of Browns Valley Ridge and then turn west toward the Feather River. The first reach would be lined and have a capacity of 400 second-feet. The remaining sections would be unlined and have a capacity of 230 second-feet reducing to 70 second-feet at the terminus.

The South Canal would extend from the diversion weir south to a point west of Beale Air Force Base runway where it would divide into two branches. The first section would be lined and have a capacity of 1,150 second-feet. The main branch, with a capacity of 900 second-feet, would go west through Olivehurst and Linda. The other branch, with a capacity of 250 second-feet, would go south to Wheatland Water District where it would again divide into two branches.

General features of the New Bullards Bar Unit are presented in Table 20 and on Plate 6. Estimated capital cost as reported by International Engineering Company, Incorporated, in June 1961, would be $161,470,000.

Operation, maintenance, and general expense costs for the irrigation and drainage facilities were estimated by the department and added to annual charges for power features as estimated by IECO in their January 1961 report resulting in a total estimated annual cost, excluding repayment, of $1,200,000. Repayment over a 50-year period at 4 percent interest would amount to $7,512,000 resulting in a total annual cost of $8,712,000.

Accomplishments of New Bullards Bar Unit

Accomplishments of the New Bullards Bar Unit presented herein, as they relate to irrigation yield and power production, were taken from Yuba County Water Agency's feasibility report prepared by International Engineering Company, Incorporated, dated January 1961, and the addendum thereto dated June 1961. Studies conducted by the department gave results which were in substantial agreement with those of IECO.

Hydroelectric power accomplishments were determined from operation studies designed to develop near-optimum dependable power output and provide supplemental water supplies adequate to satisfy projected demands. During

TABLE 20

GENERAL FEATURES OF NEW BULLARDS BAR UNIT OF LOWER YUBA RIVER PROJECT

Dams and Reservoirs	Stream	Dam: Location MDB&M Sec.	T	R	Type 1/	Height in feet	Crest elevation in feet	Normal water surface elevation in feet	Storage capacity in acre-feet: Gross	Active
New Bullards Bar	N. Yuba River	25	18N	7E	RF	634	1,967	1,955	930,000	677,700
Hour House Diversion	M. Yuba River	20	18N	9E	CA	90	2,045	2,030	-	-
Log Cabin Diversion	Oregon Creek	11	18N	8E	CA	70	1,978	1,970	-	-
Colgate Diversion	N. Yuba River	25	18N	7E	CG	50	1,350	1,350	-	-
Narrows Afterbay	Yuba River	21	16N	6E	RF	83	328	305	-	5,500
Irrigation Diversion	Yuba River	28	16N	5E	RF	17	167	165	-	-

Powerplants	Maximum static head in feet	Installed capacity in kilowatts	Number of units	Type of turbine
New Bullards Bar	605	126,000	2	Francis
New Colgate	793	130,000	2	Francis
New Narrows	240	41,000	1	Francis

Conduits	Length in feet	Capacity in second-feet	Diameter in feet	Type and cross section
Lohman Ridge Tunnel	19,700	1,000	14.0	Unlined horseshoe
Camptonville Tunnel	6,750	1,100	15.5	Unlined horseshoe
Bullards Bar Tunnel	1,500	3,800	19.0 to 15.0	Concrete and steel lined circular
Bullards Bar Penstocks	NA	3,800	2-10.5	Steel
New Colgate Tunnel	22,400	2,600	20.0	Unlined horseshoe
New Colgate Penstocks	2,300	2,600	2- 9.0	Steel
New Narrows Tunnel	1,600	3,000	19.0 2/	Lined horseshoe
New Narrows Penstock	230	3,000	13.25	Steel

1/ Type: CA - Concrete arch
CG - Concrete gravity
RF - Rockfill

2/ Prior to lining
NA - Not available

the initial 15 years of operation, the 3 new powerplants could develop 214,000 kilowatts of dependable power when operated as an integrated system with a capacity factor of 41.5 percent. Average energy generation would be 1,006,500,000 kilowatt-hours per year. In the following years it is anticipated that hydroelectric power will be marketable at 34 percent capacity factor, thereby enabling the 3 powerplants to develop 239,000 kilowatts of dependable power under the most adverse conditions of available water supply. Average annual energy generation for this period would be 998,300,000 kilowatt-hours per year.

New water supplies for irrigation developed by the unit would be 265,500 acre-feet annually for the first 15 years of operation, 366,000 acre-feet annually the following 30 years of operation, and 376,000 acre-feet annually thereafter. Shortages within permissible limits would be experienced in dry years.

New Bullards Bar Reservoir would also afford new recreational opportunities. Studies by the agency and the department indicate that recreational activities will include boating, picnicking, camping, and sightseeing. Development of onshore recreation facilities will be restricted by rugged terrain around the perimeter of the reservoir which limits the total usable area and reduces the density of units per acre. This lack of facilities will limit the level of recreation use that can be accommodated at the reservoir.

In addition to this, it is anticipated that severe competition may be generated by 1980 because of the large number of reservoirs planned for construction in the foothills and central mountain area by that time.

Recreational use at New Bullards Bar Reservoir, as projected by the department during this investigation, is shown by decades in Table 21.

TABLE 21

SUMMARY OF PROJECTED ANNUAL VISITOR DAYS
OF RECREATION USE ATTRIBUTABLE
TO NEW BULLARDS BAR RESERVOIR

Recreation use	Year					
	1970	1980	1990	2020	2010	2020
Existing reservoir	72,000	81,000	88,000	88,000	88,000	88,000
New reservoir	144,000	174,000	174,000	174,000	174,000	174,000
Increase	72,000	93,000	86,000	86,000	86,000	86,000

Partial flood control along the lower Yuba River would be provided by New Bullards Bar Reservoir when operated in accordance with the criteria set forth in Chapter IV. Studies to determine the flood control accomplishments have been completed by the U. S. Army Corps of Engineers and results published by that agency.

Controlled releases from Timbuctoo Afterbay resulting from the operation of the upstream works for power generation and irrigation would enhance the salmon fishery in the lower Yuba River assuming that proper water temperature control can be maintained. It is estimated that enhancement of the commercial fishery resulting from the development would average about 47,500 fish annually, with an increase in the sport catch of about 6,500 fish annually.

Based on preliminary studies conducted by the Department of Water Resources, the net effect of the operation of the New Bullards Bar Unit for power, irrigation, and streamflow enhancement would be to impair the availability of water for export from the Sacramento-San Joaquin Delta by an average of about 40,000 acre-feet per season. This impairment, which is relatively small in comparison with the amount of diversion for local irrigation use, is attributable to the inherent streamflow regulation afforded by releases for hydroelectric power and streamflow maintenance.

The rate of development of the Yuba and Sutter County portions of the Valley Floor Service Area to irrigated agriculture, residential farm, and urban use was projected on the basis of assumptions itemized in Chapter III. Present and projected patterns of land use are summarized by decades in Tables 22 and 23.

Water delivery requirements for irrigation, residential farm, and urban uses were determined by applying unit water requirements for irrigated agriculture and urban use presented in Chapter III to the present and projected land use patterns.

TABLE 22

SUMMARY OF PRESENT AND PROJECTED LAND USE
IN YUBA COUNTY PORTION 1/
OF VALLEY FLOOR SERVICE AREA
(in acres)

Land use	Present 2/	Year 1970	1980	1990	2000	2010	2020
rrigated agriculture							
Deciduous orchard	10,200	16,000	20,000	24,000	27,000	29,500	31,000
Subtropical orchard	250	800	1,100	1,400	1,800	2,100	2,500
Miscellaneous truck	4,490	5,500	5,600	5,300	5,200	5,200	5,250
Miscellaneous field	4,080	6,500	7,100	7,800	8,300	8,700	9,000
Alfalfa	4,450	7,000	6,400	5,800	5,200	3,250	1,900
Rice	19,570	18,000	18,800	19,600	20,400	21,200	22,000
Pasture	21,040	22,700	39,100	49,200	45,500	39,150	32,150
Double crop	200	(1,200)	(1,500)	(1,900)	(2,200)	(2,500)	(2,800)
Subtotal, net area	64,280	76,500	98,100	113,100	113,400	109,100	103,800
esidential farms	3/	1,700	2,010	2,980	4,110	5,570	7,350
rban	4,010	5,330	6,880	8,750	11,170	14,240	18,080
TOTAL, net area	68,290	83,530	106,990	124,890	128,680	128,910	129,230

/ Includes portions of Sutter and Placer Counties north of Bear River.
/ As determined from Department of Water Resources survey in 1954.
/ Included in irrigated agriculture.

TABLE 23

SUMMARY OF PRESENT AND PROJECTED LAND USE
IN SUTTER COUNTY PORTION 1/
OF VALLEY FLOOR SERVICE AREA
(in acres)

Land use	Present 2/	Year 1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Deciduous orchard	4,100	7,000	9,000	11,000	13,000	15,000	16,000
Subtropical orchard	30	---	---	---	---	---	---
Miscellaneous truck	1,200	4,000	5,500	7,000	8,000	8,500	9,000
Miscellaneous field	2,540	8,000	10,000	11,000	10,000	9,500	9,000
Alfalfa	3,420	7,000	8,000	7,160	5,460	2,910	1,140
Rice	23,790	20,000	24,000	25,000	26,000	27,000	27,500
Pasture	8,200	14,820	16,540	14,040	11,740	10,290	9,060
Double crop	---	(1,200)	(1,900)	(2,500)	(2,900)	(3,200)	(3,600)
Subtotal, net area	43,280	60,820	73,040	75,200	74,200	73,200	71,700
Residential farm	3/	480	560	1,200	1,700	2,200	2,500
Urban	110	120	190	430	910	1,610	3,010
TOTAL, net area	43,390	61,420	73,790	76,830	76,810	77,010	77,210

1/ Excludes portion of Sutter County north of Bear River.
2/ As determined from Department of Water Resources survey in 1954.
3/ Included in irrigated agriculture.

A summary of present and projected seasonal water delivery requirements by decades is presented in Tables 24 and 25.

A summary of present development and the disposition of yield from the proposed water development to meet anticipated water requirements in the Yuba and Sutter County portions of the Valley Floor Service Area is presented in Tables 26 and 27.

In determining the disposition of the water supply available under future conditions of development, it was assumed that present pumping of ground water for irrigation would decrease to an amount somewhat less than the present extractions from the basin due to the availability of low cost surface water. There would, however, be certain agricultural areas which would continue to pump from ground water due to geographic location, the existence of highly productive wells, or personal preference of the farmer.

Based on the foregoing, pumping from ground water for all uses was estimated to decrease to about 100,000 acre-feet per year upon availability of project water, and stabilize at that level of use in the future. All supplemental urban and residential farm demands were assumed would be met from this source.

A graphic presentation of anticipated water delivery requirements in the Yuba and Sutter County portions

TABLE 24

SUMMARY OF PRESENT AND PROJECTED SEASONAL WATER DELIVERY REQUIREMENTS IN YUBA COUNTY PORTION 1/ OF VALLEY FLOOR SERVICE AREA
(in acre-feet)

Land use	Year						
	Present	1970	1980	1990	2000	2010	2020
Agriculture	286,540	292,410	366,550	432,270	436,210	413,570	392,060
Residential farm	2/	5,100	6,000	8,900	12,300	16,700	22,000
Urban	7,250	9,600	12,800	16,900	22,300	29,600	38,900
TOTAL	293,790	307,110	385,350	458,070	470,810	459,870	452,960
Total, rounded	293,800	307,100	385,400	458,100	470,800	459,900	453,000

1/ Includes portions of Sutter and Placer Counties north of Bear River.
2/ Included in agriculture.

TABLE 25

SUMMARY OF PRESENT AND PROJECTED SEASONAL WATER DELIVERY REQUIREMENTS IN SUTTER COUNTY PORTION 1/ OF VALLEY FLOOR SERVICE AREA
(in acre-feet)

Land use	Year						
	Present	1970	1980	1990	2000	2010	2020
Agriculture	223,560	250,530	299,950	304,750	301,290	298,240	293,290
Residential farms	2/	1,440	1,680	3,600	5,100	6,600	7,500
Urban	60	70	150	480	1,350	2,760	5,640
TOTAL	223,620	252,040	301,780	308,830	307,740	307,600	306,430
Total, rounded	223,600	252,000	301,800	308,800	307,700	307,600	306,400

1/ Excludes portion of Sutter County north of Bear River.
2/ Included in agriculture

TABLE 26

SUMMARY OF PRESENT AND PROPOSED WATER SUPPLY DEVELOPMENT AND WATER DELIVERY REQUIREMENTS IN YUBA COUNTY PORTION 1/ OF VALLEY FLOOR SERVICE AREA

	Effective yield 2/	Water delivery requirements 3/	Indicated surplus or deficit	Remarks
Present Development				
Safe ground water pumping (est.)	140,000			
Yuba River surface diversion	111,000 5/			
Feather River surface diversion	13,000			
Enlarged Camp Far West Reservoir	6,000 4/			
Subtotal	270,000	293,800	-23,800	Deficit attributable to ground water overdraft
Proposed Development				
Change in ground water pumping	-40,000			
BVID pump diversion	13,000			
New Bullards Bar Unit	312,000			
TOTAL DEVELOPMENT	555,000	453,000	102,000	Surplus to Yuba County. To be exported to Sutter County south of Bear River

1/ Includes Sutter and Placer Counties north of Bear River
2/ Developed supply adjusted for estimated conveyance losses to farm headgate, and assumed reuse of applied water
3/ From Table 24
4/ For Camp Far West Irrigation District
5/ Additional water is diverted during irrigation season when available and during October through December for duck clubs

TABLE 27

SUMMARY OF PRESENT AND PROPOSED WATER SUPPLY DEVELOPMENT AND WATER DELIVERY REQUIREMENTS IN SUTTER COUNTY PORTION 1/ OF VALLEY FLOOR SERVICE AREA
(in acre-feet)

	Effective yield 2/	Water requirements 3/	Indicated surplus or deficit	Remarks
Present Development				
Safe ground water pumping (est.)	150,000			Increased surface applications from Enlarged Camp Far West Reservoir assumed to compensate for past ground water overpumping which averaged about 7,000 acre-feet during recent years.
Feather River surface diversions	47,000			
Enlarged Camp Far West Reservoir	27,000 4/			
Subtotal	224,000	223,600	+400	
Proposed Development to 2020				
Purchase of water from Yuba County Water Agency	82,400			
TOTAL DEVELOPMENT	306,400	306,400		

1/ Excludes portion of county north of Bear River.
2/ Developed yield adjusted for estimated conveyance losses to farm headgate and assumed reuse of applied water.
3/ From Table 25.
4/ Balance of reservoir yield assumed to be utilized in Placer County portion of South Sutter Water District.

of the Valley Floor Service Area to year 2020, and the proposed means of satisfying these requirements is presented in Figure 2.

Benefits from New Bullards Bar Unit

The primary tangible benefits that would accrue to the New Bullards Bar Unit would be derived from increased irrigation water supplies, production of hydroelectric power, flood control, increased water-associated recreational activity, and fishery enhancement.

Benefits from irrigation would consist of the net value of the returns to land and water from the agricultural lands served. As indicated in Table 26, yield developed under the Yuba County Water Agency plan of operation exceeds the projected demands for supplemental water supplies in the valley floor of Yuba County as estimated by the department, and can therefore be made available for use in Sutter County as shown in Table 27. Increased productivity would result from the application of water to presently dry-farmed and other irrigable lands. Irrigation benefits from the lands served by new water supplies were derived by applying unit values of returns to land and water to the crop pattern presented in Tables 22 and 23, and appropriately reducing the result to reflect returns from present farming operations. Detailed results of the economic studies are presented in Appendix F.

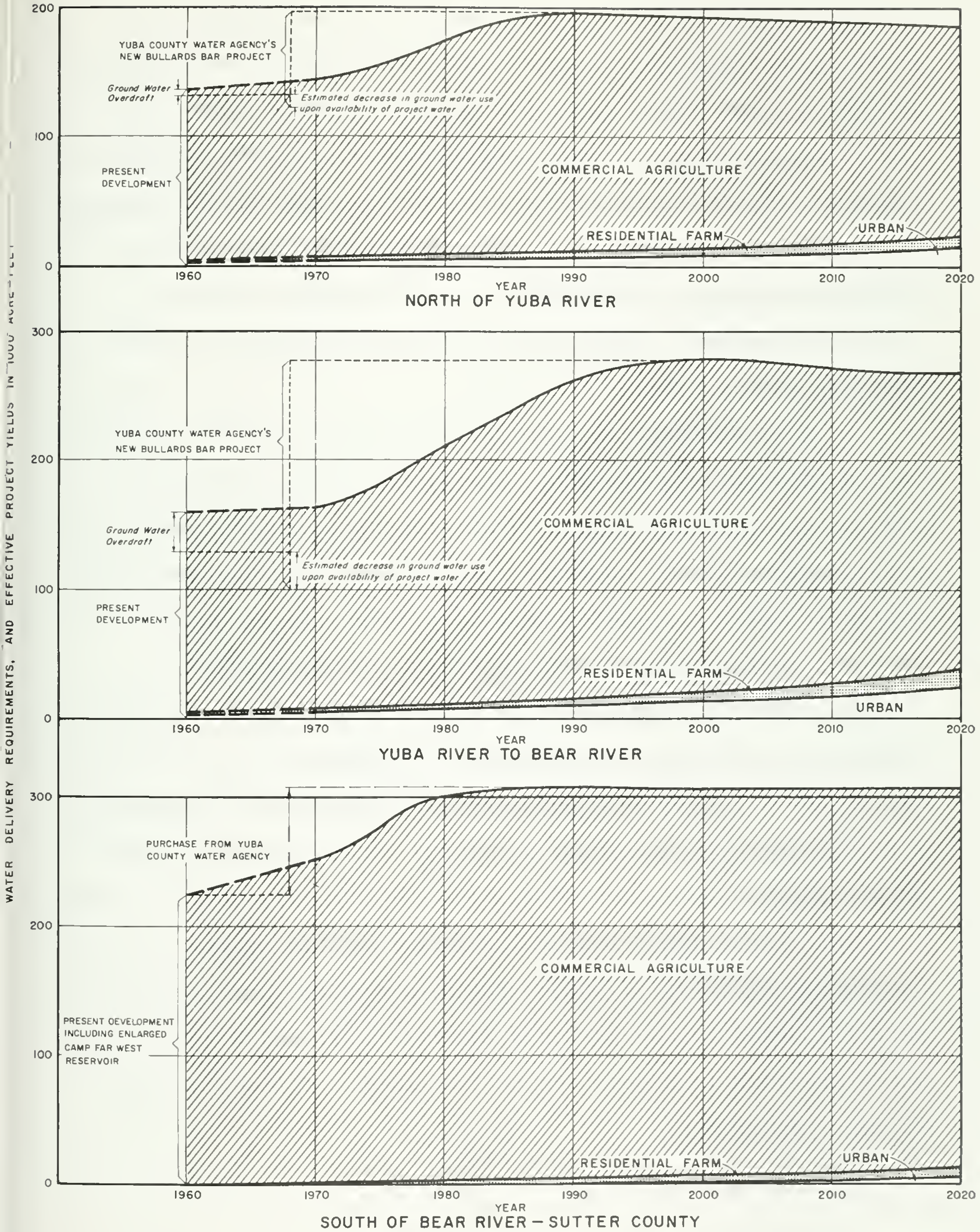


Figure 2, WATER SOURCES AND USES – VALLEY FLOOR SERVICE AREA YUBA AND SUTTER COUNTIES

There would also be benefits accruing to the New Bullards Bar Unit where use of new surface water on presently irrigated lands would result in decreased water costs. As explained previously under accomplishments, and as shown in Table 26, 40,000 acre-feet of new surface water is expected to be used in this manner. An adequate study of ground water pumping throughout the service area to evaluate benefits from this change in water use was beyond the scope of this investigation.

No residential farm or urban benefits would accrue to the proposed development. The present water supply is adequate to meet residential farm and urban demands that would develop under nonproject conditions. Application of available water supply to these more intensive land uses follows the basic assumption set forth in Chapter III.

Benefits would result from the production of hydroelectric power and were derived by applying the value of $23.30 per kilowatt of dependable capacity and the value of 3.0 mills per kilowatt-hour of energy generated to the power accomplishments.

Flood control benefits were computed by the Sacramento District, Corps of Engineers, U. S. Army, and were allocated to New Bullards Bar Reservoir and a main-stem reservoir in proportion to the amount of flood control storage required.

Unit values of recreational benefits as determined by use of the modified Trice-Wood Method of analysis were \$0.50 per visitor-day and \$2.15 per camper-day. Total benefits were estimated by applying these values to the estimated increase in visitor-days of use previously presented in Table 21.

Unit values of benefits resulting from enhancement of the salmon fishery in the lower Yuba River were estimated to be \$4.08 per fish for the commercial fishery and at least \$4.08 per fish for sport fishing. The value for the sport catch must be considered as tentative pending results of additional and more refined studies. Total benefits were computed by applying these values to the estimated increase in the salmon fishery reported on page 168.

A summary of the average annual equivalent of benefits creditable to the New Bullards Bar Unit is presented in Table 28. Values were derived using an interest rate of 4 percent per annum and a 50-year repayment period.

A comparison of total average annual equivalent project benefits (from Table 28) with total annual project costs, shown on page 164 to be \$8,712,000, indicates that the New Bullards Bar Unit would have a benefit-cost ratio of 1.36 to 1.

TABLE 28

SUMMARY OF ESTIMATED DIRECT BENEFITS CREDITABLE TO NEW BULLARDS BAR UNIT OF LOWER YUBA RIVER PROJECT

Source of benefits	Average annual equivalent of direct benefits
Irrigation	$ 2,673,000
Hydroelectric power	8,280,000
Flood Control	630,000
Recreation	72,000
Fisheries enhancement	220,000
TOTAL	$11,875,000

Marysville Unit

The Marysville Unit would be the second and final stage of the proposed lower Yuba Rivér Project and should be constructed to provide additional water supplies for export to the Sacramento-San Joaquin Delta. It would provide the balance of the flood control storage requirements for the Yuba River, and afford exceptional recreational opportunities.

Marysville Reservoir would be created by construction of a dam across the Yuba River about 12 miles upstream from the City of Marysville and about 1.5 miles upstream from Daguerre Point Diversion Dam. Gross storage capacity would be 1,000,000 acre-feet, of which 800,000 acre-feet between an elevation of 234 feet and a normal operating water surface elevation of 340 feet, would be active storage. The main dam would have a maximum height above streambed of about 215 feet and a crest length of about 11,900 feet. The south rim of the reservoir would require a wing dam with a length of about 16,200 feet. A small dam would also be required to close a low saddle on the north side of the reservoir. Dam crest would be at an elevation of 360 feet.

Topographic map coverage of the main damsite area was prepared to a scale of 1 inch equals 400 feet, and a contour interval of 5 feet. USGS topographic maps were utilized for the reservoir area. Areas and storage capacities of the reservoir at various elevations of water surface are given in Table 29.

TABLE 29

AREAS AND CAPACITIES OF MARYSVILLE RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	145	0	0
5	150	850	3,000
30	175	1,520	32,600
55	200	2,590	85,400
80	225	3,860	164,900
105	250	5,320	280,700
130	275	6,720	431,500
155	300	8,410	620,900
180	325	10,130	852,400
205	350	11,700	1,125,700
230	375	13,210	1,436,600
255	400	14,620	1,779,200

Marysville damsite on lower Yuba River. The left abutment of the main dam would be located at McCartie Hill shown in the background.

Geology. Geologic exploration consisted of reconnaissance mapping of the reservoir area and damsite, seismic surveys along the axes of the main dam and wing dam, trenching and auger drilling along the axis of the wing dam, and three diamond drill holes, two on the wing dam axis and one on the right abutment of the main dam. A study was also made of the channel section utilizing drill log data obtained from Yuba Consolidated Gold Fields, Incorporated. In addition, a seismic survey was conducted at two locations in the dredger tailings area to determine the depth to bedrock. Geologic exploration of Marysville damsite is further discussed in Appendix G.

Designs and Costs. Based on the foregoing, a cost estimate was prepared for a dam of gravelfill with impervious earth core construction. Major features of the dam are described below and are shown on Plates 7 and 8.

The main dam embankment is composed of three materials; a pervious zone of dredger tailings, a transition zone made up of fines from dredger tailings, and an impervious zone. Materials for the pervious and transition zones are found in the immediate vicinity of the dam. The impervious material would be imported from borrow areas within a 5-mile radius.

The main dam was designed with a crest width of 30 feet. Due to stability and foundation requirements, the dam section at the river channel has relatively flat slopes compared to the section on the abutments. Slopes of the channel section vary from 2 to 1 for the upper portion to 5 to 1 for the lower portion. The abutment sections have slopes of 2 to 1 upstream and downstream. A 3-foot thick riprap cover is provided on the upstream face of the dam from the crest to dead storage elevation for protection against damage from wave action. Rock for riprap would be salvaged from flood outlet works and spillway excavation. A cutoff trench along the centerline of the dam would be excavated to suitable rock foundation. In the channel section the cutoff would extend to bedrock, the greatest depth of excavation being 130 feet.

A preliminary stability analysis by the slip circle method was made in order to check the safety of the dam with respect to earthquake, slide, seepage, and water forces. The dam section was found to be satisfactory for the cases analyzed.

The <u>wing dam</u> would be located along the south shore of the reservoir, extending east from McCartie Hill a distance of approximately 3.1 miles. Height above natural ground varies from a few feet to over 80 feet. With a crest width of 30 feet, upstream and downstream slopes of 2 to 1 were considered adequate.

The embankment is of similar construction to that of the main dam. A 3-foot thick riprap cover is provided on the upstream face for protection against damage from wave action. A cutoff trench along the centerline of the dam would be excavated to suitable rock foundation.

A small saddle dam would be required along the north shore of the reservoir in Section 4, T16N, R5E. Maximum height above natural ground is approximately 35 feet. With a crest width of 20 feet, upstream and downstream slopes of 2 to 1 were considered to be adequate.

The embankment would be composed of a homogeneous section with a 3-foot thick riprap cover on the upstream face for protection against damage from wave action. A cutoff trench along the centerline of the dam would also be provided. Borrow areas for the homogeneous section can be found within a 3-mile radius.

The reservoir costs include land acquisition, clearing, and road relocation. The reservoir area consists mainly of riverbed covered with dredger tailings, wooded areas, rolling grazing land (with some irrigated pasture), and a few orchards. The Yuba Gold Fields in the damsite and reservoir area are currently being redredged to a greater depth. It has been estimated by a consultant geologist that by 1970 dredging operations will have been completed in the project area and that with no increase in the price for gold, the land will have no significant mineral value. Present net worth of estimated gold reserves remaining in 1962 is about $4,000,000.

A preliminary estimate of $2,300,000 for the cost of relocation of State Highway 20 was made in 1958 by the State Division of Highways. An additional $300,000 is believed to be adequate for relocation of all other roads around the dam and reservoir.

The spillway arrangement was based on an advantageous use of the topography in order to reduce the amount of excavation. Rock in the selected spillway appears to be adequate to resist foundation pressures and the erosive forces of water. With the purpose of controlling the spillway discharge, a lined chute for a distance of 400 feet downstream from the weir would be provided. The spillway width was selected on the basis of a maximum probable flood which was routed through the spillway without encroachment on the freeboard. The spillway would be gated, and the flow would be regulated by seven 50-foot wide by 27-foot high radial gates. A flood reservation of up to 260,000 acre-feet would be maintained in the reservoir when required.

No stilling basin would be provided for the spillway as it is assumed that the backwater in the long, broad exit channel to the main stream would be adequate to dissipate the energy of the water coming down the spillway chute. A 30-foot wide reinforced concrete service bridge over the spillway would be provided in order to gain access across the dam and also for maintenance of the outlet works and spillway gates.

The <u>flood outlet works</u> structure would be located on the left abutment immediately to the right of the spillway. It would be designed to pass a flow of 120,000 second-feet, the downstream channel capacity, at a reservoir water surface elevation of 314 feet. The structure would consist of a submerged weir with the flows controlled by six 22-foot wide by 20-foot high radial gates, a stilling basin for dissipating the energy of the water as it discharges past the gates, and an unlined chute for returning the water to the river.

The <u>north side outlet works</u> would consist of a 10-foot cut and cover conduit passing through the dam at elevation 135 feet, an intake structure, and a vertical gate shaft equipped with fixed-wheel gate. A wye in the outlet conduit at the downstream toe of the dam would allow up to 400 second-feet to be diverted into the North Canal of the New Bullards Bar Unit. The remaining flow of up to 1,100 second-feet would be discharged into the river to meet downstream requirements. During construction of Marysville Dam, the conduit would be used to pass summer flows while closure of the dam was being completed.

The <u>south side outlet works</u> would consist of an 8-foot diameter lined tunnel of horseshoe section passing through McCartie Hill, an intake structure, a gate shaft, and a stilling basin. Exit elevation of the tunnel would be approximately 200 feet. Releases of up to 1,150 second-feet would enter the South Canal of the New Bullards Bar Unit.

Fish hatchery. A fish hatchery capable of handling 56,000 fish would be provided as part of the Marysville Unit. This capacity is equal to the estimated peak run of salmon that would spawn in the area inundated by Marysville Reservoir.

Recreation facilities. Based on a preliminary evaluation of the recreation potential, recreation facilities were included as a part of the Marysville Unit. These facilities would include picnic areas, campgrounds, boat ramps, and improved swimming areas, constructed by stages to meet projected use. A "Proposed Recreation Land Use Plan for Marysville Reservoir" is shown on Plate 9.

General features of Marysville Dam and Reservoir are presented in Table 30 and shown on Plate 6. Estimated to have capital and annual costs are summarized in Table 31.

Accomplishments of the Marysville Unit.

The Marysville Unit would provide the balance of the flood control storage necessary to control flows in the lower Yuba River to 120,000 second-feet which is the design capacity of the river channel. Determination of flood control accomplishments have been made by the U. S. Army Corps of Engineers.

Marysville Reservoir could be operated to enhance the exportable water supply from the Sacramento-San Joaquin Delta. Preliminary studies show that sizable amounts of surplus Yuba River water will be exported from the Delta.

TABLE 30

GENERAL FEATURES OF MARYSVILLE UNIT OF LOWER YUBA RIVER PROJECT

	Main dam	Wing dam	Saddle dam
Damsite			
Location, MDB&M	Sec. 21, 28, 33, T16N, R5E	----	Sec. 4, T16N, R5E
Stream	Yuba River	----	---
Dams			
Type	Earthfill	Earthfill	Earthfill
Crest elevation, in feet	360	360	360
Crest width, in feet	30	30	20
Crest length, in feet	11,900	16,200	1,175
Elevation of streambed, in feet	145	-----	---
Slopes, upstream and downstream	2.0:1 to 5.0:1	2.0:1	2.0:1
Volume of fill, in cubic yards	43,000,000	2,800,000	52,000

Control structures	Spillway	Flood outlets
Type of control	radial gates	top sealing radial gates
Number and size of gates	7-50' x 27'	6-22' x 20'
Design capacity, in second-feet	334,000	120,000

Maximum water surface elevation, in feet	353
Normal water surface elevation, in feet	340
Minimum water surface elevation, in feet	234
Gross storage capacity, in acre-feet	1,000,000
Active storage capacity, in acre-feet	800,000
Maximum flood control storage reservation, in acre-feet	260,000
Water surface area at normal pool, in acres	11,100
Drainage area, in square miles	1,327

TABLE 31

SUMMARY OF ESTIMATED COSTS OF
MARYSVILLE UNIT OF LOWER YUBA RIVER PROJECT
(Based on prices prevailing in January 1963)

Item	Cost
Capital Cost	
Reservoir and improvements	$ 6,847,000
Main dam embankment	32,763,000
Wing and saddle dam embankments	2,407,000
Spillway	4,965,000
Flood outlet works	5,369,000
Irrigation and stream outlet works	2,108,000
Subtotal	$54,459,000
Contingencies, 20%	10,892,000
Subtotal	$65,351,000
Engineering and administration, 15%	9,803,000
Subtotal	$75,154,000
Interest during construction, 4%	7,515,000
Subtotal	$82,669,000
Mineral rights	4,000,000
Fish hatchery	2,500,000
Recreation development	1,660,000
TOTAL CAPITAL COST	$90,829,000
Annual Cost	
Repayment in 50 years at 4%	$ 4,228,000
Operation, maintenance, replacement, general expense and insurance:	
Dam and reservoir	111,000
Fish hatchery	250,000
Recreation facilities 1/	422,000
TOTAL ANNUAL COST	$ 5,011,000

1/ Average annual equivalent cost

These studies also indicate that an additional 220,000 acre-feet can be exported from the Delta by the operation of Marysville Reservoir.

Marysville Reservoir would also afford exceptional new water-associated recreational opportunities. Assuming that Marysville Dam is constructed by 1980, recreation use attributable to the reservoir is shown by decades in Table 32.

TABLE 32

SUMMARY OF PROJECTED ANNUAL VISITOR DAYS OF RECREATION USE ATTRIBUTABLE TO MARYSVILLE RESERVOIR

Recreation use	Year 1980	1990	2000	2010	2020	2030
Day use area	649,000	1,092,000	1,773,000	2,646,000	3,823,000	5,359,000
Camping area	70,000	126,000	199,000	290,000	411,000	569,000
TOTALS	719,000	1,218,000	1,972,000	2,936,000	4,234,000	5,928,000

Salmon propagation in the lower Yuba River would be improved by expansion of the spawning area below the reservoir through the release of increased flows during the spawning and egg incubation period. It is estimated that the resulting enhancement of the commercial fishery would average about 14,500 fish annually, with an increase in the sport catch of about 2,000 fish annually.

Benefits from Marysville Unit

The primary tangible benefits that would accrue to the Marysville Unit would be derived from increased water supplies made available at the Delta, from flood control, from increased water-associated recreational activity made possible by the development, and from enhancement of the salmon fishery in the lower Yuba River.

Benefits resulting from replenishment and augmentation of the Delta water supply were computed by using a weighted average value of $40 per acre-foot for water exported from the Delta. This value is currently being used in evaluation studies of the State Water Project, and is applicable when analyzing future projects which develop water supplies for export from the Delta Pool.

Flood control benefits were evaluated by the Corps of Engineers on the basis of the amount of flood control storage that would be required in Marysville Reservoir after construction of New Bullards Bar Reservoir, previously described.

Recreational benefits would accrue to Marysville Reservoir from the use of public recreational facilities provided by the development. Benefits were estimated by applying derived unit values of recreational benefits to the estimated project-associated visitor-days of use as summarized in Table 32.

Unit values of benefits resulting from enhancement of the salmon fishery in the lower Yuba River were computed to be $4.08 per fish for the commercial fishery, and at least $4.08 per fish for sport fishing. The value for sport fishing must be considered as tentative pending results of additional and more refined studies. Total benefits were computed by applying these values to the estimated increase in the salmon fishery reported on page 189.

A summary of estimated direct benefits creditable to the Marysville Unit is presented in Table 33. Values were derived using an interest rate of 4 percent per annum and a 50-year repayment period.

TABLE 33

SUMMARY OF ESTIMATED DIRECT BENEFITS
CREDITABLE TO MARYSVILLE UNIT
OF LOWER YUBA RIVER PROJECT

Source of Benefit	Average annual equivalent of direct benefits
Replenishment of Delta Pool	$ 8,800,000
Flood control	1,940,000
Recreation	1,354,000
Fisheries enhancement	67,000
TOTAL	$11,415,000

Summary of Lower Yuba River Project

Table 34, "Summary and Analysis of Lower Yuba Project", presents information on costs, accomplishments, and benefits of the New Bullards Bar Unit of the Lower Yuba River Project proposed by Yuba County Water Agency, and the Marysville Unit as formulated by the State. As shown therein, information on physical features, costs and accomplishments of the New Bullards Bar Unit are from the feasibility report of Yuba County Water Agency, whereas benefits are based on information developed by the department.

* * * * * * *

The remainder of this chapter is devoted to the discussion and analysis of projects designed to supplement existing works and works now under construction, and the New Bullards Bar and Marysville Units of the lower Yuba River Project, previously described. Projects proposed were formulated within the concept of comprehensive basin development to meet projected water requirements to year 2020.

Brownsville Service Area Development

The Brownsville Service Area is made up of portions of Browns Valley Irrigation District and Yuba County Water District. Present development in the area, located for the most part within the Browns Valley Irrigation District, is described at the beginning of this chapter.

TABLE 34

SUMMARY AND ANALYSIS OF
LOWER YUBA RIVER PROJECT

Item	New Bullards Bar Unit	Marysville Unit
Completion date - based on need for project water	1967	1980
Estimated capital cost	$ 161,470,000	$90,830,000
Gross reservoir storage capacity, in acre-feet	930,000	1,000,000
Active reservoir storage capacity, in acre-feet	669,000	800,000
Maximum reserved storage for flood control, in acre-feet	170,000	260,000
Hydroelectric power:		
Number of new powerplants	3	---
Installed capacity, in kilowatts	297,000	---
Average annual energy generation, in kilowatt-hours per year	1,000,000,000	---
Integrated system dependable capacity, in kilowatts		
At 41.5 percent capacity factor - first 15 years	214,000	---
At 34.0 percent capacity factor - following 35 years	239,000	---
Water development, in acre-feet per season		
New water supply for local use on valley floor	366,000	0
Estimated depletion of Delta Pool export supply resulting from local use	-40,000	0
Estimated replenishment of Delta Pool export supply from depleted base	0	220,000
Net new water supply developed	326,000	220,000
Economic analysis for project justification (from Tables 28 and 33)		
Benefits - average annual equivalent amounts		
Flood control	$ 630,000	$ 1,194,000
Hydroelectric power	8,280,000	0
Local water supply	2,673,000	0
Replenishment of Delta Pool export supply	0	8,800,000
Recreation enhancement	72,000	1,354,000
Fisheries enhancement	220,000	67,000
Total annual equivalent benefits	$ 11,875,000	$11,415,000
Costs - average annual equivalent amounts:		
Repayment in 50 years with interest at 4 percent	$ 7,512,000	$ 4,228,000
Future onshore recreation facilities	---	160,000
Operation and maintenance	1,200,000	783,000
Total annual equivalent costs	$ 8,712,000	$ 5,171,000
Benefit-cost ratio	1.36	2.21

Although the Brownsville Service Area is presented as one unit in this bulletin, plans for development were formulated with recognition of the two districts as separate entities.

Browns Valley Irrigation District

Based on anticipated future demands for water service within the Browns Valley Irrigation District as estimated by the department, present water supplies available to the district, including the yield from the Virginia Ranch Project soon to be completed, will be fully utilized by the turn of the century and possibly as early as 1990. Thereafter, supplemental water supplies will need to be developed or obtained from other sources.

Capture and use of return flow from upstream development in Yuba County Water District, together with a modification of the agreement with Pacific Gas and Electric, Company, appears to be the most probable sources for additional water supplies. The agreement with PG&E is stated earlier in this chapter. As diversions into the Browns Valley Ditch from the head of the Colgate penstock are gradually resumed to meet future supplemental requirements, the district's presently available water supply at Daguerre Point would be reduced and would therefore have to be replenished with water from the Yuba County Water Agency project. The financial effect of modifying the agreement with Pacific Gas and Electric Company in order to obtain supplemental water supplies to serve the foothill district lands will require due consideration, and if found to be infeasible, the projected growth of the area may be retarded.

Present and future patterns of land use in the Browns Valley Irrigation District within Brownsville Service Area, as foreseen by the department, is summarized by decades in Table 35. Water delivery requirements associated with this land use are summarized by decades in Table 36.

A presentation of present and anticipated water delivery requirements in the Browns Valley Irrigation District portion of the Brownsville Service Area to year 2020, and the proposed means of satisfying these requirements is shown on Figure 3, and summarized in Table 37.

Yuba County Water District

The remaining portion of the service area is largely included in the Yuba County Water District. Results of preliminary studies indicated that the cost of developing an adequate water supply for future use would be relatively high. With project financing at an interest rate of 4 percent per annum, the cost of water per acre-foot would be beyond the payment capacity of most crops adaptable to the area. Project formulation was therefore based on the assumption that interest free loans, such as may be obtained under Public Law 984, the Small Reclamation Projects Act of 1956,[1/] could be obtained for projects to serve the upper portion of the service

1/ (70 Stat. 1044; 43 U.S.C., Sec. 422a-422K, 1958 ed.)

TABLE 35

SUMMARY OF PRESENT AND PROJECTED LAND USE
IN BROWNS VALLEY IRRIGATION DISTRICT
WITHIN BROWNSVILLE SERVICE AREA
(in acres)

Land Use	Year						
	Present 1/	1970	1980	1990	2000	2010	202
Irrigated agriculture							
Subtropical orchard	280	420	660	900	1,080	1,160	1,2
Deciduous orchard	0	120	300	420	520	590	6
Pasture	2,630	4,060	7,240	8,680	9,000	9,150	9,2
Subtotal, net area	2,910	4,600	8,200	10,000	10,600	10,900	11,0
Residential farm	2/	745	790	875	1,140	1,460	1,5
Urban	50	55	60	80	120	175	2
TOTAL, net area	2,960	5,400	9,050	10,955	11,860	12,535	12,7

1/ As determined from Department of Water Resources survey in 1957.
2/ Included in irrigated agriculture.

TABLE 36

SUMMARY OF PRESENT AND PROJECTED SEASONAL WATER
DELIVERY REQUIREMENTS OF BROWNS VALLEY IRRIGATION
DISTRICT WITHIN BROWNSVILLE SERVICE AREA
(in acre-feet)

Land Use	Year						
	Present	1970	1980	1990	2000	2010	20
Agriculture	12,270	16,280	28,860	35,150	36,990	37,870	38,
Residential farm	1/	2,230	2,370	2,620	3,440	4,380	4,
Urban	20	30	50	70	130	200	[illegible]
TOTAL	12,290	18,540	31,280	37,840	40,560	42,450	42,
TOTAL, rounded	12,300	18,500	31,300	37,800	40,600	42,400	43,

1/ Included in agriculture.

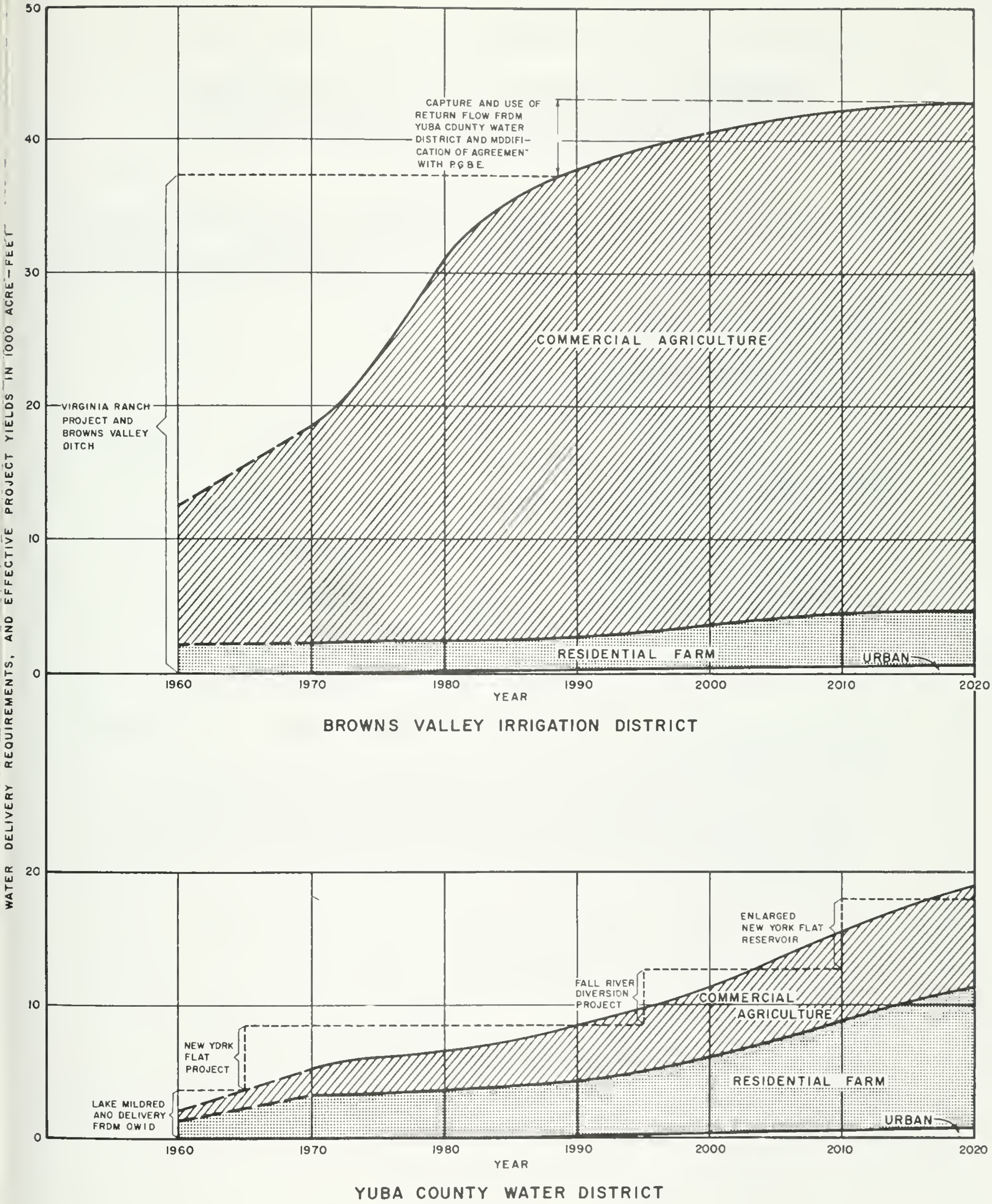


Figure 3, WATER SOURCES AND USES BROWNSVILLE SERVICE AREA

TABLE 37

SUMMARY OF PRESENT AND PROPOSED WATER SUPPLY DEVELOPMENT AND WATER DELIVERY REQUIREMENTS IN BROWNS VALLEY IRRIGATION DISTRICT WITHIN BROWNSVILLE SERVICE AREA

	Effective yield, in acre-feet	Water delivery requirements in acre-feet[1]	Indicated surplus or deficit
Present development			
Browns Valley Ditch	2,000		
Virginia Ranch Project	33,000		
Subtotal	35,000	12,300	+22,700[2]
Future development			
Return flow from YCWD and modification of Pacific Gas and Electric Company agreement	8,000		
TOTAL	43,000	43,000	0

1/ From Table 36.
2/ A portion of this amount will be utilized in valley floor portion of district. At a later date, the district proposes to provide supplemental service to the valley floor lands by pumping from the Yuba River near Daguerre Point Dam.

area, and that revenue from the Oroville-Wyandotte Irrigation District's South Fork Project would be available as outlined in an agreement between OWID and YCWD dated March 21, 1958, and amended December 9, 1959.

Based on the foregoing, a plan was formulated which could be staged to meet the need for water within the service area as it develops. The plan for staged development in the proposed order of construction is shown below.

1. New York Flat Dam and Reservoir at 10,000 acre-foot capacity designed to allow further enlargement to 30,000 acre-foot capacity, and a distribution system consisting of approximately 14 miles of canal.

2. Fall River diversion facilities, 1.0 mile of tunnel for conveying diverted flows to the South Fork Feather River, and New York Flat Feeder Canal paralleling the existing Forbestown Ditch.

3. Enlargement of New York Flat Dam and Reservoir to 30,000 acre-foot gross storage capacity with approximately 8,000 acre-foot dead storage provided for recreation enhancement, and extension of distribution facilities.

A graphic presentation of anticipated water delivery requirements in the Yuba County Water District portion of the Brownsville Service Area to the year 2020, and the staging of projects to satisfy these requirements is shown on Figure 3.

Plans for water resource development in the Yuba County Water District are tied closely to the agreement between YCWD and OWID mentioned above. The agreement resulted from the resolving of conflicting water rights applications of the two agencies on South Fork Feather River and Slate Creek, which thereby enabled OWID to proceed with construction of the South Fork Feather River Project. The agreement in turn grants to YCWD certain interests in the South Fork Project, the most pertinent of which from the standpoint of this investigation are summarized below.

The agreement provides for 3,700 acre-feet per annum to be diverted into Forbestown Ditch at the head of Woodleaf Penstock at a maximum flow of 12 second-feet on an irrigation schedule between April 15 and October 15 until such time as 50 years have elapsed from date of issue of South Fork Project bonds, at which time the right to such 3,700 acre-feet shall terminate. This 3,700 acre-feet of water, less losses, is to be rediverted into the French Dry Creek drainage basin at or near the New York Flat turnout.

The agreement also grants to YCWD certain financial interests in the South Fork Project including:

1. The sum of $150,000 from the proceeds of South Fork Project bonds for the construction of irrigation canals.

2. The sum of $700,000 in four equal semi-annual installments from the first four payments on South Fork Power Revenue bonds made by the Pacific Gas and Electric Company.

3. All net power revenues received from the South Fork Project after 50 years from the date of issuance of South Fork Project bonds to be divided and paid half to OWID and half to YCWD.

Assuming that South Fork Project power could be marketed 50 years hence at rates comparable to those received today, considerable funds would become available to YCWD beginning about 2010. The availability of these funds may make it financially possible to develop supplemental water supplies from Canyon Creek to meet probable continued increases in demands for water after 2020. Canyon Creek, a tributary to North Yuba River, has long been considered a possible source of water for the service area. At the present time, the 4 miles of tunnel which would be required to bring the water into the South Fork Project works for rediversion to the service area would make the cost of water prohibitive.

New York Flat Project

This project would provide a dependable water supply at the reservoir of about 8,900 acre-feet per year for irrigation of lands situated in the vicinity of Dobbins and Oregon House. This quantity includes 3,300 acre-feet delivered under the agreement with OWID. Storage would be provided by a dam and reservoir on New York Creek to develop the natural runoff of the stream and provide control of imports to the reservoir from the Forbestown Ditch. Other features include a diversion dam on French Dry Creek about 3 miles downstream from the main dam, and distribution facilities consisting of a canal from the diversion dam to the service area and lateral canals for distribution of the water within the service area.

New York Flat Dam and Reservoir. The reservoir would be formed by an earthfill dam on New York Creek, a tributary to French Dry Creek. Streambed elevation at the damsite is 2,290 feet as determined from USGS topographic map coverage of the area. Areas and storage capacities at various elevations of water surface are given in Table 38.

Geologic exploration at this site was limited to field reconnaissance. A discussion of the geology of the site is presented in Appendix G.

Based on the results of the geologic exploration, New York Flat damsite appears suitable for construction of an earthfill dam to a height adequate to provide 30,000 acre-feet of storage capacity.

TABLE 38

AREAS AND CAPACITIES OF NEW YORK FLAT RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	2,290	0	0
10	2,300	15	70
35	2,325	71	1,140
60	2,350	243	5,070
85	2,375	381	12,870
110	2,400	522	24,170
135	2,425	668	39,050
160	2,450	823	57,700

A cost estimate was prepared for a dam of homogeneous section to provide a gross storage capacity of 10,000 acre-feet for the initial size reservoir. Provision was made in the design of the dam to facilitate future enlargement to provide 30,000 acre-feet of gross storage capacity. Normal pool would be at elevation 2,368 feet. Crest of dam would be 86 feet above streambed. A general layout of the initial and final stages of the dam and appurtenant features is shown on Plate 10.

A chute type spillway would be excavated in the left abutment. Control would be provided by a concrete ogee section 75 feet in length designed to pass a peak discharge of 5,500 second-feet. Freeboard above maximum water level would be 1 foot. The chute would be lined and discharge into the stream channel through a terminal flip bucket. Controlled releases would flow down French Dry Creek for diversion into a canal leading to the service area in the vicinity of Dobbins and Oregon House. The outlet works would consist of a steel-lined concrete pressure conduit with emergency slide gate and control valve, and would also be used for stream diversion during construction. The conduit would be approximately 535 feet long and 3 feet nominal diameter and would be embedded in sound rock along the existing channel of New York Creek. Discharges through the conduit would be controlled by a 30-inch Howell-Bunger valve. The concrete intake structure would house the trashracks and a hydraulically operated slide gate controlled from the crest of the dam.

French Dry Creek Diversion Dam. A low concrete structure would be constructed on French Dry Creek. Streambed elevation at this location is approximately 2,000 feet as determined from USGS topographic map coverage of the area. An automatic headgate would regulate the diversion of flows into the canal for conveyance to the service area. The unregulated flow of French Dry Creek would be released to the stream for preservation of fishlife.

Initial Distribution System. A distribution system consisting of approximately 14 miles of unlined canal would be constructed as part of the initial stage of development.

The main conduit would extend from the diversion dam on French Dry Creek southeasterly for about 8 miles to a small terminal storage reservoir located in Section 29, T18N, R7E, MDB&M. Capacity of the conduit would be 70 second-feet. Irrigation releases from the terminal reservoir would enter two main distribution canals for conveyance to the service areas. One canal would extend southerly to the vicinity of Dobbins. The other would cross the saddle immediately to the southwest of the terminal reservoir by inverted siphon and provide service to lands in the Oregon House area.

General features of the initial development stage are presented in Table 39. Estimated capital and annual costs are summarized in Table 40. A summary of the monthly yield study of the initial stage development is presented in Appendix E, Table E-1.

Fall River Diversion Project

This project, which is similar to that proposed under the district's water rights Application No. 18410, is proposed as the second stage of development and would provide an additional yield of 3,600 acre-feet per year at New York Flat Reservoir. Under the proposed operation, winter flows from Fall River would be diverted through a new tunnel to the South Fork Feather River above OWID's South Fork Diversion Dam and thence through the existing South Fork Diversion Tunnel.

TABLE 39

GENERAL FEATURES OF
NEW YORK FLAT PROJECT

Damsite

Location	NW 1/4, Section 25, T19N, R6E, MDB&M
Stream	New York Creek, tributary to French Dry Creek

Dam and Appurtenant Structures

Type	Earthfill
Crest elevation, in feet	2,376
Crest width, in feet	25
Crest length, in feet.	860
Height above streambed, in feet.	86
Height, spillway lip above streambed, in feet. .	78
Elevation of streambed, in feet.	2,290
Side slopes.	
Upstream	3.5:1
Downstream	2.5:1
Volume of fill, in cubic yards	364,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet. . .	5,500
Type of outlet works	Cut and cover

Reservoir

Water surface elevation at maximum pool, in feet. . . .	2,375
Water surface elevation at normal pool, in feet. . . .	2,368
Water surface elevation at minimum pool, in feet . . .	2,320
Surface area at normal pool, in acres.	350
Storage capacity at spillway lip, in acre-feet	10,000
Drainage area, in square miles	6.5

Diversion Dam

Location	Section 2, T18N, R6E, MDB&M
Type	Concrete
Spillway discharge capacity.	Unlimited
Diversion headgate discharge capacity, in second-feet .	70

Distribution Canals

Total length, in miles	14
Main canal capacity, in second-feet	70

TABLE 40

SUMMARY OF ESTIMATED COSTS OF
NEW YORK FLAT PROJECT
(Based on prices prevailing in January 1963)

Item	Cost: 4% interest	Cost: No interest
Capital Cost		
Reservoir and improvements	93,000	93,000
Dam enbankment	585,000	585,000
Spillway	145,000	145,000
Outlet works	72,000	72,000
Distribution system	387,000	387,000
Subtotal	$1,282,000	$1,282,000
Contingencies, 20%	256,000	256,000
Subtotal	$1,538,000	$1,538,000
Engineering and administration, 15%	231,000	231,000
Subtotal	$1,769,000	$1,769,000
Interest during construction	31,000	---
Subtotal	$1,800,000	$1,769,000
Less funds received from OWID (ref. page 200[1])	[2]	500,000
TOTAL CAPITAL COST	$1,800,000	$1,269,000
Annual Cost		
Repayment in 50 years	$ 83,800	$ 25,400
Operation, maintenance, replacement, general expense, and insurance	11,400	11,400
TOTAL ANNUAL COST	$ 95,200	$ 36,800

1/ Assume $350,000 reserved for a domestic water system.
2/ Not included for economic justification.

The South Fork Diversion Tunnel was oversized by the contractor for ease of construction and therefore has ample capacity to accomodate the extra flow. Diversion of flows from Fall River would be limited to the period December through April in order to preserve the beauty of Feather Falls located downstream from the point of diversion. A minimum stream maintenance release of six second-feet or the natural flow, whichever is less, would be allowed to pass the diversion dam during the December-April period. The diverted water would pass through the South Fork Project works to the head of the Woodleaf Penstock where it would flow into the proposed New York Flat Feeder Canal for conveyance to New York Flat Reservoir.

A low concrete diversion dam with ogee overpour section would be constructed on Fall River. Streambed elevation at the site is approximately 3,920 feet as determined from USGS topographic map coverage of the area. Stoplogs would be positioned in the overpour section to divert winter flows into the tunnel. A sluice outlet would be provided to permit stream maintenance releases during this period.

Surplus flows of Fall River would be diverted through a 7-foot diameter tunnel extending from the diversion pool on Fall River to the common corner of Sections 19, 20, 29, and 30, T21N, R8E, at an elevation of 3,900 feet in the South Fork Feather River watershed. The tunnel would have a length of about 5,400 feet and would be unlined except as required for safety. The concrete intake structure would be equipped with trashracks, and stoplogs would be provided for summer closure.

New York Flat Feeder Canal would extend from the head of the Woodleaf Penstock about 10.5 miles to its terminus in NE 1/4 Section 14, T19N, R6E, immediately below the Forbestown-Challenge Road. The canal would be unlined and have a capacity of 72 second-feet.

General features of Fall River Diversion Project are presented in Table 41 and illustrated on Plate 6. Estimated capital and annual costs are summarized in Table 42.

Enlargement of New York Flat Dam and Reservoir

The final stage of development would consist of enlarging New York Flat Dam and Reservoir to a gross storage capacity of 30,000 acre-feet and extending the distribution system within the service area. Normal pool would be raised to elevation 2,411. Streambed elevation at maximum section would be 2,280 feet and maximum height of dam would be 140 feet. Minimum pool would be at approximate elevation 2,362 feet, allowing a dead storage capacity of 8,000 acre-feet. Minimum pool at this elevation is desirable from the recreation standpoint as it would maintain water over the broad area of New York Flat and thereby tend to minimize recession of the reservoir shoreline during the summer drawdown period. Final determination of dead storage capacity should however,

TABLE 41

GENERAL FEATURES OF
FALL RIVER DIVERSION PROJECT

Diversion Dam	
Location	Section 24, T21N, R7E, MDB&M
Stream	Fall River (Feather River Basin)
Type	Concrete gravity
Tunnel	
Length, in feet	5,400
Diameter, in feet	7.0
Type	Unlined
Section	Horseshoe
Feeder Canal	
Length, in feet	55,200
Capacity, in second-feet	72
Type	Unlined
Section	Trapezoidal

TABLE 42

SUMMARY OF ESTIMATED COSTS OF
FALL RIVER DIVERSION PROJECT

(Based on prices prevailing in January 1963)

Item	Cost
Capital Cost	
Access roads	$ 142,000
Diversion dam	15,000
Tunnel	597,000
Feeder canal	212,000
Subtotal	$ 966,000
Contingencies, 20%	193,000
Subtotal	$1,159,000
Engineering and administration, 15%	174,000
Subtotal	$1,333,000
Interest during construction, 4%	27,000
TOTAL CAPITAL COST	$1,360,000

Annual Cost	4% interest	No interest
Repayment in 50 years	$63,300	$26,700
Operation, maintenance, replacement, general expense, and insurance	9,300	9,300
TOTAL ANNUAL COST	$72,600	$36,000

be based on the results of an economic analysis of project costs and benefits at such time as more detailed studies of the project are conducted.

A new spillway would be excavated in the left abutment. Control would be provided by a concrete ogee section 65 feet in length designed to pass a peak discharge of 4,700 second-feet. Freeboard above maximum water level would be two feet. The transition and chute sections would be lined and discharge into the stream channel through a terminal flip bucket.

The outlet control valve would be salvaged and reinstalled in the extended conduit passing beneath the dam.

General features of enlarged New York Flat Dam and Reservoir are presented in Table 43, and illustrated on Plate 10. Estimated capital and annual costs are summarized in Table 44.

Accomplishments of Proposed Development

The projects proposed for the Yuba County Water District portion of Brownsville Service Area would provide firm water supplies almost adequate to meet projected agricultural and domestic uses to year 2020. New York Flat Reservoir would also afford new recreational opportunities. Reconnaissance studies by the department indicate that the region surrounding New York Flat Reservoir has considerable potential as a mountain recreational area. Gentle topography and a

TABLE 43

GENERAL FEATURES OF
ENLARGED NEW YORK FLAT DAM AND RESERVOIR

Damsite

Location	NW 1/4 Sec. 25, T19N, R6E, MDB&M
Stream	New York Creek, tributary to French Dry Creek

Dam and Appurtenant Structures

Type	Earthfill
Crest elevation, in feet	2,420
Crest width, in feet	25
Crest length, in feet	1,360
Height above streambed, in feet	140
Height, spillway lip above streambed, in feet	131
Elevation of streambed, in feet	2,280
Side slopes	
Upstream	3.5:1 and 3.0:1
Downstream	2.5:1
Volume of new fill, in cubic yards	748,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet	4,700
Type of outlet works	Cut and cover

Reservoir

Water surface elevation at maximum pool, in feet	2,418
Water surface elevation at normal pool, in feet	2,411
Water surface elevation at minimum pool, in feet	2,362
Surface area at normal pool, in acres	585
Storage capacity at spillway lip, in acre-feet	30,000
Storage capacity at minimum pool, in acre-feet	8,000
Drainage area, in square miles	6.5

TABLE 44

SUMMARY OF ESTIMATED COSTS FOR
ENLARGEMENT OF NEW YORK FLAT DAM AND RESERVOIR

(Based on prices prevailing in January 1963)

Item		Cost
Capital Cost		
Reservoir and improvements		$ 73,000
Dam embankment		991,000
Spillway		172,000
Outlet works		26,000
Subtotal		$1,262,000
Contingencies, 20%		252,000
Subtotal		$1,514,000
Engineering and administration, 15%		227,000
Subtotal		$1,741,000
Interest during construction, 4%		52,000
TOTAL CAPITAL COST		$1,793,000
Annual Cost	4% interest	No interest
Repayment in 50 years	$83,400	$34,800
Operation, maintenance, replacement, general expense, and insurance	9,100	9,100
TOTAL ANNUAL COST	$92,500	$43,900

relatively dense stand of pine, oak, and madrone combine to provide an area of great attractiveness. An average rainfall of 47 inches occurs during the winter months and average temperatures ranging from 49 degrees to 92 degrees during the May-to-October recreational season are ideally suited to recreational use.

The rate of development in this portion of the Brownsville Service Area to irrigated agriculture, residential farms, and urban use was projected on the basis of assumptions discussed under previous headings. Projected use of irrigable land, together with present land use, is summarized by decades in Table 45.

Water delivery requirements for irrigation, residential farm, and urban uses were determined by applying unit water delivery requirements presented in Chapter III to the present and projected land use pattern. A summary of present and projected seasonal water delivery requirements by decades is presented in Table 46.

Staging of the proposed projects was determined on the basis of need to satisfy projected demands for water, and consideration of practical aspects of financing and construction. Completion date shown for the first stage is the estimated earliest practical date the project could be put into operation assuming a period for authorization and construction. Proposed construction of the third stage coincides with the approximate date of retirement of the South Fork

TABLE 45

SUMMARY OF PRESENT AND PROJECTED LAND USE
IN YUBA COUNTY WATER DISTRICT WITHIN BROWNSVILLE SERVICE AREA
(in acres)

Land use	Present 1/	1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Subtropical orchard	190	250	380	500	610	710	800
Deciduous orchard	0	70	200	300	360	390	400
Pasture	370	400	540	740	1,000	1,320	1,500
Subtotal, net area	560	720	1,120	1,540	1,970	2,420	2,700
Residential farm	2/	1,070	1,150	1,410	1,940	2,820	3,630
Urban	210	210	230	250	310	435	545
TOTAL, net area	770	2,000	2,500	3,200	4,220	5,675	6,875

1/ As determined from Department of Water Resources survey in 1957.
2/ Included in irrigated agriculture.

TABLE 46

SUMMARY OF PRESENT AND PROJECTED SEASONAL WATER DELIVERY REQUIREMENTS
OF YUBA COUNTY WATER DISTRICT WITHIN BROWNSVILLE SERVICE AREA
(in acre-feet)

Land use	Present	1970	1980	1990	2000	2010	2020
Agriculture	2,100	2,020	3,020	4,150	5,380	6,750	7,580
Residential farm	1/	3,210	3,450	4,230	5,820	8,460	10,890
Urban	90	100	120	150	240	420	600
TOTAL	2,190	5,330	6,590	8,530	11,440	15,630	19,070
TOTAL, rounded	2,200	5,300	6,600	8,500	11,400	15,600	19,100

1/ Included in agriculture

Project bonds. A summary of yield from present development and from proposed projects, together with estimated completion date and annual costs, is presented in Table 47.

Benefits from Proposed Development

The primary tangible benefits that would accrue to the development would be derived from increased irrigation and domestic water supplies made available by the proposed projects, and from increased water-associated recreational activity made possible as a result of these projects.

Benefits from irrigation development would consist of the net value of the returns to land and water from the area served by the projects. Increased productivity would result from the application of project water to presently dry-farmed lands and lands presently receiving a partial water supply on an intermittent basis.

Irrigation benefits from the lands served by the project were derived by applying unit values of returns to land and water to the crop pattern presented in Table 45, and appropriately reducing the result to reflect returns from present farming operations. The sum of net annual direct irrigation benefits from commercial agriculture accruing to the proposed development was estimated to be $2,225,000.

The benefits attributable to the use of project water on residential farms were computed as a composite

TABLE 47

SUMMARY OF EXISTING AND PROPOSED PROJECT YIELDS, ESTIMATED ANNUAL PROJECT COSTS, AND INDICATED YEAR OF PROJECT COMPLETION FOR YUBA COUNTY WATER DISTRICT DEVELOPMENT WITHIN BROWNSVILLE SERVICE AREA

	Effective yield, in acre-feet	Annual cost including O,M&R: No interest	Annual cost including O,M&R: 4% interest	Indicated year of completion 1/
Present development (est.)	3,800 2/			-
New York Flat Project	4,700	$ 36,800	$ 95,200	1965
Fall River Project	4,200	36,000	72,600	1995
Enlarged New York Flat Reservoir	5,300	43,900	92,500	2010
TOTAL	18,000			

1/ Based primarily on need for project services.
2/ Includes 3,300 acre-feet delivered under YCWD-OWID agreement.

value based on the use of water for irrigation and for domestic service. Benefits derived for the agricultural portion were computed on the same basis as for commercial agriculture. The sum of net annual direct residential farm benefits accruing to the proposed development was estimated to be $1,880,000.

Urban benefits would not accrue to the proposed development due to the present water supply being adequate to meet urban demands that would exist under nonproject conditions of development. Application of available water supply to the more intensive uses follows the basic assumption as defined in Chapter III.

There would also be benefits accruing to the proposed development due to increased recreational opportunities. Determination of the magnitude of future recreational use and the corresponding benefits was, however, considered to be beyond the scope of this investigation.

A summary of total agricultural and residential farm benefits and total costs associated with the proposed development to year 2020 is presented in Table 48.

A comparison of total benefits from agriculture and residential farms accruing to year 2020 with total repayment and operating costs to that date, indicates that the proposed development would have a benefit-cost ratio of less than unity.

TABLE 48

SUMMARY OF TOTAL NET BENEFITS AND
TOTAL REPAYMENT AND OPERATING COSTS
FOR PROPOSED DEVELOPMENT TO YEAR 2020
(Repayment at 4% interest rate)

Benefits		Costs	
Source of benefits	Net benefits to year 2020	Project	Total repayment and O&M costs to year 2020
Agriculture	$ 2,225,000	New York Flat	$ 4,817,000
Residential farm	1,880,000	Fall River Diversion	1,815,000
Urban	none	Enl. New York Flat Reservoir	925,000
Recreation	1/		
TOTAL	$ 4,105,000	TOTAL	$ 7,557,000

1/ Not determined

Project Financing

As previously mentioned, funds in the amount of $850,000 will be received from Oroville-Wyandotte Irrigation District. Assuming that $350,000 would be reserved for a domestic water system, such as that proposed in the report to the district prepared by St. Maurice-Helmkamp and Musser, and that no-interest financing could be obtained for the balance of project costs, the average cost of water from the initial stage of development consisting of New York Flat Reservoir and irrigation canals and including the 3,300 acre-feet of water from OWID, would be about 4.35 per acre-foot.

Payment capacities for crops projected in Yuba County Water District range from $2.75 per acre-foot for pasture to a weighted value of $37.20 per acre-foot for deciduous orchard, with a weighted average payment capacity for all crops of $4.65 per acre-foot. Assuming a pricing policy for water would be adopted compatible with the crop pattern projected for the area, it appears that the New York Flat Project could be financed on the basis of irrigated agriculture alone, without consideration of the higher payment capacity for water of residential farms.

San Juan Ridge Service Area Development

Results of preliminary studies of the San Juan Ridge Service Area indicated that the cost of developing new water supplies would be relatively high. With an interest rate of 4 percent per annum, the cost of water was found to be beyond the payment capacity of most crops adaptable to the ridge. At this interest rate it appears that no irrigation project could be justified.

It is possible, however, to obtain interest free loans for qualified projects under Public Law 984, the Small Reclamation Projects Act of 1956 (70 Stat. 1044; 43 U. S. C., Sec. 422a-422k, 1958 ed.) This act makes available a maximum of $5,000,000 of federal funds for the construction of small projects, with interest charged depending upon domestic use and the extent of lands in the service area that are held under individual ownership in excess of 160 acres, or 320 acres for man and wife. Formulation of projects as presented herein is based on the assumption that the projects would qualify for loans under Public Law 984 or similar acts which may be authorized in the future, that high payment capacity crops would be grown, and in addition, that the majority of future land holdings on the ridge would be less than the acreage limitations.

Two other assumptions were made:

1. Project water would be for the use and benefit of all irrigable lands on the ridge regardless of present water district boundaries.

2. The small existing water supply facilities on the ridge would cease to operate independently and would be integrated into the proposed development.

Due to its relatively remote location in relation to other foothill regions of the Yuba-Bear Area, the high cost of developing new water supplies, and the scattered location and small areal extent of irrigable lands on the San Juan Ridge, it is envisioned that water requirements will develop slowly, with a trend of land use to small non-commercial holdings, or residential farms.

Based on the foregoing, a plan was formulated consisting of two reservoirs and a series of canals susceptible to staged construction, and a third reservoir independent of the staged construction. The proposed order of construction is:

1. North Columbia Project
2. Shady Creek Project
3. Bloody Run Reservoir

A graphic presentation of anticipated water delivery requirements in the service area to the year 2020, and the staging of projects to satisfy these requirements is shown on Figure 4. Location of projects is shown on Plate 6.

North Columbia Project

This project would be the first stage of development to provide an irrigation yield at the reservoir of 3,200 acre-feet per year. The project would originate on Poorman Creek near Graniteville. A low concrete diversion dam would divert surplus flows of Poorman Creek into rehabilitated Upper Eureka Lake Ditch. This ditch, which extends for 2.3 miles to Middle Milton Ditch, would be repaired to a capacity of 36 second-feet. Abandoned Middle Milton Ditch would be rehabilitated to a capacity of 36 second-feet to convey water the remaining 7.4 miles to Bloody Run Creek. Downstream on Bloody Run Creek a low concrete diversion dam would be constructed to divert the imported flows from Poorman Creek and surplus flows of Bloody Run Creek into rehabilitated Lower Eureka Lake Ditch. This ditch extends 2.4 miles through a low saddle into the Grizzly Creek watershed and would be repaired to a capacity of 60 second-feet. Downstream on Grizzly Creek a diversion dam would be constructed to

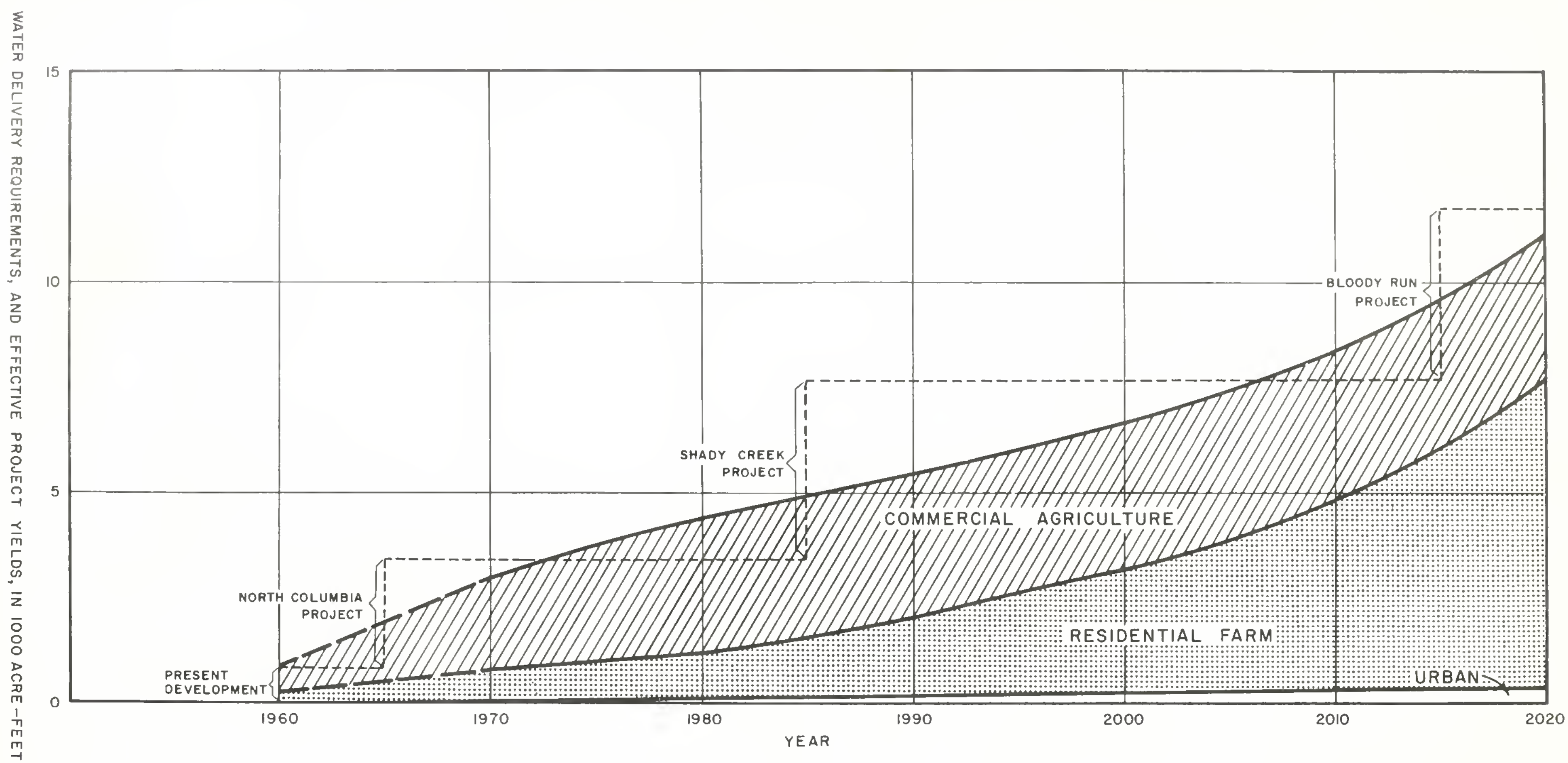


Figure 4, WATER SOURCES AND USES SAN JUAN RIDGE SERVICE AREA

divert the accumulated imported flows plus surplus flows of Grizzly Creek into a new ditch which would carry the water 2.0 miles to North Columbia Reservoir. Capacity of the new ditch would be 66 second-feet. North Columbia Reservoir, located on an intermittent tributary of Grizzly Creek, would have a gross storage capacity of 2,300 acre-feet and would serve as a terminal reservoir for storage and reregulation of the imported water. Releases from the reservoir would enter rehabilitated Milton Ditch for conveyance to the service area.

The practicability of this plan is due to the existence of the abandoned mining ditches which formerly carried water for hydraulic mining operations on the ridge. The use of these ditches as part of a water supply development for the San Juan Ridge was proposed in a report by the engineering firm of Porter, Urquhart, McCreary and O'Brien, "Reconnaissance Study on Water Supply Project for San Juan Ridge, California," August 1959. Since publication of that report, San Juan Ridge County Water District has been considering a similar project as a first stage of development for the area.

<u>North Columbia Dam and Reservoir</u> would include a dam on an intermittent tributary of Grizzly Creek, and a low auxiliary dam in a saddle a few hundred yards to the south. The main damsite, located about one-half mile northwest of the settlement of North Columbia, is at streambed

elevation 2,792 feet. A general layout of the dam and appurtenant features is shown on Plate 11, "North Columbia Dam on Tributary to Grizzly Creek."

A topographic map of the dam and reservoir area to a scale of 1 inch equals 150 feet, and a contour interval of 5 feet, was prepared by the department from aerial photographs taken in 1960. Areas and storage capacities of the reservoir at various elevations of water surface are given in Table 49.

TABLE 49

AREAS AND CAPACITIES OF NORTH COLUMBIA RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	2,792	0.0	0
8	2,800	0.1	1
18	2,810	0.4	3
28	2,820	0.8	9
38	2,830	8.8	57
48	2,840	17.0	190
58	2,850	31.0	420
68	2,860	48.0	820
78	2,870	65.0	1,380
88	2,880	84.0	2,130
98	2,890	101.0	3,050

Geologic exploration at the site included surface reconnaissance and limited drilling of the main dam axis. A discussion of geologic conditions at North Columbia damsite is presented in Appendix G.

Based on available geologic information, the North Columbia damsite is considered suitable for a 96-foot high earthfill structure. Topographic features limit the practical maximum height of a dam at this site. Accordingly, normal pool elevation was set at 2,882 feet, which corresponds to a gross storage capacity of 2,300 acre-feet.

Cost estimates were prepared for a dam of earthfill construction with a height above streambed of 96 feet. Crest elevation at this height is 2,888 feet. The spillway would be cut through the low ridge to the south adjacent to the saddle dam. Control would be provided by a concrete ogee section with a length of 35 feet, and designed to pass a peak discharge of 1,100 second-feet. Freeboard above maximum water surface would be 1 foot.

Controlled releases would be made directly into Lower Milton Ditch for conveyance to the service area. Outlet works would consist of a 3-foot diameter welded steel pipe placed in a trench excavated through the left abutment of the main dam and encased in concrete. Discharges through the outlet pipe would be controlled by a 30-inch hollow jet valve.

Grizzly Creek Diversion Dam. A low concrete structure would be constructed on Grizzly Creek immediately below Alleghany Road crossing. Streambed elevation at the site is approximately 3,000 feet, as determined from USGS topographic map coverage of the area.

A lump sum estimate was made for the cost of a broad-crested concrete weir at this site. Flashboards would be positioned atop the weir as required for the purpose of diverting streamflow into New Miners Ranch Ditch. Provision would be made to permit stream releases for preservation of fishlife below the dam.

Bloody Run Creek Diversion Dam. This dam would be constructed on Bloody Run Creek at the head of abandoned Lower Eureka Lake Ditch. Streambed elevation at the site is approximately 3,850 feet as determined from USGS topographic map coverage of the area.

The design of this dam is similar to that for Grizzly Creek described above. Flashboards would be utilized as required to divert the natural and augmented flows of the stream into rehabilitated Lower Eureka Lake Ditch. Provision would be made to permit stream releases for the preservation of fishlife below the dam.

Poorman Creek Diversion Dam. This structure would be the uppermost feature of the San Juan Ridge development. A low concrete diversion weir would be constructed across Poorman Creek at the head of abandoned Upper Eureka Lake Ditch. Streambed elevation at the site is approxiately 5,000 feet as determined from USGS topographic maps.

Design of the dam would be similar to those described above. Flashboards would be used to provide the necessary pool for diversion of the streamflow into rehabilitated

Upper Eureka Lake Ditch. Provision would be made to permit stream releases for fisheries preservation below the dam.

General features of the diversion dams are presented in Table 50.

New and Rehabilitated Ditches. The backbone of the North Columbia Project is 12 miles of rehabilitated old mining ditches extending between Poorman Creek and Grizzly Creek. The ditch from Grizzly Creek to North Columbia Reservoir would be abandoned in favor of a new ditch at a lower elevation. An additional 8.1 miles of abandoned ditch extending from North Columbia Reservoir into the service area would be rehabilitated to serve as the main distribution canal.

Earth sections of the abandoned ditches are for the most part in good condition and could be put into operation after clearing of vegetative growth and reshaping of the section. Some reaches of the Middle Milton Ditch have been destroyed by logging operations and would have to be rebuilt. The original wooden flume sections have since rotted away and would be replaced. Numerous road crossings would be constructed as required.

General features of the North Columbia Project are summarized on Table 50. Estimated capital and annual costs are summarized in Table 51. A summary of the monthly yield study of the North Columbia Project is presented in Appendix E, Table E-3.

TABLE 50

GENERAL FEATURES OF NORTH COLUMBIA PROJECT

North Columbia Dam and Reservoir

Damsite

Location	NW 1/4, Section 32, T18N, R9E, MDB&M
Stream	A tributary to Grizzly Creek

Main Dam and Appurtenant Features

Type	Earthfill
Crest elevation, in feet	2,888
Crest width, in feet	20
Crest length, in feet	800
Height above streambed, in feet	96
Height, spillway lip above streambed, in feet	90
Side slopes	
Upstream	3.0:1
Downstream	2.25:1
Elevation of streambed, in feet	2,792
Volume of fill, in cubic yards	318,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet	1,100
Type of outlet works	Cut and cover

Saddle Dam

Type	Earthfill
Crest length, in feet	350
Crest width, in feet	20
Side slopes	
Upstream	2.5:1
Downstream	2.0:1
Volume of fill, in cubic yards	13,500

Reservoir

Water surface elevation at maximum pool, in feet	2,887
Water surface elevation at normal pool, in feet	2,882
Storage capacity at spillway crest, in acre-feet	2,300
Drainage area, in square miles	1

Diversion dams	Grizzly Creek	Bloody Run Creek	Poorman Creek
Location	S21 T18N R9E	S30 T18N R10E	S10 T18N R11
Type	concrete	concrete	concrete
Spillway discharge capacity	unlimited	unlimited	unlimited
Diversion headgate discharge capacity, in second-feet	66	60	36

Ditches	Upper Eureka Lake	Middle Milton	Lower Eureka Lake	New Miners Ranch	Lower Milton
Length, in miles	2.3	7.4	2.4	2.0	8.1
Capacity, in cfs	36	36	60	66	35-20
Type	unlined	unlined	unlined	unlined	unlined

TABLE 51

SUMMARY OF ESTIMATED COSTS
OF NORTH COLUMBIA PROJECT

(Based on prices prevailing in January 1963)

Item	Cost
Capital Cost	
Reservoir	$ 18,000
Dam embankment	510,000
Spillway	46,000
Outlet works	56,000
Subtotal	$ 630,000
Diversion dams	44,000
Rehabilitated ditches	120,000
New Miners Ranch Ditch	44,000
Subtotal	$ 838,000
Contingencies, 20%	168,000
Subtotal	$ 1,006,000
Engineering and administration, 15%	151,000
Subtotal	$ 1,157,000
Interest during construction, 4%	21,000
TOTAL CAPITAL COST	$ 1,178,000

Annual Cost	4% interest	No interest
Repayment in 50 years	$ 54,800	$ 23,100
Operation, maintenance, replacement, general expense, and insurance	3,500	3,500
TOTAL ANNUAL COST	$ 58,300	$ 26,600

Shady Creek Project

The unit cost of developing new water supplies at the Shady Creek site is less than the unit cost of those from the North Columbia Project. However, due to its location, the reservoir can serve only the lower elevation lands on the ridge, and for this reason, it is not proposed as the first stage of development. Project yield measured at the reservoir would be 5,000 acre-feet annually.

The reservoir would be formed by construction of a dam on Shady Creek and two low auxiliary dams located in saddles to the north and south. The damsite is located about 2-1/2 miles south and east of North San Juan at a streambed elevation of 1,983 feet.

A topographic map of the reservoir area to a scale of 1 inch equals 300 feet was prepared by the department from aerial photographs taken in 1960. Areas and storage capacities of the reservoir at various elevations of water surface are given in Table 52.

Geologic exploration was limited to field reconnaissance. A discussion of geologic conditions at Shady Creek damsite is presented in Appendix G. Based on available geologic information, Shady Creek damsite appears suitable for a dam of earthfill construction.

Shady Creek Reservoir was sized to a gross storage capacity of 5,700 acre-feet. Topography limits the maximum practical height of dam at this site. A summary of the monthly yield study of Shady Creek Reservoir is presented in Appendix E, Table E-4.

TABLE 52

AREAS AND CAPACITIES OF SHADY CREEK RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	1,983	0	0
7	1,990	0	1
17	2,000	1	4
37	2,020	12	130
57	2,040	47	720
77	2,060	105	2,240
97	2,080	184	5,130
117	2,100	266	9,630

Cost estimates were prepared for a dam of earthfill construction with a height above streambed of 107 feet. The two small auxiliary dams would be of rolled earth construction. Normal pool would be at elevation 2,082 feet. A general layout of the dam and appurtenant features is shown on Plate 12.

The spillway would be cut through the low ridge seperating the main dam from the auxiliary dam to the south. Control would be provided by a concrete ogee section 100 feet in length, designed to pass a peak discharge of 7,300 second-feet. Freeboard above maximum water level would be 1 foot.

Controlled releases would be made directly into a new canal of 25 second-feet capacity extending approximately 1.4 miles to a junction with rehabilitated Lower Milton Ditch. Outlet works would consist of a 3-foot diameter welded steel pipe 330 feet in length, placed in a trench excavated through the right abutment of the main dam and encased in concrete. Releases through the outlet pipe would be controlled by a 30-inch hollow jet valve discharging into a small stilling basin at the head of the canal.

General features of Shady Creek Project are presented in Table 53. Estimated capital and annual costs are summarized in Table 54.

Bloody Run Reservoir

This reservoir would be the third stage of development to provide an additional water supply at North Columbia Reservoir of 4,800 acre-feet per year. Deficiencies in irrigation yield were assumed in dry years under the criteria defined in Chapter IV. A summary of the monthly yield study of Bloody Run Reservoir and the North Columbia Project are presented in Appendix E, Table E-5.

The dam would be located on Bloody Run Creek about 2-1/2 miles north of the village of North Bloomfield, and about one-half mile above the proposed Bloody Run Diversion Dam. Streambed elevation at this point is approximately 3,970 feet as determined from USGS Pike quadrangle map. Areas

TABLE 53

GENERAL FEATURES OF SHADY CREEK PROJECT

Damsite

Location	Section 16, T17N, R8E, MDB&M
Stream	Shady Creek

Main Dam and Appurtenant Features

Type	Earthfill
Crest elevation, in feet	2,090
Crest width, in feet	25
Crest length, in feet	1,200
Height above streambed, in feet	107
Height, spillway lip above streambed, in feet	99
Side slopes	
Upstream	2.5:1
Downstream	2.0:1
Elevation of streambed, in feet	1,983
Volume of fill, in cubic yards	444,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet	7,300
Type of outlet works	Cut and cover

Saddle Dams

Type	Earthfill
Combined crest length, in feet	500
Crest width, in feet	15
Side slopes	
Upstream	2.5:1
Downstream	2.0:1
Combined volume of fill, in cubic yards	9,500

Reservoir

Water surface elevation at maximum pool, in feet	2,089
Water surface elevation at normal pool, in feet	2,082
Water surface elevation at minimum pool, in feet	2,037
Surface area at normal pool, in acres	193
Storage capacity at normal pool, in acre-feet	5,700
Drainage area, in square miles	10.3

TABLE 53 (continued)

New Canal

Length, in feet	8,800
Capacity, in second-feet	25
Type	Unlined
Section	Trapezoidal

TABLE 54

SUMMARY OF ESTIMATED COSTS
OF SHADY CREEK PROJECT

(Based on prices prevailing in January 1963)

Item		Cost
Capital Cost		
Reservoir		$ 103,000
Dam embankment		600,000
Spillway		113,000
Outlet works		58,000
New canal		7,000
Subtotal		$ 881,000
Contingencies, 20%		176,000
Subtotal		$ 1,057,000
Engineering and administration, 15%		159,000
Subtotal		$ 1,216,000
Interest during construction, 4%		36,000
TOTAL CAPITAL COST		$ 1,252,000
Annual Costs	4% interest	No interest
Repayment in 50 years	$ 58,300	$ 24,300
Operation, maintenance, replacement general expense, and insurance	2,100	2,100
TOTAL ANNUAL COST	$ 60,400	$ 26,400

and storage capacities of the reservoir at various elevations of water surface are given in Table 55.

TABLE 55

AREAS AND CAPACITIES OF
BLOODY RUN RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	3,970	0	0
10	3,980	4	40
30	4,000	16	240
50	4,020	30	720
70	4,040	47	1,480
90	4,060	60	2,540
110	4,080	72	3,860
130	4,100	90	5,560
150	4,120	113	7,600

Geologic exploration was limited to field reconnaissance. A discussion of geologic conditions at Bloody Run damsite is presented in Appendix G.

Bloody Run Reservoir was sized to a gross storage capacity of 7,000 acre-feet. Selection of this size was determined primarily on the basis of the additional yield required over that developed by the North Columbia Project to meet year 2020 water requirements of lands within the service area not satisfied by proposed Shady Creek Reservoir. During formulation of Bloody Run Reservoir, consideration was also given to the cost of developing some or all of the required supplemental yield at alternative storage sites on Grizzly and East Fork Creeks. The cost of developing supplemental yield at these locations was found to be greater than at the Bloody Run site.

A dam with a height above streambed of 153 feet would provide 7,000 acre-feet of gross storage capacity at this site. Cost estimates were prepared for a dam and rock-fill construction with an impervious earth core. Normal pool would be at elevation 4,114 feet. A general layout of the dam and appurtenant features is shown on Plate 12.

The spillway would consist of a channel excavated around the left abutment with control provided by a concrete ogee section 50 feet in length, designed to pass a peak discharge of 4,500 second-feet. Freeboard above maximum water level would be 1 foot.

Controlled releases would be made directly to the stream for diversion into Lower Eureka Lake Ditch and for the preservation of the stream fishery. Outlet works would consist of a 3-foot diameter welded steel pipe 630 feet in length, placed in a trench excavated in the stream channel and encased in concrete. Releases through the outlet pipe would be controlled by a Howell-Bunger valve discharging into the stream below the dam.

General features of Bloody Run Dam and Reservoir are presented in Table 56. Estimated capital and annual costs are summarized in Table 57.

TABLE 56

GENERAL FEATURES OF BLOODY RUN
DAM AND RESERVOIR

Damsite	
Location	Sections 19 and 30, T18N, R10E, MDB&M
Stream	Bloody Run Creek
Dam and Appurtenant Features	
Type	Rockfill with impervious core
Crest elevation, in feet	4,123
Crest width, in feet	20
Crest length, in feet	1,070
Height above streambed, in feet	153
Height, spillway lip above streambed, in feet	144
Elevation of streambed, in feet	3,970
Side slopes	
Upstream	2.5:1
Downstream	2.0:1
Volume of fill, in cubic yards	726,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet	4,500
Type of outlet works	Cut and cover
Reservoir	
Water surface elevation at maximum pool, in feet	4,122
Water surface elevation at normal pool, in feet	4,114
Water surface elevation at minimum pool, in feet	3,997
Surface area at normal pool, in acres	106
Storage capacity at normal pool, in acre-feet	7,000
Storage capacity at minimum pool, in acre-feet	200
Drainage area, in square miles	4.4

TABLE 57

SUMMARY OF ESTIMATED COSTS OF
BLOODY RUN DAM AND RESERVOIR

(Based on prices prevailing in January 1963)

Item	Cost
Capital Cost	
Reservoir and improvements	$ 54,000
Dam embankment	1,037,000
Spillway	171,000
Outlet works	79,000
Subtotal	$ 1,341,000
Contingencies, 20%	268,000
Subtotal	$ 1,609,000
Engineering and administration, 15%	242,000
Subtotal	$ 1,851,000
Interest during construction, 4%	56,000
TOTAL CAPITAL COST	$ 1,907,000

Annual Cost	4% interest	No interest
Repayment in 50 years	$ 88,800	$ 37,000
Operation, maintenance, replacement, general expense, and insurance	2,300	2,300
TOTAL ANNUAL COST	$ 91,100	$ 39,300

Accomplishments of Proposed Development

The projects proposed for the San Juan Ridge would provide new water supplies adequate to meet projected agricultural and domestic uses to year 2020, and, in addition, provide new recreational opportunities which would be associated for the most part with the latter stages of development. In Bloody Run and Grizzly Creeks an improved stream fishery would result from project operation. The attractiveness of Shady Creek Reservoir, which is situated in an easily accessible location, would be enhanced by maintaining a sizable minimum pool in the reservoir.

The rate of development on the San Juan Ridge to irrigated agriculture, residential farm, and urban use was projected on the basis of assumptions discussed under previous headings, and the anticipated cost of water from the proposed staged development. Projected use of irrigable land, together with present land use, is summarized by decades in Table 58.

Water delivery requirements for irrigation, residential farm, and urban uses were determined by applying unit water requirements for irrigated agriculture and domestic use presented in Chapter III to the present and project land use pattern. A summary of present and projected seasonal water delivery requirements by decades to year 2020 is presented in Table 59.

Staging of the proposed projects was determined primarily on the basis of need to satisfy projected demands

TABLE 58

SUMMARY OF PRESENT AND PROJECTED LAND USE
IN SAN JUAN RIDGE SERVICE AREA
(in acres)

Land use	Present 1/	1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Deciduous orchard	10	450	1,000	1,170	1,180	1,190	1,200
Pasture	400	350	320	300	300	300	300
Subtotal, net area	410	800	1,320	1,470	1,480	1,490	1,500
Residential farm	2/	270	400	660	1,020	1,560	2,460
Urban	130	130	140	160	180	230	300
TOTAL, net area	540	1,200	1,860	2,290	2,680	3,280	4,260

1/ As determined from Department of Water Resources survey in 1957.
2/ Included in irrigated agriculture.

TABLE 59

SUMMARY OF PRESENT AND PROJECTED SEASONAL WATER
DELIVERY REQUIREMENTS OF SAN JUAN RIDGE SERVICE AREA
(in acre-feet)

Land use	Present	1970	1980	1990	2000	2010	2020
Agriculture	760	2,110	3,120	3,390	3,410	3,430	3,450
Residential farm	1/	810	1,200	1,980	3,060	4,680	7,380
Urban	40	30	40	70	110	180	300
TOTAL	800	2,950	4,360	5,440	6,580	8,290	11,130
TOTAL, rounded	800	3,000	4,400	5,400	6,600	8,300	11,100

1/ Included in agriculture.

for water and with consideration of practical aspects of financing and construction. Completion date shown for the first stage is the estimated earliest practical date the project could be put in operation, assuming a period of authorization and construction. Proposed construction of the third stage was delayed slightly beyond the need for additional water to allow a 50-year period for repayment of the first stage. A summary of yield from present development and from proposed projects together with estimated completion date and annual costs is presented in Table 60.

TABLE 60

SUMMARY OF EXISTING AND PROPOSED PROJECT YIELDS, ESTIMATED ANNUAL PROJECT COSTS, AND INDICATED YEAR OF PROJECT COMPLETION FOR SAN JUAN RIDGE SERVICE AREA DEVELOPMENT

	Effective yield, in acre-feet 1/	Annual cost, including O&M: 4% interest	Annual cost, including O&M: No interest	Indicated year of completion 2/
Present development (est.)	800	-	-	-
North Columbia Project	2,690	$ 58,300	$ 26,600	1965
Shady Creek Project	4,200	60,400	26,400	1985
Bloody Run Reservoir	4,030	91,100	39,300	2015
TOTAL	11,720			

1/ Based on average conveyance losses to farm headgate of 20 percent, and reuse of applied water at 5 percent.
2/ Based primarily on need for project services.

Benefits from Proposed Development

The primary tangible benefits that would accrue to the San Juan Ridge Development would be derived from increased irrigation and domestic water supplies made available by the propsed projects, and from increased water-associated recreational activity made possible as a result of these projects.

Benefits from irrigation development would consist of the net value of the returns to land and water from the area served by the projects. Increased productivity would result from the application of project water to presently dry-farmed lands and lands presently receiving a partial water supply on an intermittent basis.

Irrigation benefits from the lands served by the project were derived by applying unit values of returns to land and water to the crop pattern presented in Table 58, and appropriately reducing the result to reflect returns from present farming operations. The sum of net annual direct irrigation benefits from commercial agriculture accruing to the proposed development was estimated at $2,980,000.

The benefits attributable to the use of project water on residential farms were computed as a composite value based on the use of water for irrigation and for domestic service. Benefits derived for the agricultural portion were computed on the same basis as for commercial agriculture. The sum of net annual direct benefits accruing to the proposed development was estimated at $2,490,000.

The municipal and industrial benefits were analyzed on the basis of the least costly alternative source which was limited by the vendability of water. A survey of possible alternatives indicated the cost to be approximately $38 per acre-foot which corresponds to rates of the major service agencies nearby. On the basis of the projected urban population, the sum of net benefits accruing from municipal and industrial uses was estimated to be $101,000.

There would also be benefits accruing to the proposed development due to increased recreational opportunities and fisheries enhancement. Determination of the magnitude of these benefits was, however, considered to be beyond the scope of this investigation.

A summary of total net benefits and total costs associated with the proposed development to year 2020 is presented in Table 61.

A comparison of net agricultural and residential farm benefits accruing to year 2020 with repayment and operating costs to that date reveals that the proposed San Juan Ridge Development would have a benefit-cost ratio of 1.01 to 1. As stated previously, it was assumed that project financing could possibly be obtained under Public Law 984. Under this law, it is not necessary to show economic justification; only financial feasibility need be shown.

Weighted average annual payment capacity for crops projected for the San Juan Ridge is $19.80 per acre-foot of water delivered to the farm headgate. The average cost of water from the North Columbia Project would be about $9.90 per acre-foot, assuming no-interest financing for the entire project.

TABLE 61

SUMMARY OF TOTAL NET BENEFITS
AND TOTAL REPAYMENT AND OPERATING COSTS
FOR PROPOSED DEVELOPMENT TO YEAR 2020

(Repayment at 4% interest rate)

Benefits		Costs	
Source of benefit	Sum of annual net benefits to year 2020	Project	Sum of repayment and O&M costs to Year 2020
Agriculture	$ 2,980,000	North Columbia	$ 2,925,000
Residential farms	2,490,000	Shady Creek	2,114,000
Urban	101,000	Bloody Run	456,000
Recreation	1/		
TOTAL	$ 5,571,000	TOTAL	$ 5,495,000

1/ Not determined

Grass Valley Service Area Development

Nearly all of the presently irrigated lands in the Grass Valley Service Area are served from projects owned and operated by the Nevada Irrigation District. The district embraces approximately 80 percent of the service area, and in addition, supplies water to other lands outside the district but within the service area in the vicinity of Smartville, Yuba County.

Inasmuch as future water supply development in the Grass Valley Service Area will undoubtedly be carried out by the Nevada Irrigation District, development plans were formulated which can be integrated with existing district storage and conveyance works and added to the system as the demand for supplemental water occurs.

The proposed plan for development, which includes the Yuba-Bear Project of the district, now under construction (1963), is listed below in anticipated order of construction or occurrence. Location of proposals is shown on Plate 6.

1. Nevada Irrigation District's Yuba-Bear Project
2. Weaver Lake Project
3. Bitney Corner Project
4. Anthony House Dam and Reservoir
5. Haypress Diversion Project
6. Extensive canal improvement and lining program

A graphic presentation of anticipated water delivery requirements in the service area to year 2020, and the staging of the proposed projects to satisfy these requirements is shown on Figure 5.

The district at the present time is proceeding with plans to increase its present water supply by construction of the Yuba-Bear Project. This project includes features located not only in the Grass Valley Service Area, but also in the Mountain and Auburn Foothills Service Areas of this investigation. Rather than describe the project features as they occur by service areas, particularly in light of the interrelated nature of the project features, the entire project is described below under a single heading.

Nevada Irrigation District's Yuba-Bear Project

The Yuba-Bear Project as described herein was formulated by the firm of Ebasco Engineers, Incorporated, and presented in a report entitled "Nevada Irrigation District - Water and Power Feasibility Report" April 1960, and since amended to include the enlargement of Scotts Flat Reservoir. This development conforms substantially with the plans for development advocated by the department in Bulletin No. 3, and those formulated in the early phases of this investigation. Financing will be from the sale of revenue bonds supported by revenue from the sale of project hydroelectric power to the Pacific Gas and Electric Company. A review of designs and cost estimates of the proposed project was conducted by the department under contract to the Districts Securities

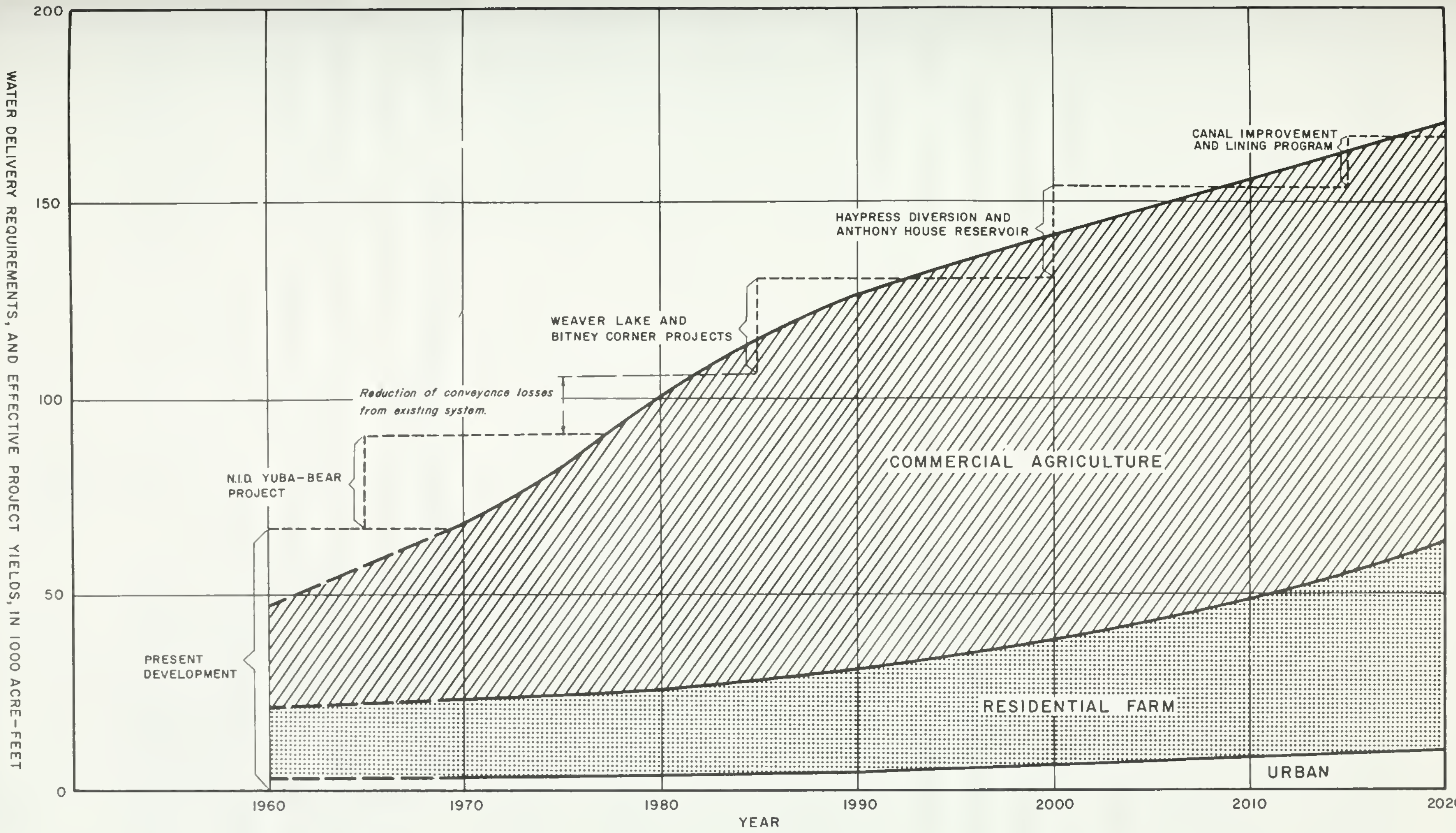


Figure 5, WATER SOURCES AND USES
GRASS VALLEY SERVICE AREA

Commission. Project costs shown herein are Ebasco estimates as revised in some cases by the department.

The project will develop new water supplies to supplement existing district project yield from Deer Creek and Scotts Flat Reservoir, and from the Bear River below Lake Combie. Yield studies conducted under this investigation indicate firm water supplies available from Deer Creek and enlarged Scotts Flat Reservoir will be increased by about 21,000 acre-feet per year and that firm supplies available from the Bear River will be increased by approximately 41,000 acre-feet per year. Hydroelectric power will be generated at two new powerplants with an aggregate installed capacity of 59,100 kilowatts. In addition, the Drum No. 2 Powerplant will be a new plant constructed by the Pacific Gas and Electric Company to utilize the new water conserved and will have an installed capacity of 44,100 kilowatts.

In descending order of elevation, the project consists of the following additions and improvements to the existing Nevada Irrigation District system.

Jackson Meadows Dam and Reservoir. Jackson Meadows Dam will be located on the Middle Yuba River about 2 miles upstream from the district's existing Milton Diversion works. It will be a rockfill structure with a height of about 190 feet and a crest length of about 1,345 feet.

Diversion and outlet works will be provided through the right abutment. The spillway, located across the left abutment, will be gated and have a maximum discharge capacity of 17,000 second-feet.

Jackson Meadows Reservoir will have a gross storage capacity of 68,000 acre-feet at normal water surface elevation of 6,035 feet, U. S. Geological Survey datum.

Milton-Bowman Conduit. The Milton-Bowman conduit conveys water from Milton Diversion Dam on the Middle Yuba River to Bowman Reservoir on Canyon Creek and is an existing feature of the district's system. The conduit consists of a wood stave pipe with a length of 3,400 feet leading to a tunnel with a length of 21,200 feet.

Under the plan for construction, the wood stave pipe will be replaced by reinforced concrete pipe. The tunnel will be repaired, and any portion where rock falls have occurred in the past will be cleaned out and lined as required. Furthermore, additional water supplies will be obtained by improvement of an existing conduit with a length of 4,500 feet which conveys water diverted from Wilson and Poison creeks to the main conduit.

Faucherie Lake. Faucherie Lake is located on Canyon Creek about 3 miles upstream from Bowman Reservoir. A rockfill dam will be constructed with a total embankment height of approximately 45 feet above streambed. Normal pool will be at elevation 6,153 feet. A spillway will be located around the right abutment with control provided by a concrete overpour section 100 feet in length. Spillway crest elevation will be 6,150 feet. Flashborads will be mounted atop the spillway weir to increase the usable storage capacity to approximately 3,500 acre-feet.

Bowman-Spaulding Conduit. The existing Bowman-Spaulding conduit extends from Bowman Reservoir to Lake Spaulding, a reservoir of the Pacific Gas and Electric Company. The present conduit capacity of 230 second-feet will be increased to 300 second-feet for the section from Bowman Reservoir to Texas Creek and 325 second-feet for the section from Texas Creek to Fuller Lake. The Pacific Gas and Electric Company, which owns the portion of the conduit extending from Fuller Lake to Lake Spaulding, will assume the financial responsibility for any enlargement required for that section of conduit.

The first section of existing conduit, with a length of approximately 13,000 feet, will be replaced by two sections of tunnel aggregating 9,600 feet and two sections of reinforced concrete flume. At Texas Creek, the existing flume will be replaced by driving a tunnel under the stream with provision for diverting the entire flow of the creek at all times. The existing Fall Creek siphon will be replaced by a canal and a short section of flume. Existing works for diverting Fall Creek flows into the conduit will be improved. Two existing tunnels in the reach of conduit between Texas Creek and Fuller Lake will be cleaned out and slightly enlarged to a conveyance capacity of 325 second-feet. Remaining sections of the existing conduit will be improved to handle increased flows.

Pacific Gas and Electric Company Works. The works undertaken by the Pacific Gas and Electric Company, which will tie into the Yuba-Bear project of the district, are briefly mentioned here for the sake of completeness of description of the total project. The Drum Canal, which extends from Lake Spaulding, will be enlarged to a conveyance capacity of about 700 second-feet. The Drum power facilities will be increased by the construction of Drum No. 2 Powerplant, with an installed capacity of about 44,100 kilowatts. Pacific Gas and Electric Company will also construct transmission lines to connect with the new powerplants of the district that are described in subsequent paragraphs.

Dutch Flat No. 2 Powerplant. The facilities of Dutch Flat No. 2 Powerplant will consist of a concrete flume with a capacity of about 570 second-feet extending from the existing Pacific Gas and Electric Company's Drum Afterbay for about 5 miles along the Bear River Canyon to a small forebay, a penstock with a length of about 2,500 feet, and a powerplant with an installed capacity of about 22,800 kilowatts. This powerplant will be located on the right bank of the Bear River almost directly opposite the Dutch Flat Powerplant of the Pacific Gas and Electric Company. An afterbay dam will be constructed just downstream from this powerplant in order to provide some flow regulation and to serve as a diversion for the Chicago Park Powerplant.

Chicago Park Powerplant. Releases from Dutch Flat Powerplant will be conveyed through a new concrete flume with a capacity of about 1,160 second-feet extending from the Dutch Flat Afterbay for a distance of about 4.4 miles along the right bank of Bear River to a small forebay. From this forebay, releases will pass through a penstock with a length of about 2,500 feet to Chicago Park Powerplant with an installed capacity of 36,300 kilowatts, located on the right bank of the Bear River.

Rollins Dam and Reservoir. Rollins Dam will be located on the Bear River about one-half mile upstream from the Colfax-Grass Valley Highway. It will be of gravel and rockfill construction with a central core of impervious material. The maximum height will be about 260 feet and the crest length about 1,200 feet. Diversion and outlet works will be provided on the left bank. An ungated spillway with a discharge capacity of 40,000 second-feet will be provided across the right abutment.

Rollins Reservoir will have a gross storage capacity of 65,000 acre-feet at normal water surface elevation of 2,170 feet, U. S. Geological Survey datum.

Enlarged Scotts Flat Dam. The existing Scotts Flat Dam on Deer Creek will be raised 35 feet to a total height of about 170 feet by the addition of fill material to the downstream face. The existing overpour spillway will be replaced by an ungated concrete ogee weir section located in the existing approach channel. Gross storage capacity of the reservoir will be increased from 26,300 acre-feet to 50,000 acre-feet at normal water surface elevation of 3,075 feet, U. S. Geological Survey datum.

General features of the district's proposed Yuba-Bear Project are summarized in Table 62, and presented on Plate 6. A summary of estimated capital costs is presented in Table 63.

Weaver Lake Project

The Weaver Lake Project would consist of diversion structures on East Fork and Toms Creeks, tributaries to the Middle Yuba River, and a conduit to convey the surplus flows of these streams into Weaver Lake. The existing storage capacity of Weaver Lake would be increased by the construction of a dam across the outlet channel and a small dam across a saddle to the east. Water supply developed by the project would enter Bowman Reservoir via a tunnel excavated through the low ridge separating the watersheds.

The project would add about 7,200 acre-feet to the water supply available for diversion to Lake Spaulding during the critical operating period July 1930 through February 1932, and an average of about 7,000 acre-feet per year during the critical dry period 1928 through 1934. A summary of

TABLE 62

GENERAL FEATURES OF NEVADA IRRIGATION DISTRICT'S YUBA-BEAR PROJECT

Dam and Reservoir	Stream	Dam: Location MDB&M	Dam: Type 1/	Dam: Height in feet	Dam: Crest length in feet	Water surface elevation, in feet: Normal pool	Water surface elevation, in feet: Minimum pool	Storage capacity, in acre-feet: Gross	Storage capacity, in acre-feet: Active
Jackson Meadows	M. Yuba River	S 18 T19N R13E	RF	190	1,345	6,035	5,935	68,000	65,000
Faucherie	Canyon Creek	S 13 T18N R12E	RF	45	NA	6,153	6,120	---	3,500
Rollins	Bear River	S 22 T15N R 9E	RF	260	1,200	2,170	2,030	65,000	60,000
Enl. Scotts Flat	Deer Creek	S2,11 T16N R 9E	EF	170	935	3,075	NA	50,000	NA
Dutch Flat Afterbay	Bear River	S 27 T16N R10E	NA	NA	NA	NA	NA	NA	NA

Powerplants	Location MDB&M	Maximum static head, in feet	Installed capacity, in kilowatts	Dependable capacity, in kilowatts
Dutch Flat No. 2	Sec. 27 T10N R10E	491	22,800	21,200
Chicago Park	Sec. 6 T15N R10E	480	36,300	33,800

Conduits	Feature	Length, in miles	Capacity, in second-feet	Type
Milton-Bowman	New pipeline	0.6	500	R. C. pipe
	Existing tunnel (to be renovated)	4.0	500	Unlined
Bowman-Spaulding	New flume	0.4	300	Concrete
	New tunnel	1.8	300	Unlined
	Enl. canal	0.9	300	Gunite lined
	Enl. tunnels	1.0	325	Unlined
	Enl. canal	4.1	325	Gunite lined
	New flume	0.1	325	Concrete
	New canal	0.9	325	Gunite lined
Dutch Flat	Tunnel	0.1	570	Unlined
	Flume	5.1	570	Concrete
	Penstock	0.5	570	Steel
Chicago Park	Flume	3.8	1,160	Concrete
	Penstock	0.3	1,160	Steel

1/ RF rockfill
EF earthfill
NA not available

TABLE 63

SUMMARY OF ESTIMATED COSTS OF NEVADA IRRIGATION DISTRICT'S YUBA-BEAR PROJECT

Item	DWR estimate 1/
Jackson Meadows Dam and Reservoir	$ 5,479,000
Milton-Bowman Conduit	440,000
Faucherie Dam and Reservoir	428,000
Bowman-Spaulding Conduit	2,736,000
Dutch Flat No. 2 Powerplant and appurtenant structures	5,841,000
Chicago Park Powerplant and appurtenant structures	8,190,000
Rollins Dam and Reservoir	7,417,000
Enlarged Scotts Flat Dam	1,077,000
Subtotal direct construction costs 2/	$31,608,000
Escalation 3/	1,723,000
Omissions and contingencies	5,000,000
Total direct construction costs	$38,331,000

1/ As reported in review report prepared for California Districts Securities Commission, January 1962
2/ November 1961 price base
3/ Start of construction May 1963
DWR - Department of Water Resources

the monthly yield study of the Weaver Lake Project is presented in Appendix E, Table E-6.

Conflicting water right applications have been filed to appropriate water from Weaver Lake and/or East Fork Creek. No attempt was made to judge which applicant might be awarded a permit by the State Water Rights Board. The Weaver Lake Project as formulated herein is multipurpose in concept with the primary goal of providing a portion of the supplemental water supplies needed to meet foothill requirements as projected to year 2020.

Weaver Lake Dam and Reservoir. This reservoir would be formed by the construction of a 45-foot high dam on Weaver Creek at the outlet of the existing lake, and a low dam in the saddle to the east.

Topographic map coverage of the area to a scale of 1 inch equals 400 feet, and a contour interval of 10 feet, was available from the files of the State Water Rights Board. Areas and storage capacities of Weaver Lake Reservoir at various elevations of water surface are given in Table 64.

Geologic exploration was limited to field reconnaissance. A discussion of geologic conditions at Weaver Lake damsite is presented in Appendix G. Based on geologic reconnaissance data, the damsite is considered suitable for a rockfill dam to a height proposed.

TABLE 64

AREAS AND CAPACITIES OF WEAVER LAKE RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
	5,560	0	0
	5,580	2	20
	5,600	9	160
	5,620	21	450
	5,640	42	1,080
	5,660	59	2,090
0	5,665*	64	2,400
15	5,680	82	3,500
35	5,700	101	5,280
55	5,720	115	7,490

* Elevation at natural lake outlet

Topographic features limit the practical height of a dam at this site to about 45 feet above the natural lake outlet channel. New storage capacity would be about 4,000 acre-feet. A cost estimate was prepared for a dam of this height of rockfill construction and concrete face. Normal pool without flashboards would be 6 feet below dam crest. The auxiliary dam would be of similar construction with a maximum height above natural ground of about 20 feet.

The spillway would be excavated around the right abutment and discharge into the stream a short distance below the dam. The chute would be lined for a distance of about 150 feet. Control would be provided by a concrete ogee section with a crest length of 30 feet.

Weaver-Bowman Tunnel. A minimum diameter tunnel would be excavated through the ridge separating Weaver and Bowman Lakes. Costs for this feature are based on an unlined tunnel 7 feet in diameter with a length of 3,700 feet. Inlet invert elevation would be about 5,650 feet. A concrete intake structure with trashracks and a closure gate would be provided.

East Fork Creek Diversion Dam. This dam would be constructed on East Fork Creek at a streambed elevation of approximately 5,740 feet. Due to the lack of adequate topographic coverage, a lump sum estimate was made for the cost of a low concrete diversion dam and canal headworks on this stream. The sluice works would be designed to allow for regulated stream releases for preservation of fishlife below the dam.

East Fork Diversion Conduit. This conduit would extend from East Fork Diversion Dam a distance of about 8,600 feet to Weaver Lake. It was estimated that elevated flume would be required for an aggregate length of about 5,600 feet due to the steep terrain, with the remaining 3,000 feet in canal. Cost estimates were based on a conduit with a design capacity of 60 second-feet for the entire length. Provision would be made to intercept surplus flows from Toms Creek enroute.

General features of the Weaver Lake Project are presented in Table 65. Estimated capital and annual costs are summarized in Table 66.

Bitney Corner Project

This project includes a dam and reservoir on Deer Creek, and a new canal from Deer Creek, below the dam, extending southerly to a junction with existing Tarr Ditch. The reservoir would provide a supplemental water supply of 17,000 acre-feet per year measured at the reservoir for use on district lands primarily in the Penn Valley area. Deficiencies in agricultural yield were assumed during dry years under the criteria defined in Chapter IV. Construction of the Bitney Corner Canal would enable the distribution of water developed by this project and that available from enlarged

TABLE 65

GENERAL FEATURES OF WEAVER LAKE PROJECT

Weaver Lake Dam and Reservoir

Damsite

Location	SW 1/4 Section 32, T19N, R12E, MDB&M
Stream	Weaver Creek

Main Dam and Appurtenant Features

Type	Rockfill with concrete face
Crest elevation, in feet	5,710
Crest width, in feet	20
Height above streambed, in feet	45
Height, spillway lip above streambed, in feet	39
Side slopes	
Upstream	1.0:1
Downstream	1.4:1
Elevation of streambed, in feet	5,665
Volume of fill, in cubic yards	21,200
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet .	1,280

Saddle Dam

Type	Rockfill with concrete face
Crest width	15
Side slopes	
Upstream	1.0:1
Downstream	1.4:1
Volume of fill, in cubic yards	6,500

Reservoir

Maximum water surface elevation, in feet . . .	5,709
Normal water surface elevation with flashboards, in feet	5,707
Minimum water surface elevation, in feet . . .	5,659
Gross storage capacity with flashboards, in acre-feet	6,000
Storage capacity at minimum pool, in acre-feet	2,000
Drainage area, in square miles	1

Conduits	East Fork Conduit		Weaver-Bowman
	Canal	Flume	Tunnel
Section	Trapezoidal	Semicircular	Horseshoe
Length, in miles	0.6	1.1	0.7
Capacity, in sec.-ft.	60	60	---
Diameter, in feet	----	5.1	7.0
Type	Unlined	Metal	Unlined

TABLE 66

SUMMARY OF ESTIMATED COSTS
OF WEAVER LAKE PROJECT

(Based on prices prevailing in January 1963)

Item		Costs
Capital Cost		
Weaver Lake Dam and Reservoir		$ 275,000
East Fork Diversion Dam and Conduit		260,000
Weaver-Bowman Tunnel		390,000
Subtotal		$ 925,000
Contingencies, 20%		185,000
Subtotal		$ 1,110,000
Engineering and administration, 15%		167,000
Subtotal		$ 1,277,000
Interest during construction, 4%		26,000
TOTAL CAPITAL COST		$ 1,303,000
Annual Cost	4% interest	No interest
Repayment in 50 years	$ 60,600	$ 25,500
Operation, maintenance, replacement, general expense, and interest	5,300	5,300
TOTAL ANNUAL COST	$ 65,900	$ 30,800

Scotts Flat Reservoir over a wide area as the demand for additional supplies arises.

The reservoir would be formed by the construction of a dam on Deer Creek about 3 miles northwest of Grass Valley and about 6 miles downstream from Nevada City. Streambed elevation at this point is 1,958 feet as determined from USGS Grass Valley quadrangle map. Areas and storage capacities at various elevations of water surface are given in Table 67.

TABLE 67

AREAS AND CAPACITIES OF BITNEY CORNER RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	1,958	0	0
22	1,980	4	40
42	2,000	17	250
62	2,020	51	930
82	2,040	90	2,340
102	2,060	154	4,780
122	2,080	234	8,660
142	2,100	331	14,310
162	2,120	534	22,960
182	2,140	789	36,190

Geologic exploration was limited to field reconnaissance and should be followed by further field study at such time as more detailed studies of the project are conducted A discussion of geologic conditions at Bitney Corner damsite is presented in Appendix G.

A possible alternate location for storage on Deer Creek exists upstream from the selected site in Section 16, T16N, R8E, MDB&M, at approximate streambed elevation 2,090 feet.

Although the upstream site is topographically more desirable for reservoir storage, and would not require costly road relocation, geologic conditions appear less favorable with serpentine occurring on the left abutment. Due to the uncertainty of foundation conditions, the downstream site was selected for the purposes of project formulation. Further consideration should be given the upper site when more detailed studies are conducted.

Bitney Corner Reservoir was sized to a gross storage of 20,000 acre-feet which is the maximum obtainable without the addition of an auxiliary dam in the saddle on the north side of the reservoir. Selection on this size was determined after consideration of economic analyses of cost per acre-foot of yield for various storage capacities, service area requirements and payment capacities. Dead storage capacity would be about 2,200 acre-feet. A summary of the monthly yield study of Bitney Corner Reservoir in presented in Appendix E, Table E-7.

Cost estimates were prepared for a dam of earthfill construction with a height of 173 feet above streambed. Normal pool would be at elevation 2,114 feet.

The spillway would be excavated in the left abutment. Control would be provided by a concrete gravity ogee section 125 feet in length designed to pass a peak discharge of 28,500 second-feet. Freeboard above maximum water level would be two feet. The transition section and chute would be lined and discharge to the stream channel through a terminal flip bucket.

Controlled releases would be made to the stream for later diversion into proposed Bitney Corner Canal and for maintenance of fishlife below the diversion dam. Outlet works would consist of a 3-foot diameter cut and cover conduit passing beneath the dam. Releases would be controlled by a Howell-Bunger valve discharging into the stream below the dam. A hydraulically operated high-pressure slide gate and trashracks would be located in the intake structure.

Bitney Corner Canal would begin on Deer Creek near the head of existing Tunnel Ditch and extend for about 13 miles to a junction with Tarr Ditch. Cost estimates were prepared for an unlined canal of 125 second-foot capacity from Deer Creek to Squirrel Creek, 90 second-foot capacity from Squirrel Creek to Clear Creek, and 60 second-foot capacity from Clear Creek to Tarr Ditch. A siphon approximately 1,000 feet in length would be used to cross Squirrel Creek near the existing Tunnel Ditch siphon. A low concrete diversion weir would be constructed on Deer Creek at the head of the canal to divert controlled releases from Bitney Corner Reservoir.

General features of Bitney Corner Dam, Reservoir, and Canal, are presented in Table 68 and illustrated on Plate 13. Estimated capital and annual costs are summarized in Table 69.

Anthony House Dam and Reservoir

This reservoir as proposed would provide a supplemental firm water supply of about 15,000 acre-feet annually to meet year 2020 demands of lands commanded by the project, most of which are situated outside the Nevada Irrigation District in Yuba County. At the present time, lands in this area receive water supplies from the China Ditch, which is fed mainly from imports to Deer Creek via Excelsior Ditch. A reservoir at the Anthony House site would afford the most practical means of providing a dependable water supply to meet anticipated demands for water service in the Smartville area and to former Camp Beale lands. In determining project water requirements, lands within proposed Marysville Reservoir were excluded.

Anthony House Reservoir would be formed by the construction of a dam on Deer Creek about 3 miles east of Englebright Dam, and about 6 miles downstream from proposed Bitney Corner Reservoir. Streambed elevation at this point

TABLE 68

GENERAL FEATURES OF BITNEY CORNER PROJECT

Damsite	
Location	SE 1/4 Sec. 18, T16N, R8E, MDB&M
Stream	Deer Creek
Dam and Appurtenant Features	
Type	Earthfill
Crest elevation, in feet	2,131
Crest width, in feet	30
Crest length, in feet	1,020
Height above streambed, in feet	173
Height spillway lip above streambed, in feet	156
Elevation of streambed, in feet	1,958
Side slopes	
Upstream	3.0:1
Downstream	2.5:1
Volume of fill, in cubic yards	1,430,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet	28,500
Type of outlet works	Cut and cover
Reservoir	
Maximum water surface elevation, in feet	2,129
Normal water surface elevation, in feet	2,114
Minimum water surface elevation, in feet	2,036
Surface area at normal pool, in acres	460
Storage capacity at normal pool, in acre-feet	20,000
Storage capacity at minimum pool, in acre-feet	2,200
Drainage area, in square miles	44
Bitney Corner Canal	
Section	Trapezoidal
Length, in feet	69,700
Capacity, in second-feet	125 to 60
Type	Unlined

TABLE 69

SUMMARY OF ESTIMATED COSTS
OF BITNEY CORNER PROJECT

(Based on prices prevailing in January 1963)

Item	Cost
Capital Cost	
Reservoir	$ 356,000
Dam embankment	1,688,000
Spillway	464,000
Outlet works	150,000
Subtotal	$2,658,000
Diversion dam	20,000
New canal	238,000
Subtotal	$2,916,000
Contingencies, 20%	583,000
Subtotal	$3,499,000
Engineering and administration, 15%	525,000
Subtotal	$4,024,000
Interest during construction, 4%	154,000
TOTAL CAPITAL COST	$4,178,000

Annual Cost	4% interest	No interest
Repayment in 50 years	$ 194,500	$ 80,500
Operation, maintenance, replacement, general expense, and insurance	17,300	17,300
TOTAL ANNUAL COST	$ 211,800	$ 97,800

is 1,139 feet as determined from the USGS river survey map of the damsite area. Reservoir topography was obtained from the USGS Rough and Ready quadrangle map. Areas and storage capacities of the reservoir at various elevations of water surface are given in Table 70.

TABLE 70

AREAS AND CAPACITIES OF ANTHONY HOUSE RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	1,139	0	0
21	1,160	26	190
41	1,180	107	1,510
61	1,200	316	5,740
81	1,220	496	13,860
101	1,240	690	25,720

Geologic exploration was limited to field reconnaissance and should be followed by further field study at such time as more detailed studies of the project are conducted. A discussion of geologic exploration at Anthony House damsite is presented in Appendix G.

Based on available geologic information, Anthony House damsite appears suitable for construction of the proposed earthfill dam.

Anthony House Reservoir was sized to a gross storage capacity of 11,500 acre-feet. A minimal dead pool of 300 acre-feet was provided. The natural inflow to the reservoir from Deer Creek below Bitney Corner Reservoir would be augmented by diversions from the South Yuba River via Excelsior Ditch. A summary of the monthly yield study of Excelsior Ditch and Anthony House Reservoir is presented in Appendix E, Table E-8.

Cost estimates were prepared for a dam of earthfill construction with a height of 92 feet above streambed. Normal pool would be at elevation 1,214 feet.

The spillway would be located around the right abutment of the dam. Control would be provided by a concrete ogee section 120 feet in length, designed to pass a peak discharge of 30,000 second-feet. Freeboard above maximum water level would be 1 foot.

Controlled releases would be made to Deer Creek for delivery to China Ditch which diverts one-quarter mile below the dam. The outlet works would consist of a 3-foot diameter cut and cover conduit passing beneath the dam. Releases would be controlled by a Howell-Bunger valve discharging directly into the stream.

General features of Anthony House Dam and Reservoir are presented in Table 71 and illustrated on Plate 13. Estimated capital and annual costs are summarized in Table 72.

Haypress Diversion Project

Following construction of Jackson Meadows Reservoir and the Weaver Lake Project, the drainage basin of the Middle Yuba River and Canyon Creek susceptible to development by Nevada Irrigation District will have reached near optimum practical development. No spills would have occurred at Milton Diversion Dam or Bowman Dam when operated through the critical dry period July 1928 through December 1934. At Spaulding Dam spills would have occurred in 1930 and 1932, due in part to the delivery of water from Bowman Reservoir (assuming operation under the present contract criteria), and to less than optimum storage in the drainage basin above Spaulding Dam. However, the cost of additional storage above Spaulding Dam probably cannot be economically justified, and therefore, this basin is also considered to have been developed to the optimum practical extent.

There remains, then, only the possibility of diverting water from the North Yuba River watershed to the Middle Yuba River above Milton Diversion Dam as a means of developing supplemental water supplies for district use. The Haypress Diversion Project, as proposed, would import surplus flows of Haypress Creek, a tributary of the North Yuba River, into the Middle Yuba River above Milton Diversion Dam. Adequate capacity is available in district works existing and under construction to provide full regulation of the imported water, and for delivery of the water to Spaulding Reservoir.

Construction of the Haypress Diversion Project, together with the Weaver Lake Project, would make available new water supplies adequate to allow an increased yield at enlarged Scotts Flat Reservoir of 13,000 acre-feet per year

TABLE 71

GENERAL FEATURES OF
ANTHONY HOUSE DAM AND RESERVOIR

Damsite	
Location	NW 1/4 Sec. 20, T16N, R7E, MDB&M
Stream	Deer Creek
Dam and Appurtenant Features	
Type	Earthfill
Crest elevation, in feet	1,231
Crest width, in feet	30
Crest length, in feet	855
Height above streambed, in feet	92
Height, spillway lip above streambed, in feet	75
Elevation of streambed, in feet	1,139
Side slopes	
Upstream	2.5:1
Downstream	2.0:1
Volume of fill, in cubic yards	255,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second-feet	30,000
Type of outlet works	Cut and cover
Reservoir	
Maximum water surface elevation, in feet	1,230
Normal water surface elevation, in feet	1,214
Minimum water surface elevation, in feet	1,164
Surface area at normal pool, in acres	440
Storage capacity at normal pool, in acre-feet	11,500
Storage capacity at minimum pool, in acre-feet	300
Drainage area, in square miles	55

TABLE 72

SUMMARY OF ESTIMATED COSTS OF
ANTHONY HOUSE DAM AND RESERVOIR

(Based on prices prevailing in January 1963)

Item		Cost
Capital Cost		
Reservoir and improvements		$ 238,000
Dam embankment		379,000
Spillway		303,000
Outlet works		80,000
Subtotal		$ 1,000,000
Contingencies, 20%		200,000
Subtotal		$ 1,200,000
Engineering and administration, 14%		180,000
Subtotal		$ 1,380,000
Interest during construction, 4%		41,000
TOTAL CAPITAL COST		$ 1,421,000
Annual Cost	4% interest	No interest
Repayment in 50 years	$ 66,100	$ 27,600
Operation, maintenance, replacement, general expense, and insurance	3,800	3,800
TOTAL ANNUAL COST	$ 69,900	$ 31,400

and at Rollins Reservoir of 3,000 acre-feet per year over that available after completion of the Yuba-Bear Project now under construction. A summary of the monthly yield study of Haypress Diversion Project is presented in Appendix E, Table E-6. A summary of monthly yield studies of enlarged Scotts Flat Reservoir and Rollins Reservoir with proposed upstream projects in operation, is presented in Appendix E, Tables E-7 and E-9.

The proposed project would consist of a low diversion dam on Haypress Creek, and a conduit consisting of flume and tunnel to convey the surplus flows of this stream into the Middle Yuba River watershed above Milton Diversion Dam.

Topographic map coverage of the area was limited to the USGS Sierra City quadrangle map to a scale of 1:62,500 and a contour interval of 80 feet. Elevations in the following discussion are, therefore, approximate; to be used for reference purposes only.

Haypress Creek Diversion Dam. A low concrete diversion structure would be constructed on Haypress Creek at streambed elevation of approximately 6,240 feet. The structure would include headworks for the diversion conduit with a capacity of 90 second-feet. Provision would be made to permit stream releases for preservation of fishlife below the dam.

Haypress Diversion Conduit. This conduit would extend from Haypress Diversion Dam a distance of about 16,200 feet into the Middle Yuba River watershed above Milton Diversion Reservoir. The initial and final sections would consist of benched flume with lengths of about 3,500 and 4,700 feet, with a central section of unlined tunnel about 8,000 feet in length. Design capacity would be 90 second-feet. Provision would be made to intercept surplus flows from a small tributary of Haypress Creek crossed enroute.

General features of Haypress Diversion Project are presented in Table 73. Estimated capital and annual costs of Haypress Diversion Project are summarized in Table 74.

Canal Improvement and Lining Program

Present conveyance losses in the district's extensive system of earth canals amount to about one-fourth of the approximately 100,000 acre-feet annually diverted into the service area. It is envisioned that this loss can be reduced in the near future by moderate improvement of existing facilities and better water management.

As a future step, an intensive program of canal improvement and lining could further eliminate these conveyance losses and would make a sizable amount of water available to meet future demands. Based on the assumption that substantial annual power revenues would become available to the district after Yuba=Bear Project bonds are retired, the canal improvement and lining program could be gradually accomplished by utilizing these surplus revenues. It is estimated that a net

TABLE 73

GENERAL FEATURES OF HAYPRESS DIVERSION PROJECT

Diversion Dam	
Location	Sec. 32, T20N, R13E, MDB&M
Stream	Haypress Creek
Type	Concrete gravity
Spillway discharge capacity	Unlimited
Diversion headgate discharge capacity, in second-feet	90
Tunnel	
Length, in feet	8,000
Diameter, in feet	7.0
Type	Unlined
Section	Horseshoe
Flumes	
Total length, in feet	8,200
Type	Benched Lennon
Capacity, in second-feet	90
Diameter, in feet	6.3

TABLE 74

SUMMARY OF ESTIMATED COSTS
HAYPRESS DIVERSION PROJECT

(Based on prices prevailing in January 1963)

Item	Cost
Capital cost	
Access roads	$ 142,000
Diversion dam	43,000
Tunnel	808,000
Flume	200,000
Subtotal	$1,193,000
Contingencies, 20%	239,000
Subtotal	$1,432,000
Engineering and administration, 15%	215,000
Subtotal	$1,647,000
Interest during construction, 4%	27,000
TOTAL CAPITAL COST	$1,674,000

Annual cost	4% interest	No interest
Repayment in 50 years	$77,900	$ 33,500
Operation, maintenance, replacement, general expense, and insurance	4,700	4,700
TOTAL ANNUAL COST	$82,600	$ 38,200

increase in water supply made available by such a future program would amount to about 13,400 acre-feet.

Accomplishments of Proposed Development

The projects proposed for the Grass Valley Service Area, together with the Yuba-Bear Project under construction by Nevada Irrigation District, would provide supplemental water supplies very nearly adequate to meet projected agricultural and domestic uses to year 2020, and in addition, provide new water-associated recreational opportunities.

The rate of development of irrigable lands in the Grass Valley Service Area to irrigated agriculture, residential farms, and urban use was projected on the basis of assumptions itemized in Chapter III, and consideration of the anticipated cost of water from the proposed projects. Present and projected land uses are summarized by decades in Table 75.

Water delivery requirements for irrigation, residential farm and urban uses were determined by applying unit water delivery requirements for irrigated agriculture and urban use, presented in Chapter III, to the present and projected land use pattern. A summary of present and projected seasonal water delivery requirements by decades is presented in Table 76.

Staging of the proposed projects was determined primarily on the basis of need to satisfy projected demands for water. A summary of yield from present development and

TABLE 75

SUMMARY OF PRESENT AND PROJECTED LAND USE IN
GRASS VALLEY SERVICE AREA
(in acres)

Land Use	Year						
	Present 1/	1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Deciduous orchard	1,060	1,800	4,000	5,600	6,600	6,950	7,300
Misc. truck and field	40	--	--	--	--	--	--
Pasture	9,620	11,800	19,350	24,260	26,030	26,630	26,500
Subtotal, net area	10,720	13,600	23,350	29,860	32,630	33,580	33,800
Residential farm	2/	6,495	7,190	8,720	10,720	13,700	17,790
Urban	2,960	3,100	3,610	4,450	5,500	6,780	8,260
TOTAL, net area	13,680	23,195	34,150	43,030	48,850	54,330	59,850

1/ As determined by Department of Water Resources survey in 1957.
2/ Included in irrigated agriculture.

TABLE 76

SUMMARY OF PRESENT AND PROJECTED SEASONAL WATER DELIVERY REQUIREMENTS
OF GRASS VALLEY SERVICE AREA
(in acre-feet)

Land Use	Year						
	Present	1970	1980	1990	2000	2010	2020
Agriculture	44,820	44,520	75,030	95,000	103,100	106,000	106,310
Residential farm	1/	19,480	21,570	26,160	32,160	41,100	53,370
Urban	3,220	3,380	3,950	4,930	6,150	7,750	9,660
TOTAL	48,040	67,380	100,550	126,090	141,410	154,850	169,340
TOTAL, rounded	48,000	67,400	100,600	126,100	141,400	154,800	169,300

1/ Included in agriculture.

from proposed projects, together with project costs and indicated date of project completion, is presented in Table 77.

TABLE 77

SUMMARY OF EXISTING AND PROPOSED PROJECT YIELDS, ESTIMATED ANNUAL PROJECT COSTS, AND INDICATED YEAR OF PROJECT COMPLETION FOR GRASS VALLEY SERVICE AREA DEVELOPMENT

Development	Effective yield, in acre-feet	Annual cost, including OM&R: No interest	Annual cost, including OM&R: 4% interest	Indicated year of completion 1/
Present development	73,500 2/	---	---	---
Yuba-Bear Project	20,500	---	---	1965
Reduction of present conveyance losses	11,000	---	---	1970 to 1985
Weaver Lake Project	6,900	$30,800	$65,900	1985
Bitney Corner Project	17,600	97,800	211,800	1985
Anthony House Reservoir	14,800	31,400	69,900	2000
Haypress Diversion	8,800	37,600	82,600	2000
Canal improvement and lining program 3/	13,400	---	---	2015
TOTAL	166,500			

1/ Based primarily on need for project services.
2/ Includes utilization of present D-S Canal spill to Bear River.
3/ Assumed to be financed by surplus power revenues after retirement of Yuba-Bear Project bonds.

Benefits from Proposed Development

The primary tangible benefits that would accrue to the development proposed for the Grass Valley Service Area would be derived from increased water supplies made available by the projects, and from increased water-associated recreational activity made possible as a result of this development. The Weaver Lake and Haypress Diversion projects could also provide some new hydroelectric power benefits by virtue of the additional water which would be made available to the existing powerplants of the Pacific Gas and Electric Company and future powerplants of the district.

For purposes of this investigation the assumption was made that without new water development projects, existing water supplies would be diverted from the least intensive use (agriculture) to more intensive uses (urban and residential farms) to meet demands imposed by increasing population. Based on this assumption, the year 2020 demands shown in Table 76 which would be met by the 84,500 acre-feet available from the present development would include 9,700 acre-feet for urban demand, 53,400 acre-feet for residential farm demand, and 21,400 acre-feet for agriculture. The proposed projects would therefore be credited with the incremental agricultural demand of 82,000 acre-feet.

Benefits from irrigation development would consist of the net value of the returns to land and water from the area served by the projects. Increased productivity would result from the application of project water to presently dry-farmed lands and lands presently receiving a partial water supply on an intermittent basis.

Irrigation benefits from the lands served by the projects were derived by applying unit values of returns to land and water to the crop pattern presented in Table 75, and appropriately reducing the result to reflect returns from present farming operations. The sum of net annual direct irrigation benefits from commercial agriculture accruing to the proposed development to year 2020 was estimated to be $14,990,000 and would require a total of 2,273,200 acre-feet of water, amounting to an average benefit of $6.60 per acre-foot.

There will also be benefits accruing to the proposed development due to increased recreational opportunities and increased hydroelectric power generation. Determination of the magnitude of these benefits was, however, considered to be beyond the scope of this investigation.

Residential farm and urban benefits were not evaluated for the proposed development due to the presently available water supply being adequate to meet residential farm and urban demands that would exist under nonproject conditions. Application of available water supply to the more intensive uses follows the basic assumption set forth above and in Chapter III.

The use of the above method of evaluating the benefits accruing to the proposed development results in a conservative estimate of new project benefits. By taking the approach that new project water would be utilized to satisfy all types of new demands within the service area, the higher unit benefits from increased domestic use rather than agricultural use would result in greater project benefits. From inspection of Table 76, it can be seen that after 2000, very little increase in commercial agriculture is projected, and supplemental water supplies will be required for the most part to meet projected urban and residential farm increased demands. If no new water supplies are provided however, it is envisioned that the use of water by agriculture will decrease in order to meet the more intensive domestic demand.

A summary of the average cost of developing new water supplies by the proposed development is presented in Table 78.

TABLE 78

SUMMARY OF AVERAGE COST OF DEVELOPING NEW WATER SUPPLIES GRASS VALLEY SERVICE AREA

Development	New effective yield, in acre-feet	Annual cost including OM&R		Average cost per acre-foot	
		No interest	4% interest	No interest	4% interest
Yuba-Bear Project	20,500	---	---	---	---
Reduction of present conveyance losses	11,000	---	---	---	---
Weaver Lake Project	6,900	$30,800	$ 65,900	$4.47	$ 9.55
Bitney Corner Project	17,600	97,800	211,800	5.55	12.02
Haypress Diversion	8,800	37,600	82,600	4.28	9.40
Anthony House Reservoir	14,800	31,400	69,900	2.12	4.72
Canal improvement	13,400	---	---	---	---

A comparison of the average net benefit from irrigation of $6.60 per acre-foot with the annual repayment and operating costs of each proposed project reveals that at least three of the proposed projects for the Grass Valley Service Area, to follow the district's Yuba-Bear Project, would have a benefit-cost ratio of less than 1 to 1.

It is believed reasonable to assume, however, that some or all of the above projects could qualify for low or no-interest financing. On the basis of no-interest financing, the average cost of water from these projects would range from about $2.12 to $5.55 per acre-foot. Assuming that recreational grants may be obtainable, some power benefits realized, and possibly some surplus revenues available, the net cost may be even lower.

Payment capacity for crops projected in the Grass Valley Service Area ranges from $3.10 per acre-foot for pasture for water delivered to the farm headgate, to a weighted value of $23.90 for deciduous orchard, with a weighted average payment capacity for all crops of $5.45 per acre-foot. Under the above assumptions, financial feasibility of the proposed development is not an unreasonable conclusion.

Colfax Ridge Service Area Development

It is anticipated that the future supplemental water requirements for the Colfax Ridge Service Area to year

2020 and beyond can be met by increased use from the Boardman Canal. Under the assumed operation of the Drum Canal and Bear River as summarized in Appendix E, Table E-9, flows diverted into the Boardman Canal average about 22,000 acre-feet per year during the critical period. These amounts are based on historic flows diverted during that period, although recent diversions have been somewhat less. Assuming continued improvement to the canal to reduce conveyance losses, 20,000 acre-feet of water per year can reasonably be expected to reach points of delivery along the ridge. The anticipated future water needs for the area by year 2020 aggregate only about 11,000 acre-feet annually, primarily for domestic and residential farm use. The remaining amount of about 9,000 acre-feet per year would be available to the foothill region. The reduced deliveries to the foothill region as the result of increased use along the ridge would be augmented from other sources as explained under heading of Auburn Foothill Service Area.

Projected patterns of land use, together with present land use, is summarized by decades in Table 79. A summary of present and projected seasonal water delivery requirements by decades to year 2020 is presented in Table 80. A graphic presentation of anticipated water delivery requirements in the service area to year 2020 and the proposed

TABLE 79

SUMMARY OF PRESENT AND PROJECTED LAND USE
IN COLFAX RIDGE SERVICE AREA
(in acres)

Land use	Present 1/	1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Deciduous orchard	460	450	480	520	560	580	600
Pasture	170	200	220	230	440	480	500
Subtotal, net area	630	650	700	750	1,000	1,060	1,100
Residential farm	2/	1,290	1,540	1,750	1,940	2,000	2,100
Urban	530	610	730	910	1,110	1,330	1,530
TOTAL, net area	1,160	2,550	2,970	3,410	4,050	4,390	4,730

1/ As determined from Department of Water Resources survey.
2/ Included in irrigated agriculture.

TABLE 80

SUMMARY OF PROJECTED SEASONAL WATER DELIVERY REQUIREMENTS
OF COLFAX RIDGE SERVICE AREA
(in acre-feet)

Land use	Present	1970	1980	1990	2000	2010	2020
Agriculture	1,860	1,490	1,580	1,720	2,450	2,620	2,720
Residential farm	1/	3,870	4,620	5,250	5,820	6,000	6,300
Urban	600	720	900	1,170	1,470	1,800	2,160
TOTAL	2,460	6,080	7,100	8,140	9,740	10,420	11,180
Total, rounded	2,500	6,100	7,100	8,100	9,700	10,400	11,200

1/ Included in agriculture.

use of the Boardman Canal to satisfy these requirements, is shown on Figure 6.

Auburn Foothills and Placer County Valley Floor Service Areas Development

In formulating projects to meet the anticipated needs for water in the Auburn Foothills Service Area and Placer County portion of the Valley Floor Service Area, it was assumed that the two major water supply agencies for the area - Nevada Irrigation District and Pacific Gas and Electric Company - would continue to provide service as required to meet the needs within their respective service areas up to the limit of their ability to provide or develop new water supplies, and that any additional water supplies needed would be available from Placer County Water Agency's Middle Fork American River Project.

Further assumptions made in regard to the availability of water from the existing Bear River Canal, and from the tailrace of Wise Powerplant are listed below.

1. Releases from the Wise Powerplant which are in excess of the anticipated future demands within the Pacific Gas and Electric Company service area and which would therefore spill to the American River through the South Canal, could be obtained from tne company for use elsewhere in areas of need.

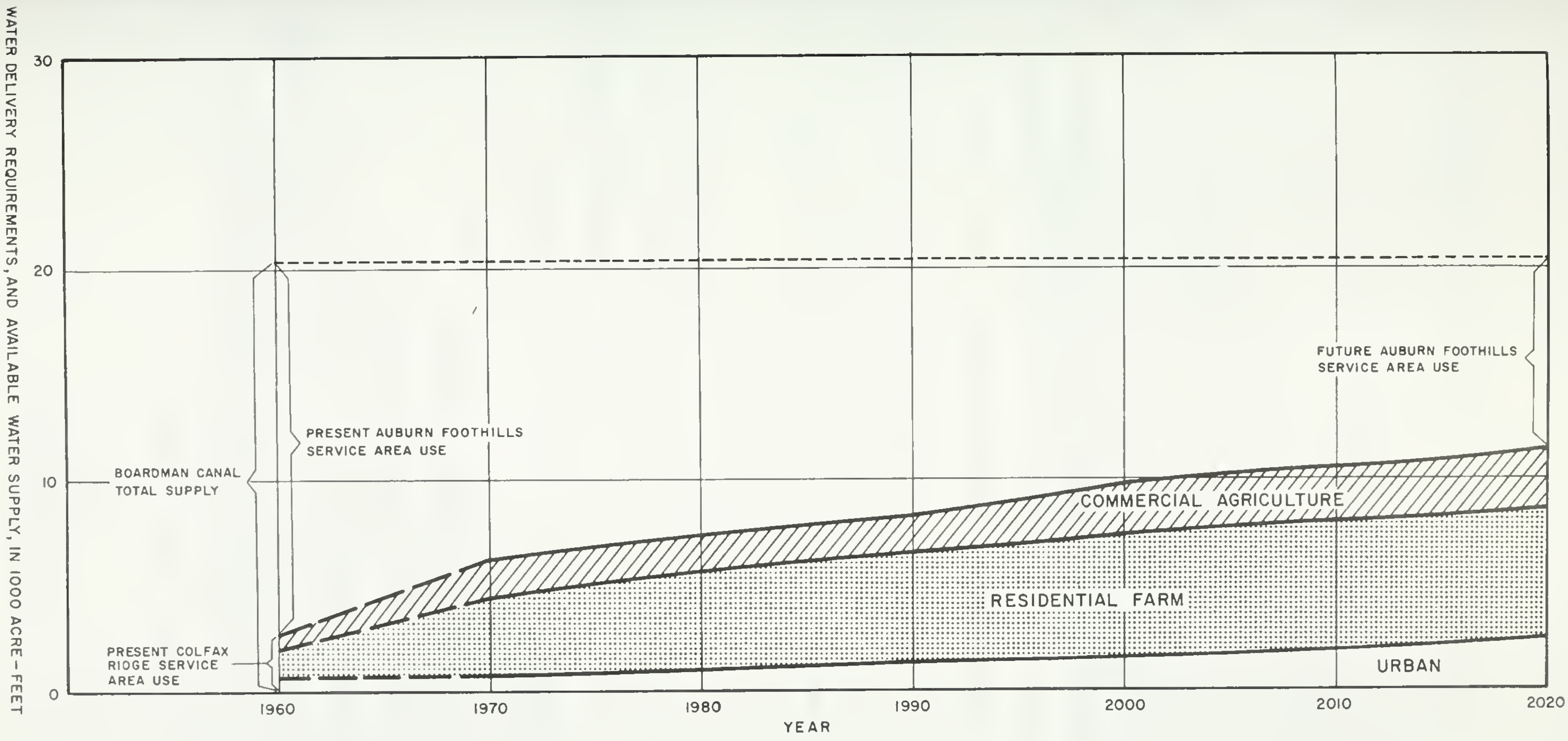


Figure 6, WATER SOURCES AND USES
COLFAX RIDGE SERVICE AREA

2. Supplemental water supplies for domestic and residential farm use in the region between Meadow Vista and Auburn would be available from the Bear River Canal, and the rate for this water would be approximately equal to the value of this water in terms of net power revenue at the Halsey and Wise powerplants.

In regard to the availability of surplus water from the tailrace of Wise Powerplant, it was assumed that the amount of water in the lower Boardman Canal would diminish in the future as the demand for water service from the canal increases along the Colfax Ridge, and that the amount of this depletion would be made up from excess water available below the Wise Powerplant.

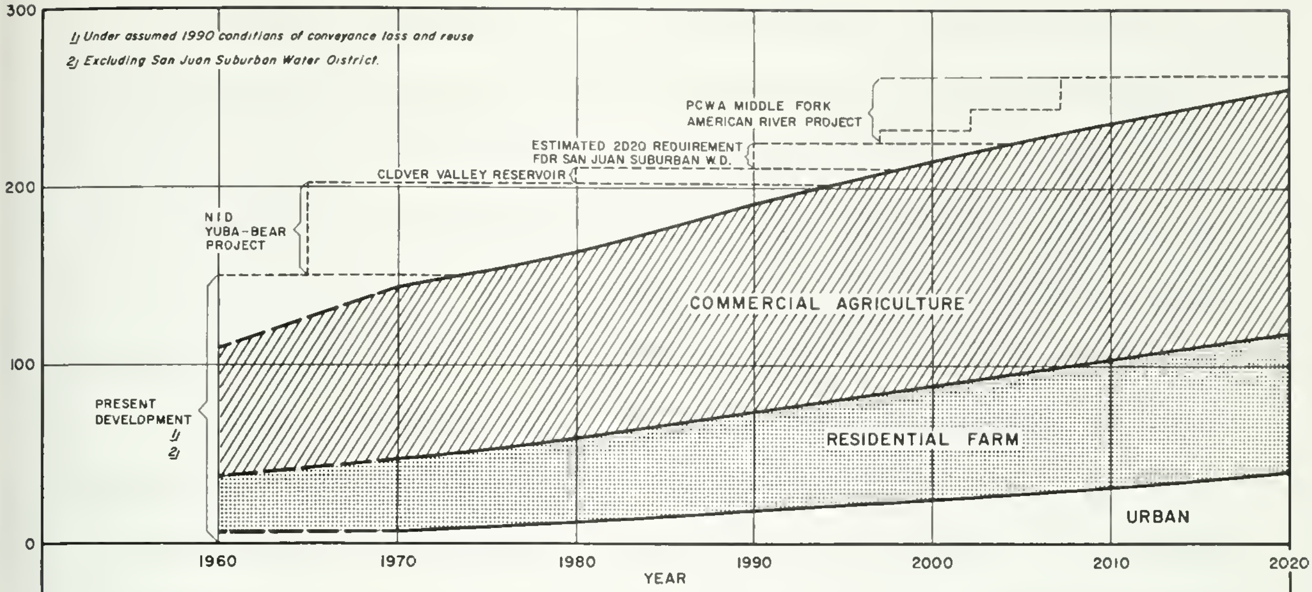
Based on the foregoing, the following plan for development was formulated for the Auburn Foothills and Placer County valley floor area, listed in order of occurrence.

1. Nevada Irrigation District's Yuba-Bear Project

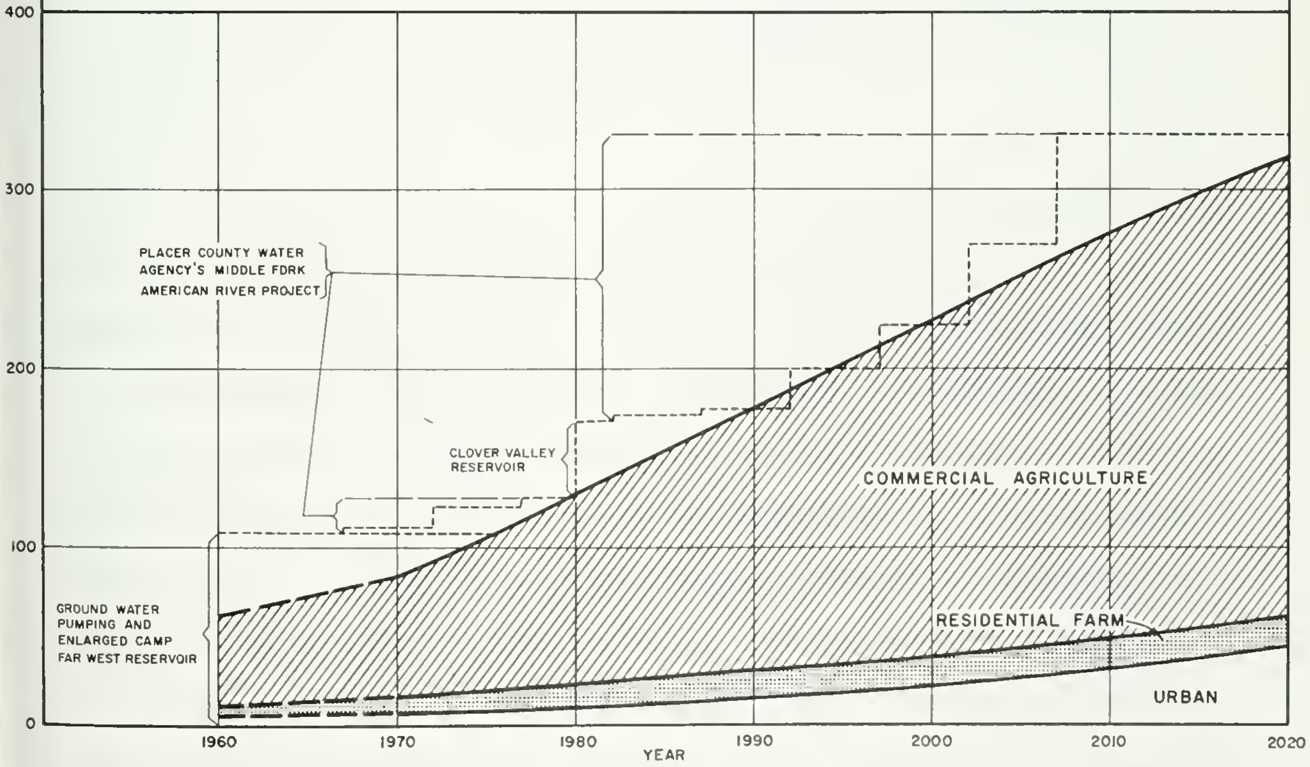
2. Placer County Water Agency's Middle Fork American River Project

3. Clover Valley Dam and Reservoir

A graphic presentation of anticipated water delivery requirements in the service areas to the year 2020, and the staging of projects or water deliveries to satisfy these requirements is shown on Figure 7.



AUBURN FOOTHILLS SERVICE AREA



VALLEY FLOOR SERVICE AREA

Figure 7, WATER SOURCES AND USES
PLACER COUNTY

Present plans for water development for the Auburn Foothills Service Area include the Nevada Irrigation District's Yuba-Bear Project and Placer County Water Agency's Middle Fork American River Project. Both of these projects are now under construction (1963). The Nevada Irrigation District's project was described previously under heading of Grass Valley Service Area.

The PCWA project was conceived primarily for the purpose of providing surface water supplies to the valley floor region of western Placer County in order to augment supplies presently obtained for the most part by pumping from the ground water basin. The project will also serve lands within the Auburn Foothills Service Area lying below an elevation of about 400 feet. The major portion of these foothill lands are situated within the Nevada Irrigation District.

Although the entire service area of the Middle Fork American River Project is located within the area of investigation, the water development features of the project are located outside the investigational area in the American River Basin. An analysis of the cost and accomplishments of the project is therefore not included as part of this report. Additional information on this project can be obtained from a report prepared by McCreary-Koretsky Engineers entitled "Feasibility Report, Placer County Water Agency Middle Fork American River Project" dated June 1961.

For purposes of this investigation, water supplies available from the PCWA project were distributed on the basis of need to meet the demand for supplemental water supplies of the combined Auburn Foothills and Placer County valley floor area. Availability of water was governed by the schedule of water deliveries from the American River to be allowed under the agreement between PCWA and the U. S. Bureau of Reclamation dated July 16, 1962. Excerpts from this agreement are shown in Table 81.

TABLE 81

SCHEDULE OF WATER DELIVERIES AVAILABLE FROM THE AMERICAN RIVER FOR DIVERSION TO WESTERN PLACER COUNTY UNDER AN AGREEMENT BETWEEN PLACER COUNTY WATER AGENCY AND U. S. BUREAU OF RECLAMATION DATED JULY 16, 1962

(in acre-feet)

Intervals	Required minimum amounts of water from the American River as determined by USBR	Amount the agency may divert from American River without charge during normal years 2/	Minimum amounts the agency will be required to purchase from CVP during normal years 3/
1967-1971	5,000	5,000	0
1972-1976	10,000	15,000	0
1977-1981	20,000	20,000	0
1982-1986	25,000	25,000	0
1987-1991	30,000	30,000	0
1992-1996	55,000	40,000	15,000
1997-2001	90,000	55,000	35,000
2002-2006	155,000	70,000	85,000
2007-2011	237,000	120,000 1/	117,000

1/ 2007 and thereafter
2/ Deficiencies will be imposed during dry years on agricultural water.
3/ Deficiencies will be imposed during dry years on all water purchased by the agency from the CVP.

Clover Valley Dam and Reservoir

Under the plan for development proposed by Placer County Water Agency, the first phase water delivery unit of the Middle Fork American River Project would include a South Conduit leading from Auburn Ravine below Wise Powerplant to Clover Valley Creek, with terminal storage to be provided on Clover Valley Creek as the need arises.

Studies conducted as part of this investigation indicate that supplemental water requirements in western Placer County will exceed the amounts of water available under the PCWA-USBR agreement, and that additional water supplies will be needed to meet the projected demands for water, possibly beginning as early as 1980. As stated previously, it was assumed that supplemental water supplies to meet these needs could be obtained from PG&E at the Wise Powerplant tailrace.

In the event that Auburn Reservoir is constructed by the USBR, thus affording full reregulation of flows released from the Middle Fork American River Project, the need for a large pumping plant on the American River or terminal reservoirs in western Placer County would be precluded. However, storage adequate to reregulate surplus Wise Powerplant releases would still be necessary. Clover Valley Reservoir is herein considered for this purpose.

Alternative resevoir sites are also available on Doty Ravine and Coon Creek which could also be utilized to reregulate winter releases from Wise Powerplant. Terminal storage at one of these sites will be required between 1980 and 1990 to supplement available water from the American River. As this need arises and depending upon the degree of local development, a more detailed investigation of each site will be necessary to make a final choice. For the purposes of this investigation, however, the Clover Valley Project is presented as a possibility for future development.

Clover Valley Reservoir would be formed by construction of a dam on Clover Valley Creek about 2 miles due north of Rocklin. Streambed elevation at this location is 301 feet as determined from USGS Rocklin quadrangle map. Areas and storage capacities at various elevations of water surface are given in Table 82.

TABLE 82

AREAS AND CAPACITIES OF CLOVER VALLEY RESERVOIR

Depth of water at dam, in feet	Water surface elevation, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	301	0	0
19	320	33	250
39	340	87	1,450
59	360	147	3,790
79	380	217	7,430
99	400	273	12,330
119	420	338	18,440
139	440	399	25,810
159	460	450	34,300

Geologic exploration consisted of surface reconnaissance and a small amount of refraction seismograph work. A discussion of geologic exploration at Clover Valley damsite is presented in Appendix G.

The reservoir was sized to a gross storage capacity of 32,000 acre-feet. Selection of this size was determined after consideration of potential service area supplemental water requirements and the availability of water for diversion to the reservoir from Auburn Ravine based on an assumed operation of the Bear River Canal system. Diversions to Clover Valley Reservoir were limited to 6,000 acre-feet per month on the assumption that available conduit capacity would be 200 second-feet, and the Wise Powerplant would be operated at a monthly capacity factor of 50 percent. A summary of the monthly operation of the Bear River Canal system and Clover Valley Reservoir is presented in Appendix E, Table E-10.

Cost estimates were prepared for a dam of earthfill construction with a height of 159 feet above streambed. Normal pool would be at elevation 455 feet.

Due to proposed utilization of the valley immediately downstream from the dam as part of the Sunset City development, the spillway was designed to discharge into the Pleasant Grove Creek drainage to the west. Control would be provided by a concrete gravity ogee section 40 feet in length, designed to pass a peak discharge of 800 second-feet. Freeboard above maximum water level would be two feet. The approach channel, transition section, and chute would be lined as required.

Controlled releases would be made to the stream for diversion at a lower elevation to service areas in the vicinity of Rocklin and on the valley floor west of Roseville. Outlet works would consist of a four-foot diameter cut and cover conduit passing beneath the dam. Releases would be controlled by a Howell-Bunger valve discharging into the stream below the dam. A hydraulically operated high-pressure slide gate and trashracks would be located in the intake structure.

General features of Clover Valley Dam and Reservoir are presented in Table 83 and illustrated on Plate 14, "Clover Valley Dam and Clover Valley Creek." Estimated capital and annual costs are summarized in Table 84.

Accomplishments of Proposed Development

Projects of the Nevada Irrigation District and Placer County Water Agency, together with a future Clover Valley Project, would provide supplemental water supplies for irrigation and urban use in the foothill and valley floor regions of Placer County. Clover Valley Reservoir would also provide additional recreational opportunities for the fast-growing suburban area in the vicinity of Roseville.

The rate of development within the Auburn Foothills and Valley Floor service areas to irrigated agriculture, residential farm, and urban use, was projected on

TABLE 83

GENERAL FEATURES OF
CLOVER VALLEY DAM AND RESERVOIR

Damsite	
Location	NE 1/4 Sec. 7, T11N. R7E, MDB&M
Stream	Clover Valley Creek
Dam and Appurtenant Features	
Type	Earthfill
Crest elevation, in feet	460
Crest width, in feet	30
Crest length, in feet	2,020
Height above streambed, in feet	159
Height, spillway crest above streambed, in feet	154
Elevation of streambed, in feet	301
Side slopes	
Upstream	3.0:1
downstream	2.0:1
Volume of fill, in cubic yards	2,943,000
Type of spillway	Ungated ogee weir
Spillway discharge capacity, in second feet.	800
Type of outlet works	Cut and cover
Reservoir	
Maximum water surface elevation, in feet . .	458
Normal water surface elevation, in feet . .	455
Minimum water surface elevation, in feet . .	345
Surface area at normal pool, in acres . . .	440
Storage capacity at normal pool, in acre-feet	32,000
Storage capacity at minimum pool, in acre-feet	4,200
Drainage area, in square miles	3.0

TABLE 84

SUMMARY OF ESTIMATED COSTS OF
CLOVER VALLEY DAM AND RESERVOIR

(Based on prices prevailing in January 1963)

Capital Cost		
Reservoir and improvements		$ 255,000
Dam embankment		3,057,000
Spillway		145,000
Outlet works		142,000
Subtotal		$3,599,000
Contingencies, 20%		720,000
Subtotal		$4,319,000
Engineering and administration, 15%		648,000
Subtotal		$4,967,000
Interest during construction, 4%		199,000
TOTAL CAPITAL COST		$5,166,000
Annual Cost	4% interest	No interest
Repayment in 50 years	$240,500	$ 99,300
Operation, maintenance, replacement, general expense, and insurance	9,500	9,500
TOTAL ANNUAL COST	$250,000	$108,800

the basis of assumptions itemized in Chapter III and the anticipated population distribution within these areas. It is expected that population growth within these areas will occur most rapidly in the region between Roseville and Auburn, with land use trending predominantly to urban and residential farms, and that agricultural growth will occur primarily within the Nevada Irrigation District and on the valley floor. Projected patterns of land use, together with present land use for these areas are summarized by decades in Tables 85 and 86.

Water delivery requirements for irrigation, residential farm, and urban uses were determined by applying unit water requirements presented in Chapter III to the present and projected land use pattern. A summary of present and projected seasonal water delivery requirements by decades is presented in Tables 87 and 88.

Based on projected land use, deliveries from the PCWA Middle Fork American River Project would be inadequate to meet project service area demands beginning about 1980, and yield from Clover Valley Reservoir would be required at that time to meet supplemental requirements. A summary of yield from present development and from proposed projects for Auburn Foothills and the Placer County portion of the Valley Floor Service Area, together with indicated completion dates is presented in Table 89.

TABLE 85

SUMMARY OF PRESENT AND PROJECTED LAND USE
WITHIN AUBURN FOOTHILLS SERVICE AREA
(in acres)

Land Use	Present: 1/	1970	1980	1990	2000	2010	2020
r;gated agriculture							
ꞁeciduous orchard	16,870	16,570	16,910	17,330	17,830	18,300	18,640
ubtropical orchard	280	480	870	1,580	2,450	3,120	3,600
isc. field	320 2/	200	600	1,300	2,000	2,500	2,700
lfalfa	230	200	500	1,000	1,500	1,800	2,000
asture	14,130	15,020	16,210	17,940	19,300	20,410	20,360
Subtotal, net area	31,830	32,470	35,090	39,150	43,080	46,130	47,300
s̶ential farms	3/	13,320	15,820	18,670	21,550	24,010	26,350
on	4,360	6,050	8,760	12,600	16,880	21,040	27,700
TOTAL, net area	36,190	51,840	59,670	70,420	81,510	91,180	101,350

As determined from Department of Water Resources survey in 1957.
Includes miscellaneous truck crops and grain.
Included in irrigated agriculture.

TABLE 86

SUMMARY OF PRESENT AND PROJECTED LAND USE
WITHIN PLACER COUNTY PORTION 1/ OF VALLEY FLOOR SERVICE AREA
(in acres)

Land Use	Present: 2/	1970	1980	1990	2000	2010	2020
gated agriculture							
eciduous orchard	1,010	1,000	2,300	3,000	3,500	3,800	4,000
ubtropical orchard	40	---	---	---	---	---	---
iscellaneous truck	0	500	1,000	1,200	1,200	800	600
iscellaneous field	620	1,500	3,800	6,500	8,000	9,000	10,000
lfalfa	620	800	1,000	500	0	0	0
ice	4,060	5,000	8,000	12,000	13,000	13,500	14,000
asture	5,530	6,900	9,000	11,800	18,300	26,600	32,000
ouble Crop	---	(200)	(600)	(1,100)	(1,500)	(1,800)	(2,100)
Subtotal, net area	11,880	15,700	25,100	35,000	44,000	53,700	60,600
dential farm	3/	3,300	4,200	4,900	5,200	5,400	5,500
n	3,500	4,500	6,200	8,600	11,400	14,900	19,500
TOTAL, net area	15,380	23,500	35,500	48,500	60,600	74,000	85,600

Excludes portion of Placer County north of Bear River.
As determined from Department of Water Resources survey in 1961.
Included in irrigated agriculture.

TABLE 87

SUMMARY OF PRESENT AND PROJECTED SEASONAL
WATER DELIVERY REQUIREMENTS OF
AUBURN FOOTHILLS SERVICE AREA
(in acre-feet)

	Year						
	Present	1970	1980	1990	2000	2010	2020
Agriculture	104,500	97,360	104,850	116,370	127,100	135,310	137,820
Residential farm	1/	39,960	47,460	56,010	64,650	72,030	79,050
Urban	5,800	8,350	12,460	18,230	24,630	30,910	39,090
TOTAL	110,300	145,670	164,770	190,610	216,380	238,250	255,960
Total, rounded	110,300	145,700	164,800	190,600	216,400	238,200	256,000

1/ Included in agriculture.

TABLE 88

SUMMARY OF PRESENT AND PROJECTED SEASONAL WATER
DELIVERY REQUIREMENTS IN PLACER COUNTY PORTION1/
OF VALLEY FLOOR SERVICE AREA
(in acre-feet)

	Year						
	Present	1970	1980	1990	2000	2010	2020
Agriculture	56,920	68,270	106,830	150,230	187,490	228,160	256,710
Residential farm	2/	9,900	12,600	14,700	15,600	16,200	16,500
Urban	4,200	6,180	9,940	15,400	22,710	32,160	45,480
TOTAL	61,120	84,350	129,270	180,330	225,800	276,520	318,690
Total, rounded	61,100	84,400	129,300	180,300	225,800	276,500	318,700

1/ Excludes portion of Placer County north of Bear River.

2/ Included in agriculture.

TABLE 89

SUMMARY OF EXISTING AND PROPOSED PROJECT YIELDS, AND INDICATED YEAR OF PROJECT COMPLETION FOR AUBURN FOOTHILLS AND PLACER COUNTY VALLEY FLOOR 1/ SERVICE AREAS DEVELOPMENT

	Effective yield, in acre-feet 2/		Indicated year of project completion 3/
	Auburn Foothills	Placer Co. Valley Floor	
Present Development			
PG&E	121,000 4/		
Nevada Irrigation Dist.	30,500		
Safe Ground Water Pumping (estimated)		60,000	
Enlarged Camp Far West Reservoir		48,000 5/	
San Juan Suburban WD	6/		
Subtotal	151,500	108,000	
Proposed Development			
Yuba-Bear Project			1965
PG&E	15,000		
Nevada Irrigation Dist.	36,300		
Middle Fork American River Project	37,000	184,000	1966
Clover Valley Reservoir	8,000	40,000	1980
San Juan Suburban WD (estimated)	15,000		
TOTAL	262,800	332,000	

1/ Excluding portion of Placer County north of Bear River.
2/ Yield is based on assumed 1990 conditions of reuse and conveyance losses.
3/ Based on need for project services or earliest possible completion date.
4/ Estimated yield available without reregulatory storage of Wise Powerplant releases.
5/ Includes yield of project utilized by Camp Far West Irrigation District. Distribution of project yield between Sutter and Placer Counties is based on estimate of future requirements.
6/ Estimated total amount supplied from Folsom Reservoir shown under proposed development.

Benefits from Proposed Development

Benefits that would accrue to the development proposed for the Auburn Foothills and Placer County valley floor areas were computed on an areawide basis, and as such are not necessarily representative of individual projects within the area. On an areawide basis, present water development is adequate to meet all of the projected urban and residential farm demands and a portion of the agricultural demands for water through the year 2020. Following the assumption that presently available water would be diverted to the more intensive uses in the absence of new water supply projects, no benefits have been attributed to the increase in urban and residential farm uses. Accordingly, only new irrigation benefits were determined for the area.

The sum of the net annual irrigation benefits from commercial agriculture accruing in the area to year 2020 was estimated to be $36,250,000 for the Auburn Foothills Service Area and $41,465,000 for the Placer County portion of the Valley Floor Service Area. Based on the projected water demands, the average annual irrigation benefits would be $14.15 and $8.55 per acre-foot in the respective areas.

Since the major portion of the projected supplemental water requirements will be satisfied by the Nevada Irrigation District's Yuba-Bear Project and the Placer County Water Agency's Middle Fork American River Project, only one future additional water development has been proposed as necessary to meet anticipated future needs. This is the Clover Valley Project which would provide re-regulatory storage for winter releases from Wise Powerplant resulting in an effective yield of 48,000 acre-feet per season. Water made available from Clover Valley Reservoir would be used to meet increasing demands between 1980 and 1990 which are in excess of the water supply available from the Middle Fork American River Project.

The major part of the yield from the reservoir will probably be utilized on the valley floor lands north and west of Roseville for the irrigation of pasture. Irrigation benefits for pasture in this area were computed to be about $7 per acre-foot of applied water. Similarly, payment capacity was computed at $4.65 per acre-foot. Assuming the balance of the project yield would be for urban and residential farm use, overall benefits and payment capacity of lands served by this project would be considerably higher than the above figures.

Based on estimated annual equivalent cost for the dam and reservoir of $250,000, and an effective yield of $48,000 acre-feet, average cost of water would be about $5.20 per acre-foot, plus any charges which might be associated with obtaining and importing surplus water from below Wise Powerplant. With charges up to about $1.80 per acre-foot for this water, economic justification is indicated on the basis of agricultural use alone and would be substantially higher if benefits from residential farm, urban uses and recreation were considered.

Mountain Service Area Development

Although about 7,100 acres of mountain lands have been classified as irrigable, it is anticipated that recreation will continue to grow in importance as a leading economic activity. For example, the Department of Fish and Game considers that the North Yuba River above New Bullards Bar Reservoir has certain unique and desirable flow characteristics for angling that should be preserved in perpetuity for future generations to enjoy. No works are required or desired to sustain these flows. Furthermore, the mountain streams flow through areas rich in historical background associated with the discovery of gold. Historic Downieville, for example, at the confluence of Downie River and North Yuba River, sometimes suffers damage from floods, but it is improbable that corrective measures other than the possible relocation of some buildings to a safe level could ever be justified under presently accepted methods of evaluating projects for flood control.

Additional water supplies for the Mountain Service Area can be obtained in small amounts, as the need develops, by direct diversion of streamflow and the development of springs. In view of the probable nature of future uses of water and the indicated present infeasibility of protecting

Downieville

" . . . it is anticipated that recreation will continue to grow in importance as a leading economic activity."

North Yuba River above Downieville

mountain areas such as Downieville against floods, no specific projects have been planned for the Mountain Service Area.

CHAPTER VI. SUMMARY AND CONCLUSIONS, AND RECOMMENDATIONS

The Yuba and Bear Rivers Basin Investigation was initiated in 1957 following a request by the Legislature

> " . . . to expedite the ... investigation and the formulation of plans for the full development of the Yuba and Bear Rivers under the ... California Water Development Program."

This request was followed in 1958 by a request to conduct a detailed investigation for selection of a flood control project on the Yuba River to be constructed in cooperation with the United States.

The formulation of a comprehensive plan for basinwide development to meet projected water requirements to the year 2020 was established as the overall objective of the investigation. Selection of a major, multipurpose project on the lower Yuba River was of initial concern to fulfill the requirements of water resource development including flood control and possible export of water to the Delta under the State Water Resource Development System.

During the period of this investigation, local agencies, representing nearly the entire Yuba-Bear Area, initiated detailed studies of projects to meet increasing demands for water in their particular areas. Construction of projects for South Sutter Water District and Browns Valley Irrigation District was initiated during the period of project formulation studies. These projects, enlarged Camp Far West and

Virginia Ranch, respectively, were therefore considered to be existing developments for analysis purposes. Projects proposed by other agencies for which engineering and financial feasibility have been demonstrated were not further analyzed, but are shown as integral units of the plan for basin development.

Summary and Conclusions

The area of investigation is the drainage basins of the Yuba and Bear Rivers, and the adjacent valley and foothill lands of Placer, Sutter, and Yuba Counties, which now or in the future will receive water supplies from these rivers. The area ranges in elevation from less than 20 feet above sea level near the Feather River on the west, to over 9,000 feet along the crest of the Sierra Nevada. Of a total of 1,685,000 acres, about 360,000 acres, or roughly 20 percent, are located below an elevation of 200 feet and were considered to be valley floor lands. The remaining 80 percent of the area is about evenly divided between foothill agricultural lands and forest or mountainous lands.

The variation in precipitation and climate of the area is typical of the western slope of the Sierra Nevada and the contiguous Central Valley. Mean annual precipitation is about 20 inches on the valley floor, increasing with elevation to greater than 80 inches in portions of the central mountain region and then decreasing to about 60 inches along the Sierra Divide. The valley lands experience hot, dry summers and mild winters. The central region experiences moderate summers and cool winters. Above an elevation of about 5,000 feet, winters are long with precipitation usually occurring in the form of snow which tends to sustain streamflow well into the summer months. Practically all precipitation occurs in the period October through May.

The 50-year mean annual unimpaired runoff (1906-07 through 1955-56) of the Yuba River at the base of the foothills is 2,336,000 acre-feet, and for the Bear River is 330,000 acre-feet. The combined runoff of these rivers is about 60 percent of the corresponding flow of the Feather River at Oroville and about equal to the flow of the American River.

Water supplies can be developed from the Yuba and Bear Rivers adequate to permit full development of the valley floor lands, and in addition permit some export of water from the Yuba River. At the same time, it is expected that future development of some of the higher elevation foothill lands will be curtailed beginning about year 2020 due to deficient water supply conditions. This situation will not result from use on the valley floor or export to the Delta but is due to the topographic relationship between the rivers of the Yuba-Bear Basin and the irrigable lands for which they are the logical source of water supply. About half the runoff of the Yuba River comes from the North Yuba River, but by far the greatest need for water in the foothill region is south of the South Yuba River. It is economically infeasible to import adequate water supplies from the North Yuba River to meet the supplemental requirements in the southern foothill regions of the Yuba-Bear Area. The usable water yield from the Middle Yuba, South Yuba, and the Bear Rivers will be developed to the maximum practical extent in the near future insofar as their potential to provide water supplies for the higher elevation foothill lands is concerned.

Agriculture and lumbering are dominant in the economy of the Yuba-Bear Area, with recreation becoming an increasingly important segment of the overall economic picture. Also of considerable importance is the production of hydroelectric power. Power generation will increase sharply in the near future when projects presently under construction or in advanced stages of planning are in operation. These projects will bring development to a level close to the full potential for the basin.

On the valley floor, pasture and rice are the major irrigated crops, with acreage devoted to deciduous orchard next in importance. It is anticipated that these crops will also predominate in the future. In the foothills, pasture presently occupies about 58 percent of land devoted to irrigated agriculture, and deciduous orchard about 38 percent. It is expected that these crops will continue to occupy about the same proportionate acreages of irrigated agriculture in the year 2020. The evident trend to small, rural, noncommercial, agricultural holdings, referred to herein as residential farms, is expected to be the most significant change in the present pattern of land use in the foothill regions.

Consumptive use of applied water in the Yuba-Bear Area by year 2020 is estimated to be about 1.1 million acre-feet per year, or an increase to about two and one-half times the present level. However, water delivery requirements for consumptive uses are expected to little more than double due to more efficient use of applied water and by lining and general improvement of canals to reduce conveyance losses presently experienced.

The plan for development of the Yuba-Bear Area presented herein is designed to meet the year 2020 supplemental requirements for water to provide for all beneficial uses including irrigation, domestic, recreation, fish and wildlife, and production of hydroelectric power. Provision for control of floods was included where recommended by the Corps of Engineers. The plan is basinwide in concept and was formulated with due consideration of the economics of water use in the various service areas. Export of water from the Yuba River to the Delta was also considered.

The plan for development includes a large multipurpose project on the lower Yuba River to provide supplemental water supplies for valley floor lands in Yuba and Sutter Counties, develop hydroelectric power, provide flood control, and enhance the export supply of the Delta; and a complex of smaller projects in the adjacent foothill and mountainous regions designed to fulfill the remaining requirements for practical basin development.

The multipurpose project on the lower Yuba River would be constructed in two units consisting of New Bullards Bar Dam and Reservoir on the North Yuba River, with associated diversion and power features, and Marysville Dam and Reservoir on the main stem Yuba River. The New Bullards Bar Unit is currently proposed for construction in the immediate future by the Yuba County Water Agency. The Marysville Unit is presently desirable for its flood control function, and appears attractive as a future state or federal project from the standpoint of the exportable water supply developed. A summary of the costs and accomplishments of this project is presented in Chapter V, Table 34.

The New Bullards Bar Unit will develop new water supplies adequate to meet ultimate requirements on the valley floor in Yuba and Sutter Counties. The project will also develop the hydroelectric power potential of the lower Yuba River above Marysville Reservoir, provide a portion of the flood regulation required on the Yuba River, enhance the existing salmon fishery in the Yuba River, and provide new recreation opportunities. Marysville Reservoir would provide the remaining flood regulation required on the Yuba River, develop water for export to the Delta during periods of deficient supply therein, and provide exceptional new recreation opportunities.

Supplemental water supplies for the valley floor in Placer County can be met from the Middle Fork American River Project now under construction by Placer County Water Agency, and by reregulation of surplus releases from Wise Powerplant.

In the foothill service areas, demands for supplemental water supplies are expected to increase at a slower rate than on the valley floor with growth in some areas being retarded initially by the lack of existing facilities and by the cost of water development. For this reason, relatively small projects were formulated which could be constructed as stages of an overall development plan to provide additional supplies as the demands for water increase, and at the same time keep project financing within the ability of the water users to repay. Projects for development of the Yuba-Bear Area are shown in red on Plate 6.

Additional conclusions reached from analyses of data developed from the Yuba and Bear Rivers Basin Investigation are itemized below.

1. An estimated 654,000 gross acres within the area of investigation are irrigable. Of this amount, irrigable valley lands comprise 329,000 acres, and irrigable foothill lands comprise 325,000 acres. In addition, there are 116,000 acres of irrigable land classified as best suited to forest management.

2. Under present development, a gross area of about 167,000 acres in the Yuba-Bear Area is irrigated. Of this amount, irrigated valley lands comprise 120,000 acres and irrigated foothill lands comprise 47,000 acres. In addition, there are about 64,000 acres of dry-farmed lands in the Yuba-Bear Area.

3. By year 2020, it is expected that a gross area of about 334,000 acres in the Yuba-Bear Area will be devoted to irrigated agriculture, and that residential farms will comprise an additional 69,000 acres. Of these amounts, valley lands will comprise 236,000 acres of irrigated agriculture, and 15,000 acres of residential farms.

4. The estimated present average annual consumptive use of applied water in the Yuba-Bear Area is 450,000 acre-feet. Of this amount, 438,000 acre-feet are used by irrigated agriculture, and 12,000 acre-feet are used in urban areas.

5. The estimated average annual consumptive use of applied water in year 2020 is 1,063,000 acre-feet. Of this amount, 817,000 acre-feet are for irrigated agriculture, 175,000 acre-feet for residential farms, and 71,000 acre-feet for urban use.

6. Water delivery requirements for consumptive uses in the Yuba-Bear Area by year 2020 are estimated to total 1,588,000 acre-feet.

7. The waters of the Yuba and Bear Rivers are of excellent quality and suitable for all beneficial uses.

8. Water supplies can be developed for all service areas within the area of investigation at a cost within the payment capacities of potential future land uses as projected to year 2020, assuming in some cases the availability of low cost financing for qualified projects.

9. The average annual equivalent direct benefits creditable to the New Bullards Bar Unit of the lower Yuba River Project would be about $11,875,000, accruing to the project purposes as follows: Irrigation, $2,673,000;

hydroelectric power, $8,280,000; flood control, $630,000; recreation, $72,000; and fisheries enhancement, $220,000. Average annual costs over a 50-year repayment period at four percent interest would be about $8,712,000. Project benefits would exceed costs by a ratio of 1.36 to 1.

10. The average annual equivalent direct benefits creditable to the Marysville Unit of the lower Yuba River Project would be about $11,415,000, accruing to the project purposes as follows: Replenishment of the Delta Pool, $8,800,000; flood control, $1,194,000 recreation, $1,354,000 and fisheries enhancement, $67,000. Average annual costs over a 50-year repayment period at four percent interest would be about $5,011,000. Project benefits would exceed costs by a ratio of 2.21 to 1.

11. The most practical plan to meet projected year 2020 supplemental water requirements in the Yuba County Water District portion of the Brownsville Service Area (see plates 4 and 5) was found to be a 3-stage development consisting of (1) a New York Flat Reservoir of 10,000 acre-feet gross capacity, (2) import of water from Fall River (Feather River Basin), and (3) enlargement of New York Flat Reservoir to approximately 30,000 acre-feet gross capacity. Benefit-cost ratio for the overall development was found to be less than unity on the basis of water use for irrigated agriculture and residential farms only. On this same basis, the average cost of water for the initial stage development would be about $4.35 per acre-foot, assuming no-interest financing over a 50-year period and use of district funds received from Oroville-Wyandotte Irrigation District.

12. Near future water resource development on the San Juan Ridge is contingent upon establishment of high payment capacity crops such as deciduous orchard. With such development, the most practical first stage project would consist of North Columbia Reservoir, with water supply augmented by diversion from Grizzly, Bloody Run, and Poorman Creeks. More distant agricultural and residential farm demands on the San Juan Ridge could best be met from a Shady

Creek Reservoir followed by a reservoir on Bloody Run Creek. A comparison of only the net agricultural, residential farm and urban benefits accruing to year 2020 with project repayment and operating costs to that date reveals that the proposed San Juan Ridge Development would have a benefit-cost ratio slightly greater than unity. On the same basis, assuming no-interest financing over a 50-year period, the average cost of water for the initial stage project would be about $9.90 per acre-foot.

13. Presently developed water supplies, plus yield from the Yuba-Bear Project now under construction, can meet projected demands in the Grass Valley Service Area to about 1985. Subsequent demands to year 2020 can best be met as the need arises by construction of Weaver Lake, Bitney Corner, Haypress Diversion, and Anthony House projects, and by improvement and lining of main canals to reduce conveyance losses. The estimated average cost of water from these projects, assuming no-interest financing over a 50-year period and without consideration of project costs possibly allocable to recreation, range from $2.12 to $5.55 per acre-foot. On the same basis, payment capacity for crops projected in the service area ranges from $3.10 per acre-foot for pasture to $23.90 for deciduous orchard, with a weighted average value for all crops of $5.45 per acre-foot.

14. Water supplies presently available to the Colfax Ridge are adequate to meet projected year 2020 demands.

15. Presently developed water supplies, together with yield from the Yuba-Bear and Middle Fork American River Projects now under construction, can satisfy projected Auburn Foothills Service Area requirements to year 2020.

16. On the valley floor in Placer County, supplemental water supplies to meet projected demands can be satisfied from the Middle Fork American River Project, and by regulation of surplus winter releases from Wise Powerplant in Clover Valley Reservoir. This, or an alternate foothill reservoir with the same function, would fit into the overall plan for development of western Placer County. The average cost of

water based on repayment of dam and reservoir costs at 4 percent interest over a 50-year period would be about $5.20 per acre-foot.

Recommendations

It is recommended that:

1. This bulletin be used as a guide to plans for future development of the water resources of the Yuba and Bear Rivers, and further, that the plans for development presented in this bulletin be reviewed periodically and revised where necessary in light of additional information available at that time.

2. The Marysville Unit of the lower Yuba River Project be constructed at the earliest possible date in the interest of flood control and water conservation.

3. The department continue to assist local water agencies in formulating definite water resource development projects to meet future needs which will lead to the optimum comprehensive development of the Yuba and Bear River Basins.

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APPENDIX A

UNIMPAIRED STREAMFLOW

YUBA AND BEAR RIVERS

(Unpublished office report.
Available in department files)

APPENDIX B

COMMENTS AND RECOMMENDATIONS OF THE

DEPARTMENT OF FISH AND GAME

ON

WATER DEVELOPMENT PROPOSALS PRESENTED IN

DEPARTMENT OF WATER RESOURCES BULLETIN NO. 115

"YUBA AND BEAR RIVERS BASIN INVESTIGATION"

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APPENDIXES

INTRODUCTION

Department of Water Resources Bulletin No. 115, "Yuba and Bear Rivers Basin Investigation," presents the proposals of seven different water development agencies. These plans involve the construction of 26 new dams in the two river basins and changes in the operation of 6 existing reservoirs. The degree to which the Department of Fish and Game has evaluated the impact of these developments upon the fish and wildlife resources of the project areas has, for the most part, been determined by the diligence with which the individual project sponsors have pursued their water rights applications and general project planning.

The probable effects of the Yuba and Bear Rivers development proposals upon fish and wildlife have been under investigation by the Department of Fish and Game intermittently since 1957. Recommendations stemming from these studies have served as the basis of agreements recently consummated between the Department of Fish and Game and the sponsors of the two largest development proposals in the investigative area, the Nevada Irrigation District and the Yuba County Water Agency. These agreements, which are self-explanatory, are appended to this report.

For those projects investigated by the Department of Water Resources and not covered in the aforementioned agreements, this report specifies the streamflow requirements which have thus far been determined necessary to protect existing fish populations under project conditions.

Evaluation of probable project effects on wildlife population is still in progress. The results of these studies will be made available later this year, together with recommendations for the protection of wildlife populations under project conditions.

Authorization for Report

This report was prepared under the authority of Interagency Agreement No. 252087 made between the Department of Fish and Game and the Department of Water Resources.

Objective of Report

This report is intended to provide the Department of Water Resources with a single document containing those recommendations for the protection of fish and wildlife populations which have a major effect on the formulation and analysis of water developments proposed for the Yuba and Bear River Basins. Although recommendations in this report are limited largely to the streamflow requirements of fish populations below proposed dams, additional recommendations for the protection and enhancement of fish and wildlife will be made by this department as more detailed information about the design and operation of individual projects becomes availa

Some comment is provided regarding the potential for fish and wildlife enhancement for projects where such potential is apparent.

Copies of two agreements concerning the protection of fish and wildlife resources in the investigative area under project conditions are appended to the report to assist the Department of Water Resources with its review of these projects.

Related Reports and Investigations

Reports have been prepared outlining the probable effects upon fish and wildlife of the projects proposed by the Nevada Irrigation District (Wooster and Collins, 1962) and the Yuba County Water Agency (Wooster, 1963).

An extensive discussion of the Yuba River salmon runs was presented by Hayes (1962) together with recommendations for their preservation under Mayrsville Project conditions. These recommendations resulted from a study conducted jointly by the Department of Fish and Game and the U. S. Fish and Wildlife Service during the period 1958 to 1961.

The development on Fall River and French Dry Creek, proposed by the Yuba County Water District, is being evaluated currently by Region 2, Department of Fish and Game.

Recommendations regarding the additional projects covered in this report are based on the results of field investigations conducted by the Department of Fish and Game since 1960.

STUDY METHODS

The recommendations for streamflow releases for salmon production in the main stem of the Yuba River were based on the results of a study of the spawning areas conducted in the manner first described by Westgate (1958) and later modified by Savage (1962). The Yuba River salmon spawning area survey is explained in detail by Hayes (1962).

The streamflow requirements of trout populations in the mountain areas were determined by the method described by Delisle and Eliason (1961).

Information regarding project effects on wildlife was derived from field reports prepared by personnel of the department's Game Management Branch.

NORTH YUBA RIVER

Haypress Diversion

The Haypress Diversion damsite is on Haypress Creek in Section 32, T20N, R13E, at approximate elevation 6,240. Haypress Creek is tributary to the North Yuba River near Sierra City, Sierra County. The dam would divert water southward to the Middle Yuba River for irrigation and power purposes. The stream, both above and below the damsite, supports excellent populations of rainbow trout (*Salmo gairdnerii*), brown trout (*Salmo trutta*), and eastern brook trout (*Salvelinus fontinalis*).

Most of the land along the stream is in public ownership and public access is excellent. Near its mouth, Haypress Creek passes through Wild Plum Campground, one of the most heavily used public campgrounds in the Tahoe National Forest.

Streamflow accretion below the proposed diversion is negligible.

Minimum fish release requirements: 8 cubic feet per second or the full natural flow, whichever is less, all year.

Comment: In dry years[1/] the stream release may be reduced to 4 cubic feet per second or the full natural flow, whichever is less.

1/ A "dry year" is one in which the April-July runoff forecast made by the Department of Water Resources on May 1 for the "Bowman area -- Middle Yuba River and Canyon Creek" is for less than 70,000 acre-feet.

East Fork Diversion

The East Fork Diversion damsite is on the East Fork of the Middle Yuba River, popularly known as "East Fork Creek," in Section 28, T19N, R12E, at approximate elevation 5,740. A Forest Service road provides good public access from the Graniteville Road to the bank of the stream one mile below the diversion site.

Although good populations of rainbow trout and brown trout exist below the proposed diversion site, angling is limited in the late summer due to low flows. Despite this, East Fork Creek remains a popular streamside camping area throughout the season, due largely to its proximity to Weaver Lake, one mile to the south.

Minimum fish release requirements:	5 cubic feet per second or the full natural flow, whichever is less, March 15 to May 31; 2 cubic feet per second or the full natural flow, whichever is less, June 1 to March 14.

Weaver Lake Reservoir

Weaver Lake lies 7 air miles south of Sierra City in the Tahoe National Forest in Section 32, T19N, R12E. The elevation of this natural lake is 5,665 feet. The lake level fluctuates to an undesirable degree due to an uncontrolled diversion tunnel constructed near the lake outlet by miners in the late nineteenth century. In 1930, recreation interests successfully sealed the tunnel and the then Division of Fish and Game established a highly successful rainbow trout fishery in the lake. In 1950, the seal failed, the lake resumed its periodic fluctuations, and the trout fishery began a steady decline.

Despite the absence of a good trout fishery, recreation use at Weaver Lake has continued at a steady, albeit low, level. Such use is attributable to the excellent access to the lake and the abundance of attractive campsites near the lake shore.

In 1956, the Wildlife Conservation Board allocated $13,000 for sealing the diversion tunnel and repairing the low dam across the outlet stream in order that the U.S. Forest Service might proceed with the development of recreation facilities at Weaver Lake. This allocation was, unfortunately, withdrawn pending settlement of Weaver Lake water rights in favor of the Forest Service.

The development of virtually all of the nearby lakes and streams by the Nevada Irrigation District and the Pacific Gas and Electric Company has placed an unusually high value on Weaver Lake, both for its natural beauty and for its great recreational development potential. The development of Weaver Lake as a fluctuating storage reservoir as proposed by the Nevada Irrigation District, would destroy the potential for re-establishing a trout fishery and its associated recreation at this attractive site.

The Department of Fish and Game is opposed to the development of Weaver Lake for purposes other than fish and wildlife enhancement and recreation. At the time of this report a decision of the State Water Rights Board was being awaited by the parties of interest.

Bloody Run Diversion

The Bloody Run Diversion site is on Bloody Run Creek in Section 30, T18N, R10E, at approximate elevation 3,880. This trout stream is easily fished and the streamside camping sites, although not yet developed, are excellent. Access to the stream is good, since nearly all of the adjacent land is in public ownership.

The proposed diversion site is roughly half-way between the stream's headwaters and its mouth. Accretion to streamflow below the diversion site is negligible.

Minimum fish release requirements: 5 cubic feet per second or the full natural flow, whichever is less, March 1 to May 31; 2.5 cubic feet per second or the full natural flow, whichever is less, June 1 to February 28.

Comment: In dry years[1/] the stream release may be reduced to 2.5 cubic feet per second or the full natural flow, whichever is less, year around.

1/ Definition of a "dry year" to be determined mutually by the project sponsor and the Department of Fish and Game.

Grizzly Creek Diversion

The Grizzly Creek Diversion site is on Grizzly Creek, 2 miles northeast of North Columbia, in Section 21, T18N, R9E. The proposed dam, at streambed elevation 3,010, will divert water to North Columbia Reservoir 2 miles to the west. An improved road, connecting North Columbia with Alleghany, crosses the stream just above the diversion site.

Access to the rainbow trout fishing available below the diversion site is gained by a Forest Service road which crosses the stream 2 miles above its mouth.

Minimum fish release requirements: 2 cubic feet per second or the full natural flow, whichever is less, year around.

North Columbia Reservoir

North Columbia Reservoir would be located on an unnamed tributary to Grizzly Creek in Section 32, T18N, R9E, at streambed elevation 2,792. Maximum depth of the reservoir at normal pool would be 90 feet; the surface area would be approximately 85 acres.

North Columbia Reservoir would be located in an area virtually devoid of permanent lakes or ponds. For this reason, the proposed reservoir affords a remarkable opportunity for fish and wildlife enhancement and water-associated recreation if project operation so permits. A good warm-water fishery could be established in the reservoir if drawdown remains minimal until early summer. A permanent water supply to the reservoir service area will improve conditions for upland game.

Minimum fish release requirements: None.

Poorman Creek Diversion

The Poorman Creek Diversion damsite is in Section 10, T18N, R11E, at elevation 5,000 near the headwaters of Poorman Creek. This site is just upstream from Graniteville, a summer colony of growing popularity. Poorman Creek is tributary to the South Yuba River 1 mile below Washington, Nevada County. Access to the stream is provided at several points by county and Forest Service roads.

Fishing for rainbow trout and brown trout is good on this stream throughout the spring and summer.

Minimum fish release requirements: 2 cubic feet per second or the full natural flow, whichever is less, year around.

Shady Creek Reservoir

Shady Creek Reservoir would be located in Section 16, T17N, R8E, at streambed elevation 1,984, approximately 6 air miles northwest of Nevada City, Nevada County. Maximum depth of the proposed reservoir at normal pool would be 100 feet; the surface area would be 225 acres.

This reservoir would provide essentially the same opportunities for fish and wildlife enhancement and recreation as were indicated for North Columbia Reservoir. Here, again, project operation will determine whether these enhancement opportunities are to be realized.

Minimum fish release requirements: None.

DEER CREEK

Bitney Corner Reservoir

Bitney Corner damsite is located 5 miles downstream from Nevada City on Deer Creek, in Section 18, T16N, R8E. Streambed elevation at the site is 1,958. Releases from reservoir storage will be diverted about 1 mile below the dam into proposed Bitney Corner Canal and transported to the southwest for irrigation use in Penn Valley and beyond. There are both rainbow trout and brown trout in Deer Creek in and below the reservoir area.

Storage capacity of the proposed reservoir will be 20,000 acre-feet; the anticipated minimum pool is 2,000 acre-feet. Due to the nature of the reservoir basin, a minimum pool of approximately 10,000 acre-feet would be required to assure good production of either warmwater gamefish or trout. Adequate stream releases below Bitney Corner Canal diversion would enhance downstream conditions for trout.

Minimum fish release requirements: 5 cubic feet per second or the full natural flow, whichever is less, year around.

Anthony House Reservoir

Anthony House damsite is 11 miles downstream from Nevada City and 5 miles above the confluence of Deer Creek with the Yuba River. The damsite lies in Section 20, T16N, R7E, at streambed elevation 1,139. Brown trout and green sunfish are the principal gamefish species in and below the reservoir area.

Each year a few king salmon spawn in Deer Creek near its mouth. The upstream migration of these fish is interrupted by a falls one-half mile above the mouth of the stream. Above these falls, the streambed is not suitable for salmon reproduction. Timbuctoo Afterbay, a unit of the Yuba County Water Agency development, will soon block the migration of salmon to Deer Creek. Provisions have been made for the maintenance of these fish under the agreement between the agency and this department.

Storage capacity of the proposed Anthony House Reservoir is 11,500 acre-feet; the designed minimum pool is 300 acre-feet. A minimum pool of 4,000 acre-feet would be required to provide good gamefish production in the reservoir. Adequate stream releases below Anthony House Dam would enhance downstream conditions for resident fish.

Minimum fish release requirements:	5 cubic feet per second or the full natural flow, whichever is less, year around.

FALL RIVER

Fall River Diversion

The Fall River Diversion site lies 8 air miles west of LaPorte, Plumas County, in Section 24, T21N, R7E, at elevation 3,920. Irrigation water will be diverted at this site through new and existing conveyance facilities for use in northeastern Yuba County.

Angling for both rainbow trout and brown trout is excellent below the proposed diversion. Appoximately one-half of the land adjacent to the stream below the site is in public ownership; access to the stream is gained by several Forest Service roads.

Feather Falls, the second highest waterfall in the State, is located 12 miles below the proposed diversion near the confluence of Fall River with the Middle Fork Feather River. The California Riding and Hiking Trail, a unit of the State Park System, provides access to the falls.

Minimum fish release requirements: 6 cubic feet per second or the full natural flow, whichever is less, December 1 to March 14; 10 cubic feet per second or the full natural flow, whichever is less, March 15 to April 30; the full natural flow of the stream May 1 to November 30.

FRENCH DRY CREEK

New York Flat Reservoir

The New York Flat damsite lies 2 miles due west of Challenge, Yuba County, in Section 25, T19N, R6E, one-fourth mile above the confluence of New York Creek with French Dry Creek. Development of the reservoir is proposed for two stages. The first stage development would utilize the natural flow of New York Creek, augmented by approximately 3,300 acre-feet per annum from the Forbestown Ditch, to create a reservoir of 10,000 acre-feet with a maximum depth of 78 feet. As local demand increases, an additional 20,000 acre-feet of capacity would be added by enlargement of the reservoir to a maximum depth of 121 feet and a surface area of 585 acres to provide storage and re-regulation of water imported from Fall River.

Both of the reservoir schemes appear attractive from a warmwater gamefish production standpoint. The first-stage reservoir will receive a sustained supply of water from the Forbestown Ditch throughout the summer, thereby minimizing drawdown during the critical reproduction and growth periods. A minimum end-of-season pool of 4,000 acre-feet will provide satisfactory carryover conditions for fish without adversely affecting other project purposes. Further reductions in carryover storage would damage the proposed fishery and should be made only following extremely dry years.

Evaluation of fishery developments at the first-stage project would serve as the best basis for recommendations regarding the ultimate or enlarged reservoir.

Although the stream section between the proposed dam and French Dry Creek is short, it is considered to be a significant nursery area for trout which enter the French Dry Creek fishery and, as such, requires a firm flow release.

Minimum fish release requirements: 0.5 cubic feet per second year around.

Dry Creek Diversion

Dry Creek Diversion Dam would be located 3 miles downstream from the mouth of New York Creek on French Dry Creek in Section 2, T18N, R6E. This low concrete dam would divert releases from New York Flat Reservoir to the adjacent service areas.

The stream below the proposed diversion flows uninterrupted for 6 miles until it reaches Lake Mildred, a locally owned irrigation storage reservoir. French Dry Creek above and below the Dry Creek Diversion site provides good angling for rainbow trout and brown trout.

Minimum fish release requirements: 4 cubic feet per second year around.

Comment: In dry years1/ the stream release may be reduced to 2 cubic feet per second year around.

1/ Definition of a "dry year" to be determined mutually by the project sponsor and the Department of Fish and Game.

YUBA RIVER

Marysville Reservoir

Marysville Reservoir would be located on the main stem of the Yuba River 12 miles above its confluence with the Feather River. The reservoir would be a large, fluctuating warmwater impoundment. Enhancement of warmwater fishing in the reservoir basin would be provided by this project. Wildlife populations, primarily small game species, that inhabit the reservoir basin, would be lost.

The major concern of the Department of Fish and Game with regard to the development of the Marysville Project is the preservation of the migratory fish populations, especially king salmon, which now use the Yuba River above and below the damsite. Insufficient knowledge is available at this time to accurately forecast the effect of the project on the striped bass and American shad populations which use the stream below the project site for spawning and nursery areas. Substantial information is available, however, to guide planning for the protection of king salmon.

Much of the present information regarding the Yuba River king salmon runs and their investigation by this department was presented by Hayes (op. cit.) to the Department of Water Resources. Data obtained subsequent to this investigation confirm the conclusion that the Yuba River salmon runs are experiencing an increase in numbers. An analysis of expected spawning conditions in the river with the proposed New Bullards Bar Project shows that a sizable increase in salmon can be expected. Preliminary estimates indicate a peak run of 75,000.

Marysville Reservoir will inundate 75 percent of the Yuba River salmon spawning area available after the construction of the New Bullards Bar Project. Accordingly, salmon propagation facilities capable of handling about 56,000 fish will be required at Marysville Dam should it be constructed.

It is our understanding that releases of 800 cubic feet per second during normal and wet years could be made from Marysville Reservoir to the stream during the salmon spawning and egg incubation period (October 1 through February 28) without adversely affecting other project purposes. It is estimated that increases in flows to this level would provide spawning area for 11,000 more salmon in this lower reach than are expected under New Bullards Bar Project conditions.

The most difficult task in the protection of the Yuba River salmon run is that of providing water of suitable temperature for satisfactory spawning in the stream and for suitable operation of the proposed Marysville Project fish facilities. The effect of the New Bullards Bar Project on downstream water temperatures is yet to be determined. It is obvious that the stream will be subjected to further warming when it enters Marysville Reservoir. It is inconceivable that water of suitable temperature for salmon spawning, i.e., 42 to 56° Farenheit, could be provided when needed below Marysville Dam without special provisions for temperature control both there and at the proposed New Bullards Bar Dam.

It is essential that the Department of Water Resources initiate a comprehsensive analysis of the feasibility of supplying water of suitable temperature for salmon propagation below the proposed Marysville Reservoir. Such a study should be undertaken immediately in the event that modification in the present design of New Bullards Bar Dam might be indicated.

The Department of Fish and Game looks upon the Marysville Reservoir proposal with grave concern in relation to its effects on fish and wildlife resources with particular concern for its effects on the important salmon runs of the Yuba River. Further and extensive studies of both salmon and other fish resources and wildlife in connection with this dam will be necessary.

Minimum fish release requirement:[1/]	400 cubic feet per second October 1 to March 1
	250 cubic feet per second March 1 to August 1
	70 cubic feet per second August 1 to October 1

1/ These are the minimum releases recommended for fisheries maintenance below Marysville Reservoir. It is recommended that a release of 800 cubic feet per second from October through February be provided in order that full advantage be taken of remaining spawning areas below the damsite.

CLOVER VALLEY CREEK

Clover Valley Reservoir

Clover Valley damsite lies 3 miles west of Penryn, Placer County, and 2 miles above the confluence of Clover Valley Creek with Antelope Creek. The reservoir would re-regulate surplus releases from Wise Powerplant on Auburn Ravine for local domestic and irrigation delivery. At normal pool elevation of 455, the reservoir will have a maximum depth of 150 feet and a surface area of 440 acres. The proposed minimum pool would leave a reservoir only 55 feet deep with a surface area of about 150 acres.

Clover Valley Reservoir provides a striking opportunity to provide fishing recreation in the heart of an expanding suburban population center. Reservoir water supply, since it will be conveyed to the site largely through a system of tunnels and penstocks, should be unusually cool for a foothill impoundment. Although we have not yet had an opportunity to investigate this proposal, it would appear that a minimum pool somewhat in excess of that selected by the Department of Water Resources would provide for the establishment of an artificially managed trout fishery at a very nominal cost. It is recommended that the project sponsor investigate this concept with the Department of Fish and Game before the project planning is finalized.

Minimum fish release requirements: Undetermined.

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APPENDIX B-a

AGREEMENT BETWEEN THE CALIFORNIA DEPARTMENT OF FISH AND GAME AND THE NEVADA IRRIGATION DISTRICT

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AGREEMENT BETWEEN THE CALIFORNIA DEPARTMENT OF FISH AND GAME AND THE NEVADA IRRIGATION DISTRICT

This agreement is made this 10th day of May, 1963, between the Nevada Irrigation District, hereinafter called District and the People of the State of California acting by and through the California Department of Fish and Game, hereinafter called Department. This agreement amends and supersedes the agreements which the parties hereto entered into on March 13, 1962 and April 26, 1963.

W I T N E S S E T H

WHEREAS, District is seeking water rights and permits from the State of California pursuant to Applications 5193, 15525, 20017 and 20072, for diversion and use of certain quantities of water from the Upper Yuba and Upper Bear River systems for irrigation and municipal purposes and for the generation of electrical power under Federal Power Commission Project No. 2266; and District proposes to construct Jackson Meadows Dam on the Middle Yuba, Faucherie Dam on Canyon Creek, Dutch Flat Afterbay Dam on Bear River, Rollins Dam on Bear River, Scott's Flat Reservoir on Deer Creek and pertinent tunnels, flumes and ditches in order to put the diverted or stored water to beneficial use pursuant to said permits and/or said Federal Power Commission Project No. 2266; and

WHEREAS, District is including the present Milton Diversion Dam on the Middle Yuba, Milton-Bowman pipeline and tunnel, Jackson Lake Dam on Jackson Creek, French Lake Dam on Canyon Creek and Bowman-Spaulding conduit within Federal Power Commission Project No. 2266; and

WHEREAS, Deer Creek, the Upper Yuba River and the Upper Bear River and their tributaries comprise natural river systems frequented by brown trout, rainbow trout, brook trout and certain warm water species of fish; and

WHEREAS, Department, in the interest of protecting and preserving the fish and wildlife resources of the state, seeks to have certain conditions maintained in relation to each of the proposed project works for the preservation and improvement of those resources in and around said river system;

NOW, THEREFORE, in consideration of the premises herein contained, it is agreed by and between District and Department as follows:

1. The following minimum flow shall be released by District for maintenance of fish life below Jackson Meadows Dam into the Middle Yuba:

a. 5 cubic feet per second year around. Changes in flow other than spill shall not cause vertical fluctuations in the stream level of more than 1 foot in 6 hours nor more than 3 inches during any one hour. Fluctuations and the minimum flow release in the stream shall be gaged within one-half mile downstream of Jackson Meadows Dam.

2. District shall maintain the following minimum pools in Jackson Meadows Reservoir:

a. Normal or wet years.

(1) June 1 through September 30 - 21,000 acre feet

(2) October 1 through May 31 - 10,000 acre feet

b. Dry years*

(1) June 1 through September 30 - 21,000 acre feet

(2) October 1 through May 31 - 3,000 acre feet

*A "dry year" is one in which the April-July runoff forecast made by the Department of Water Resources on May 1 for the "Bowman area-Middle Yuba River and Canyon Creek" is for less than 70,000 acre feet.

3. District shall maintain a normal pool in Milton Reservoir at elevation 5686 year around except when repair to the Milton-Bowman Tunnel is necessary at which time the normal pool may be drawn down to a minimum elevation of 5678 feet.

4. District shall at all times release a minimum flow for the maintenance of fish life from Milton Diversion Dam into the Middle Yuba River of 3 cubic feet per second.

5. District shall at all times release a minimum flow for the maintenance of fish life from Jackson Lake Dam into Jackson Creek of 1 1/2 cubic feet per second.

6. District shall at all times maintain a minimum flow of 2 1/2 cubic feet per second in the reach of Canyon Creek between French Lake Dam and Bowman Reservoir.

7. District shall release the following minimum flows for the maintenance of fish life from the Bowman-Spaulding Canal intake into Canyon Creek;

a. April 1 through October 31
3 cubic feet per second

b. November 1 through March 31 -
2 cubic feet per second

8. District agrees not to impair or interfere with the present water release for the maintenance of fish life made by the Pacific Gas and Electric Company from the Drum Afterbay Dam into Bear River. This flow release established in 1942 is as follows:

a. Normal or wet years

(1) March 1 through September 30-
10 cubic feet per second

(2) October 1 through February 28 -
5 cubic feet per second

b. Dry years*

(1) 5 cubic feet per second at all times

*A "dry year" is defined as a year wherein precipitation of less than

45 inches occurs at Lake Spaulding by the end of April.

9. District agrees not to impair or interfere with any water release for the maintenance of fish life made by the Pacific Gas and Electric Company from Spaulding Dam at any point above District's Excelsior diversion.

10. District shall release the following minimum flows for the maintenance of fish life from Dutch Flat Afterbay Dam into Bear River:

a. May 1 through October 31 -
10 cubic feet per second

b. November 1 through April 30
5 cubic feet per second

11. District shall maintain a minimum pool in Rollins Reservoir at all times of not less than 5000 acre feet.

12. District shall release the following minimum flows for the maintenance of fish life from Rollins Reservoir into the Bear River:

a. Normal Water Conditions*

(1) May 1 through October 31 -
75 cubic feet per second

(2) November 1 through April 30 -
20 cubic feet per second

b. Less than Normal Water Conditions

(1) May 1 through October 31 -
40 cubic feet per second

(2) November 1 through April 30 -
15 cubic feet per second

Said flow releases shall be measured at the Colfax-Grass Valley Gage. *Normal Water Conditions are defined as follows: Water conditions which, for the purposes of this agreement, shall be deemed to prevail any month of the year if the water supply indicator* for that month equals or exceeds the following:

November 1	1 inch
December 1	7 inches
January 1	12 inches
February 1	20 inches
March 1	26 inches
April 1	34 inches
May 1	36 inches
June 1	40 inches
July 1	42 inches
August 1	42 inches
September 1	43 inches
October 1	44 inches

*Water Supply Indicator: The indicator for any calendar month shall be the total accumulated precipitation of inches of water as measured in reasonable accordance with the accepted practices of the United States Weather Bureau at the existing Lake Spaulding Gage for the period from October 1 up to the beginning of the month in question; for example, the indicator for the month of February will be such accumulated precipitation for the preceding four-month period from and including October 1 up to and including January 31.

13. Changes in flow releases by District from Rollins Dam into Bear River shall not cause vertical fluctuations in the stream level greater than one foot in 6 hours or 3 inches during any one hour. Fluctuations in stream level shall be measured at the Colfax-Grass Valley Gage.

14. District shall order release of the following minimum flows for the maintenance of fish life from the Deer Creek powerhourse tailrace into Deer Creek and Scott's Flat Reservoir;

a. 3 c.f.s. July 1 through September 30

b. 10 c.f.s. October 1 through June 30

These releases shall apply except at such times as the South Yuba Canal is out of service for system maintenance or repair.

15. District shall maintain the following minimum pools in Scotts Flat Reservoir:

a. Normal or wet years, 5,000 acre feet

b. Dry years (as defined in Section 2 of this agreement) - 1,000 acre feet.

16. District shall provide such features as will enable deer to move over, under and along District's water conduits. Department will determine the number of cross walks and escape ramps and amount of fencing necessary to insure the protection of deer herds in the project area and will supply these data to District together with specifications for their construction.

17. In instances where District or its contractors propose to remove vegetation from a reservoir site, strip earth from the abutements, remove sand or gravel from a stream, wash gravel near a stream or carry on any activity in or along a stream which might result in muddying, silting or allowing to enter the stream any substance, (such as oil), which might impair fish or aquatic life or habitat, District shall be responsible for providing and maintaining in effective condition, check dams, settling ponds and such other features as may be required to maintain the fishery resources of the streams below such operations.

District shall be responsible for its contractor's compliance with sections 5650, 5948, 1901 and 1902, of the California Fish and Game Code and other applicable statutes relating to pollution prevention or abatement.

18. District shall allow free public access within the proposed project boundaries, except in areas where public safety, security of District's property or interference with project operations are the controlling factors.

19. District shall construct, maintain, and operate such protective devices and shall comply with such reasonable modifications of project structures and operation in the interest of fish and wildlife resources, provided that such modifications shall be reasonably consistent with the primary purpose of the project, as may be prescribed hereafter by the Commission upon its own motion or upon recommendation of the Secretary of the Interior or the California Department of Fish and Game after notice and opportunity for such hearing and upon a finding that such modifications are necessary and desirable and consistent with the provisions of the Act: Provided further, that subsequent to the approval of the final design drawings prior to commencement of construction, no modification of project structures in the interest of fish and wildlife resources which involve a change in the location, height, or main structure of a dam, or the addition of or changes in outlets at or through a dam, or a major change in generating units, or a rearrangement or relocation of a power house, or major changes in a spillway structure, shall be required.

20. The minimum flow releases and minimum storage requirements for these projects to be made by the District as provided heretofore in this agreement shall take effect after construction or fillings as specified below or after four years from time of letting the prime contract for construction of the project whichever date occurs first.

For purposes of this section the construction period shall be defined as commencing with letting of the prime contract for construction of the proposed project or if later when construction work alters stream flow, water quality or stream bed and shall continue until the reservoir filling period commences. The filling period shall commence when the District notifies the Department in writing that the filling of Jackson Meadows, Faucherie and Rollins reservoirs has started and the period shall be considered ended when the following total project storage (including storage for Milton, French, Jackson Lake, Sawmill Lake, Jackson Meadows, Faucherie, and Bowman Reservoirs) shall have been reached in the amount shown for any month:

	Acre Feet
January	70,000
February	68,000
March	71,000
April	104,000
May	137,000
June	156,000
July	142,000
August	130,000
September	113,000
October	98,000
November	88,000
December	78,000

21. District shall make releases or allow for maintenance of specified stream flows at the places noted below during the construction and project reservoir filling stages, as follows:

a. Jackson Meadows

At least 5 c.f.s. or the natural flow whichever is less during the construction period and 3 c.f.s. or the natural flow whichever is less during the filling period.

b. Faucherie

At least 2.5 c.f.s. or the natural flow whichever is less during construction and filling periods.

c. Dutch Flat Afterbay

The entire flow of the stream during the construction period and the following flows during the filling period and power plant testing periods and operation at Chicago Park powerhouse:

10 c.f.s. May 1 through October 31

5 c.f.s. November 1 through April 30

d. Rollins

(1) District shall release a minimum of 15 c.f.s. of its water during the 48 hour period of the diversion closure for Rollins Dam.

(2) If the storage in Rollins reservoir at anytime during the filling period reaches 50,000 acre feet prior to June 1, 1967 and at all times after June 1, 1967 the flow release schedule as set forth in Paragraph 12 of this agreement shall be in full force and effect. The beginning of the filling period is defined as being after closure is completed under paragraph 21.d(1) above.

(3) Whenever, during the filling period, the storage in Rollins Reservoir is less than 50,000 acre feet, District shall release 40 c.f.s. July 1 through September 30 and 15 c.f.s. October 1 through June 30 or such inflow to Rollins as District is entitled, which ever is less. Said flow shall be measured at the Colfax-Grass Valley gage as provided in Paragraph 12.

22. District and Department agrees that the provisions of this agreement may be included by reference or otherwise in any permit or license issued by the State Water Rights Board pursuant to Applications 5193, 15525, 20017, and 20072, in place of the provision contained in the aforesaid agreement between the parties hereto, dated March 13, 1962, and the provision of this agreement may be

included in any licenses issued by the Federal Power Commission in Project No. 2266. If the terms of this agreement are included in such licenses, Department agrees that its petition to intervene in Project No. 2266 may be considered withdrawn and disregarded.

APPROVED AS TO FORM

/s/ P. J. Minasian
Attorneys for Nevada Irrigation District

NEVADA IRRIGATION DISTRICT

/s/ Warren S. Wilson
WARREN S. WILSON, President

/s/ H. Georgia Scobie
H. GEORGIA SCOBIE, Secretary

APPROVED AS TO FORM

STANLEY MOSK, Attorney General
J. M. SANDERSON, Deputy Attorney General

By /s/ J. M. Sanderson
Attorneys for the California Department of Fish and Game

CALIFORNIA DEPARTMENT OF FISH AND GAME

/s/ W. T. Shannon
Director

APPENDIX B-b

AGREEMENT BETWEEN THE CALIFORNIA
DEPARTMENT OF FISH AND GAME
AND THE
YUBA COUNTY WATER AGENCY

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AGREEMENT BETWEEN THE CALIFORNIA DEPARTMENT OF FISH AND GAME AND THE YUBA COUNTY WATER AGENCY

This agreement is made this 28th day of Nov., 1962, between the Yuba County Water Agency, an agency of the State of California, hereinafter called "Agency," and the State of California, represented by the California Department of Fish and Game, hereinafter called "State."

W I T N E S S E T H

WHEREAS, the Yuba River and its tributaries comprise a natural river system frequented by king salmon, steelhead trout, brown trout, rainbow trout, shad, and other fish; and

WHEREAS, the Agency is seeking water rights and permits from the State of California for diversion and use of certain quantities of water from the Yuba River system for irrigation and municipal purposes and for the generation of electrical power; and Agency proposes to construct Hour House Diversion Dam on the Middle Yuba River, Log Cabin Diversion Dam on Oregon Creek, New Bullards Bar Dam and Reservoir and New Colgate Diversion Dam on North Yuba, Timbuctoo Afterbay Dam and an Irrigation Diversion Weir on the mainstem Yuba River in order to divert and store the water for beneficial uses pursuant to said permits applied for; and

WHEREAS, the future construction of an Irrigation Diversion Weir and Timbuctoo Dam will block free and natural access to a substantial portion of the spawning area presently utilized by king salmon and steelhead trout runs of the Yuba River, and will require the release of water from said weir and dam and Hour House Dam, Log Cabin Dam, and New Colgate Dam for the preservation and enhancement of the fisheries in said river system below said dams;

NOW THEREFORE, in consideration of the mutual covenants herein contained, it is agreed between the parties hereto as follows:

Section 1.1 - The following minimum flows shall be released into the Middle Yuba River immediately below Hour House Diversion Dam for the maintenance of fishlife:

> 50 cubic feet per second or the natural flow, whichever is less, from April 15 through June 15
>
> 30 cubic feet per second or the natural flow, whichever is less, from June 16 through April 14

The above releases shall be measured at a stream gaging station located not more than 500 feet downstream of the dam.

Section 1.2 - The following minimum flows shall be released into Oregon Creek from Log Cabin Diversion Dam for the maintenance of fishlife:

> 12 cubic feet per second or the natural flow, whichever is less, from April 15 to June 15
>
> 8 cubic feet per second or the natural flow, whichever is less, from June 16 to April 14

The above releases shall be measured at a stream gaging station located not more than 500 feet downstream of the dam.

Section 1.3 - The flows stipulated above in Sections 1.1 and 1.2 shall not fluctuate more than plus or minus 10 per cent from the respective mean flows in any 24-hour period. The term "natural flow" in Sections 1.1 and 1.2 means the inflow to the respective reservoirs.

Section 1.4 - The following minimum flow shall be released for maintenance of fishlife from the New Colgate Dam on the North Yuba River:

5 cubic feet per second year around

The flow shall be measured at a stream gaging station located not more than 500 feet downstream of the dam.

Section 1.5 - The following minimum flows shall be released to the Yuba River immediately below Timbuctoo Afterbay Dam for the maintenance of fishlife:

January 1 - June 30 ------- 245 cubic feet per second
July 1 - September 30 ----- 70 cubic feet per second
October 1 - December 31 --- 400 cubic feet per second

These flow releases shall be in addition to releases made to satisfy existing downstream water rights and shall be measured at a stream gaging station located not more than one-half mile downstream of the Irrigation Diversion Weir.

Section 1.6 - Water releases for fishlife shall be subject to reduction in critical dry years.

A critical dry year, as used herein, is defined as a water year for which the April 1 forecast of the California Department of Water Resources predicts that streamflow in the

Yuba River at Smartville will be 50 per cent or less than 50 per cent of normal. The critical dry year provisions herein shall be effective from the time the aforesaid forecast is available until the April 1 forecast of the following year.

The water release curtailment schedule for critical dry years will be as follows:

Yuba River at Smartville Streamflow Forecast Per Cent of Normal	Reduction in Water Releases for Fishlife, Per Cent
50	15
45	20
40 or less	30

However, in no event shall releases below Timbuctoo Afterbay Dam be reduced to less than 70 cubic feet per second.

Section 1.7 - A minimum pool shall be maintained in New Bullards Bar Reservoir at elevation 1730 feet.

Section 1.8 - The Agency shall maintain as large a minimum pool behind Timbuctoo Dam as is possible under the power and irrigation demand schedule.

Section 1.9 - The Agency shall clear vegetation in New Bullards Bar Reservoir from 1700 foot elevation to the 1955 foot elevation.

Where borrow areas are proposed, the top soil shall be stripped first and stockpiled. When borrow operations are completed, the area shall be graded as practicable, and the top soil shall be replaced where the topography permits. Borrow areas on U.S. Government land shall be revegetated with browse species. This stipulation does not apply to those areas which will be inundated by the reservoirs.

Section 2.0 - Agency shall mitigate damages to wildlife resulting from project activities in accordance with recommendations of the Department of Fish and Game. The extent of Agency's obligation under this Section will be determined through further investigation and negotiation.

Section 2.1 - Flows released by the Agency from the Timbuctoo Afterbay Dam during normal operation, shall not fluctuate at an hourly rate of more than 300 cubic feet per second. Fluctuations in the stream flow are to be gaged within one-half mile below the Timbuctoo Afterbay Dam.

Section 2.2 - In instances where the Agency or its contractors propose to remove vegetation from a reservoir site, strip earth from the abutments, remove sand or gravel from a stream, wash gravel near a stream or carry on any activity in or along a stream which might result in muddying, silting or allowing to enter the stream any substance, such as oil, which might injure fish life or fish habitat, the Agency shall be responsible for providing and maintaing in effective condition check dams, settling ponds, and such other features as may be required to maintain the fishery values of the streams below such operations.

The Agency shall be responsible for its contractor's compliance with Sections 5650, 5948, 12015, 1601, and 1602 of the California Fish and Game Code and other applicable statutes relating to pollution prevention or abatement.

Section 2.3 - Free public access shall be allowed within the proposed project boundary, except in areas where public safety, security of Agency's property, or interference with project operations are the controlling factors.

Section 2.4 - It is recognized by the Agency and the State that the temperature of water released from the New Bullards Bar Reservoir during the spawning seasons of king salmon in the fall and shad in the spring can have an effect upon mitigation and enhancement of the salmon and shad runs in the Yuba River. It is agreed that these problems shall be taken into consideration in finally locating the power intake and outlet works at the New Bullards Bar Dam and that the Agency shall so locate the outlets as to provide water temperatures at Colgate Diversion Dam comparable to present values with regard to the fisheries resource.

Outlet works at the Irrigation Diversion Weir shall be so constructed by the Agency to permit lowering of the water level behind the weir to provide, insofar as is practicable, maximum additional salmon spawning area.

Section 2.5 - Agency shall bear the cost of constructing, operating and maintaining a fishway and fish screening facilities at the Irrigation Diversion Weir.

Section 2.6 - Salmon and Steelhead trapping facilities shall be constructed and maintained by the Agency at Timbuctoo Afterbay Dam; however, the trapping of fish at, and their transfer from the facility at said dam shall be conducted by the State, at State expense.

Section 2.7 - Design of facilities referred to in Sections 2.5 and 2.6 above will be in accord with the criteria described in Exhibit A attached hereto, and which is made a part of this agreement. If said criteria are revised, whereby the cost of fish facilities is increased, such increase shall not be the responsibility of the Agency.

Section 2.8 - This agreement supersedes the preliminary agreement dated December 28, 1961, between the Agency and the State.

AGENCY:

/s/ Ben Rose
Chairman

/s/ E. L. Gray
Secretary

CALIFORNIA DEPARTMENT OF FISH AND GAME

/s/ W. T Shannon
Director

(Dec. 11, 1962)

EXHIBIT A

Design Criteria for Fish Facilities at
Irrigation Diversion Weir & Timbuctoo Afterbay Dam

IRRIGATION DIVERSION WEIR

A. Bypass

1. A bypass with a maximum discharge capacity of 800 c.f.s. shall be provided at the Irrigation Diversion Weir. Selection of the bank at which the bypass shall be located shall be made at the time of final project designs when the necessary information on channel conditions and flow characteristics is available.

2. The bypass outlet channel shall be aligned as close to the toe of the weir as permissible without affecting the safety of the weir. The outlet channel of the bypass combined with the discharge channel of the fishway, shall be so designed that during normal operation (that is, except during flood conditions), the velocity of flow shall not exceed 5.0 ft. per sec. and the minimum depth of water in the channel shall not be less than one foot.

B. Fishway

1. A fishway shall be provided adjacent to the bypass designed to operate under any flow condition up to 15,000 c.f.s. Flow from the fishway shall discharge into the outlet channel of the bypass. The fishway shall be of a type similar to that used at Ice Harbor Dam, Washington.

2. The fishway shall be designed according to the following criteria:

Minimum entrance velocity of flow - 4.0 ft. per sec.

Maximum entrance velocity of flow - 8.0 ft. per sec.

Size of pools - 10 ft. long and 8 ft. wide

Height of weirs - 6.0 ft.

Minimum depth of water over weir crest - 1.0 ft.

Minimum normal freeboard - 3.0 ft.

Floor slope - 1 in 10

3. The downstream end of the fishway shall be so located with reference to bypass stilling basin as to be readily accessible and attractive to fish.

4. Provision shall be made for an auxiliary flow of 100 c.f.s. near the lower end of the fishway.

5. Submerged orifice type flow control arrangement shall be provided at the inlet.

6. The following additional provisions shall be made in design of the fishway:

a. A counting facility located in 20 ft. long x 8 ft. wide pool.

b. Means of draining and cleaning the pools.

c. Orifices, 18-in. square, in the weirs.

d. A trashrack with 12-inch bar spacing.

e. Protective fence around the facility.

C. Fish screens

1. Vertical louver type screens shall be provided at headworks of the North Yuba and South Yuba canals to divert

the fingerling fish from the canals back into the Yuba River downstream of the Irrigation Diversion Weir. The fish diversion basins and facilities may be located on the canals a suitable distance downstream of the canal intakes.

2. Each canal shall be widened into a basin with a rectangular cross-section in which the louver screen shall be located. The design of the transitions upstream and downstream of the louver structure shall be such as to assure a uniform velocity of approach at the louvers. Trash-racks, capable of removing debris that may clog the screens, shall be installed upstream of the louver basin.

3. The louver screens and structure shall be designed according to the following criteria:

Normal velocity of approach - 3.5 ft. per sec.

Minimum velocity of approach - 1.0 ft. per sec.

Angle of line of louvers to direction of flow - 16°

Angle of louver slats to direction of flow - 90°

Louver slats - 2.5 in. wide

Adequate flow straighteners shall be provided

Clear spacing between louver slats - 1.5 in. to 2 in.

Velocity at bypass entrance - 1 to 1.4 x approach velocity

Width of bypass opening - 8 in.

Minimum diameter of bypass pipes - 12 in.

4. The bypass structure shall be of a design which assures a uniform velocity distribution from top to bottom as well as a transition of uniform flow into the bypass pipe.

5. Provisions shall be made for cleaning the louver screens under operating conditions.

D. Trapping Facility at Timbuctoo Afterbay Dam

1. A facility consisting of a fish ladder, a holding tank, an anesthetic tank and the necessary accessories, shall be provided below the Timbuctoo Afterbay Dam to trap the fish that may be stranded at the outlet works. The exact location of the trapping facility shall be determined after the completion of the dam and trial operation of the outlet works through at least one spawning season, when it shall be possible to observe the stablized (sic.) channel characteristics as well as the probable areas where the fish may accumulate.

2. Normal minimum tunnel velocities shall be such as to exclude salmon during the period October 1 to December 31.

3. The fish ladder shall be capable of transporting the fish from elevation 245 to elevation 265. It shall be designed according to the following criteria:

Minimum flow - 40 cu. ft. per sec. at the lower end of the ladder.

Minimum entrance velocity of flow - 4.0 ft. per sec.

Maximum entrance velocity of flow - 8.0 ft. per sec.

Size of pools - 5 ft. wide and 10 ft. long

Type of weir - Notched weir with no orifice; provision for draining

Height of weirs - 3 ft.

Minimum depth of water over weirs - 1.0 ft.

Floor slope - 1 in 10

Freeboard - 3.0 ft.

4. The holding tank at the upstream end of the ladder shall be 8 ft. wide, 20 ft. long and 4 ft. deep. It shall be equipped with a mechanical sweep.

5. The anesthetic tank shall be 8 ft. wide, 8 ft. long and 2 ft. deep. It shall be equipped with a suitable escalator capable of transferring the fish to a transfer truck.

APPENDIX C

WATER QUALITY CRITERIA

APPENDIX C

WATER QUALITY CRITERIA

Criteria presented in this appendix are those commonly employed by the Department of Water Resources in evaluating the quality of water relative to existing or anticipated beneficial uses. It should be pointed out that these criteria are merely guides to the establishment of suitable quality limits.

Domestic and Municipal Water Supply

Chapter 7 of the California Health and Safety Code contains provisions relating to domestic water supply and refers to drinking water standards promulgated by the United States Public Health Service for water used on interstate carriers. These criteria have been adopted by the State of California and chemical substances in drinking water supplies, either natural or treated, should conform to the limitations presented in Table C-1.

TABLE C-1

UNITED STATES PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS, 1946

Constituents	mg/L
Mandatory	
Fluoride (F)	1.5
Lead (Pb)	0.1
Selenium (Se)	0.05
Hexavalent Chromium (Cr^{+6})	0.05
Arsenic (As)	0.05
Nonmandatory but Recommended Values	
Iron (Fe) and Manganese (Mn) together	0.3
Magnesium (Mg)	125
Chloride (Cl)	250
Sulfate (SO_4)	250
Copper (Cu)	3.0
Zinc (Zn)	15
Phenolic compounds in terms of phenol	0.001
Total solids - desirable	500
- permitted	1,000

The 1946 standards also states that turbidity shall not exceed 10 mg/L (silica scale), that color shall not exceed 20 (platinum-cobalt scale), and that water shall have no objectionable odor.

Irrigation Water

Because of the diverse climatological conditions, crops, soils, and irrigation practices in California, criteria which may be set up to evaluate the suitability of water for irrigation use must necessarily be of a general nature, and judgment must be used in their application to individual cases. Suggested limiting values for total dissolved solids, chloride concentration, percent sodium, and boron concentration for three general classes of irrigation waters are shown in Table C-2.

Preservation and Protection of Fish and Wildlife

A healthy and diversified aquatic population is indicative of good water quality conditions which, in turn, permit optimum beneficial uses of the water. For such a population to exist, the environment must be suitable for both the fish and the food-chain organisms.

Many mineral and organic substances, even in low concentrations, are harmful to fish and aquatic life. Insecticides, herbicides, ether-soluble materials, and salts of heavy metals are of particular concern. It may be noted that although the drinking water standards presented in Table C-1 permit as much as 3.0 and 15 mg/L of copper and zinc, respectively, such levels are highly toxic to fish.

The minimum requirements for dissolved oxygen concentrations vary with the location and season. In general, 5 ppm is satisfactory for migrating fish. However, anadromous fish in spawning areas require at least 7 ppm dissolved oxygen and under some conditions 9 ppm is needed.

It has been found that fish can thrive between pH limits of 6.5 to 8.5.

TABLE C-2

QUALITATIVE CLASSIFICATION OF IRRIGATION WATERS

Chemical properties	Class 1 Excellent to good (Suitable for most plants under any conditions of soil and climate)	Class 2 Good to injurious (Possibly harmful for some crops under certain soil conditions)	Class 3 Injurious to unsatisfactory (Harmful to most crops and unsatisfactory for all but the most tolerant)
Total dissolved solids:			
In ppm	Less than 700	700 - 2,000	More than 2,000
In conductance micromhos at 25° C.	Less than 1,000	1,000 - 3,000	More than 3,000
Chloride ion concentration:			
In milliequivalents per liter	Less than 5	5 - 10	More than 10
In ppm	Less than 175	175 - 350	More than 350
Sodium in percent of base constituents	Less than 60	60 - 75	More than 75
Boron in ppm	Less than 0.5	0.5 - 2.0	More than 2.0

APPENDIX D

WATER RIGHTS

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APPENDIX D

WATER RIGHTS

Since the effective date of the Water Commission Act (Calif. Stats. 1913, Ch. 586) on December 19, 1914, many applications to appropriate waters of the Yuba and Bear Rivers have been filed with the State Water Rights Board or its predecessor agencies. This appendix will not attempt to list all of these applications, nor will it present a complete accounting of all existing water rights on these rivers. However, a brief discussion of state applications, and established rights, uses, or claims of the major water users within the Yuba-Bear Area will be made.

State Applications

The Legislature, during its 1927 session, enacted Chapter 286, which is now codified in Part 2 of Division 6 of the Water Code. Section 10500 of Part 2 provides, in part, as follows:

> "10500. The department shall make and file applications for any water which in its judgment is or may be required in the development and completion of the whole or any part of a general or co-ordinated plan looking toward the development, utilization, or conservation of the water resources of the State."

The effect of such state applications is to hold water in public trust for future use.

Applications filed by the State may be assigned or may be released from priority in favor of junior applications. Since 1959 this authority has been vested in the California Water Commission by Section 10504 of the Water Code, which reads, in part, as follows:

> "10504 . . . The commission may release from priority or assign any portion of any application filed under this part when the release or assignment is for the purpose of development not in conflict with such general or co-ordinated plan. The assignee of any such application whether heretofore or hereafter assigned, is subject to all the requirements of diligence as provided in Part 2 (commencing at Section 1200) of Division 2 of this code. "Assignee" as used herein includes, but is not limited to, state agencies, commissions and departments, and the United States of America or any of its departments or agencies."

Pursuant to Section 10504.1 of the Water Code, the California Water Commission is required to hold a public hearing on any request for an assignment or release from priority of any state application. The commission must give a 45-day notice to all counties affected by the project.

Under the provisions of Section 10507 of the Water Code, the commission, upon its own motion within 30 days after adoption of an order or decision relating to a state application, or upon petition of any interested party filed within 30 days after the adoption of such an order or decision, may order reconsideration of the order or decision.

Within 30 days after final action by the commission, any interested person may file a petition for writ of mandate to test the validity of the commission's action in the courts.

An assignment or release from priority does not give the recipient a perfected water right. After an assignment has been made, the recipient will generally have to amend the application to include the details of the proposed project and submit the amended application to the commission for approval. The application is then submitted to the State Water Rights Board. The application is advertised by the board and an opportunity is provided for protests. On protested applications a hearing is held by the State Water Rights Board concerning the issuance of a permit on the application. Protestants and interested parties may present evidence. The Department of Water Resources, under Sections 184 and 1256 of the Water Code, may appear at such a hearing to present information it deems pertinent. Subsequent to the hearing the State Water Rights Board determines whether a permit should be issued and generally includes various conditions concerning the project. Following the issuance of the permit, the permittee proceeds with construction and application of the water to beneficial use. Releases from priority of state applications in favor of the applications of one proposing to build a project may be made before or after permits have been issued on his applications, but otherwise the procedure is the same.

Water Code Section 10504.5 has an important place in the procedure for assigning or releasing from priority state applications. This section states:

> "10504.5. In order to insure that projects will be constructed in accordance with a general or co-ordinated plan for the development of water:
>
> (a) The recipient of a release from priority or assignment under this part shall, before making any changes determined by the California Water Commission to be substantial in the project in furtherance of which the release or assignment was made, submit such changes to the California Water Commission for its approval. The commission shall approve any such change only if it determines that such change will not conflict with the general or co-ordinated plan. All permits and licenses issued pursuant to applications so released or assigned shall contain terms conditioning such permits and licenses upon compliance with this subdivision.
>
> (b) The holder of applications that have been assigned, or in favor of which a release from priority has been made, shall submit any proposed amendments to such applications to the commission before their submission to the State Water Rights Board. The commission shall approve such amendments only if it determines that the amendments will not conflict with the general or co-ordinated plan. The commission shall notify the holder of the application and the State Water Rights Board of its approval or disapproval. No amendments to any such application shall be authorized by the State Water Rights Board unless they are first approved by the commission."

Water Rights Applications

The following is a summary and brief discussion of water rights applications of major water users in the Yuba-Bear Area.

State of California

The State, pursuant to Water Code Section 10500, has filed Applications Nos. 5631 and 5632 proposing appropriations from the Yuba River; Applications Nos. 20713 and 20714 proposing appropriations from the Yuba River and Dry Creek; and Applications Nos. 5633, 5634, and 10221, proposing appropriations from the Bear River System. The essential features of these applications as filed by the State are set forth in Table D-1.

The place of use described under Applications Nos. 5632, 5634, and 10221, is 2,500,000 acres on the Sacramento and San Joaquin Valley Floors. In accordance with the provisions of Section 10504 of the Water Code, the release from priority of Applications Nos. 5631 and 5632 was made in favor of Application No. 8794 presently held by the Pacific Gas and Electric Company for the operation of the Narrows Powerhouse on the Yuba River. This release, dated December 30, 1938, contains a general reservation for the counties of origin.

A second release from priority of Applications Nos. 5631 and 5632 was made in favor of Applications Nos.

TABLE D-1

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE YUBA AND BEAR RIVERS BASIN
FILED BY THE STATE PURSUATNT TO
WATER CODE SECTION 10500
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Purpose of use
5631	Incomplete	Yuba River (Narrows Reservoir)	1,800	490,000	Power
5632	Incomplete	Yuba River (Narrows Reservoir)	1,700	490,000	Irrigation and domestic
5633	Incomplete	Bear River (Parker Reservoir)	120	110,000	Power
5634	Incomplete	Bear River (Parker Reservoir)	400	110,000	Irrigation and domestic
10221	Pending	Bear River (Camp Far West Project)	250	40,000	Irrigation and domestic
20713	Incomplete	Yuba River and Dry Creek (Marysville Res.)	2,200	1,000,000	Power
20714	Incomplete	Yuba River and Dry Creek (Marysville Res.)	500	1,000,000	Irrigation and domestic

13676, 13956, and 13957 held jointly by Oroville-Wyandotte Irrigation District and Yuba County Water District for the Slate Creek features of the South Fork Feather River Project. This release, dated December 12, 1958, also contained a general reservation for the counties of origin and is subject to the terms of the March 21, 1958, agreement between the

Oroville-Wyandotte Irrigation District and Yuba County Water District. The March 21, 1958, agreement was superseded by an agreement dated December 9, 1959.

On September 17, 1959, a release from priority of State Applications Nos. 5633 and 5634 was made in favor of Application No. 14804 held by South Sutter Water District. Concurrently, an assignment of State Application No. 10221 was also made to South Sutter Water District for its Camp Far West Project on the Bear River. Both the release and assignment were made subject to a general reservation for the counties of origin and to the terms of the August 31, 1957, agreement between the South Sutter Water District and the Camp Far West Irrigation District.

On October 5, 1962, Applications Nos. 5631 and 5632 were assigned to the Yuba County Water Agency in furtherance of its Yuba River development. At the same time a release from priority of these applications was made in favor of Applications Nos. 6701, 6702, 8177, 8178, 8179, 8180, 15525, 20017, and 20072 held by Nevada Irrigation District. Both the assignment and the release from priority contained a general reservation for the counties of origin and the assignment contained a reservation for the California Water Commission to consider the objections of San Juan Ridge County Water District to the release from priority of Applications Nos. 5631 and 5632 in favor of Applications Nos. 19138 and 19139 of Nevada Irrigation District.

Browns Valley Irrigation District

Browns Valley Irrigation District, in accordance with Section 12 of the Water Commission Act of 1913, filed a certificate prescribing the time for completion of water to beneficial use with the State Water Commission, a predecessor agency of the State Water Rights Board. This certificate is now designated in the records of the State Water Rights Board as Application 12-1986. On April 14, 1921, the commission certified that the Browns Valley Irrigation District had a right to divert 47.20 cubic feet per second from the North Yuba River under a priority of March 21, 1890.

The district also holds four applications on file with the State Water Rights Board, under which the right has been confirmed by the issuance of a license or diversions authorized by the issuance of permits. Water diverted under this license and these permits is for domestic and irrigation purposes within the district's boundaries. A summary of the district's applications on file with the State Water Rights Board is set forth in Table D-2.

Camp Far West Irrigation District

The district holds four applications on which licenses have been issued confirming the rights to divert from the Bear River for irrigation uses within the boundaries of the district.

A summary of the district's applications is set forth in Table D-3.

TABLE D-2

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE YUBA RIVER BASIN HELD BY
BROWNS VALLEY IRRIGATION DISTRICT
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
12-1986	-	North Yuba River (Sec. 25, T18N, R7E)	47.2		Irrigation
8986	L-2182	Tennessee Creek (Sec. 24, T17N, R5E)	3		Irrigation
12543	P-8648	Honcut Creek (Honcut Reservoir)	100	20,000	Irrigation
13130	P-8649	(French) Dry Creek (Virginia Ranch Res.)		20,000	Irrigation and domestic
13873	P-9703	(French) Dry Creek (Virginia Ranch Res.)		40,000	Irrigation and domestic

Cordua Irrigation District

The district holds Applications Nos. 9927 and 12371 on which licenses have been issued confirming the right to divert a total of 90 cubic feet per second from the Yuba River at Daguerre Point Dam for irrigation and domestic uses within the boundaries of the district.

A summary of the district's applications on file with the State Water Rights Board is set forth in Table D-4.

TABLE D-3

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE BEAR RIVER BASIN HELD BY
CAMP FAR WEST IRRIGATION DISTRICT
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
959	L-385	Bear River (Bear River Diversion Dam)	13.24		Irrigation
2881	L-2266	Bear River (Camp Far West Reservoir)		5,000	Irrigation
3843	L-2267	Bear River (Bear River Diversion Dam)	11.76		Irrigation
10190	L-2740	Bear River (Camp Far West Reservoir)		5,000	Irrigation

TABLE D-4

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE YUBA RIVER BASIN HELD BY
CORDUA IRRIGATION DISTRICT
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
9927	L-3984	Yuba River (Daguerre Point Dam)	40		Irrigation and domestic
12371	L-3985	Yuba River (Daguerre Point Dam)	50		Irrigation and domestic

City of Grass Valley

The city holds Application No. 15642 which has been approved by the issuance of Permit No. 11459. This permit authorizes the diversion to storage of 12,500 acre-feet per annum on Rock Creek in Blue Tent Reservoir for municipal and domestic purposes by the city.

Hallwood Irrigation Company

The company holds Application No. 9899 on which License 4443 has been issued confirming the right to divert 100 cubic feet per second from the Yuba River at Daguerre Point Dam. Water diverted under this license is used for irrigation purposes in the company's service area.

Johnson Rancho County Water District

The district holds nine pending applications proposing appropriations, principally from the Yuba River system, for irrigation and domestic purposes in a service area extending from Butte County on the north to Placer County on the south including parts of Sutter, Placer, and Yuba Counties.

Before the rights under the district's applications can be determined it may be necessary for the board to hold hearings and issue a decision.

A summary of the district's pending applications is set forth in Table D-5.

TABLE D-5

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE YUBA AND BEAR RIVERS BASIN
HELD BY JOHNSON RANCHO COUNTY WATER DISTRICT
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
13687	Pend.	Dry Creek (Sec. 12, T14N, R5E)	25	35,000	Irrigation and domestic
		Best Slough (Sec. 25, T14N, R4E)			
15560	Pend.	Yuba River (Englebright Reservoir)	3,000	420,000	Irrigation and domestic
		North Yuba River			
15585	Pend.	Middle Yuba River (Freeman Reservoir)		180,000	Irrigation and domestic
15656	Pend.	Yuba River (Sec. 26, T16N, R5E)	500		Irrigation and domestic
15700	Pend.	North Yuba River (Indian Valley Reservoir)	900	340,000	Power
		Middle Yuba River (Freeman Reservoir)	900	200,000	
		Yuba River (Englebright Reservoir)	800		Power
15873	Pend.	North Yuba River (Bullards Bar Reservoir)		282,000	Irrigation and domestic
15930	Pend.	North Yuba River		440,000	Power
15944	Pend.	Deer Creek (Sec. 24, T16N, R8E)	200	50,000	Irrigation and domestic
		North Yuba River (Bullards Bar Reservoir)		158,000	
		Middle Yuba River (Freeman Reservoir)		60,000	
15945	Pend.	North Yuba River (Indian Valley Reservoir)	3,400		Power
		Middle Yuba River (Freeman Reservoir)	3,400	40,000	
		Yuba River (Englebright Reservoir)	2,200		

Nevada Irrigation District

Diversions from the Bear and Upper Yuba Rivers system are made by the district under 22 applications on which either permits or licenses have been issued. Under these applications the district stores and diverts water through the Milton-Bowman-Spaulding system for irrigation and domestic purposes within the district and for the generation of hydroelectric power at Spaulding Powerplants Nos. 1, 2, and 3, Drum, Dutch Flat, Colfax, Deer Creek, Chicago Park, Halsey, and Wise Powerplants. The district also holds five pending applications which propose diversions from the Upper Yuba River Basin.

A summary of the district's applications on the Yuba and Bear Rivers system is set forth in Table D-6.

Pacific Gas and Electric Company

The company holds five applications on which licenses have been issued confirming the rights to divert from the North Yuba River for the generation of hydroelectric power at the Colgate and Narrows Powerplants. The company also holds three applications on the Bear River, of which one has been approved by the issuance of a permit. The rights under the remaining two applications have been confirmed by the issuance of licenses to divert from the Bear River for the generation of hydroelectric power at the

TABLE D-6

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE YUBA AND BEAR RIVERS BASIN
HELD BY NEVADA IRRIGATION DISTRICT
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
1270	P-2082	Jackson Creek (Jackson Lake)	250	1,060	Irrigation
		Canyon Creek (Sawmill Flat Res.) (Bowman Reservoir)	200	63,950	Irrigation
1614	P-1481	Deer Creek (Scotts Flat Res.)		60,000	Irrigation
1615	P-5801	Deer Creek (China Ditch Intake)	100		Irrigation
1616	P-5802	South Yuba River (Excelsior Ditch Intake)	125		Irrigation
2275	P-2084	Middle Yuba River (Jackson Meadows Res.) (Milton Reservoir)		75,000	Power
2276	P-2085	Middle Yuba River (Jackson Meadows Res.) (Milton Reservoir)		75,000	Irrigation
2372	P-2087	Jackson Creek (Jackson Lake Reservoir)		1,060	Power
		Canyon Creek (Sawmill Flat Reservoir)		615	
		Canyon Creek (Bowman Reservoir)	250	63,325	
		Texas Creek	30		
		Fall Creek	15		
		Trap Creek (Bowman-Spaulding Conduit)	5		
2652	P-5803*	Bear River (Combie Reservoir)		12,500	Irrigation
2652	P-11626*	Bear River (Combie Reservoir)		87,500	Irrigation

* Application No. 2652 was approved by two permits.

TABLE D-6 (continued)

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
4309	L-4544	South Yuba River (Spaulding Reservoir)	135		Power
4310	L-1707	South Yuba River (Spaulding Reservoir)	126		Power
5193	P-13770	Middle Yuba River (Jackson Meadows Res.)		50,000	Irrigation
6229	P-5804	Bear River (Bear River Canal Intake)	120		Irrigation
6529	L-4403	Auburn Ravine	8		Irrigation
6701	P-5806	Fall Creek	10		Power
		Trap Creek	5		
		Clear Creek	5		
6702	P-5807	Fall Creek	10		Irrigation
		Trap Creek	5		
		Clear Creek	5		
8177	P-5812	Poison Creek	50	6,000	Irrigation and domestic
		Wilson Creek (Milton-Bowman Conduit)			
8178	P-5813	Texas Creek	70		Power
		Clear Creek	30		
		Fall Creek	85		
		Trap Creek	15		
		Rucker Creek (Bowman-Spaulding Conduit)	25		
8179	P-5814	Poison Creek	25	3,000	Power
		Wilson Creek (Milton-Bowman Conduit)	25	3,000	
8180	P-5815	Texas Creek	70	14,000	Irrigation and domestic
		Clear Creek	30	6,000	
		Fall Creek	85	17,000	
		Trap Creek	15	3,000	
		Rucker Creek (Bowman-Spaulding Conduit)	25	5,000	

TABLE D-6 (Continued)

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
14700	Pend.	Haypress Creek (Haypress Diversion Dam) (Haypress Reservoir)	230	75,000	Power
14701	Pend.	Haypress Creek	230	75,000	Irrigation
15524	Pend.	South Yuba River (Sec. 26, T17N, R8E)	420		Power
15525	P-13771	South Yuba River (Spaulding Reservoir)	200		Power
19138	Pend.	East Fork Creek Weaver Lake	70	 4,730	Irrigation
19139	Pend.	East Fork Creek Weaver Lake	70	 4,730	Power
20017	P-13772	South Yuba River (Spaulding Reservoir)	200	18,000	Irrigation and domestic
20072	P-13773	Middle Yuba River (Jackson Meadows Res.)		50,000	Power

existing Dutch Flat, Halsey, and Wise Powerplants and the proposed Chicago Park Powerplant.

The applications of Pacific Gas and Electric Company are summarized in Table D-7.

TABLE D-7

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE YUBA AND BEAR RIVERS BASIN
HELD BY PACIFIC GAS AND ELECTRIC COMPANY
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
2197	L-435	North Yuba River (Bullards Bar Reservoir)	700	5,000	Power
2753	L-987	Bear River (Bear River Canal Intake, Sec. 22, T15N, R9E)	100		Power
5004	L-777	North Yuba River (Bullards Bar Reservoir)		15,000	Power
5970	P-5725	Bear River (Dutch Flat Tunnel Intake, Sec. 17, T16N, R11E)	525		Power
6332	L-1375	Bear River (Bear River Canal Intake)	120		Power
8794	L-6388	Yuba River (Narrows Reservoir)	700	45,000	Power
9516	L-3050	North Yuba River (Bullards Bar Reservoir)	100		Power
10282	L-5544	North Yuba River (Bullards Bar Reservoir)		5,335	Power

San Juan Ridge County Water District

The district holds ten applications proposing appropriations at various points in the upper Middle and South Yuba Rivers Basins. The district contemplates using the Upper and Lower Milton and the Eureka Lake Ditches to convey water to the district located on the San Juan Ridge between the Middle and South Yuba Rivers. Water sought under the district's pending or incomplete applications is to be used for domestic and irrigation purposes within the district.

A summary of the district's applications is set forth in Table D-8.

TABLE D-8

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE YUBA RIVER BASIN HELD BY THE
SAN JUAN RIDGE COUNTY WATER DISTRICT
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
16177	Pend.	Bloody Run Creek (Sec. 30, T18N, R10E)	5		Irrigation and domestic
16178	Pend.	Grizzly Creek (Sec. 22, T18N, R9E)	2.5		Irrigation and domestic
16207	Pend.	East Fork Creek (Sec. 30, T19N, R12E)	5		Irrigation and domestic
16208	Pend.	Poorman Creek (Sec. 9, T18N, R11E)	2.5		Irrigation and domestic
16209	Pend.	McMurray Lake	25		Irrigation and domestic

TABLE D-8 (continued)

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
16210	Pend.	Weaver Lake	50		Irrigation and Domestic
16211	Pend.	Middle Yuba River	50		Irrigation and domestic
16818	Pend.	Weaver Lake		5,000	Irrigation and domestic
16841	Inc.	Unnamed stream (Sec. 26, T19N, R11E)	3		Irrigation, domestic, and municipal
		Poorman Creek (Poorman Reservoir)		4,690	
		Poorman Creek (Sec. 9, T18N, R11E)	9		
		3 unnamed streams (Sec. 13, 14, and 23, T18N, R10E)	3		
		Bloody Run Creek (Sec. 30, T18N, R10E)	63	7,100	
		Unnamed stream (Sec. 25, T18N, R9E)	1		
		Grizzly Creek (Sec. 22, T18N, R9E)	67		
		3 unnamed streams (Sec. 22, 27, and 28, T18N, R9E)	2		
		2 unnamed streams (Sec. 28 and 29, T18N, R9E)	2		
		Unnamed stream (Sec. 32, T18N, R9E)	75	3,260	
19842	Pend.	Shady Creek (Sec. 10, T17N, R8E)	2	400	Irrigation and domestic

South Sutter Water District

The district, in furtherance of its Camp Far West Project, holds Application No. 14804 on which Permit No. 11297 has been issued authorizing the diversions from the Bear River at the Camp Far West Reservoir site, 360 cubic feet per second by direct diversion and 95,000 acre-feet per annum by storage. Water diverted under Application No. 14804 is used for domestic and irrigation purposes within the boundaries of the district.

The district also holds State Application No. 10221 which was assigned to its on September 17, 1959. Application No. 10221 has been completed by the district and is presently pending further action before the State Water Rights Board. Application No. 10221 proposes appropriations from the Bear River at Camp Far West Reservoir of 250 cubic feet per second by direct diversion and 40,000 acre-feet per annum by storage. Water sought under this application will be used for irrigation and domestic purposes within the district.

The Camp Far West Irrigation District and the South Sutter Water District on August 31, 1957, entered into an agreement whereby the South Sutter Water District recognized the prior rights of the Camp Far West Irrigation District to the waters of the Bear River.

Yuba County Water District

The Yuba County Water District holds five applications jointly with the Oroville-Wyandotte Irrigation District on which permits have been issued authorizing diversions from the South Fork Feather River Basin and Slate Creek within the North Yuba River Basin. Under an agreement entered into by the districts on December 9, 1959, the Yuba County Water District is to receive 3,700 acre-feet of water annually from the South Fork Feather River Project.

The Yuba County Water District also holds pending Application No. 18410 proposing diversions from Fall River, a tributary to the Middle Fork Feather River and Rock Creek, a tributary to the South Fork Feather River. Under this application, water will be diverted to offstream storage in New York Flat Reservoir and will be distributed to the district's service area for domestic and irrigation purposes.

A summary of the district's applications is set forth in Table D-9.

Yuba County Water Agency

The agency holds six applications proposing diversions on the North Yuba River, Middle Yuba River, and the main Yuba River. Two of these applications, namely Applications Nos. 5631 and 5632, were assigned by the California Water Commission to the agency on October 5, 1962. The remaining four applications were filed by the agency in

TABLE D-9

SUMMARY OF WATER RIGHTS APPLICATIONS
IN THE FEATHER RIVER AND YUBA RIVER BASINS
HELD BY YUBA COUNTY WATER DISTRICT
AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
13676*	P-11514	S. F. Feather River (Little Grass Valley Res. and S. F. Diversion Dam)	200	77,300	Power
		Lost Creek (Lost Creek Reservoir)	100	40,000	
13956*	P-11515	Slate Creek (Sec. 1, T20N, R8E)	300	35,000	Power
13957*	P-11516	Slate Creek (Sec. 1, T20N, R8E)	300	35,000	Irrigation and domestic
14112*	P-11517	S. F. Feather River (S. F. Diversion Dam	150		Power
		Lost Creek (Lost Creek Reservoir)	250		
14113*	P-11518	S. F. Feather River (S. F. Diversion Dam)	700		Irrigation domestic
		Lost Creek (Lost Creek Reservoir)		117,300	
18410	Pend.	Fall River (Sec. 24, T21N, R7E)		20,000	Irrigation and domestic
		Rock Creek (Sec. 19, T21N, R8E)		3,000	

* Held jointly by Yuba County Water District and Oroville-Wyandotte Irrigation District.

furtherance of its Yuba River Project. Water sought under these applications is for the generation of hydroelectric power at New Bullards Bar, New Colgate, and New Narrows Powerplants, and for irrigation and domestic purposes within the district.

A summary of the agency's applications is set forth in Table D-10.

TABLE D-10

SUMMARY OF WATER RIGHTS APPLICATIONS IN THE YUBA RIVER BASIN HELD BY THE YUBA COUNTY WATER AGENCY AS OF DECEMBER 20, 1962

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
5631	Inc.	Middle Yuba River (Hour House Dam)	1,000*		Power
		Oregon Creek (Log Cabin Dam)	1,000*		
		North Yuba River (New Bullards Bar Res.)	1,800*	490,000	
		Yuba River (Englebright Reservoir)	1,800*		
5632	Inc.	North Yuba River (New Bullards Bar Res.)	43	490,000	Irrigation and domestic
		Yuba River (Englebright Reservoir)	1,657		
15204	Pend.	North Yuba River (New Bullards Bar Res.)	43	300,000	Irrigation, domestic, and industrial
		Yuba River (Sec. 30, T16N, R6E)	657		
15205	Pend.	Middle Yuba River (Hour House Dam)	800	120,000**	Power
		North Yuba River (New Bullards Bar Res.)			
15563	Pend.	Middle Yuba River (Hour House Dam)	200	30,000**	Power
		Oregon Creek (Log Cabin Dam)	1,000	44,000**	
		North Yuba River (New Bullards Bar Res.)	1,800	146,000	
		Yuba River (Englebright Reservoir)	1,800		

TABLE D-10 (continued)

Appl. No.	Status	Source (Point of diversion)	Amount cfs	Amount AF/a	Major purpose of use
15574	Pend.	Middle Yuba River (Hour House Dam)		150,000**	Irrigation, domestic, and industrial
		Oregon Creek (Log Cabin Dam)		44,000**	
		North Yuba River (New Bullards Bar Res.)		320,000	
		Yuba River (Sec. 30, T16N, R6E)	829		

* Total direct diversion from all sources not to exceed 1,800 cfs.
** To be diverted to offstream storage in New Bullards Bar Reservoir.

Summary

The majority of the agencies making major diversions from the Yuba and Bear Rivers Basin hold water rights applications on which permits and licenses have been issued. However, several agencies hold applications which have not been approved by the issuance of a permit by the State Water Rights Board. Agencies holding such applications are Nevada Irrigation District, San Juan Ridge County Water District, Yuba County Water Agency, Johnson Rancho County Water District, and Yuba County Water District.

Nevada Irrigation District holds Applications Nos. 14700, 14701, 15524, 19138, and 19139 which have not been approved by the State Water Rights Board. The first two applications propose diversion from Haypress Creek into the Milton-Bowman-Spaulding system for power and irrigation purposes. Under Application No. 15524, the district proposes diversions from the South Yuba River for power purposes. Applications Nos. 19138 and 19139 propose diversions from Weaver Lake and East Fork Creek. The latter two appear to be in conflict with the plan of development proposed by the San Juan Ridge County Water District under its Applications Nos. 16207, 16209, 16210, and 16818 which also propose diversions from Weaver Lake and East Fork Creek.

Including its aforementioned applications, the San Juan Ridge County Water District holds 10 pending applications. These applications propose appropriations from various streams and lakes in the Middle and South Yuba River watersheds.

The Yuba County Water Agency holds six applications, and the Johnson Rancho County Water District holds nine applications, proposing appropriations from the North, Middle and main stem of the Yuba River. The projects proposed by these two agencies contemplate the utilization of the same reservoir site and therefore, the developments on the Yuba River system proposed by these agencies are in conflict.

Under Application No. 18410, the Yuba County Water District proposes to divert 23,000 acre-feet annually from Fall River and Rock Creek into the Yuba River Basin. This project contemplates the utilization of a portion of the Oroville-Wyandotte Irrigation District's South Fork Feather River facilities to convey water from the sources of supply to storage in New York Flat Reservoir on New York Creek.

Before the extent of the rights that these agencies may acquire under their pending applications can be established, the State Water Rights Board will, in view of the conflict between some of the proposed projects, and the protests submitted against these applications, be required to hold hearings and to approve applications in favor of one project over another where appropriate.

APPENDIX E

RESERVOIR YIELD STUDIES

TABLE OF CONTENTS

SUMMARY OF MONTHLY YIELD STUDY
NEW YORK FLAT RESERVOIR
(In 1,000 Acre-Feet)

Gross storage capacity: 10,000 acre-feet

Seasonal Yield: 8,400 acre-feet

Season	Period	Estimated natural flow at damsite	Import via: Forbestown Ditch under 1958 agreement	Total inflow	Gross storage first of period	Evaporation	Demand	Spill	Deficiency: In acre-feet	Deficiency: In percent of irrigation demand
1927-28	Nov.1-Apr.30	6.9	0.2	7.1	5.5		0.9	1.7		
	May 1-Oct.31	0.3	3.1	3.4	10.0	0.7	7.5			
1928-29	Nov.1-Apr.30	1.7	0.2	1.9	5.2		0.9			
	May 1-Oct.31	0.6	3.1	3.7	6.2	0.6	7.5		1.2	15
1929-30	Nov.1-Apr.30	5.4	0.2	5.6	3.0		0.9			
	May 1-Oct.31	0.4	3.1	3.5	7.7	0.7	7.5			
1930-31	Nov.1-Apr.30	1.4	0.2	1.6	3.0		0.9			
	May 1-Oct.31	0.1	3.1	3.2	3.7	0.6	7.5		2.7	35
1931-32	Nov.1-Apr.30	6.3	0.2	6.5	1.5		0.9			
	May 1-Oct.31	1.0	3.1	4.1	7.1	0.7	7.5			
1932-33	Nov.1-Apr.30	2.0	0.2	2.2	3.0		0.9			
	May 1-Oct.31	0.9	3.1	4.0	4.3	0.6	7.5		1.2	15
1933-34	Nov.1-Apr.30	1.8	0.2	2.0	1.4		0.9			
	May 1-Oct.31	0.3	3.1	3.4	2.5	0.3	7.5		2.7	35
1934-35	Nov.1-Apr.30	6.2	0.2	6.4	0.8		0.9			
	May 1-Oct.31	1.1	3.1	4.5	6.3	0.6	7.5			

Table E-2

SUMMARY OF MONTHLY OPERATION STUDY
FALL RIVER DIVERSION AND NEW YORK FLAT RESERVOIR
(in 1,000 acre-feet)

Gross Storage Capacity: 30,000 acre-feet — Seasonal Yield: 17,000 acre-feet

Season	Period	Fall River: Estimated natural flow at diversion site	Fall River: Stream release: 6 cfs Dec-Apr: natural flow May-Nov	Fall River: Diversion to New York Flat Reservoir	New York Flat Reservoir: Estimated natural flow at damsite	New York Flat Reservoir: Import via Forbestown ditch under 1958 agreement	New York Flat Reservoir: Total inflow	New York Flat Reservoir: Gross storage first of period	New York Flat Reservoir: Evaporation	New York Flat Reservoir: Demand	New York Flat Reservoir: Spill	Deficiency: in 1,000 acre-feet	Deficiency: in percent of irrigation demand
1927-28	Nov.1-Apr.30	19.2	9.8	9.4	6.9	0.2	16.5	16.0[e]	-0.2	1.9	0.8		
	May 1-Oct.31	3.9	3.9	0.0	0.3	3.1	3.4	30.0	1.1	15.1			
1928-29	Nov.1-Apr.30	6.3	2.3	4.0	1.7	0.2	5.9	17.2	-0.2	1.9			
	May 1-Oct.31	3.5	3.5	0.0	0.6	3.1	3.7	21.4	0.9	15.1		2.3	15
1929-30	Nov.1-Apr.30	14.8	2.0	12.8	5.4	0.2	18.4	11.4	-0.2	1.9			
	May 1-Oct.31	4.0	4.0	0.0	0.4	3.1	3.5	28.1	1.0	15.1			
1930-31	Nov.1-Apr.30	5.3	2.3	3.0	1.4	0.2	4.6	15.5	-0.2	1.9			
	May 1-Oct.31	2.0	2.0	0.0	0.1	3.1	3.2	18.4	0.9	15.1		5.4	35
1931-32	Nov.1-Apr.30	12.3	2.2	10.1	6.3	0.2	16.6	10.0	-0.2	1.9			
	May 1-Oct.31	6.7	6.7	0.0	1.0	3.1	4.1	25.9	1.0	15.1			
1932-33	Nov.1-Apr.30	5.8	2.1	3.7	2.0	0.2	5.9	13.9	-0.2	1.9			
	May 1-Oct.31	5.1	5.1	0.0	0.9	3.1	4.0	18.1	0.9	15.1		4.6	30
1933-34	Nov.1-Apr.30	9.2	2.2	7.0	1.8	0.2	9.0	10.7	-0.2	1.9			
	May 1-Oct.31	2.4	2.4	0.0	0.3	3.1	3.4	18.0	1.0	15.1		2.7	18
1934-35	Nov.1-Apr.30	11.5	2.5	9.0	6.2	0.2	15.4	8.0	-0.2	1.9			
	May 1-Oct.31	4.1	4.1	0.0	1.1	3.1	4.2	21.7	0.9	15.1			

e - Estimated

TABLE E-3

SUMMARY OF MONTHLY YIELD STUDY
NORTH COLUMBIA PROJECT
(in acre-feet)

Gross Storage Capacity: 2,300 acre-feet — Seasonal Yield: 3,200 acre-feet

Season	Period	Poorman Creek: Estimated natural flow at diversion site	Poorman Creek: Stream release for fish, and spill 2/	Poorman Creek: Net delivery to Bloody Run Creek 1/ 3/	Bloody Run Creek: Estimated natural flow at diversion site	Bloody Run Creek: Stream release for fish 4/	Bloody Run Creek: Net delivery to Grizzly Creek 1/ 3/	Bloody Run Creek: Spill	Grizzly Creek: Estimated natural flow at diversion site	Grizzly Creek: Stream release for fish 2/	Grizzly Creek: Net delivery to North Columbia Reservoir 1/	Grizzly Creek: Spill	North Columbia Reservoir: Estimated natural flow at North Columbia damsite	North Columbia Reservoir: Total inflow to North Columbia Reservoir	North Columbia Reservoir: Gross storage first of period	North Columbia Reservoir: Evaporation	North Columbia Reservoir: Demand	Deficiency: in acre-feet	Deficiency: in percent of total demand
1927-28	Nov 1-May 31	8,870	3,020	5,850	6,800	1,440	9,830	1,380	1,750	710	1,450	9,420	1,030	2,480	150	20	460		
	Jun 1-Oct 31	690	320	350	180	180	350	0	40	40	350	0	30	370	2,300	90	2,740	160	5
1928-29	Nov 1-May 31	3,500	780	2,720	2,070	930	3,860	0	530	470	2,470	1,450	310	2,780	0	20	460		
	Jun 1-Oct 31	1,140	340	750	200	190	750	0	50	50	670	70	30	700	2,300	110	2,740		
1929-30	Nov 1-May 31	7,520	1,560	5,960	5,320	1,370	9,910	0	1,370	730	1,830	8,720	800	2,630	150	20	460		
	Jun 1-Oct 31	1,530	410	1,030	190	190	1,030	0	50	50	670	350	30	700	2,300	110	2,740		
1930-31	Nov 1-May 31	2,630	620	2,010	1,410	840	2,580	0	360	360	2,420	160	210	2,630	150	20	460		
	Jun 1-Oct 31	420	270	140	120	120	140	0	30	30	140	0	20	160	2,300	90	2,740	370	12
1931-32	Nov 1-May 31	7,020	3,110	3,910	6,610	1,490	9,030	0	1,710	760	1,780	8,200	1,000	2,780	0	20	460		
	Jun 1-Oct 31	3,100	1,420	1,610	420	250	1,740	0	110	110	650	1,070	60	710	2,300	120	2,740		
1932-33	Nov 1-May 31	2,980	510	2,470	2,420	710	4,180	0	620	430	2,260	2,110	370	2,630	150	20	460		
	Jun 1-Oct 31	2,740	940	1,610	300	230	1,650	0	80	80	660	970	50	710	2,300	120	2,740		
1933-34	Nov 1-May 31	4,350	800	3,550	1,950	910	4,590	0	500	470	2,340	2,280	290	2,630	150	20	460		
	Jun 1-Oct 31	280	220	70	120	120	70	0	30	30	70	0	20	90	2,300	90	2,740	440	14
1934-35	Nov 1-May 31	8,570	4,700	3,870	6,840	1,500	7,960	1,250	1,760	700	1,750	7,270	1,030	2,780	0	20	460		
	Jun 1-Oct 31	2,570	770	1,620	260	240	1,610	0	70	70	670	920	40	710	2,300	120	2,740		

1/ Office studies indicate that enroute accretions from sidehill runoff exceed conveyance losses in Nov-May period
2/ Recommended release of 2 second-feet or natural flow
3/ Note: Under actual operation, amount diverted would be governed by the amount required to fill North Columbia Reservoir.
4/ Recommended release in normal years of 5 second-feet May-May; 2.5 second-feet June-February. In dry years, releases were reduced to 2.5 second-feet and 1.0 second-foot, respectively.

TABLE E-4

SUMMARY OF MONTHLY YIELD STUDY
NORTH COLUMBIA PROJECT AND
BLOODY RUN RESERVOIR
(in acre-feet)

Total Gross Storage Capacity: 9,300 acre-feet | Seasonal Yield: 8,000 acre-fee

Season	Period	Import from Poorman Creek 1/ 4/	Bloody Run Reservoir: Estimated natural flow at Bloody Run damsite	Bloody Run Reservoir: Total inflow to Bloody Run Reservoir	Bloody Run Reservoir: Gross storage at first of period	Bloody Run Reservoir: Evaporation	Bloody Run Reservoir: Stream release for fish 2/	Bloody Run Reservoir: Stream release for diversion to Grizzly Creek 1/	Bloody Run Reservoir: Spill	Grizzly Creek: Estimated natural flow Grizzly Creek at diversion site	Grizzly Creek: Stream release for fish 3/	Grizzly Creek: Diversion to North Columbia Reservoir 1/	North Columbia Reservoir: Estimated natural flow at North Columbia damsite	North Columbia Reservoir: Total inflow to North Columbia Reservoir	North Columbia Reservoir: Gross storage at first of period	North Columbia Reservoir: Evaporation	North Columbia Reservoir: Demand	Deficiency in acre-feet	Deficiency in percent of total demand
1927-28	Nov 1-May 31	5,850	6,800	12,650	2,000e	20	1,500	210	5,920	1,750	710	1,250	1,030	2,280	1,800e	20	1,760		
	Jun 1-Oct 31	350	180	530	7,000	150	750	5,830		40	40	5,690	30	5,720	2,300	140	6,240		
1928-29	Nov 1-May 31	2,720	2,070	4,790	800	10	1,050	1,120		530	470	1,180	310	1,490	1,640	10	1,760		
	Jun 1-Oct 31	750	200	950	3,410	70	300	3,790		50	50	3,720	30	3,750	1,360	100	6,240	1,230	15
1929-30	Nov 1-May 31	5,960	5,320	11,280	200	20	1,140	2,630	690	1,370	730	3,270	800	4,070	0	10	1,760		
	Jun 1-Oct 31	1,030	190	1,220	7,000	160	750	5,920		50	50	5,780	30	5,810	2,300	110	6,240		
1930-31	Nov 1-May 31	2,010	1,410	3,420	1,390	10	1,050	0		360	360	0	210	210	1,760	10	1,760		
	Jun 1-Oct 31	140	120	260	3,750	70	300	3,440		30	30	3,390	20	3,410	200	80	6,240	2,710	34
1931-32	Nov 1-May 31	3,910	6,610	10,520	200	20	1,140	2,130	430	1,710	760	3,080	1,000	4,080	0	20	1,760		
	Jun 1-Oct 31	1,610	420	2,030	7,000	160	750	5,640		110	110	5,500	60	5,560	2,300	120	6,240		
1932-33	Nov 1-May 31	2,470	2,420	4,890	2,480	10	1,050	1,310		620	430	1,500	370	1,870	1,500	20	1,760		
	Jun 1-Oct 31	1,610	300	1,910	5,000	160	300	5,070		80	80	4,940	40	4,980	1,590	100	6,240		
1933-34	Nov 1-May 31	3,550	1,950	5,500	1,380	10	300	2,850		500	470	2,820	290	3,110	230	10	1,760		
	Jun 1-Oct 31	70	120	190	3,720	100	300	3,310		30	30	3,240	20	3,260	1,570	110	6,240	1,520	19
1934-35	Nov 1-May 31	3,870	6,840	10,710	200	20	1,140	1,980	770	1,760	700	3,040	1,030	4,070	0	10	1,760		
	Jun 1-Oct 31	1,620	260	1,880	7,000	150	750	6,000		70	70	5,860	40	5,900	2,300	140	6,240		

1/ Office studies indicate enroute accretions from sidehill runoff would equal or exceed conveyance losses Nov.-May; deliveries in June are net amounts. No direct diversions were made July-Oct.
2/ Normal years 5.0 second-feet March-May; 2.5 second-feet June-Feb. Dry years releases reduced to 2.5 second-feet and 1.0 second-foot, respectively.
3/ Maintenance release of 2 second-feet or natural flow.
4/ Under actual operation, amount diverted would be governed by amount required to fill reservoir.
e - Estimated

SUMMARY OF MONTHLY YIELD STUDY
SHADY CREEK RESERVOIR
(In Acre-Feet)

Gross storage: 5,700 acre-feet — Seasonal Yield: 5,000 acre-feet

Season	Period	Estimated natural flow at Shady Creek damsite	Gross storage at first of period	Evaporation	Demand	Spill	Deficiency in acre-feet	Deficiency in percent of total demand
1927-28	Nov.1-May 31	12,010	2,100e	40	1,000	7,370		
	Jun.1-Oct.31	310	5,700	320	4,000			
1928-29	Nov.1-May 31	3,660	1,690	40	1,000			
	Jun.1-Oct.31	350	4,310	280	4,000		220	4
1929-30	Nov.1-May 31	9,400	600	40	1,000	3,160		
	Jun.1-Oct.31	330	5,700	320	4,000			
1930-31	Nov.1-May 31	2,500	1,710	30	1,000			
	Jun.1-Oct.31	210	3,170	240	4,000		1,460	29
1931-32	Nov.1-May 31	11,680	600	40	1,000	5,540		
	Jun.1-Oct.31	740	5,700	320	4,000			
1932-33	Nov.1-May 31	4,270	2,120	40	1,000			
	Jun.1-Oct.31	530	5,340	310	4,000			
1933-34	Nov.1-May 31	3,450	1,560	40	1,000			
	Jun.1-Oct.31	210	3,970	280	4,000		700	14
1934-35	Nov.1-May 31	12,080	600	40	1,000	5,940		
	Jun.1-Oct.31	460	5,700	320	4,000			

e - Estimated

TABLE E-6

SUMMARY OF MONTHLY OPERATION STUDY OF
HAYPRESS DIVERSION, JACKSON MEADOWS RESERVOIR,
WEAVER LAKE PROJECT, AND BOWMAN RESERVOIR
(in 1,000 acre-feet)

Season	Period	Haypress Diversion: Estimated natural flow at diversion site	Haypress Diversion: Stream release for fish 1/ and spill	Haypress Diversion: Diversion to Middle Yuba River 2/	Jackson Meadows Reservoir: Estimated natural flow at damsite	Jackson Meadows Reservoir: Storage at first of period	Jackson Meadows Reservoir: Evapo-ration	Jackson Meadows Reservoir: Stream release	Milton Diversion Reservoir: Estimated natural inflow to reservoir	Milton Diversion Reservoir: Diversion to Bowman Reservoir	Milton Diversion Reservoir: Stream release for fish 3/ and spill	Weaver Lake Project: Estimated natural flow at diversion sites	Weaver Lake Project: Release to East Fork Creek for fish 4/ and spill	Weaver Lake Project: Diversion to Weaver Lake Reservoir 5/	Weaver Lake Project: Estimated natural runoff into Weaver Lake	Weaver Lake Project: Total inflow to reservoir	Weaver Lake Project: Active storage at first of period	Weaver Lake Project: Stream release for fish 6/ and spill	Weaver Lake Project: Diversion to Bowman Reservoir	Bowman and upstream reservoirs: Estimated natural flow at Bowman Dam	Bowman and upstream reservoirs: Total inflow to storage above Bowman Dam	Bowman and upstream reservoirs: Storage at first of period 7/	Bowman and upstream reservoirs: Evapo-ration	Bowman and upstream reservoirs: Diversion to Spaulding Reservoir	Bowman and upstream reservoirs: Stream release for fish 8/ and spill
1928	Jan 1-Jun 30	22.3	6.8	15.5	65.1	50.6	0.2	47.5	4.7	62.8	4.9	11.7	7.6	4.1	1.9	6.0	0.0	2.0	0.0	70.3	133.1	51.6	0.3	70.3	27.3
	Jul 1-Dec 31	2.9	2.6	0.3	3.2	68.0	0.8	22.5	0.2	21.8	1.2	0.4	0.3	0.1	0.1	0.2	4.0	0.4	3.8	7.4	33.0	86.8	0.8	81.6	0.9
1929	Jan 1-Jun 30	11.0	2.4	8.6	30.7	47.9	0.2	10.4	2.2	20.3	0.9	5.7	0.3	5.4	0.9	6.3	0.0	0.3	2.3	45.5	68.1	36.5	0.3	45.1	0.7
	Jul 1-Dec 31	4.8	1.7	3.1	7.9	68.0	0.8	22.7	0.6	25.8	0.6	1.4	0.3	1.1	0.2	1.3	3.7	0.4	4.1	12.8	42.7	58.5	0.7	81.6	0.3
1930	Jan 1-Jun 30	17.4	2.4	15.0	58.9	52.4	0.2	43.1	4.1	61.3	0.9	10.5	0.7	9.8	1.7	11.5	0.5	0.3	9.0	49.0	119.3	18.6	0.3	50.2	0.6
	Jul 1-Dec 31	3.5	3.0	0.5	2.9	68.0	0.8	23.0	0.0	22.3	1.2	0.5	0.3	0.2	0.1	0.3	2.7	0.4	2.6	5.6	30.5	86.8	0.8	81.6	0.9
1931	Jan 1-Jun 30	7.9	2.4	5.5	21.1	47.1	0.2	21.4	1.2	27.2	0.9	3.7	0.4	3.3	0.6	3.9	0.0	0.3	1.0	28.0	56.2	34.0	0.3	47.7	0.7
	Jul 1-Dec 31	2.5	1.8	0.7	2.4	46.6	0.7	45.3	0.1	45.5	0.6	0.4	0.3	0.1	0.1	0.2	2.6	0.4	2.4	5.6	53.5	41.5	0.4	79.6	0.3
1932	Jan 1-Jun 30	23.7	8.7	15.0	70.6	3.0	0.2	5.4	5.3	24.8	0.9	12.7	3.5	9.2	2.1	11.3	0.0	0.3	7.0	78.0	109.8	14.7	0.3	34.7	2.7
	Jul 1-Dec 31	4.0	3.0	1.0	3.6	68.0	0.8	23.9	0.4	24.1	1.2	0.6	0.3	0.3	0.1	0.4	4.0	0.4	4.0	9.1	37.2	86.8	0.8	81.6	0.9
1933	Jan 1-Jun 30	10.7	2.8	7.9	39.4	46.9	0.2	21.7	3.1	31.5	1.2	7.1	0.6	6.5	1.2	7.7	0.0	0.3	3.4	44.5	79.4	40.7	0.3	44.3	0.9
	Jul 1-Dec 31	3.5	2.8	0.7	3.8	64.4	0.8	22.1	0.1	21.7	1.2	0.7	0.3	0.4	0.1	0.5	4.0	0.4	4.1	13.7	39.5	74.6	0.8	81.6	0.9
1934	Jan 1-Jun 30	10.3	2.4	7.9	32.5	45.3	0.2	15.2	2.0	24.2	0.9	5.8	0.3	5.5	0.9	6.4	0.0	0.3	2.1	40.2	66.5	30.8	0.3	48.2	0.6
	Jul 1-Dec 31	2.4	1.8	0.6	3.0	62.4	0.7	31.9	0.1	32.0	0.6	0.5	0.3	0.2	0.1	0.3	4.0	0.4	3.9	7.3	43.2	48.2	0.6	77.4	0.3
1935	Jan 1-Jun 30	23.7	8.5	15.2	69.7	32.8	0.2	36.9	4.9	56.1	0.9	12.5	9.0	3.5	2.0	5.5	0.0	0.7	0.8	75.0	131.9	13.1	0.3	35.1	22.8
	Jul 1-Dec 31	3.9	3.0	0.9	2.9	65.4	0.6	21.8	0.2	21.7	1.2	0.4	0.3	0.1	0.1	0.2	4.0	0.4	3.8	8.2	33.7	86.8	0.8	81.6	0.9

1/ 8 cfs normal years and 4 cfs dry years when available
2/ Limited to 75 cfs on mean monthly basis. Conduit capacity 90 cfs
3/ 3 cfs normal years, 1.5 cfs dry years
4/ 1 cfs all year when available
5/ Limited to 50 cfs on mean monthly basis. Conduit capacity 60 cfs
6/ 1 cfs all year
7/ Minimum storage occurs March 1, 1932 (7,600 acre-feet)
8/ 2.5 cfs normal years, 1.2 cfs dry years

Notes: A dry year is one in which the April through July runoff forecast by the Department of Water Resources on May 1 for the "Bowman area - Middle Yuba River and Canyon Creek" is for less than 70,000 acre-feet.

Stream release for fish shown above do not in all cases correspond to the agreement between the California Department of Fish and Game and the Nevada Irrigation District, negotiated subsequent to completion of operation studies for this investigation. A slight reduction in deliveries to Spaulding Reservoir will result under recommendations shown in Appendix B.

Season	Period	Haypress Diversion: Estimated natural flow at diversion site	Haypress Diversion: Stream release for fish: 1/ and spill	Haypress Diversion: Diversion to Middle Yuba River2/	Jackson M…: Estimated natural flow at damsite	Jackson M…: St… at … of …
1928	Jan 1-Jun 30	22.3	6.8	15.5	65.1	5…
	Jul 1-Dec 31	2.9	2.6	0.3	3.2	6…
1929	Jan 1-Jun 30	11.0	2.4	8.6	30.7	4…
	Jul 1-Dec 31	4.8	1.7	3.1	7.9	6…
1930	Jan 1-Jun 30	17.4	2.4	15.0	58.9	5…
	Jul 1-Dec 31	3.5	3.0	0.5	2.9	6…
1931	Jan 1-Jun 30	7.9	2.4	5.5	21.1	4…
	Jul 1-Dec 31	2.5	1.8	0.7	2.4	4…
1932	Jan 1-Jun 30	23.7	8.7	15.0	70.6	
	Jul 1-Dec 31	4.0	3.0	1.0	3.6	6…
1933	Jan 1-Jun 30	10.7	2.8	7.9	39.4	4…
	Jul 1-Dec 31	3.5	2.8	0.7	3.8	6…
1934	Jan 1-Jun 30	10.3	2.4	7.9	32.5	4…
	Jul 1-Dec 31	2.4	1.8	0.6	3.0	6…
1935	Jan 1-Jun 30	23.7	8.5	15.2	69.7	3…
	Jul 1-Dec 31	3.9	3.0	0.9	2.9	6…

1/ 8 cfs normal years and 4 cfs dry years when available
2/ Limited to 75 cfs on mean monthly basis. Conduit capacity …
3/ 3 cfs normal years, 1.5 cfs dry years
4/ 1 cfs all year when available
5/ Limited to 50 cfs on mean monthly basis. Conduit capacity …
6/ 1 cfs all year
7/ Minimum storage occurs March 1, 1932 (7,600 acre-feet)
8/ 2.5 cfs normal years, 1.2 cfs dry years

TABLE E-7

SUMMARY OF MONTHLY YIELD STUDY
ENLARGED SCOTTS FLAT AND
BITNEY CORNER RESERVOIRS
(in 1,000 acre-feet)

Total Gross Storage Capacity: 70,000 acre-feet

Gross Seasonal Yield: 72,000 acre-feet

		South Yuba Canal and Deer Creek					Enlarged Scotts Flat Reservoir							Bitney Corner Reservoir							
												Deficiency								Deficiency	
Season	Period	Release from Spaulding Reservoir 1/	Enroute spills and losses	Flow through Deer Creek P.H.	Natural flow Deer Creek	Cascade and Snow Mountain Ditch diversions 2/	Total inflow	Storage first of period	Evaporation	Demand	Spill	in 1,000 acre-feet	in percent of irrigation demand	Natural inflow	Total inflow	Storage first of period	Evaporation	Demand	Spill	in 1,000 acre-feet	in percent of irrigation demand
1927-28	Oct 1-Apr 30	52.5	0.2	52.3	28.6	17.9	63.0	9.6	1.0	9.7	12.9			27.3	40.2	7.7	0.8	2.8	25.1		
	May 1-Sept 30	37.5	4.7	32.8	1.7	18.1	16.4	50.0		55.3				1.4	1.4	20.0		14.2			
1928-29	Oct 1-Apr 30	52.5	0.2	52.3	9.8	17.9	44.2	7.4	1.0	9.7				9.0	9.0	6.4	0.6	2.8			
	May 1-Sept 30	37.5	2.5	35.0	2.2	20.5	16.7	42.4		55.3		8.3	15	2.0	2.0	12.8		14.2		2.8	20
1929-30	Oct 1-Apr 30	52.5	0.2	52.3	22.1	18.5	55.9	10.4	1.0	9.7	6.8			21.2	28.0	2.5	0.8	2.8	7.8		
	May 1-Sept 30	37.5	5.5	32.0	1.9	22.9	11.0	50.0		55.3				1.8	1.8	20.0		14.2			
1930-31	Oct 1-Apr 30	51.0	0.2	52.3	8.4	18.1	42.6	4.7	1.0	9.7				7.5	7.5	6.8	0.4	2.8			
	May 1-Sept 30	30.0	2.7	27.3	0.6	20.2	7.7	37.7		55.3		19.7	35	0.7	0.7	11.9		14.2		5.1	35
1931-32	Oct 1-Apr 30	44.8	0.2	52.3	26.3	19.5	59.1	6.8	1.0	9.7	0.2			24.6	24.6	2.6	0.7	2.8	4.5		
	May 1-Sept 30	37.5	3.8	33.7	4.5	19.2	19.0	48.9		55.3				4.3	4.5	20.0		14.2	1.2		
1932-33	Oct 1-Apr 30	52.5	0.2	52.3	9.1	22.8	38.6	11.4	1.0	9.7				8.6	8.6	8.4	0.7	2.8			
	May 1-Sept 30	37.5	4.3	33.2	4.0	23.2	14.0	40.8		55.3		8.3	15	3.8	3.8	14.3		14.2		1.4	10
1933-34	Oct 1-Apr 30	52.5	0.2	52.3	10.2	20.8	41.7	6.1	1.0	9.7				9.3	9.3	4.5	0.5	2.8			
	May 1-Sept 30	37.5	2.3	35.2	0.9	23.1	13.0	38.8		55.3		8.3	15	0.9	0.9	11.4		14.2		5.1	35
1934-35	Oct 1-Apr 30	52.5	0.2	52.3	26.6	21.3	57.6	3.1	1.0	9.7	1.2			24.8	26.0	2.1	0.8	2.8	5.5		
	May 1-Sept 30	37.5	2.5	35.0	4.3	23.2	16.1	50.0		55.3	0.1			4.0	4.1	20.0		14.2	1.4		

1/ Based on assumed operation of Spaulding Reservoir after construction of Jackson Meadows Reservoir, Weaver Lake Project, Haypress diversion, and improvement of Bowman-Spaulding Canal.
2/ Based on trend of recent historical diversions.
A recommended stream release of 5 second-feet for fish (not shown) would be provided below Bitney Corner Diversion Dam. Reduction in dry years to be mutually agreed upon by project sponsor and Department of Fish and Game.

TABLE E-8

SUMMARY OF MONTHLY YIELD STUDY
EXCELSIOR DITCH AND
ANTHONY HOUSE RESERVOIR
(in 1,000 acre-feet)

Gross Storage Capacity: 11,500 acre-feet | Gross Seasonal Yield: 20,000 acre-feet

Season	Period	South Yuba River impaired flow 1/	Excelsior Ditch: Diversion	Excelsior Ditch: Conveyance losses	Excelsior Ditch: Service area demand	Excelsior Ditch: Delivery to Anthony House Reservoir	Deer Creek natural flow below Bitney Corner Reservoir	Bitney Corner Reservoir spill	Anthony House Reservoir: Total inflow	Anthony House Reservoir: Storage first of period	Anthony House Reservoir: Evaporation	Anthony House Reservoir: Demand	Anthony House Reservoir: Stream release for fish 2/ and spill	Anthony House Reservoir: Deficiency in 1,000 acre-feet	Anthony House Reservoir: Deficiency in percent of total demand
1927-28	Oct 1-May 31	370.8	10.5	1.6	0.6	8.3	10.9	25.1	44.3	7.0		4.4	35.4		
	Jun 1-Sept 30	18.2	10.7	0.8	2.1	7.8	0.3		8.1	11.5	0.6	15.6	1.2		
1928-29	Oct 1-May 31	79.8	14.7	1.6	0.6	12.5	4.2		16.7	2.2		4.4	3.0		
	Jun 1-Sept 30	16.0	12.1	0.8	2.1	9.2	0.2		9.7	11.5	0.6	15.6	0.4		
1929-30	Oct 1-May 31	186.5	12.0	1.6	0.6	9.8	9.4	7.8	26.6	4.6		4.4	15.3		
	Jun 1-Sept 30	12.3	11.4	0.8	2.1	8.5	0.3		8.8	11.5	0.6	15.6	1.2		
1930-31	Oct 1-May 31	66.4	15.0	1.6	0.6	12.8	2.8		15.6	2.9		4.4	2.9		
	Jun 1-Sept 30	8.3	8.3	0.8	2.1	5.4	0.0		5.4	11.2	0.6	15.6	0.4	0.3	2
1931-32	Oct 1-May 31	190.5	15.8	1.6	0.6	13.6	11.2	5.7	30.5	0.3		4.4	14.9		
	Jun 1-Sept 30	73.5	14.7	0.8	2.1	11.8	0.8		12.6	11.5	0.6	15.6	1.2		
1932-33	Oct 1-May 31	80.1	12.0	1.6	0.6	9.8	4.8		14.6	6.7		4.4	5.4		
	Jun 1-Sept 30	23.0	12.9	0.8	2.1	10.0	0.8		10.8	11.5	0.6	15.6	0.4		
1933-34	Oct 1-May 31	79.5	13.3	1.6	0.6	11.1	3.6		14.7	5.7		4.4	4.5		
	Jun 1-Sept 30	7.6	7.6	0.8	2.1	4.7	0.1		4.8	11.5	0.6	15.6	0.4	0.6	3
1934-35	Oct 1-May 31	264.8	13.9	1.6	0.6	11.7	11.8	6.9	31.1	0.3		4.4	15.5		
	Jun 1-Sept 30	65.6	14.2	0.8	2.1	11.3	0.1		11.4	11.5	0.6	15.6	0.4		

1/ Based on operation of upstream works including Jackson Meadows Reservoir, Weaver Lake Project, Haypress diversion, and improved Bowman-Spaulding Canal.
2/ 5 second-feet normal years, 2 second-feet dry years.

TABLE E-9

SUMMARY OF MONTHLY YIELD STUDY
ROLLINS AND COMBIE RESERVOIRS
(in 1,000 acre-feet)

Gross Storage Capacity: 72,200 acre-feet

Gross Seasonal Yield: 81,500 acre-feet

Season	Period	Drum Canal and Bear River: Release from Spaulding Reservoir 1/	Drum Canal and Bear River: Diversion to Boardman Canal	Drum Canal and Bear River: Releases from South Yuba Canal to Bear River above Boardman Canal	Drum Canal and Bear River: Lake Valley release to Drum Canal	Drum Canal and Bear River: Estimated natural flow at damsite	Rollins Reservoir: Total inflow to Rollins Reservoir	Rollins Reservoir: Storage first of period	Rollins Reservoir: Evaporation	Rollins Reservoir: Bear River Canal	Rollins Reservoir: Release to Lake Combie	Rollins Reservoir: Spill	Combie Reservoir: Natural runoff between Rollins and Combie	Combie Reservoir: Total impaired flow	Combie Reservoir: Storage first of period	Combie Reservoir: Evaporation	Combie Reservoir: Demand	Combie Reservoir: Spill	Deficiency: in 1,000 acre-feet	Deficiency: in percent of total demand
1927-28	Oct 1-May 31	204.8	20.2	0.0	2.8	136.0	323.4	38.6	0.0	185.9	17.0	94.1	58.0	169.1	6.1	-0.1	19.5	148.9		
	Jun 1-Sept 30	120.4	10.1	3.9	5.0	9.2	128.4	65.0	1.1	104.1	58.0		3.8	61.8	7.2	0.6	62.0	0.6		
1928-29	Oct 1-May 31	118.1	13.1	0.0	3.9	53.6	162.5	30.2	0.0	123.6	16.1		14.1	30.2	5.8	-0.1	19.5	15.7	15.2	19
	Jun 1-Sept 30	120.4	8.1	1.7	5.5	3.4	122.9	53.1	0.8	109.0	61.0		0.9	61.9	3.7	0.4	62.0			
1929-30	Oct 1-May 31	187.0	15.6	0.0	0.6	82.7	254.7	17.1	0.0	168.7	13.4	24.8	43.6	81.8	3.6	0.0	19.5	58.8		
	Jun 1-Sept 30	125.7	8.7	4.7	6.1	6.1	133.9	65.0	1.4	105.7	58.0		2.7	60.7	7.2	0.6	62.0			
1930-31	Oct 1-May 31	115.6	15.1	0.0	1.8	27.7	130.0	33.8	-0.1	114.7	16.1		6.9	23.0	5.3	-0.1	19.5	9.7	17.9	22
	Jun 1-Sept 30	120.4	5.2	1.9	3.4	0.4	120.9	33.1	0.6	99.9	46.0		0.0	46.0	2.7	0.4	62.0			
1931-32	Oct 1-May 31	137.6	14.8	0.0	2.9	119.6	245.3	7.5	0.0	165.2	16.3	6.7	28.1	51.1	0.7	-0.1	19.5	27.2		
	Jun 1-Sept 30	136.0	6.0	3.0	5.8	6.2	145.0	65.0	1.4	109.1	58.0	2.6	1.8	62.4	7.2	0.6	62.0	2.4		
1932-33	Oct 1-May 31	125.6	14.2	0.0	1.9	59.4	172.7	38.9	0.0	121.9	17.0	7.7	6.5	31.2	4.6	-0.1	19.5	9.2		
	Jun 1-Sept 30	136.0	8.8	3.5	5.1	2.8	138.6	65.0	1.3	109.1	58.0		0.5	58.5	7.2	0.6	62.0			
1933-34	Oct 1-May 31	160.5	13.8	0.0	5.9	53.9	206.5	35.2	0.0	145.5	17.0	14.2	11.2	42.4	3.1	-0.1	19.5	18.9		
	Jun 1-Sept 30	120.4	5.8	1.5	5.3	3.2	124.6	65.0	1.0	100.9	58.0		0.6	58.6	7.2	0.6	62.0			
1934-35	Oct 1-May 31	143.5	7.4	0.0	2.1	131.6	269.8	29.7	0.0	153.3	17.0	64.2	82.0	163.2	3.2	0.1	19.5	139.8		
	Jun 1-Sept 30	136.0	8.5	1.7	6.3	10.7	146.2	65.0	1.3	109.0	58.0	3.4	4.7	66.1	7.2	0.6	62.0	4.2		

1/ Based on an assumed operation of Spaulding Reservoir after construction of Jackson Meadows Reservoir, Weaver Lake Project, Haypress diversion, and improvement of Bowman-Spaulding Canal.

TABLE E-10

SUMMARY OF MONTHLY OPERATION STUDY
OF BEAR RIVER CANAL SYSTEM AND
CLOVER VALLEY RESERVOIR
(in 1,000 acre-feet)

Gross Storage Capacity: 32,000 acre-feet

Gross Seasonal Yield: 51,000 acre-feet

Season	Period	Bear River Canal System: Bear River Canal at intake	Bear River Canal System: Delivery to NID	Bear River Canal System: Delivery to Meadow Vista-Auburn area	Bear River Canal System: PG&E service area requirement	Bear River Canal System: Surplus flow below Wise PH	Bear River Canal System: Diversion to Clover Valley Reservoir	Bear River Canal System: Spill to American River via South Canal	Clover Valley Reservoir: Natural flow of Clover Valley Creek1/	Clover Valley Reservoir: Total inflow	Clover Valley Reservoir: Gross storage first of period	Clover Valley Reservoir: Evaporation	Clover Valley Reservoir: Demand	Deficiency: In 1,000 acre-feet	Deficiency: in percent
1927-28	Oct. 1- Apr. 30	158.8	32.0	2.3	12.0	112.5	31.4	81.1	--	31.4	5.4[e]		4.8		
	May 1- Sept. 30	131.2	25.8	17.3	58.8	29.3	15.1	14.2	--	15.1	32.0	0.5	46.3	3.8	8
1928-29	Oct. 1- Apr. 30	95.9	32.0	2.1	12.0	49.8	32.5	17.3	--	32.5	4.2		4.7		
	May 1- Sept. 30	136.7	18.7	14.0	58.8	45.2	26.3	18.9	--	26.3	32.0	0.5	46.3		
1929-30	Oct. 1- Apr. 30	140.4	21.2	2.2	12.0	105.0	25.2	79.8	--	25.2	11.5		4.7		
	May 1- Sept. 30	134.0	25.8	17.3	58.8	32.1	16.7	15.4	--	16.7	32.0	0.5	46.3	2.3	5
1930-31	Oct. 1- Apr. 30	97.9	32.0	2.1	12.0	51.8	32.5	19.3	--	32.5	4.2		4.7		
	May 1- Sept. 30	116.7	18.7	14.0	58.8	25.2	19.6	5.6	--	19.6	32.0	0.5	46.3		
1931-32	Oct. 1- Apr. 30	136.9	21.2	2.2	12.0	101.5	31.9	69.6	--	31.9	4.8		4.7		
	May 1- Sept. 30	137.4	25.8	17.3	58.8	35.5	20.1	15.4	--	20.1	32.0	0.5	46.3		
1932-33	Oct. 1- Apr. 30	96.4	32.0	2.1	12.0	50.3	31.4	18.9	--	31.4	5.3		4.7		
	May 1- Sept. 30	134.6	18.7	14.0	58.8	43.1	26.3	16.8	--	26.3	32.0	0.5	46.3		
1933-34	Oct. 1- Apr. 30	128.7	21.2	2.0	12.0	93.5	25.2	68.3	--	25.2	11.5		4.7		
	May 1- Sept. 30	117.7	18.7	14.0	58.8	26.2	20.3	5.9	--	20.3	32.0	0.5	46.3		
1934-35	Oct. 1- Apr. 30	125.0	21.2	2.2	12.0	89.6	31.2	58.4	--	31.2	5.5		4.7		
	May 1- Sept. 30	137.3	25.8	17.3	58.8	35.4	20.0	15.4	--	20.0	32.0	0.5	46.3		

1/ Considered to be negligible for purposes of this study.
e Estimated

APPENDIX F

ECONOMIC ANALYSIS

OF THE

YUBA AND BEAR RIVERS BASIN INVESTIGATION

1970-2020

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INTRODUCTION

General

The Yuba and Bear Rivers Basin Investigation encompasses an area of about 1,685,100 acres situated between the Sacramento and Feather rivers and the crest of the Sierra Nevada watershed. It extends from the Sacramento-Sutter county line and approximately from the American River on the south to South Honcut Creek and the crest of the Yuba River watershed on the north. Due to the vastness of the area and the multitude of variable conditions throughout the region, the area of investigation was divided into seven water service areas shown on Plate 4, each of which contains a series of relatively homogeneous hydrographic and economic conditions.

The most recent survey of the land area conducted by the Land and Water Use Unit classifies the land into the following categories and amounts:

	Acres	Percent of total
Irrigable	654,200	39
Urban	16,500	1
Recreational and parks	17,800	1
Forest lands	115,900	7
Nonirrigable	880,700	52
TOTAL	1.685,100	100

The irrigable land shown above represents the maximum gross area which is suitable for further development if water could be supplied to meet the demand.

The urban land is occupied by eight incorporated1/ and two unincorporated2/ sizable towns and cities. In addition, there are numerous villages and developments with a high population density, which approximate urban conditions and have been classified as urban herein. Although the latter are presently unincorporated, these will undoubtedly incorporate into towns or annex to existing cities before the end of the period of analysis used in this study.

Objectives

One of the objectives of this report is to provide an estimate of the payment capacity for irrigation water and the benefits attributed to water provided by the various proposed projects for agricultural, residential farms, municipal and industrial (urban), recreational, and hydroelectric power uses. The derived payment capacity for the respective service areas is an estimate of an area's ability to pay for project water and serves as a basis for determining the financial feasibility of a proposed project.

Urban localities and 1960 population per Bureau of Census:

1/ Auburn (5,586); Colfax (915); Grass Valley (4,876); Lincoln (3,197); Marysville (9,553); Nevada City (2,353); Roseville (13,421); Wheatland (813)
2/ Linda (6,129); Olivehurst (4,835)

Benefits from the various uses of project water are to be compared to the costs of providing water for the respective uses to determine the economic justification of potential future projects.

Another objective is to estimate the supply of water which will be required to satisfy the anticipated demand based on projected growth. This phase of the analysis is intended to determine the quantity of water which will enable the areas of origin to continue their economic growth without being restrained due to a short supply of water.

Scope

To attain these objectives, the investigation included the accumulation of pertinent field data by personal interviews with prominent authorities in various fields of planning and advisory personnel within the respective counties. Data provided in the annual reports submitted by the Yuba, Sutter, Nevada, and Placer counties' agricultural commissioners were used as the primary basis for projecting the yields and prices of the selected representative crops for the agricultural development in the respective areas. Reference was also made to the statistical data provided by the California Crop and Livestock Reporting Service as supporting information and for basic data not provided by local sources.

The economic analysis was based on a 50-year period, divided into decades, beginning in 1970 and extending to the year 2020. The cost-price relationship for the five years of

1952-1956, inclusive, was used as the base period for computing the payment capacity and benefit for each representative crop.

The projections made for each of the service areas herein are based on value judgments and the assumptions stated later in the text. These judgments and assumptions take into consideration (1) statistical data and other information presented by various state and county agencies; (2) field studies conducted in the initial phase of the investigation; and (3) economic analyses applied to the specific service areas.

Benefits attributable to the cost savings in pumping ground water in the Valley Floor Service Area under project conditions were not evaluated. The data necessary to make a reliable analysis were not available in sufficient detail to correlate the ground water supply with the projected uses in the respective areas. Also, the analysis is not intended to imply that urban benefits are not justifiable in specific portions of the Valley Floor Service Area, especially in Placer County. A more detailed analysis of ground water conditions regarding the safe yield in a specific area may indicate additional project benefits are justified.

Designation of Service Areas

As mentioned previously, the area of investigation has been divided into seven service areas. The valley floor was further divided into three major subareas. Hereafter, these areas will be considered independently as follows:

A. Valley Floor Service Area

1. Valley Floor Subarea No. 1 (North of Yuba River)

2. Valley Floor Subarea No. 2 (Yuba River to Bear River)

3. Valley Floor Subarea No. 3 (South of Bear River)

a. Placer County

b. Sutter County

B. Brownsville Service Area

C. San Juan Ridge Service Area

D. Grass Valley Service Area

E. Auburn Foothills Service Area

F. Colfax Ridge Service Area

G. Mountain Service Area

These service areas were established on the basis of similar physical aspects such as climate, topography, and soils, as well as the location with respect to the source of water supply.

THE PROPOSED SERVICE AREAS

Physical Characteristics

The physical characteristics of the proposed service areas are briefly discussed in the following paragraphs. These physical aspects are climate, topography, and soils.

Climate.[1/] The climate throughout the Valley Floor Service Area is characterized by dry, hot summers, mild spring and fall seasons, and cool, wet winters. There are approximately 300 frost-free days beginning some time in February and continuing through November. Occasional frosts occur during December and January, but severe freezes and prolonged cold spells are rare. The average annual rainfall is about 19 inches, largely from rainstorms during the late fall,winter, and early spring months.

In the foothills and lower mountainous service areas, the same general pattern of climatic conditions prevails. The summer months are slightly cooler than the valley floor area and are generally dry except for occasional ineffective showers from the latter part of June through the first part of September. The spring and fall seasons

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1/ Summarized from the "Office Report on the Climatology of the Yuba-Bear Area" by the Climatology Group, Delta Branch, Department of Water Resources, May 1961.

are also cooler than the valley floor, but there is a considerable increase in the amount of rainfall, especially above the 1,000-foot contour. Rains beneficial to the growth and development of various crops are normal during the spring and fall months.

The winters vary considerably according to elevation. In the areas below the 1,000-foot contour, snow storms of any magnitude are rare, although frosts are frequent. The growing season normally exceeds 250 days and approaches 270 days in the lower regions. Above the 1,000-foot contour, snow and colder weather increases in frequency and intensity with increased elevation. Historical data indicate the average annual temperature decreases about three degrees for each 1,000-foot increase in elevation. The growing season ranges from 250 days at the lower elevation to about 150 days in the higher areas near the 2,650-foot elevation. Rainfall amounts to about 25 inches at the 500-foot contour and increases to as much as 50 inches at about 2,700 feet elevation.

Topography.[1/] The topography of the valley floor area varies from smooth on the recent alluivial soils predominant in the western portion to gently undulating on the older hardpan terrace soils in the eastern part. As a general rule, these lands can be developed for irrigation

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1/ Summarized from an office report by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

with a minimum of leveling to permit flood irrigation of the various crops utilizing the soils.

The next major soil zone is the foothill area adjacent to the valley floor and encompasses the lands on the western portion of Brownsville, Grass Valley, and Auburn Foothills Service Areas. The land within this zone lies roughly between the 200 and the 1,000-foot contour and is predominantly classified as hilly to mountainous according to the slope of the surface. Leveling to permit flood irrigation is virtually impossible as the soils are usually shallow. However, flood irrigation is a general practice on these lands and is accomplished by spreading the water, which accumulates in the low outlets, with small dikes or levees.

The upland zone is comprised of the lands generally between the 1,000 and 2,500-foot contour. The terrain is mostly hilly and mountainous. The serviceable lands are mostly those adjacent to the streams through the small valleys and plateaus interspersed in the mountains. The general topography in this zone limits the use of the land to permanent crops such as pasture and deciduous orchards.

The mountainous zone includes the area above the 2,500-foot contour to the crest of the Sierra Nevada mountains. Serviceable lands in this zone are scattered on the long, gently sloping areas on top of numerous ridges except for a few small plateaus near the streams. The slope and the geographic location of these lands relegate their use basically to irrigated pasture.

Soils.[1/] The valley floor soils are of recent and older alluvial origin formed from outwash materials from the streams which transect the area. The immature alluvial soils generally located adjacent to the Feather, Yuba, and Bear Rivers are coarse to medium-textured capable of growing a wide variety of crops. The older valley floor soils range from the low, smooth basin soils to the gently undulating hardpan series. The latter soils are mostly fine-textured and shallow hardpan which limit their use to shallow rooted crops such as rice, field crops, and irrigated pasture.

Soils in the second major zone are primarily residual material formed on granitic parent rock. The surface area is somewhat sandy and friable underlain with clay loam subsoils up to depths of 3 to 5 feet where the granitic parent material is encountered. Although many rock out-croppings are apparent, the soils are relatively deep near the protruding rocks and drain quite rapidly except in the low depressed areas. These soils are capable of supporting deciduous orchards such as pears, plums, and peaches as well as irrigated pasture.

1/ Summarized from an office report by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

The upland soils are mostly residual derived from basic and metavolcanic rock material. The Auburn series located near Camp Far West Reservoir has a yellow clay subsoil which makes it best suited for shallow rooted crops. This soil series ordinarily has many rock outcroppings. Generally, the best uses of the upland soils are to grow pastures and deciduous orchards such as pears, plums, and possibly apples.

Soils in the mountainous zone are typically deep, somewhat rocky, and clay loam in texture. Forests occupy many parcels of these lands which are under one of the many timber, range, or watershed management programs. Some scattered parcels of pasture adjacent to the various streams are irrigated by means of wild flooding. Due to the climatic factors and the dispersion of the serviceable lands, the present use of the land seems to be the best utilization of the soils. Consequently, the demand for additional water service is virtually nonexistent now and in the foreseeable future and has not been considered in this report.

Development in the Areas

The economic development in the Yuba and Bear Rivers Basin began about 1845, when early settlers planted grain to support the initial population influx. The discovery of gold in 1848 fostered a major surge of emigrants, which was the basis for further agricultural, population, transportation, and market development to the present time.

Agriculture. Early agriculture on the Valley Floor consisted largely of grain and livestock enterprises stimulated by the spontaneous demand of the gold rush era. These were virtually all dry land operations until about the end of the century when diminishing profits and the development of more satisfactory pumping plants gave impetus to increased irrigation especially after 1910. The irrigated acreage increased throughout the ensuing years until about 120,000 acres were brought under irrigation. Rice, pasture, and deciduous fruits and nuts account for the major portion of the total irrigated acreage with field, truck, and alfalfa crops accounting for a smaller but important portion of the remainder. In addition to the irrigated acreage there are about 52,000 acres of dry-farmed hay, grain, fallow, and idle land. Most of the latter acreage can be irrigated with a nominal additional capital outlay.

Agriculture also represents a major factor in the development of the industry within the study area. During the harvest season, about 100 plants are in operation to can, dehydrate, dry, pack, and store the various fruit, nut, rice, and other crops grown in the study area. The concrete pipe manufactured locally is used in the irrigation systems to serve the crops. Several lumber reprocessing and molding plants as well as sand and gravel plants also contribute to the local economy.

Agriculture in the Brownsville Service Area has been basically a livestock economy beginning with the first development in the mid-1800's. Although water for gold mining was diverted into the area as early as the 1850's, there was no conscientious effort to irrigate crops until the Browns Valley Irrigation District was established in 1888. The latest estimates indicate the irrigated acreage to be about 3,000 acres of pasture and about 470 acres of olives. The agricultural production is marketed mostly through the various outlets in the nearby towns such as Marysville and Yuba City.

The historical development in the San Juan Ridge Service Area began with the discovery of gold, which was mined by large hydraulic operations supplied by a network of ditches along the ridge. Irrigated agriculture consisting mostly of pasture for cattle was encouraged after the hydraulic mining was virtually stopped by the California Debris Commission Act of 1893. The ditch owners tried to sell the entire system to the farmers, but the offer was refused. The ditches were abandoned and, subsequently, slides and cave-ins rendered the system useless. In the intervening years, feeble attempts have been made to rejuvenate the ditches but have failed due to the shortage of funds. A few acres of orchard, mostly apples, have been planted and irrigated with a certain degree of success. However, these plantings were abandoned after water service was discontinued. At present, about 400 acres of pasture receive a partial supply of irrigation water from the various mountain streams which transect the ridge.

In the initial years of settlement, agriculture in the Grass Valley Service Area was of minor importance and was basically a cattle grazing operation. As the mining industry declined, irrigation of crops from the old ditch system assumed greater importance. In August 1921, the Nevada Irrigation District was formally organized and has provided water to the area in the ensuing years. The latest estimates indicate there are about 10,700 acres irrigated, of which about 9,600 acres are pasture. Although there are a few market outlets for agricultural commodities, forestry-oriented industry continues to predominate in importance. In recent years, light industrial operations have shown an interest in establishing plants in the area.

The development of agriculture in the Auburn Foothills Service Area has been more oriented to deciduous orchards, which, records indicate, were planted as early as 1846. At that time, two emigrant ranchers planted some peach and almond seeds to pioneer commerical orchards in the Sacramento Valley. These enterprises flourished from the sale of products to the miners. The stage route and later the railroads which transect the area gave further impetus to the expansion of the acreage which continues to predominate the agricultural economy today. There are about

17,200 acres of orchards and about 14,100 acres of irrigated pasture according to the latest estimates. Although some of the fruit is transported to processing and packing plants in the valley, a large portion of the crops is marketed through numerous local outlets.

The agricultural economy in the Colfax Ridge Service Area paralleled the growth of that in the Grass Valley Service Area. The first major interest was gold mining beginning about 1850. However, as the mining declined, agriculture increased in importance. At first, the fruit was sold locally, but with the installation of the railroad, produce was packed and shipped out of the area. Current estimates indicate about 450 acres of deciduous orchard and 170 acres of pasture land are being irrigated with water purchased from the Pacific Gas and Electric Company.

Population. Historical data indicate the population in the Valley Floor Service Area increased from about 34,600 in 1950 to about 49,700 in 1960. This increase has been attributed to the emigration from other states and a slight shift of population within the state. Of this population, about 38,400 or 77 percent are estimated as urban dwellers. The projected population for the year 2020 amounts to 335,500, of which 302,700 or 90 percent will be classified as urban. This was based on recent trends evident in the various metropolitan areas within the service area and the potential growth with an adequate labor force.

Although the population in the Brownsville Service Area increased from about 830 in 1930 to 1,770 in 1940, the increases recorded in the subsequent decades have been less. The 1960 population was estimated to be 2,220, a gain of 30 over the estimate for 1950. Of this total, less than 400 are classified as urban dwellers. By 2020, the total population in the area is projected to be 10,000, of which 3,000 will be in the urban areas and 7,000 in rural areas. This distribution which depicts larger rural growth was made after considering the limited transportation facilities in conjunction with the small labor market and the remoteness of the area in respect to market outlets.

Population in the San Juan Ridge Service Area reached its maximum in the past 30 years in 1940 when an estimated 830 people resided in the area. Since then, the number declined to about 400 people as of 1960. Although there are no incorporated towns within the area, about 100 live in small villages which resemble urban conditions. Ultimate growth in the area is anticipated to provide about 5,000 people by the year 2020. The urban portion is foreseen to be about 1,000 with the remainder distributed largely in small noncommercial agricultural holdings. The projected total population was very restrained because the area is very remote and, except for a small amount of lumbering, does not have any industry to support the populace. During the 1800's, there was a large influx of gold miners, but with high mining costs and the controlled price of gold, this industry is not likely to be reactivated in the foreseeable future.

Between 1930 and 1940, the population in the Grass Valley Service Area increased about twofold from about 8,500 to 17,300. However, the population has increased only slightly in the intervening years until there were about 18,400 as of 1960. The distribution is estimated to be about 10,700 in the urban areas and 7,700 live in the rural areas. This was projected as increasing to a total of 57,250 in the service area with 32,200 urban and 25,050 rural residents. Although the growth in the past years has been relatively slow, the future appears more favorable especially since the county instituted a planning commission to encourage industry to enter the area. A few light industrial plants have already been built and are in operation. The lumber mills have curtailed operations for relatively short intervals, but due to their proximity to a long-range supply and good access to market outlets, their permanency and possible expansion appear favorable in the future.

The Auburn Foothills Service Area has had a steady increase in population beginning at about 13,000 people in 1930 to about 31,700 people in 1960. Of the latter figure, about 19,500 are estimated to reside in urban areas and 12,200 in rural areas. The 2020 projected population totalled

178,000 people of which 130,300 are presumed to be urban and 47,700 in the rural areas. This area has a very good potential for future development as urban and small non-commerical farms. These types of development are already apparent in the most southern portion of the service area especially along the Old Auburn-Folsom Road. The eastern portion of the Sunset City development (near Rocklin) is also located in the area.

The Colfax Ridge Service Area has increased slowly yet steadily in population from about 2,400 in 1930 to about 4,000 in 1960. The latter figure is estimated to be about 2,000 urban and 2,000 in the rural areas. The population is anticipated to increase to about 10,900 by 2020 with about 7,000 classified as urban and the remainder in the rural areas. The disproportionate growth in urban to rural growth is based on a somewhat limited supply of water which will probably discourage rural development. However, the area is enticing to those who prefer a mountainous climate and scenic views in conjunction with good access to more populated centers.

Transportation. The Valley Floor Service Area has very good transportation facilities throughout the area. U. S. Highway 99E is the major route which provides easy access to Marysville on the north and Sacramento on the south. Numerous all-weather roads transect the area and make connections with other major routes. The Western Pacific and the Southern Pacific railroads run through the area in a general north-south direction.

The Brownsville, San Juan Ridge, and Grass Valley Service Areas consist wholly of a network of state routes interconnected with series of well maintained county roads. Although facilities are somewhat limited, they provide very good accessibility to markets for the various agricultural and forestry products grown in the area. Some of the roads in the higher elevations are subjected to snowstorms, but these are infrequent and do not interfere seriously with the movement of the commodities to market.

The Auburn Foothills and Colfax Ridge Service Areas are served by the main east-west line of the Southern Pacific Railroad and U. S. Highway 40, which is an all-weather route. Numerous state and county roads transect the areas to provide very good access to other major shipping points and markets in the valley. Additional roads and freeways are planned to accommodate the population increase which is already apparent in the southern portion of the Auburn Foothills area.

Markets. Local markets serve as a major outlet for many of the agricultural commodities grown in the area. In addition, there is easy access to major markets in the larger cities in California as well as the more distant out-of-state areas.

There are three commercial feedlots plus other minor operations which serve as an outlet for the beef cattle produced in the area. Finished cattle can be slaughtered in two packing houses in the immediate vicinity or shipped to other packing houses within two hours' driving time. These feeding lots also provide a market for the hay and grain grown in the service area. In addition to the beef enterprise, there are numerous dairies, which require hay and grain in their operations, largely in the valley floor and foothill areas.

The deciduous fruit and nut crops are marketed through about 20 packing sheds located throughout the area of investigation, wherever sufficient quantity of the various crops warrant the operation. There are about seven large processing plants in addition to the fresh market outlets. Numerous other packing sheds and processing plants are located near the growing areas and provide additional market outlets.

The processors of fruit are also capable of handling tomatoes as the operations are planned to utilize the trained labor and specialized equipment to the best advantage. The melons are largely hauled to packing sheds located in and near the Woodland and Yuba City areas.

Rice, which has been considered separately from the major crop categories, is marketed mainly through grower cooperatives. Dryers and storage facilities in and near the service areas are easily accessible to the producer. Exports have been accomodated through the Port of Stockton. Facilities are now available for trade out of the Port of Sacramento via the Deep Water Channel.

Existing Water Entities

Water, primarily for irrigation purposes, is provided to the various defined areas through 15 water and irrigation districts and companies. Besides these agencies, there are five reclamation districts adjacent to the major streams in the valley floor portion of the study, which provide water for irrigation in their respective areas.1/ The pertinent data and historical information on these agencies are presented in Chapter III of this bulletin.

1/ Valley Floor Subarea No. 1 - Reclamation District No. 10
Valley Floor Subarea No. 2 - Reclamation Districts Nos. 784 and 817
Valley Floor Subarea No. 3 - Reclamation Districts Nos. 1000 and 1001

EVALUATION OF PROJECT CONDITIONS

Assumptions

The unforeseeable changes which are certain to occur in our dynamic economy require the establishment of certain assumptions on which the analysis of a long-term project is based. These assumptions define the value judgments made from a knowledge and review of the present and historical trends and conditions which are associated with the respective study areas. For the purpose of these projections and economic analysis, the following general assumptions are made:

1. The price-cost relationship for agricultural commodities will resemble those prevailing for the period of 1952-56.

2. A relatively high level of employment and consumption will prevail during the period of the economic analysis.

3. Population will continue to grow, increasing to an estimated 420 million in the United States; 56 million in California by 2020.

4. Irrigation water in sufficient quantity and of adequate quality will be available by 1970 at a cost that does not prohibit irrigation development as projected herein.

5. Land, as a scarce resource, will increase in importance and the various service areas considered herein will at least sustain the present comparative advantage with respect to crops grown in competing areas.

6. The future economic development in the various service areas will attain, as a minimum, the level of the projected growth.

7. There will be no disruption of world trade by the outbreak of major hostilities or by imposing trade barriers not presently in existence.

8. Production controls presently imposed by the government on the selected representative crops projected in this study will eventually be withdrawn or modified to the extent that they will not restrict future development to a greater degree than anticipated in making the projections.

9. The prevailing supply of ground water, present surface diversion, and project-developed water will contribute their designated yields to the total available water in the respective areas.

10. The efficiency in the use of irrigation water will increase through improved irrigation practices.

11. Urban land use will follow the current pattern with the cities spreading onto lands deemed suitable for subdivision and industrial purposes with consideration given to existing transportation routes and accessibility of land.

12. Water, under nonproject conditions, will be diverted from the least intensive use to more intensive uses to meet the demands imposed by increasing population.

13. Virginia Ranch and enlarged Camp Far West Projects will be in operation by 1970.

Land Use

The projected land use as presented in Tables I-A through I-F herein was made through the conjunctive effort of personnel from the Land and Water Use Unit and the Economics Unit. Present and historical land use data served as the basis for projecting the anticipated land use throughout the period of analysis. The uses were also intensified during the period of analysis to represent market conditions and the availability of suitable soils for the various representative crops. Consequently, those areas having a comparative advantage over any of the others were projected to develop more completely and more rapidly than those with a lesser advantage.

Land Classification. Land in the various service areas was segregated into the classes as prescribed by departmental standards. This classification data served as a basis for projecting the crop pattern and for determining the water requirements by decades for the respective areas.

Urban Use. The land classified as urban includes the areas occupied by cities, towns, and other significant urban-associated areas included in the standard land use legend. These include urban residential, commercial, industrial, or military uses. Scattered residential areas must have at least one home per two acres and have at least five homes in a group in order to qualify as urban developed. There are approximately 16,500 acres mapped as urban land within the area of investigation.

Residential Farm Use. Since World War II, there has been an obvious trend of people moving onto small agricultural plots surrounding urban development and other more remote areas. This encroachment has definitely assumed a major role in the economic development in these service areas and, therefore, is considered as a special category in this analysis of the water requirements and the benefits of the respective areas. Due to the nature of these small holdings, they are referred to as residential farms. These may be defined as avocational farms or agricultural enterprises which are intended to provide to the resident an additional income or benefit in supplement to another source of livelihood.

The trend to this type of development has increased for three basic reasons. One reason is the aesthetic value to the owner who wishes to reside in a rural atmosphere and still have easy access to urban facilities such as shopping, entertainment, and/or professional pursuits. A second reason for the increase number of these units is speculation and a hedge against inflation. The tremendous increase in the State's postwar population stimulated the demand for housing near the urban centers. This demand has and is now being met by large tract developments in the fringe area occupied in many cases by residential farm units. Consequently, any prudent land investment in these areas would provide an investor a substantial profit in a relatively short time. Thirdly, the income derived from the crops grown on the plots serves to supplement retirement payments or the income of seasonally employed people.

Agricultural Use. The difference in water requirements, benefits, and payment capacities among crops makes forecasting or projecting of a crop pattern an important and essential consideration. The crop projections in the various areas reflect consideration of the existing crop pattern, climatic adaptability, the comparative advantage or least disadvantage of the area, location of markets, capital requirements, and the pertinent assumptions noted previously.

Under project conditions, the rate of agricultural development is anticipated to be fairly rapid in the initial years of service as the best lands are brought into production. Maximum development in the Yuba and Sutter Counties portion of the Valley Floor Service Area is projected to occur by about 1990 and decline thereafter as urban and residential farm uses encroach on the agricultural area. The agricultural development in the foothill region, and on the valley floor in Placer County is projected less rapidly throughout the study to correspond to the difference in the comparative advantage inherent to the respective areas.

In addition to increasing the irrigated area, the intensive crop acreage was increased basically by shifting the better land from extensive uses, within the limits imposed by the soil characteristics and the estimated demand for the products. Double-cropped acreage was projected in the Valley Floor Service Area only, as the growing season in the other areas is prohibitive for any significant amount of double-cropping. The projected land use by decades for the respective service areas is presented in Table I of this appendix.

Recreational Use. An analysis of the recreational use was made for two reservoirs in the study area, namely, Marysville and New Bullards Bar. Benefits attributable to these reservoirs were derived on the basis of the Trice-Wood method from data provided by the Recreation Unit of the Delta Branch. The lands projected to recreational uses do not encroach on the other major uses.

Water Requirements

Water requirements were derived by decades for agriculture, residential farms, and urban uses. The point of reference was at the farm headgate for agricultural and residential farm uses and at the treatment plant for urban uses.

Urban. Present and future urban water requirements were estimated to average about 260 gallons per capita per day or about 0.29 acre-feet annually according to data compiled by the Land and Water Use Unit. The total urban water requirements were derived by multiplying the daily per capita requirements and the projected population for each respective decade. The consumptive use was estimated to be 50 percent of the required amount.

Residential Farms. Total water requirements for residential farms were calculated at the rate of three acre-feet per irrigated acre. The general household uses were assumed to be served from this requirement. Water presently delivered by canal is generally of adequate quality for the various household uses and, in some cases, is even consumed. However, most of the drinking water is bottled and purchased from the various companies serving the areas from regular established routes.

Agriculture. Irrigation water requirements for the principal crops were derived by the Blaney-Criddle method. The consumptive use of applied water for the respective crops served as the base to determine the delivery demand. The amount consumed was divided by the efficiency factors pertaining to the land class and the crop pattern projected thereon. The estimated water requirements by crop category are summarized in Table II. In the Valley Floor Service Area, the maximum estimated water requirement is attained about 1990 in Yuba and Sutter counties. Thereafter, the requirement declines as the areas approach full development accompanied with shifts from agriculture to residential farms and urban uses.

Water requirements in the foothill, mountain, and Placer County valley floor service areas are expected to increase at a decreasing rate as the areas approach full development and as the supply of water diminishes. Although continued growth is projected in the foothill and mountainous areas through the last decade, the decade ending at 2020 is foreseen as the last years of any major increase in agricultural acreage, due to the limited water supply. Thereafter, the desirable lands will be diverted to the more intensive uses of residential farms and urban development. The valley floor area of Placer County has potential for further development in the submarginal areas if demand for the crops develops. The data for the projected water requirements are presented in Table III of this appendix.

Crop Prices and Yields

The historical prices and yields reported by the Sutter, Yuba, Placer, and Nevada County Commissioners for the five-year base period 1952-56 inclusive, served as the primary guide for selecting the data projected in the payment capacity and benefit derivations. Data from the California Crop and Livestock Reporting Service were used when county information was incomplete or missing altogether. Information obtained in field interviews of county officials, farmers, and other individuals familiar with the local agriculture was also utilized in selecting the yields and prices applied to the crop budget calculations.

The prices projected in the analysis represent the net amount received for a specified unit of a commodity at the delivery point. The production costs to the point of delivery were included in the analysis of payment capacity and benefit for each representative crop. Adjustments were made in a few instances when historical data had been abnormally high or low due to short supply from weather conditions during the base period or some other phenomenon which distorted the average price from the historical trend.

The projected yields were based on the historical averages with slight adjustments made according to the type of land projected for a particular crop. In a few instances, the yields were projected higher than the historical data indicated when it was known that dry land yields had distorted the average or when a higher yielding variety had been introduced since the base years.

Production Costs

All variable and fixed costs attributed to the production of an agricultural commodity were computed on the basis of the unit costs prevailing for 1952-56. An allowance of 10 percent of the gross income was made to the management charge as an incentive to undertake a particular enterprise in which there is the element of risk involved. The variable costs are the operating expenses incurred during the production period and include marketing costs to the point where the producer relinquishes title of ownership. The fixed costs are those expenses which accrue independently of the usual production expenses incurred annually in the normal course of producing an agricultural commodity. Except for the interest and taxes on the land, the amount of the average fixed costs is dependent on the economic unit of each particular crop.

Payment Capacity for Irrigation Water

Definition. Payment capacity is that portion of the gross income from crops grown under irrigated conditions, which remains after deducting all farm production costs including the imputed cost of the operator's labor and an allowance for a management charge. This represents the maximum ability of the bulk of the water uses to pay for irrigation water delivered to the farm headgate.

Estimated Payment Capacities. The payment capacity for each of the service areas is contingent upon the accuracy of the 1990 crop projections for the respective service areas. With the exception of the San Juan Ridge Service Area, the projected acreage is largely a matter of increasing the total irrigated acreage devoted to the existing crop pattern. In the San Juan Ridge area, historical information, crop adaptability, and the anticipated high cost of irrigation water were the basis for the crop projections.

The payment capacity for the representative crops and the major crop categories within the respective service areas are shown in Table IV. The weighted average payment capacity per acre and per acre-foot as of 1990 for each service area are briefly summarized as follows:

Service area	Weighted average payment capacity	
	Per acre ($)	Per acre-foot ($)
Valley Floor:		
Subarea No. 1	35.60	9.05
Subarea No. 2	35.00	9.35
Subarea No. 3	33.80	8.20
Placer County	28.60	6.65
Sutter County	36.20	8.95
Brownsville	15.80	4.65
San Juan Ridge1/	45.60	19.80
Grass Valley	17.30	5.45
Auburn Foothills	36.80	12.40
Colfax Ridge	40.50	17.70

1/ Dependent upon major change from the present agricultural development.

BENEFITS

General

Benefits, used to evaluate the economic justification of water resource projects, were determined for irrigation of agricultural and residential farms and for urban and recreational uses. The derivation of the benefits from hydroelectric power is also presented. Water available under nonproject conditions was expected to be diverted from the least intensive use such as agriculture to more intensive uses such as residential farms and urban within the limits of the present total supply. The present supply consists of the safe ground water yield, surface diversions, and present project water including that from an enlarged Camp Far West Reservoir and the Virginia Ranch Dam project, and about 3,300 acre-feet available to the Yuba County Water District from Oroville-Wyandotte Irrigation District.

Irrigation Benefits

Definition. Direct irrigation benefits are the net increase in the returns to land and to water. This serves as a means to measure the economic gains attributable to project water. The mathematical derivation is accomplished by substracting all farm costs, inclusive of a management charge but exclusive of the interest on the land investment and water costs, from the gross income per acre.

Evaluation of Irrigation Benefits. The irrigation benefits are based on the projected land use for each decade and the average benefits per acre for the major crop category. The average benefit per acre is a weighted average based on the crop pattern projected in the respective areas as of 1990. The benefits for each decade are reduced by the interest to the dry land investment to derive the net benefit for each area. On the valley floor the interest was estimated to amount to $7.50 per acre and in the other areas $5.00 per acre.

The results of these calculations are summarized for each of the service areas in Table V of this appendix. The weighted average benefit per acre and the present worth are presented below:

Service area	Average annual benefit (Per acre) ($)	Present worth	
		Per acre ($)	Per acre-foot ($)
Valley Floor			
Subarea No. 1	50.70	17.90	4.65
Subarea No. 2	47.90	17.90	4.75
Subarea No. 3	43.30	14.90	3.60
Placer County	36.20	10.60	2.50
Sutter County	51.80	20.00	4.95
Brownsville	24.20	7.70	2.45
San Juan Ridge 1/	54.90	21.70	9.40
Grass Valley	20.70	6.30	2.00
Auburn Foothills	41.10	12.10	4.20

1/ Dependent upon major change from the present agricultural development.

Residential Farms

Definition. The benefits attributable to the use of project water on residential farms are considered to be a composite value based on the anticipated uses of water on the unit. The water used to irrigate the agricultural portion is expected to provide an average benefit to the landowner in the amount of the derived average agricultural benefit for the same area. Similarly, the portion utilized as domestic water is projected at the same average benefit as the water provided for urban uses.

Evaluation of Residential Farm Benefits. The present water supply is adequate to meet the projected demands for residential farms in all areas except the Brownsville and the San Juan Ridge service areas. The Brownsville Service Area benefits from residential farms average $45.00 per acre. The average present worth amounts to $10.70 per acre and $3.55 per acre-foot of water. In the San Juan Ridge area, the benefit per acre is calculated to be $57.00. On a present worth basis, this amounts to $16.60 per acre or $5.50 per acre-foot. The data are presented in detail in Table VI.

Municipal and Industrial Benefits

Definition. The benefits of municipal and industrial water are the gains derived from the use of water for domestic, industrial, commercial, and public urban uses. In this analysis, only the benefits attributed to direct users of project water are evaluated.

Evaluation of Municipal and Industrial Benefits.

The demand for municipal and industrial water is expected to usurp the available water supply, under nonproject conditions, from residential farms and agricultural uses. The present supply is adequate to meet the projected urban demand in all the service areas except the San Juan Ridge Service Area. In the latter case, it is not economical to divert water from agricultural to urban uses under non-project conditions as the present total water supply consists of small quantities from many diverse sources. The cost of assembling the present supply to a common distribution center capable of serving the urban population is prohibitive and, consequently, other sources were considered in evaluating the monetary benefits attributable to municipal and industrial uses. The analysis is based on the concept of the least costly alternative source limited by vendability. The costs of two alternative sources were analyzed to determine the least costly alternative. In both instances, the average cost of untreated water delivered to a central distribution center amounts to about $38.00 per acre-foot. This price was comparable to the quotations of three districts1/ nearby and ultimately accepted as the benefit of municipal and industrial water in the San Juan Ridge area.

1/ The 1961 prices to urban consumers as submitted to the Districts Securities Commission were (per month);
Nevada Irrigation District - $3.19
Oroville Wyandotte Irrigation District - $3.50 (minimum)
El Dorado Irrigation District (untreated) - $3.50

Recreation Benefits

Definition. Recreation benefits consist of the increase in recreation uses and corresponding values which can be attributed to conditions arising from the development of the project.

Evaluation of Recreation Benefits. Within the scope of this report, a monetary value of recreation benefits has been derived for two projects; namely, Marysville and New Bullards Bar reservoirs. Based upon the method used by the department[1/], the value of recreation benefits due to the construction of the two projects is estimated at about $29,000,000 and $1,500,000, respectively (Tables VIII and IX). The net increase in recreation visitation atttributable to these projects occurs in both camping and day use. The majority of use at both sites is estimated to be day use (under 8 hours). For the proposed Marysville Reservoir, Table VIII indicates total benefits of over $9,000,000 and $19,000,000

1/ The present method used by the Department of Water Resources is derived from "Measurement of Recreation Benefits," Trice, Andrew H., and Wood, Samuel C., Land Economics, a quarterly Journal of Planning, Housing, and Public Utilities Volume XXXIV, No. 3, August 1958, pages 195-207. In brief, this method is based upon the theoretical concept of consumer surplus. On the basis of mileage cost, a monetary value is derived which indicates a relative worth per visitor day of water-associated recreation attributable to a given water resource project. The value for this report, based upon this method, is an estimated $2.15 per camper-day. The department has set a minimum of $0.50 per visitor-day for day use activities and this is used in lieu of lower value derived by the foregoing method.

for camping and day use, respectively, and for New Bullards Bar Reservoir, Table IX indicates benefits of about $900,000 and $600,000 for camping and day use.

Evaluation of economic benefits accruing to other reservoirs in the proposed plans for development was outside the scope of this investigation.

Hydroelectric Power Benefits

Definition. The usual measure of benefits attributable to hydroelectric power is the alternative cost of producing equivalent power in a modern steam-electric plant.

Evaluation of Hydroelectric Power Benefits. The values of capacity and energy used in estimating power benefits were based on costs for a 975,000 kilowatt steam plant consisting of three 325,000 kilowatt units. A lifetime capacity factor of 51.4 percent, or 4,500 hours operation annually, was assumed. A station heat rate of 9,400 BTU per net kilowatt-hour was used.

For the purposes of determining the cost of power from an alternative stream-electric plant, the steam investment cost was estimated at $135 per net kilowatt. The 230 kilovolt stepup substation was estimated to cost $8.68 per net kilowatt. Fixed charges on the steam-electric production facilities and transmission lines to load center were estimated as follows:

Fixed Charges	Production plant	Substation	Lines
	Percent of plant investment		
Interest	6.00	6.00	6.00
Depreciation	0.90	0.90	0.34
Interim replacements	0.35	0.35	0.10
Insurance	0.25	0.25	0.10
Taxes	5.96	5.96	5.96
Total	13.46	13.46	12.50

The annual cost of fuel stock investment, no load fuel, fixed operating and maintenance costs and the administration and general expenses were estimated at $3.34 per net kilowatt.

The transmission distance from a steam plant to the theoretical 230 kilovolt load center was assumed to be 30 miles. The distance from load center to the Yuba-Bear development was estimated to be approximately 100 miles.

The cost of fuel was based on the cost to the utilities assuming the use of gas at a cost of 35.6 cents per thousand cubic feet and oil at a cost of $2.38 per barrel, including tax and transportation charge. It was assumed that the fuel supply to the steam plants consisted of 67 percent natural gas and 33 percent fuel oil. The BTU content of the fuel burned was assumed to be 6,392,000 BTU per barrel for oil and 1,100 BTU per cubic foot for gas. On this basis the composite cost of fuel was 34 cents per million BTU, equivalent to $2.17 per barrel of oil.

In recognition of the outstanding advantages of hydro plants, including reliability and operating flexibility, a credit of five percent of the at-market value of capacity was applied.

On the foregoing bases the alternative cost of steam power at load center was used as the value of hydro power at load center. This value was translated to the 230 kilovolt bus at the powerplants by adjustment for transmission costs and losses. The two part rate of the value of the Yuba-Bear power development is derived in Table X, and estimated to be:

Capacity component:	\$23.30 per kilowatt year of dependable capacity
Energy component:	3.0 mills per kilowatt-hour

SUMMARY AND CONCLUSIONS

General

Each of the respective service areas has the potential for further development provided an adequate supply of suitable water is available. If given the water, the individual areas will undoubtedly develop as rapidly and to the extent that economic conditions will permit. Throughout the periods of development, the economy can be expected to advance through a gradual shift from extensive, less profitable to more intensive and higher profit-yielding uses. After attaining full land development, this process is expected to continue at varying rates according to the comparative advantages inherent to the respective service areas.

The initial year for water service from any of the projects under analysis was established as 1970 in consideration of the time necessary for project authorization and construction. An allowance was made for additional build-up of the respective services in the intervening years, but in general, the major portion of the irrigable land will be developed by the end of the third decade. The marginal lands were projected into use in the latter decades as the water supply and the anticipated market conditions warrant development. The latter factor also served as the basis for changing the general crop pattern to the more intensive and higher income crops.

Residential farms are expected to constitute a significant portion of the demand for water service in many of the study areas. These units have attained a major role in the development especially on the fringe of urban areas and in other more remote areas. The water requirements for these units were computed at the rate of three acre-feet per acre including the water supply for home use.

Urban areas consist of incorporated municipalities and unicorporated residential developments having at least one home per two acres of land and at least five homes in a group. Data obtained recently by the Land and Water Use Unit indicate the average water requirement in these areas to be about 260 gallons per capita per day. This represents approximately 0.29 acre-foot annually and was the amount used to compute the water requirements for the respective service areas. In the valley floor areas, urban encroachment was projected wholly on irrigable lands as there is no nonirrigable land available in the vicinity of this type of development. In the foothill and mountainous areas, urban encroachment was proportioned between lands classified as irrigable and nonirrigable at the rate of 80 and 20 percent, respectively.

Recreational benefits were evaluated for two projects, the Marysville and New Bullards Bar reservoirs, on the basis of the modified Trice-Wood method. The facilities were assumed to be built and in operation by

1970 for New Bullards Bar and by 1980 for Marysville Reservoir. Total benefits based on the projected recreational uses amount to $3,776,600 for New Bullards Bar, which at present worth is $1,540,000. The corresponding benefits for Marysville Reservoir amount to a total of $90,622,500, which at present worth is $29,086,000. These data are based on a derived value of $2.15 per camper-day and $0.50 per visitor-day for both reservoirs.

The benefits attributable to hydroelectric power were based on the alternative cost of producing equivalent power in a modern privately financed steam-electric plant. On the basis of this method, the benefits were estimated to be $23.30 per kilowatt year of dependable power, and 3.0 mills per kilowatt hour.

Valley Floor Subarea No. 1

Subarea No. 1 is bound on the west by the Feather River and extends to the east to about the 200-foot contour. It is bound on the north by South Honcut Creek and on the south by the Yuba River. Marysville is the only incorporated municipality in the area. The 1960 population within the area was estimated to be about 11,400 people of which 9,700 were living in urban areas. By 2020 the total population is expected to increase to 55,000 and the urban to 49,500. The remainder of the population will reside in the rural areas or on residential and commercial farms.

Of the total 60,032 acres within the area, about 53,570 acres are considered to be irrigable. The presently irrigated area of 28,850 acres is expected to increase to 47,000 acres by 1990 provided sufficient water is available beginning in 1970. As the economy of the area grows, the agricultural acreage is expected to diminish as it shifts to residential farm and urban uses. By 2020, the agricultural acreage is expected to be 42,700 acres; residential farm uses will require water for 2,600 acres; and the urban area will cover 6,490 acres. Based on the 1990 crop pattern, the payment capacity was computed as $35.60 per acre, or about $9.05 per acre-foot.

The benefits from supplying additional water to the area were attributed to agricultural uses as the present supply is adequate to meet the demands imposed by the projected residential farm and urban uses. These net benefits amounted to $20,865,000 or the equivalent average of $50.70 per acre. The total present worth of benefits were computed to be $7,381,000 which averaged about $17.90 per acre.

Valley Floor Subarea No. 2

The area designated Subarea No. 2 is bound on the west by the Feather River and extends eastward to about the 200-foot contour. The northern boundary is the Yuba River and the southern boundary follows the Bear River. The 1960 population was estimated to be about 16,000 people exclusive of about 3,400 service personnel stationed at Beale

Air Force Base. The urban centers (Linda, Olivehurst, and Wheatland) are estimated to have about 14,500 people and the remainder reside in the rural areas. By 2020, the total population is expected to increase to 92,000 with 82,800 living in urban areas. The remaining 9,200 people will live on residential and commercial farms.

The gross area consists of 91,964 acres (excluding 17,795 acres in Beale Air Force Base) of which 78,800 acres are classified as irrigable. At present, about 33,400 acres are irrigated. The area is projected to maximum agricultural development of 67,600 acres by the year 2000 and then diminishing to 61,100 acres by 2020. Residential farms will irrigate 4,750 acres and urban development will occupy 11,590 acres. The payment capacity for the 1990 projected crop pattern was computed as $35.00 per acre or about $9.35 per acre-foot.

The benefits attributed to agricultural uses for the study period amount to $82,770,000 or $47.90 per acre. The present worth of the benefits total $30,894,000, which averages $17.90 per acre. Benefits from other uses were not claimed as the present supply is sufficient to meet the projected residential farm and urban demand as well as part of the agricultural growth.

Valley Floor Subarea No. 3a

This area extends from the western Placer county line to about the 200-foot contour on the east. The southern boundary is the Placer-Sacramento county line and the area extends northward to the Bear River. Sheridan and Roseville are the principal municipalities,but developments such as. Sunset City will have a marked impact on the area. The 1960 population is estimated as 16,650 of which 14,000 are classified in the urban areas. The population for 2020 is expected to be 160,000 with 151,600 living in the urban areas. The remaining population will reside on residential and commercial farms.

The irrigable portion of the gross 105,300 acres amounts to 97,500 acres. The latest estimates indicate there are about 11,900 acres in irrigated crops at present. The irrigated agriculture is expected to increase throughout the study period, reaching 60,600 acres by 2020. The irrigated portion in residential farms is expected to amount to 5,500 acres and urban encroachment will claim 19,500 acres. The full development of the irrigable lands was not foreseeable during the study period due to the marginal nature of the various soils which predominate in the area. The payment capacity for the crop pattern projected in the year 1990 amounts to $28.60 per acre or $6.65 per acre-foot.

The total net benefits from agricultural uses amounts to $41,465,000 for the study period. This is an average of $36.20 per acre. The present worth of the total benefits is computed as $12,167,000 and averages $10.60 per acre.

Valley Floor Subarea No. 3b

This subarea is located in the eastern part of Sutter County between the Sacramento-Feather rivers and the Sutter-Placer county line. It extends from the Sacramento-Sutter county line on the south to the Bear River on the north. There are no incorporated towns in the area. However, the concentration of people in and near the villages of Pleasant Grove, Nicolaus, and East Nicolaus resembles urban conditions and may serve as the nucleus for future development. Only about 200 people of the 1960 population of 2,250 were classified as urban dwellers. During the initial years of the study period, the increase in urban population is expected to be small, but substantial increases are foreseen in the latter years as the urban complex expands from the Sacramento metropolitan area. By 2020, the urban population is projected to be 18,800 people out of a total of 25,000 expected in the area.

The gross area in Subunit 3b amounts to 84,524 acres and contains 81,780 irrigable acres. About half of the area (43,300 acres) is presently irrigated. This is expected to increase to the maximum of about 75,200 acres by the end of the second decade after water is available. Thereafter, more intensive uses are expected to encroach on the agricultural portion until by 2020 the irrigated acreage will amount to 71,700 acres. Residential farms will irrigate an additional 2,500 acres and urban development will occupy about 3,000 acres. The estimated payment capacity based on the 1990 projected crop pattern is $36.20 per acre and $8.95 per acre-foot of water.

The total benefits attributed to irrigation water were computed to be $49,535,000 which is an average of $51.80 per acre. The present worth of the total benefits amount to $19,153,000 for an average of $20.00 per acre. No benefits were claimed for residential farm and urban types of development as the present water supply is adequate to meet these requirements as well as a partial supply for irrigated agriculture.

Brownsville Service Area

The western boundary of the Brownsville Service Area is adjacent to the eastern boundary of the Valley Floor Subarea No. 1 near the 200-foot contour. It extends eastward between the Yuba River and South Honcut Creek to approximately the 3,000-foot contour on the crest of the Oregon Hills. There are no major urban developments within the area; however, the communities of Browns Valley, Dobbins, and Challenge are centers of population capable of future urban development. The 1960 population was estimated as 2,220, of which about 380 were considered to reside in the urban-type settlements. By 2020, the population is expected to be about 10,000 people with 3,000 in the urban areas and the remainder in the rural areas largely on residential farms.

The gross area contains 128,957 acres inclusive of 41,760 irrigable acres. The presently irrigated area amounts to 3,470 acres, consisting of 3,000 acres of pasture and the remainder in olives. The irrigated agriculture is projected to utilize the most suitable land until there are 13,700 acres irrigated in 2020. The development of residential farm units is already apparent and this use is estimated to require water for as much as 5,130 acres. Urban-type residents are expected to occupy 770 acres. The payment capacity, based on the projected crop pattern for 1990 amounts to $15.80 per acre and $4.65 per acre-foot.

The net benefits were computed on the basis of development under conditions with the Virginia Ranch Project in operation. The yield of this project will satisfy nearly all the projected demand in the lower portion of the Brownsville Service Area. Thus, benefits accrue, in varying degrees of magnitude, from two major uses of water and amount to the following:

Use	Total	Per acre	Present worth	
			Total	Per acre
Agriculture	$3,345,000	$24.20	$1,064,000	$ 7.70
Residential farms	1,880,000	45.00	447,000	10.70
TOTAL	$5,225,000		$1,511,000	

San Juan Ridge Service Area

This service area is located on the ridge bound by the Middle and South Yuba rivers and extends eastward from the confluence of the two streams to approximately the 3,000-foot contour. There are no incorporated towns in the area although the small communities of North San Juan and French Corral were once thriving mining towns with about 10,000 population. Presently there are about 400 people residing in the area. The urban population is estimated to be about 120 with 280 living in rural areas. The 2020 population is expected to be 5,000 people, of which 1,000 will live in the urban area and 4,000 in the rural area.

The total area contains 37,632 acres, including 6,600 irrigable acres. Only about 400 acres of pasture are currently irrigated and this does not receive a full supply of water. Due to the high cost of developing new water supplies, the projected agricultural development was modified drastically from the initial period and throughout the study period. In selecting a crop pattern reference was made to historical information and climatically adapted crops. The agricultural development is projected to be about 1,500 acres consisting of 1,300 acres of deciduous orchard and the remainder in irrigated pasture. Residential farms are already being promoted and appear to be the best potential use of the land. This use is projected as irrigating about 2,460 acres. Urban development is expected to occupy 300 acres.

The payment capacity for irrigation water was computed to be $45.60 per acre, which averages $19.80 per acre-foot for the crop pattern projected for 1990.

The present water supply is not enough to meet the projected demand for any of the principal uses and, therefore benefits accrue from each use. The benefits attributable to project water are:

Use	Total	Per acre	Present worth Total	Present worth Per acre
Agriculture	$2,980,000	$54.90	$1,178,000	$21.70
Residential farms	2,490,000	57.00	726,000	16.60
Urban	100,700	1/	23,000	2/
TOTAL	$5,570,700		$1,927,000	

1/ The average per acre-foot is $38.00
2/ The average present worth is $8.50 per acre-foot

The present worth of benefits for residential farms and urban uses is a smaller proportionate part of the total because most of the increase occurs in the latter decades.

Grass Valley Service Area

The western boundary of the Grass Valley Service Area is adjacent to the eastern boundary of the Valley Floor Subarea No. 2 at approximately the 200-foot contour. It extends eastward into the mountainous areas to roughly the longitude passing through the town of Colfax. The southern boundary is the Bear River which is the Nevada-Placer county line and the northern boundary is the South

Yuba River. The area encompasses the incorporated towns of Grass Valley and Nevada City and smaller urban-type settlements such as Chicago Park, La Barr Meadows, Rough and Ready, Cedar Ridge, Union Hill, and Peardale. The 1960 population was estimated to be about 18,400 people, of which about 10,700 lived in urban areas and the remainder in rural areas. By 2020 the population is expected to increase to 57,250, with 32,200 in urban and 15,050 in rural areas.

The gross area amounts to 253,170 acres including about 15,900 acres within the boundaries of Beale Air Force Base. The irrigable acreage is estimated to be about 133,760 acres and the presently irrigated acreage is 10,720 acres. By 2020 irrigated agriculture is projected to 33,800 acres. Although pasture represents the major agricultural use of irrigation water throughout the study period, its importance is expected to decline after about 2010 as water becomes more costly. The potential development of residential farms is very good as is indicated by current trends in many of the valley areas. This use is projected as irrigating about 17,800 acres of land by 2020. Urban facilities are expected to occupy 8,260 acres. The payment capacity for irrigation water was computed to be $17.30 per acre or $5.45 per acre-foot, based on the projected crop pattern for 1990.

The benefits were attributed wholly to the expanded agricultural economy as the present available water supply is sufficient to meet the demand arising from increased population. The total of these benefits amounts to $14,990,000 for the 50-year period and averages $20.70 per acre. The present worth of the total benefits is $4,573,000, which averages 6.30 per acre.

Auburn Foothills Service Area

The western boundary of the Auburn Foothills Service Area corresponds roughly to the 200-foot contour and is adjacent to the eastern portion of Valley Floor Subarea No. 3a, Placer County. The area extends eastward to the American River and an arbitrary boundary defined by the Bear River Canal. The Sacramento-Placer county line is the southern boundary and the Bear River is the northern boundary. The area encompasses Lincoln and Auburn, both incorporated, and the unincorporated towns of Rocklin, Loomis, Penryn, Newcastle, Bowman, and Clipper Gap. The population for 1960 was estimated at 31,700 people, consisting of 19,520 in the urban areas and the remainder in the rural regions. Present trends indicate the total population will increase to 178,000 people by 2020, of which 130,300 will be in urban areas and the remainder rural.

The gross area contains 174,649 acres inclusive of about 127,120 acres of irrigable land. There are approximately 31,830 acres irrigated at present, about equally divided between pasture and deciduous orchard crops. Due to the many towns already present in the area and its proximity to Sacramento, residential farms are expected to be the major type of development. By 2020, as much as 26,350 acres will require water service and 27,700 acres will be devoted to urban uses. The payment capacity based on the 1990 crop pattern is calculated to be $36.80 per acre and $12.40 per acre-foot.

The present water supply is adequate for the projected urban and residential farm uses and also to provide irrigation water to sustain some agricultural development to about 2020. The total benefits attributable to project water have been determined to be $36,250,000 which represents an average of $41.10 per acre. The corresponding present worth amounts to $10,714,000 and $12.10, respectively.

Colfax Ridge Service Area

The western boundary of the Colfax Ridge Service Area follows along the arbitrary boundary corresponding to the Bear River Canal and the ridges separating the Bear and American rivers, and Coon Creek. It extends eastward along the ridge to a vertex near Emigrant Gap. However, the major portion of the area of effective demand was considered to be west of an arbitrary north-south line just east of the town of Baxter. The northern boundary follows the Bear River, and on the south, approximately the North Fork of the American River. The urban centers included are Applegate, Weimar, Colfax, Gold Run, Monte Vista, Dutch Flat, Alta, and Emigrant Gap, which contain an estimated total population of 2000 people. By 2020, the projected population amounts to 10,900 people, of which 7,200 are expected to be in urban areas and 3,700 in rural areas.

The gross land area amounts to 60,894 acres, inclusive of about 9,300 irrigable acres. The presently irrigated area of 630 acres is composed of 460 acres of deciduous orchard and 170 acres of pasture. The irrigated area in agricultural crops was projected to utilize 2,100 acres by 2020. However, the favorable transportation facilities and the rugged mountain beauty are expected to foster the development of residential farms. This use is projected as irrigating as much as 2,100 acres. The derived payment capacity for the 1990 crop pattern amounts to $40.50 per acre, or $17.70 per acre-foot.

No benefits were claimed for the projected development as there is sufficient water to meet the projected demand for the study period.

TABLE 1-A

PRESENT AND PROJECTED LAND USE[1]
VALLEY FLOOR SERVICE AREA - TOTAL
(Acres)

Land Use	Present[2]	1970	1980	1990	2000	2010	2020
		Decade					
Irrigated agriculture							
Deciduous orchard	15,310	24,000	31,300	38,000	43,500	48,300	51,000
Subtropical orchard	320	800	1,100	1,400	1,800	2,100	2,500
Miscellaneous truck	5,690	10,000	12,100	13,500	14,400	14,500	14,850
Miscellaneous field	7,240	16,000	20,900	25,300	26,300	27,200	28,000
Alfalfa	8,490	14,800	15,400	13,460	10,660	6,160	3,040
Rice	47,420	43,000	50,800	56,600	59,400	61,700	63,500
Pasture	34,770	44,420	64,640	75,040	75,540	76,040	73,210
Double crop	200	(2,600)	(4,000)	(5,500)	(6,600)	(7,500)	(8,500)
Total Net Irrigated	119,440	153,020	196,240	223,300	231,600	236,000	236,100
Residential farms	3/	5,480	6,770	9,080	11,010	13,170	15,350
Urban	7,620	9,950	13,270	17,840	23,480	30,750	40,590
Total Water Service Area	127,060	168,450	216,280	250,220	266,090	279,920	292,040
Total Nonwater Service Area	214,750	173,360	125,530	91,590	75,720	61,890	49,770
Gross Area	341,810	341,810	341,810	341,810	341,810	341,810	341,810

1/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch, DWR.
2/ Compiled by the Land and Water Use Unit, Delta Branch, DWR.
3/ Included in the agricultural crop data above.

TABLE I-A - 1

PRESENT AND PROJECTED LAND USE [1]
VALLEY FLOOR SUBAREA NO. 1[2]
(Acres)

Land Use	Present[3]	Decade 1970	1980	1990	2000	2010	202
Irrigated agriculture							
Deciduous orchard	5,100	8,000	9,000	10,000	11,000	11,500	12,0
Subtropical orchard	60	400	500	600	800	900	1,0
Miscellaneous truck	2,670	3,000	3,000	2,600	2,400	2,300	2,2
Miscellaneous field	1,260	3,000	3,200	3,500	3,700	3,900	4,0
Alfalfa	1,650	2,000	1,600	1,400	1,200	1,100	1,0
Rice	10,140	9,000	9,200	9,400	9,600	9,800	10,0
Pasture	8,030	9,500	15,400	19,500	17,100	14,900	12,4
Double crop	200[4]	(600)	(700)	(900)	(1,000)	(1,100)	(1,20)
Total Net Irrigated	29,110	34,900	41,900	47,000	45,800	44,400	42,7
Residential farms	[5]	1,000	1,110	1,380	1,770	2,230	2,6
Urban	1,070	1,560	2,160	2,950	3,870	5,040	6,4
Total Water Service Area	30,180	37,460	45,170	51,330	51,440	51,670	51,7
Total Nonwater Service Area	29,850	22,570	14,860	8,700	8,590	8,360	8,24
Gross Area	60,030	60,030	60,030	60,030	60,030	60,030	60,03

1/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch, DWR.
2/ Area between South Honcut Creek and the Yuba River.
3/ Compiled by the Land and Water Use Unit, Delta Branch, DWR.
4/ Grain and grain hay which is not necessarily double cropped.
5/ Included in the agricultural crop data above.

TABLE I-A - 2

PRESENT AND PROJECTED LAND USE 1/
VALLEY FLOOR SUBAREA NO. 2 2/
(Acres)

Land Use	Present 3/	Decade 1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Deciduous orchard	5,100	8,000	11,000	14,000	16,000	18,000	19,000
Subtropical orchard	190	400	600	800	1,000	1,200	1,500
Miscellaneous truck	1,820	2,500	2,600	2,700	2,800	2,900	3,000
Miscellaneous field	2,820	3,500	3,900	4,300	4,600	4,800	5,000
Alfalfa	2,800	5,000	4,800	4,400	4,000	2,150	900
Rice	9,430	9,000	9,600	10,200	10,800	11,400	12,000
Pasture	13,010	13,200	23,700	29,700	28,400	24,250	19,700
Double crop	---	(600)	(800)	(1,000)	(1,200)	(1,400)	(1,600)
Total Net Irrigated	35,170	41,600	56,200	66,100	67,600	64,700	61,100
Residential farms	4/	700	900	1,600	2,340	3,340	4,750
Urban	2,940	3,770	4,720	5,800	7,300	9,200	11,590
Total Water Service Area	38,110	46,070	61,820	73,560	77,240	77,240	77,440
Total Nonwater Service Area	53,850	45,890	30,140	18,400	14,720	14,720	14,520
Gross Area	91,960	91,960	91,960	91,960	91,960	91,960	91,960

1/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch DWR.
2/ Area between Yuba and Bear Rivers. Includes small portion of Sutter and Placer Counties north of the Bear River.
3/ Compiled by the Land and Water Use Unit, Delta Branch, DWR.
4/ Included in the agricultural crop data above.

TABLE 1-A - 3

PRESENT AND PROJECTED LAND USE 1/
VALLEY FLOOR SUBAREA NO. 3 SUMMARY 2/
(Acres)

Land Use	Present 3/	Decade 1970	1980	1990	2000	2010	2
Irrigated agriculture							
Deciduous orchard	5,110	8,000	11,300	14,000	16,500	18,800	20
Subtropical orchard	70	---	---	---	---	---	-
Miscellaneous truck	1,200	4,500	6,500	8,200	9,200	9,300	9
Miscellaneous field	3,160	9,500	13,800	17,500	18,000	18,500	19
Alfalfa	4,040	7,800	9,000	7,660	5,460	2,910	1
Rice	27,850	25,000	32,000	37,000	39,000	40,500	41
Pasture	13,730	21,720	25,540	25,840	30,040	36,890	41
Double crop	---	(1,400)	(2,500)	(3,600)	(4,400)	(5,000)	(5
Total Net Irrigated	55,160	76,520	98,140	110,200	118,200	126,900	132,
Residential farms	4/	3,780	4,760	6,100	6,900	7,600	8,
Urban	3,610	4,620	6,390	9,030	12,310 5/	16,510 5/	22,
Total Water Service Area	58,770	84,920	109,290	125,330	137,410	151,010	162,
Total Nonwater Service	131,050	104,900	80,530	64,490	52,410	38,810	27,
Gross Area	189,820	189,820	189,820	189,820	189,820	189,820	189,

1/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch, DWR.
2/ Area south of the Bear River.
3/ Compiled by the Land and Water Use Unit, Delta Branch, DWR.
4/ Included in the agricultural crop data above.
5/ Includes 2,100 acres of land classified as nonirrigable for agriculture.

TABLE I-A - 3a

PRESENT AND PROJECTED LAND USE 1/
VALLEY FLOOR SUBAREA NO. 3 - PLACER COUNTY 2/
(Acres)

Land Use	Present 3/	1970	1980	1990	2000	2010	2020
		Decade					
Irrigated agriculture							
Deciduous orchard	1,010	1,000	2,300	3,000	3,500	3,800	4,000
Subtropical orchard	40	---	---	---	---	---	---
Miscellaneous truck	0	500	1,000	1,200	1,200	800	600
Miscellaneous field	620	1,500	3,800	6,500	8,000	9,000	10,000
Alfalfa	620	800	1,000	500	0	0	0
Rice	4,060	5,000	8,000	12,000	13,000	13,500	14,000
Pasture	5,530	6,900	9,000	11,800	18,300	26,600	32,000
Double crop	---	(200)	(600)	(1,100)	(1,500)	(1,800)	(2,100)
Total Net Irrigated	11,880	15,700	25,100	35,000	44,000	53,700	60,600
Residential farms	4/	3,300	4,200	4,900	5,200	5,400	5,500
Urban	3,500	4,500	6,200	8,600	11,400 5/	14,900 5/	19,500 5/
Total Water Service Area	15,380	23,500	35,500	48,500	60,600	74,000	85,600
Total Nonwater Service Area	89,920	81,800	69,800	56,800	44,700	31,300	19,700
Gross Area	105,300	105,300	105,300	105,300	105,300	105,300	105,300

1/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch, DWR.
2/ Area south of the Bear River in Placer County.
3/ Compiled by the Land and Water Use Unit, Delta Branch, DWR.
4/ Included in the agricultural crop data.
5/ Includes 2,100 acres of land classified as nonirrigable for agriculture.

TABLE I-A - 3b

PRESENT AND PROJECTED LAND USE 1/
VALLEY FLOOR SUBAREA NO. 3 - SUTTER COUNTY 2/
(Acres)

Land Use	Present 3/	Decades 1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Deciduous orchard	4,100	7,000	9,000	11,000	13,000	15,000	16,000
Subtropical orchard	30	---	---	---	---	---	---
Miscellaneous truck	1,200	4,000	5,500	7,000	8,000	8,500	9,000
Miscellaneous field	2,540	8,000	10,000	11,000	10,000	9,500	9,000
Alfalfa	3,420	7,000	8,000	7,160	5,460	2,910	1,140
Rice	23,790	20,000	24,000	25,000	26,000	27,000	27,500
Pasture	8,200	14,820	16,540	14,040	11,740	10,290	9,060
Double crop	---	(1,200)	(1,900)	(2,500)	(2,900)	(3,200)	(3,600)
Total net irrigated	43,280	60,820	73,040	75,200	74,200	73,200	71,700
Residential farms	4/	480	560	1,200	1,700	2,200	2,500
Urban	110	120	190	430	910	1,610	3,010
Total water service area	43,390	61,420	73,790	76,830	76,810	77,010	77,210
Total nonwater service	41,130	23,100	10,730	7,690	7.710	7,510	7,310
Gross area	84,520	84,520	84,520	84,520	84,520	84,520	84,520

1/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch, Department of Water Resources.
2/ Area south of the Bear River in Sutter County.
3/ Compiled by the Land and Water Use Unit, Delta Branch, Department of Water Resources.
4/ Included in the agricultural crop data above.

TABLE I-B

PRESENT AND PROJECTED LAND USE[1/]
BROWNSVILLE SERVICE AREA
(Acres)

Land Use	Present[2/]	1970	1980	1990	2000	2010	2020
		Decades					
rrigated agriculture							
Deciduous orchard	---	190	500	720	880	980	1,000
Subtropical	470	670	1,040	1,400	1,690	1,870	2,000
Pasture	3,000	4,460	7,780	9,420	10,000	10,470	10,700
otal net irrigated	3,470	5,320	9,320	11,540	12,570	13,320	13,700
esidential farms	3/	1,815	1,940	2,285	3,085	4,280	5,130
rban 4/	260	265	290	330	430	610	770
otal water service area	3,730	7,400	11,550	14,155	16,085	18,210	19,600
otal nonwater ervice area	125,230	121,560	117,410	114,805	112,875	110,750	109,360
ross area	128,960	128,960	128,960	128,960	128,960	128,960	128,960

/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch, Department of Water Resources.
/ Compiled by the Land and Water Use Unit, Delta Branch, Department of Water Resources.
/ Included in the agricultural crop data above.
/ Urban utilization assumed to occur on 80 percent of the serviceable lands.

TABLE I-C

PRESENT AND PROJECTED LAND USE 1/
SAN JUAN RIDGE SERVICE AREA
(Acres)

Land Use	Present 2/	1970	1980	1990	2000	2010	20
		Decade					
Irrigated agriculture							
Deciduous orchard	10	450	1,000	1,170	1,180	1,190	1,
Pasture	400	350	320	300	300	300	[illegible]
Total net irrigated	410	800	1,320	1,470	1,480	1,490	1,
Residential farms	3/	270	400	660	1,020	1,560	2,
Urban 4/	130	130	140	160	180	230	[illegible]
Total water service area	540	1,200	1,860	2,290	2,680	3,280	4,
Total nonwater service area	37,090	36,430	35,770	35,340	34,950	34,350	33,
Gross area	37,630	37,630	37,630	37,630	37,630	37,630	37,

1/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch Department of Water Resources
2/ Compiled by the Land and Water Use Unit, Delta Branch, Department of Water Resources.
3/ Included in the agricultural crop data above.
4/ Urban utilization assumed to occur on 80 percent of the serviceable land.

TABLE I-D

PRESENT AND PROJECTED LAND USE 1/
GRASS VALLEY SERVICE AREA
(Acres)

Land Use	Present 2/	1970	1980	1990	2000	2010	2020
		Decade					
rrigated agriculture							
Deciduous orchard	1,060 3/	1,800	4,000	5,600	6,600	6,950	7,300
Miscellaneous truck and field	40	---	---	---	---	---	---
Pasture	9,620	11,800	19,350	24,260	26,030	26,630	26,500
otal net irrigated	10,720	13,600	23,350	29,860	32,630	33,580	33,800
esidential farms	4/	6,495	7,190	8,720	10,720	13,700	17,790
rban 5/	2,960	3,100	3,610	4,450	5,500	6,780	8,260
otal water service area	13,680	23,195	34,150	43,030	48,850	54,060	59,850
otal nonwater service area	239,490	229,975	219,020	210,040	204,320	199,110	193,320
ross area	253,170	253,170	253,170	253,170	253,170	253,170	253,170

/ Estimated jointly by the Land and Water Use and Economic Units, Delta Branch, Department of Water Resources.
/ Compiled by the Land and Water Use Unit, Delta Branch, Department of Water Resources.
/ Includes 20 acres of subtropical orchard
/ Included in the agricultural crop data above
/ Urban utilization assumed to occur on 80 percent of the serviceable land.

TABLE I-E

PRESENT AND PROJECTED LAND USE 1/
AUBURN FOOTHILLS SERVICE AREA
(Acres)

Land Use	Present 2/	1970	1980	1990	2000	2010	2020
Irrigated agriculture							
Deciduous orchard	16,870	16,570	16,910	17,330	17,830	18,300	18,64
Subtropical orchard	280	480	870	1,580	2,450	3,120	3,60
Miscellaneous field	320 3/	200	600	1,300	2,000	2,500	2,70
Alfalfa	230	200	500	1,000	1,500	1,800	2,00
Pasture	14,130	15,020	16,210	17,940	19,300	20,410	20,36
Total net irrigated	31,830	32,470	35,090	39,150	43,080	46,130	47,30
Residential farms	4/	13,320	15,820	18,670	21,550	24,010	26,35
Urban 5/	4,360	6,050	8,760	12,600	16,880	21,040	27,70
Total water service area	36,190	51,840	59,670	70,420	81,510	91,180	101,35
Total nonwater service area	138,460	122,810	114,980	104,230	93,140	83,470	73,30
Gross area	174,650	174,650	174,650	174,650	174,650	174,650	174,65

1/ Estimated jointly by the Land and Water Use and Economics Units, Delta Branch, Department of Water Resources.
2/ Compiled by the Land and Water Use Unit, Delta Branch, Department of Water Resources.
3/ Includes 140 acres of miscellaneous truck crops and 50 acres of grain.
4/ Included in the agricultural crop data above.
5/ Urban utilization assumed to occur on 80 percent of the serviceable lands.

TABLE I-F

PRESENT AND PROJECTED LAND USE 1/
COLFAX RIDGE SERVICE AREA
(Acres)

Land Use	Present 2/	Decade 1970	1980	1990	2000	2010	2020
rrigated agriculture							
Deciduous orchard	460	450	480	520	560	580	600
Pasture	170	200	220	230	440	480	500
'otal net irrigated	630	650	700	750	1,000	1,060	1,100
esidential farms	3/	1,290	1,540	1,750	1,940	2,000	2,100
rban 4/	530	610	730	910	1,110	1,330	1,530
'otal water ervice area	1,160	2,550	2,970	3,410	4,050	4,390	4,730
'otal nonwater ervice area	59,730	58,340	57,920	57,480	56,840	56,500	56,160
ross area	60,890	60,890	60,890	60,890	60,890	60,890	60,890

/ Estimated jointly by the Land and Water Use and Economics Units, Delta Branch, Department of Water Resources.
/ Compiled by the Land and Water Use Unit, Delta Branch, Department of Water Resources.
/ Included in the agricultural crop data above.
/ Urban utilization assumed to occur as 80 percent of the serviceable lands.

TABLE II-A

ESTIMATED IRRIGATION EFFICIENCY AND
UNIT IRRIGATION REQUIREMENT
VALLEY FLOOR SERVICE AREA

Crop	Consumptive Use (Ac.Ft.)/(Acre)	Irrigation Efficiency in Percent					Irrigation Requirements in Acre Feet Per Acre				
			Projected 2/					Projected 2/			
		Present	A	B	C	D	Present	A	B	C	D
Alfalfa	2.3	65	75	70	70	--	3.5	3.1	3.3	3.3	--
Pasture	2.6	60	70	60	70	60	4.3	3.7	4.3	3.7	4.3
Deciduous orchard	1.6	55	70	65	70	60	2.9	2.3	2.5	2.3	2.7
Subtropical orchard	1.7	55	70	65	70	60	3.1	2.4	2.6	2.4	2.8
Miscellaneous field	1.6	65	75	70	--	--	2.5	2.1	2.3	--	--
Rice	4.1	65	--	70	--	--	6.5	--	6.0	--	--
Miscellaneous truck 3/	2.2	75	75	65	--	--	2.9	2.9	---	--	--
Double crop	0.3	60	60	60	60	60	0.5	0.5	0.5	0.5	0.5

1/ Developed by the Land and Water Use Unit of the Delta Branch, DWR.
2/ Letters refer to the following land class groupings:

(A) V (C) H, M, Hr

(B) Vr, Vl, Vp, Vh (D) Hp, Hpr, Mp, Mr, Mpr

3/ Weighted at approximately 85 percent tomatoes and 15 percent melons

ESTIMATED IRRIGATION EFFICIENCY AND
UNIT IRRIGATION REQUIREMENT
FOOTHILL SERVICE AREAS 1/

Crop	Consumptive Use (Ac.Ft./Acre)	Irrigation Efficiency in Percent					Irrigation Requirements in Acre Feet Per Acre				
			Projected 2/					Projected 2/			
		Present	A	B	C	D	Present	A	B	C	D
Alfalfa	2.3	65	75	65	70	--	3.5	3.1	3.5	3.3	--
Pasture	2.2	50	70	60	70	60	4.4	3.1	3.7	3.1	3.7
Deciduous orchard	1.3	55	70	65	70	60	2.4	1.9	2.0	1.9	2.2
Subtropical orchard	1.4	55	70	65	70	60	2.5	2.0	2.2	2.0	2.3
Miscellaneous field	1.0	60	70	65	--	--	1.7	1.4	1.5	--	--

1/ Developed by the Land and Water Use Unit of the Delta Branch, DWR.
2/ Letters refer to the following land class groupings:

(A) V (C) H, M, Hr

(B) Vr, Vl, Vp, Vh (D) Hp, Hpr, Mp, Mr, Mpr

TABLE III-A - 1

AVERAGE ANNUAL WATER REQUIREMENTS
VALLEY FLOOR SUBAREA NO. 1
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	14,800	8,160	18,600	12,800	20,930	14,400	23,240	16,000	25,560	17,600	26,780	18,400	28,000	19,200
Subtropical orchard	200	110	1,040	680	1,300	850	1,560	1,020	2,080	1,360	2,340	1,530	2,600	1,700
Miscellaneous truck	7,470	5,600	8,700	6,600	8,700	6,600	7,540	5,720	6,960	5,280	6,670	5,060	6,520	4,950
Miscellaneous field	3,160	2,020	6,300	4,800	6,810	5,120	7,610	5,600	8,240	5,920	8,830	6,240	9,200	6,400
Alfalfa	5,790	3,800	6,200	4,600	4,960	3,680	4,340	3,220	3,720	2,760	3,410	2,530	3,100	2,300
Rice	65,920	41,580	54,000	36,900	55,200	37,720	56,400	38,540	57,600	39,360	58,800	40,180	60,000	41,000
Pasture	34,510	20,870	40,550	24,700	66,220	40,040	83,850	50,700	73,530	44,460	64,070	38,740	53,540	32,370
Double crop	100	60	300	180	350	210	450	270	500	300	550	330	600	360
Total agriculture	131,950	82,200	135,690	90,960	164,470	108,620	184,990	121,070	178,190	117,040	171,450	113,010	163,560	108,280
Residential farms	1/	1/	3,000	2,500	3,300	2,750	4,100	3,420	5,300	4,420	6,700	5,580	7,800	6,500
Urban	2,900	1,450	3,800	1,900	5,000	2,500	6,700	3,350	8,700	4,350	11,500	5,750	14,800	7,400
Total	134,850	83,650	142,490	95,360	172,770	113,870	195,790	127,840	192,190	125,810	189,650	124,340	186,160	122,180
Rounded	134,800	83,600	142,500	95,400	172,800	113,900	195,800	127,800	192,200	125,800	189,600	124,300	186,200	122,200

1/ Included in the data for agriculture

TABLE III-A - 2

AVERAGE ANNUAL WATER REQUIREMENTS
VALLEY FLOOR SUBAREA NO. 2
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	14,790	8,160	18,500	12,800	25,500	17,600	32,500	22,400	37,140	25,600	41,780	28,800	44,100	30,400
Subtropical orchard	590	320	1,040	680	1,560	1,020	2,080	1,360	2,600	1,700	3,120	2,040	3,900	2,550
Miscellaneous truck	5,100	3,830	7,250	5,500	7,540	5,720	7,830	5,940	8,120	6,160	8,410	6,380	8,700	6,600
Miscellaneous field	7,050	4,510	7,450	5,600	8,370	6,240	9,290	6,880	10,160	7,360	10,860	7,680	11,500	8,000
Alfalfa	9,800	6,440	15,740	11,500	15,060	11,040	13,750	10,120	12,480	9,200	6,700	4,950	2,790	2,070
Rice	61,300	38,670	54,000	36,900	57,600	39,360	61,200	41,820	64,800	44,280	68,400	46,740	72,000	49,200
Pasture	55,960	33,840	52,440	34,320	86,050	61,620	120,130	77,220	122,120	73,840	102,150	63,050	84,710	51,220
Double crop	--	--	300	180	400	240	500	300	600	360	700	420	800	480
Total agriculture	154,590	95,770	156,720	107,480	202,080	142,840	247,280	166,040	258,020	168,500	242,120	160,060	228,500	150,520
Residential farms	1/	1/	2,100	1,750	2,700	2,250	4,800	4,000	7,000	5,830	10,000	8,330	14,200	11,830
Urban	4,350	2,180	5,800	2,900	7,800	3,900	10,200	5,100	13,600	6,800	18,100	9,050	24,100	12,050
Total	158,940	97,950	164,620	112,130	212,580	148,990	262,280	175,140	278,620	181,130	270,220	177,440	266,800	174,400
Rounded	158,900	98,000	164,600	112,100	212,600	149,000	262,300	175,100	278,600	181,100	270,200	177,400	266,800	174,400

1/ Included in the data for agriculture

TABLE III-A - 3

AVERAGE ANNUAL WATER REQUIREMENTS
VALLEY FLOOR SUBAREA NO. 3 - SUMMARY
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	15,000	8,280	18,520	12,800	26,220	18,080	32,530	22,400	38,400	26,400	43,730	30,080	46,520	32,000
Subtropical orchard	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Miscellaneous truck	3,370	2,520	13,050	9,900	18,850	14,300	23,780	18,040	26,680	20,240	26,970	20,460	27,840	21,120
Miscellaneous field	7,920	5,060	20,150	15,200	30,800	22,080	40,010	28,000	41,400	28,800	42,550	29,600	43,700	30,400
Alfalfa	14,150	9,300	24,180	17,940	27,900	20,700	23,750	17,620	16,930	12,560	9,020	6,690	3,530	2,620
Rice	181,020	114,180	150,000	102,500	192,000	131,200	222,000	151,700	234,000	159,900	243,000	166,050	249,000	170,150
Pasture	59,020	35,690	92,200	56,470	109,760	66,400	111,110	67,180	129,170	78,100	158,630	95,910	176,560	106,760
Double crop	--	--	700	420	1,250	750	1,800	1,080	2,200	1,320	2,500	1,500	2,850	1,710
Total agriculture	280,480	175,030	318,800	215,230	406,780	273,510	454,980	306,020	488,780	327,320	526,400	350,290	550,000	364,760
Residential farms	1/	1/	11,340	9,450	14,280	11,900	18,300	15,250	20,700	17,250	22,800	19,000	24,000	20,000
Urban	4,260	2,130	6,250	3,130	9,990	5,000	15,880	7,940	24,060	12,040	34,920	17,460	51,120	25,560
Total	284,740	177,160	336,390	227,810	431,050	290,410	489,160	329,210	533,540	356,610	584,120	386,750	625,120	410,320
Rounded	284,700	177,200	336,400	227,800	431,000	290,400	489,200	329,200	533,500	356,600	584,100	386,800	625,100	410,300

1/ Included in the data for agriculture

TABLE III-A - 3a

AVERAGE ANNUAL WATER REQUIREMENTS
VALLEY FLOOR SUBAREA NO. 3 - PLACER COUNTY
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	3,050	1,680	2,320	1,600	5,350	3,680	7,000	4,800	8,170	5,600	8,860	6,080	9,320	6,400
Subtropical orchard	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Miscellaneous truck	--	--	1,450	1,100	2,900	2,200	3,480	2,640	3,480	2,640	2,320	1,760	1,740	1,320
Miscellaneous field	1,560	1,000	3,150	2,400	8,540	6,080	14,910	10,400	18,400	12,800	20,700	14,400	23,000	16,000
Alfalfa	2,180	1,430	2,480	1,840	3,100	2,300	1,550	1,150	--	--	--	--	--	--
Rice	26,390	16,650	30,000	20,500	48,000	32,800	72,000	49,200	78,000	53,300	81,000	55,350	84,000	57,400
Pasture	23,740	14,360	28,770	17,940	38,640	23,400	50,740	30,680	78,690	47,580	114,380	69,160	137,600	83,200
Double crop	--	--	100	60	300	180	550	330	750	450	900	540	1,050	630
Total agriculture	56,920	35,120	68,270	45,440	106,830	70,640	150,230	99,200	187,490	122,370	228,160	147,290	256,710	164,950
Residential farms	1/	1/	9,900	8,250	12,600	10,500	14,700	12,250	15,600	13,000	16,200	13,500	16,500	13,750
Urban	4,200	2,100	6,180	3,090	9,840	4,920	15,400	7,700	22,710	11,360	32,160	16,080	45,480	22,740
Total	61,120	37,220	84,350	56,780	129,270	86,060	180,330	119,150	225,800	146,730	276,520	176,870	318,690	201,440
Rounded	61,100	37,20C	84,400	56,800	129,300	86,100	180,300	119,200	225,800	146,700	276,500	176,900	318,700	201,400

1/ Included in the data for agriculture

TABLE III-A - 3b

AVERAGE ANNUAL WATER REQUIREMENTS
VALLEY FLOOR SUBAREA NO. 3 - SUTTER COUNTY
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	11,950	6,600	16,200	11,200	20,870	14,400	25,530	17,600	30,230	20,800	34,870	24,000	37,200	25,600
Subtropical orchard	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Miscellaneous truck	3,370	2,520	11,600	8,800	15,950	12,100	20,300	15,400	23,200	17,600	24,650	18,700	26,100	19,800
Miscellaneous field	6,360	4,060	17,000	12,800	22,260	16,000	25,100	17,600	23,000	16,000	21,850	15,200	20,700	14,400
Alfalfa	11,970	7,870	21,700	16,100	24,800	18,400	22,200	16,470	16,930	12,560	9,020	6,690	3,530	2,620
Rice	154,630	97,530	120,000	82,000	144,000	98,400	150,000	102,500	156,000	106,600	162,000	110,700	165,000	112,750
Pasture	35,280	21,330	63,430	38,530	71,120	43,000	60,370	36,500	50,480	30,520	44,250	26,750	38,960	23,560
Double crop	--	--	600	360	950	570	1,250	750	1,450	870	1,600	960	1,800	1,080
Total agriculture	223,560	139,910	250,530	169,790	299,950	202,870	304,750	206,820	301,290	204,950	298,240	203,000	293,290	199,810
Residential farms	1/	1/	1,440	1,200	1,680	1,400	3,600	3,000	5,100	4,250	6,600	5,500	7,500	6,250
Urban	60	30	70	40	150	80	480	240	1,350	680	2,760	1,380	5,640	2,820
Total	223,620	139,940	252,040	171,030	301,780	204,350	308,830	210,060	307,740	209,880	307,600	209,880	306,430	208,880
Rounded	223,600	139,900	252,000	171,000	301,800	204,400	308,800	210,100	307,700	209,900	307,600	209,900	306,400	208,900

1/ Included in the data for agriculture

TABLE III-B

AVERAGE ANNUAL WATER REQUIREMENTS
BROWNSVILLE SERVICE AREA
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	--	--	380	250	1,000	650	1,430	940	1,750	1,150	1,950	1,280	1,990	1,300
Subtropical orchard	1,170	650	1,530	940	2,250	1,450	3,210	1,960	3,880	2,360	4,270	2,610	4,550	2,800
Pasture	13,200	6,600	16,390	9,810	28,630	17,120	34,660	20,730	36,740	22,000	38,400	23,030	39,220	23,540
Total agriculture	14,370	7,250	18,300	11,000	31,880	19,220	39,300	23,630	42,370	25,510	44,620	26,920	45,760	27,640
Residential farms	1/	1/	5,440	4,900	5,820	5,250	6,850	6,160	9,260	8,330	12,840	11,550	15,390	13,850
Urban	110	60	130	70	170	90	220	120	370	190	620	310	900	450
Total	14,480	7,310	23,870	15,970	37,870	24,560	46,370	29,910	52,000	34,030	58,080	38,780	62,050	41,940
Rounded	14,500	7,300	23,900	16,000	37,900	24,600	46,400	29,900	52,000	34,000	58,100	38,800	62,000	41,900

1/ Included in the data for agriculture

TABLE III-C

AVERAGE ANNUAL WATER REQUIREMENTS
SAN JUAN RIDGE SERVICE AREA
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	20	10	900	580	2,010	1,300	2,350	1,520	2,370	1,530	2,390	1,550	2,410	1,560
Pasture	740	370	1,210	770	1,110	700	1,040	660	1,040	660	1,040	660	1,040	660
Total agriculture	760	380	2,110	1,350	3,120	2,000	3,390	2,180	3,410	2,190	3,430	2,210	3,450	2,220
Residential farms	1/	1/	810	680	1,200	1,000	1,980	1,650	3,060	2,550	4,680	3,900	7,380	6,150
Urban	40	20	30	10	40	20	70	40	110	50	180	90	300	150
Total	800	400	2,950	2,040	4,360	3,020	5,440	3,870	6,580	4,790	8,290	6,200	11,130	8,520
Rounded	800	400	3,000	2,000	4,400	3,000	5,400	3,900	6,600	4,800	8,300	6,200	11,100	8,500

1/ Included in the data for agriculture

TABLE III-D

AVERAGE ANNUAL WATER REQUIREMENTS
GRASS VALLEY SERVICE AREA
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	2,500 1/	1,360 1/	3,450	2,340	7,690	5,200	10,770	7,280	12,700	8,580	13,390	9,040	14,090	9,490
Pasture	42,320	21,160	41,070	25,960	57,340	42,570	84,230	53,370	90,400	57,270	92,610	58,590	92,220	58,300
Total agriculture	44,820	22,520	44,520	28,300	75,030	47,770	95,000	60,650	103,100	65,850	106,000	67,630	106,310	67,690
Residential farms	2/	2/	19,480	16,350	21,570	18,150	26,160	22,020	32,160	27,090	41,100	34,560	53,370	44,820
Urban	3,220	1,610	3,380	1,690	3,950	1,970	4,930	2,470	6,150	3,080	7,750	3,880	9,660	4,840
Total	48,040	24,130	67,380	46,340	100,550	67,890	126,090	85,140	141,410	96,020	154,850	106,070	169,340	117,350
Rounded	48,000	24,100	67,400	46,300	100,600	67,900	126,100	85,100	141,400	96,000	154,800	106,100	169,300	117,400

1/ 101-acre subtropical orchard included in deciduous orchard.
2/ Included in the data for agriculture

TABLE III-E

AVERAGE ANNUAL WATER REQUIREMENTS
AUBURN FOOTHILL SERVICE AREA
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	40,510	21,940	38,470	24,660	39,150	25,100	39,990	25,650	41,020	26,300	41,990	26,910	42,670	27,350
Subtropical orchard	690	390	1,150	760	2,070	1,360	3,730	2,450	5,760	3,780	7,310	4,790	8,440	5,520
Miscellaneous field	320	190	300	200	870	600	1,920	1,300	3,000	2,000	3,690	2,500	3,990	2,600
Alfalfa	800	520	640	460	1,590	1,150	3,180	2,300	4,780	3,450	5,730	4,140	6,370	4,600
Pasture	62,180	31,090	56,800	33,970	61,170	36,590	67,550	40,380	72,540	43,340	76,590	45,750	76,350	45,590
Total agriculture	104,500	54,130	97,360	60,050	104,850	64,800	116,370	72,080	127,100	78,870	135,310	84,090	137,820	85,660
Residential farms	1/	1/	39,960	33,300	47,460	39,550	56,010	46,680	64,650	53,880	72,030	60,020	79,050	65,880
Urban	5,800	2,900	8,350	4,170	12,460	6,220	18,230	9,130	24,630	12,320	30,910	15,450	39,090	19,540
Total	110,300	57,030	145,670	97,520	164,770	110,570	190,610	127,890	216,380	145,070	238,250	159,560	255,960	171,080
Rounded	110,300	57,000	145,700	97,500	164,800	110,600	190,600	127,900	216,400	145,100	238,200	159,600	256,000	171,100

1/ Included in the data for agriculture

TABLE III-F

AVERAGE ANNUAL WATER REQUIREMENTS
COLFAX RIDGE SERVICE AREA
(Acre-feet)

Crop	Present		1970		1980		1990		2000		2010		2020	
	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use	Unit delivery	Consumptive use
Deciduous orchard	1,090	590	860	590	910	620	990	680	1,060	730	1,100	750	1,140	780
Pasture	770	380	630	440	670	480	730	510	1,390	970	1,520	1,060	1,580	1,100
Total agriculture	1,860	970	1,490	1,030	1,580	1,100	1,720	1,190	2,450	1,700	2,620	1,810	2,720	1,880
Residential farms	1/	1/	3,870	3,220	4,620	3,850	5,250	4,300	5,820	4,850	6,000	5,000	6,300	5,250
Urban	600	300	720	360	900	450	1,170	580	1,470	740	1,800	900	2,160	1,080
Total	2,460	1,270	6,080	4,610	7,100	5,400	8,140	6,070	9,740	7,290	10,420	7,710	11,180	8,210
Rounded	2,500	1,300	6,100	4,600	7,100	5,400	8,100	6,000	9,700	7,300	10,400	7,700	11,200	8,200

1/ Included in the data for agriculture

TABLE IV-A - 1

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

VALLEY FLOOR SUBAREA NO. 1

Crops	Total Irrigated Acres	Payment Capacity Per Acre ($)	Payment Capacity Total ($)	Annual Irrigation Requirements 1/ Per Acre (Acre-Feet)	Annual Irrigation Requirements 1/ Total (Acre-Feet)	Payment Capacity Per Ac.-Ft ($)
Major Season						
Deciduous orchard	10,000	73.10	731,320	2.3	23,240	31.50
Almonds	640	95.00	60,800	2.3	1,470	41.40
Cling peaches	4,960	58.00	287,680	2.3	11,410	25.20
Prunes	3,140	83.00	260,620	2.4	7,460	34.90
Walnuts	1,260	97.00	122,220	2.3	2,900	42.10
Subtropical orchard	600	24.00	14,400	2.6	1,560	9.25
Miscellaneous truck	2,600	57.00	148,120	2.9	7,540	19.60
Tomatoes	2,180	56.00	122,080	2.9	6,410	19.00
Melons	420	62.00	26,040	2.7	1,130	23.00
Miscellaneous field	3,500	22.90	80,070	2.2	7,610	10.50
Milo	1,070	17.00	18,190	2.2	2,370	7.70
Dry beans	1,510	25.00	37,750	2.2	3,290	11.50
Corn grain	570	19.00	10,830	2.1	1,220	8.90
Sugar beets	350	38.00	13,300	2.1	730	18.20
Alfalfa	1,400	29.00	40,600	3.1	4,340	9.35
Rice	9,400	28.00	263,200	6.0	56,400	4.65
Pasture	19,500	20.00	390,000	4.3	83,850	4.65
Minor Season	(900)	8.70	7,800	0.5	450	17.30
Grain	(600)	12.00	7,200	0.5	300	24.00
Grain hay	(300)	2.00	600	0.5	150	4.00
Total	47,000		1,675,510		184,990	
Average		35.60		3.9		9.05

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-A - 2

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

VALLEY FLOOR SUBAREA NO. 2

Crops	Total Irrigated Acres	Payment Capacity		Annual Irrigation Requirements 1/ (Acre-Feet)		Payment Capacity Per Ac.-Ft. ($)
		Per Acre ($)	Total ($)	Per Acre	Total	
Major Season						
Deciduous orchard	14,000	74.40	1,023,940	2.3	32,500	31.50
Almonds	900	95.00	85,500	2.4	2,130	40.10
Cling Peaches	6,940	58.00	402,520	2.3	15,960	25.20
Prunes	4,400	83.00	365,200	2.4	10,360	35.20
Walnuts	1,760	97.00	170,720	2.3	4,050	42.20
Subtropical orchard	800	24.00	19,200	2.6	2,080	9.25
Miscellaneous truck	2,700	57.00	153,780	2.9	2,830	19.60
Tomatoes	2,270	56.00	127,120	2.9	6,670	19.10
Melons	430	62.00	26,660	2.7	1,160	23.00
Miscellaneous field	4,300	22.90	98,410	2.2	9,290	10.60
Milo	1,310	17.00	22,270	2.2	2,840	7.85
Dry beans	1,860	25.00	46,500	2.2	4,080	11.40
Corn grain	700	19.00	13,300	2.1	1,470	9.05
Sugar beets	430	38.00	16,340	2.1	900	18.20
Alfalfa	4,400	29.00	127,600	3.1	13,750	9.30
Rice	10,200	28.00	285,600	6.0	61,200	4.65
Pasture	29,700	20.00	594,000	4.0	120,130	4.95
Minor Season	(1,000)	10.00	10,000	0.5	500	20.00
Grain	(800)	12.00	9,600	0.5	400	24.00
Grain hay	(200)	2.00	400	0.5	100	4.00
Total	66,100		2,312,530		247,280	
Average		35.00		3.7		9.35

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-A-3

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

VALLEY FLOOR SUBAREA NO. 3
SUMMARY

Crops	Total Irrigated Acres	Payment Capacity Per Acre ($)	Payment Capacity Total ($)	Annual Irrigation Requirements 1/ Per Acre (Acre-Feet)	Annual Irrigation Requirements 1/ Total (Acre-Feet)	Payment Capacity Per Ac. Ft. ($)
Major Season						
Deciduous orchard	14,000	77.90	1,090,520	2.3	32,530	33.50
Almonds	2,460	95.00	233,700	2.3	5,750	40.60
Cling peaches	5,580	58.00	323,640	2.3	12,840	25.20
Prunes	3,210	83.00	266,430	2.4	7,620	35.00
Walnuts	2,750	97.00	266,750	2.3	6,320	42.20
Miscellaneous truck	8,200	56.30	461,840	2.9	23,780	19.40
Tomatoes	7,760	56.00	434,560	2.9	22,600	19.20
Melons	440	62.00	27,280	2.7	1,180	23.10
Miscellaneous field	17,500	20.60	360,020	2.3	40,010	9.00
Milo	9,500	17.00	161,500	2.3	21,700	7.45
Dry beans	5,790	25.00	144,750	2.3	13,220	10.90
Corn grain	1,590	19.00	30,210	2.3	3,660	8.25
Sugar beets	620	38.00	23,560	2.3	1,430	16.50
Alfalfa	7,660	29.00	222,140	3.1	23,750	9.35
Rice	37,000	28.00	1,036,000	6.0	222,000	4.65
Pasture	25,840	20.00	516,800	4.3	111,110	4.65
Minor Season	(3,600)	10.00	36,000	0.5	1,800	20.00
Grain	(2,880)	12.00	34,560	0.5	1,440	24.00
Grain hay	(720)	2.00	1,440	0.5	360	4.00
Total	110,200		3,723,320		454,980	
Average		33.80		4.1		8.20

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-A - 3a

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

VALLEY FLOOR SUBAREA NO. 3 - PLACER COUNTY

Crops	Total Irrigated Acres	Payment Capacity Per Acre ($)	Payment Capacity Total ($)	Annual Irrigation Requirements 1/ Per Acre (Acre-Feet)	Annual Irrigation Requirements 1/ Total (Acre-Feet)	Payment Capacity Per Ac-Ft.
Major Season						
Deciduous orchard	3,000	74.70	224,020	2.3	7,000	32.00
Almonds	980	95.00	93,100	2.4	2,350	39.60
Cling peaches	1,660	58.00	96,280	2.3	3,820	25.20
Prunes	20	83.00	1,660	2.5	50	33.20
Walnuts	340	97.00	32,980	2.3	780	42.30
Miscellaneous truck	1,200	56.30	67,560	2.9	3,480	19.40
Tomatoes	1,140	56.00	63,840	2.9	3,320	19.20
Melons	60	62.00	3,720	2.7	160	23.20
Miscellaneous field	6,500	17.30	112,680	2.3	14,910	7.55
Milo	5,410	17.00	91,970	2.3	12,400	7.40
Dry beans	---	25.00	---	---	---	---
Corn grain	1,090	19.00	20,710	2.3	2,510	8.25
Sugar beets	---	38.00	---	---	---	---
Alfalfa	500	29.00	14,500	3.1	1,550	9.35
Rice	12,000	28.000	336,000	6.0	72,000	4.65
Pasture	11,800	20.00	236,000	4.3	50,740	4.65
Minor Season	(1,100)	10.00	11,000	0.5	550	20.00
Grain	(880)	12.00	10,560	0.5	440	24.00
Grain hay	(220)	2.00	440	0.5	110	4.00
Total	35,000		1,001,760		150,230	
Average		28.60		4.3		6.65

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-A - 3b

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

VALLEY FLOOR SUBAREA NO. 3 - SUTTER COUNTY

Crops	Total Irrigated Acres	Payment Capacity Per Acre ($)	Payment Capacity Total ($)	Annual Irrigation Requirements[1] Per Acre (Acre-Feet)	Annual Irrigation Requirements[1] Total (Acre-Feet)	Payment Capacity Per Ac-Ft. ($)
Major Season						
Deciduous orchard	11,000	78.80	866,500	2.3	25,530	33.90
Almonds	1,480	95.00	140,600	2.3	3,400	41.40
Cling peaches	3,920	58.00	227,360	2.3	9,020	25.20
Prunes	3,190	83.00	264,770	2.4	7,570	35.00
Walnuts	2,410	97.00	233,770	2.3	5,540	42.20
Miscellaneous truck	7,000	56.30	394,280	2.9	20,300	19.40
Tomatoes	6,620	56.00	370,720	2.9	19,280	19.20
Melons	380	62.00	23,560	2.7	1,020	23.10
Miscellaneous field	11,000	22.50	247.340	2.3	25,100	9.85
Milo	4,090	17.00	69,530	2.3	9,300	7.50
Dry beans	5,790	25.00	144,750	2.3	13,220	10.90
Corn grain	500	19.00	9,500	2.3	1,150	8.25
Sugar beets	620	38.00	23,560	2.3	1,430	16.50
Alfalfa	7,160	29.00	207,640	3.1	22,200	9.35
Rice	25,000	28.00	700,000	6.0	150,000	4.65
Pasture	14,040	20.00	280,800	4.3	60,370	4.65
Minor Season	(2,500)	10.00	25,000	0.5	1,250	20.00
Grain	(2,000)	12.00	24,000	0.5	1,000	24.00
Grain hay	(500)	2.00	1,000	0.5	250	4.00
Total	75,200		2,721,560		304,750	
Average		36.20		4.1		8.95

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-B

SUMMARY OF THE AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

BROWNSVILLE SERVICE AREA

Crops	Total Irrigated Acres	Payment Capacity: Per Acre ($)	Payment Capacity: Total ($)	Annual Irrigation Requirements 1/: Per Acre (Acre-Feet)	Annual Irrigation Requirements 1/: Total (Acre-Feet)	Payment Capacity Per Ac.-Ft. ($)
Deciduous orchard	720	73.80	53,130	2.0	1,430	37.20
Freestone peaches	110	39.00	4,290	2.0	220	19.50
Pears	140	40.00	5,600	2.0	280	20.00
Plums	470	92.00	43,240	2.0	930	46.50
Subtropical orchard	1,400	24.00	33,600	2.3	3,210	10.50
Pasture	9,420	10.10	95,140	3.7	34,660	2.75
Total	11,540		181,870		39,300	
Average		15.80		3.4		4.65

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-C

SUMMARY OF THE AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

SAN JUAN RIDGE SERVICE AREA

Crops	Total Irrigated Acres	Payment Capacity: Per Acre ($)	Payment Capacity: Total ($)	Annual Irrigation Requirements 1/: Per Acre (Acre-Feet)	Annual Irrigation Requirements 1/: Total (Acre-Feet)	Payment Capacity Per Ac.-Ft. ($)
Deciduous orchard	1,170	54.40	63,640	2.0	2,350	27.10
Apples	600	62.00	37,200	2.0	1,200	31.00
Pears	500	40.00	20,000	2.0	1,000	20.00
Plums	70	92.00	6,440	2.0	150	42.90
Pasture	300	11.50	3,450	3.5	1,040	3.30
Total	1,470		67,090		3,390	
Average		45.60		2.3		19.80

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-D

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

GRASS VALLEY SERVICE AREA

Crops	Total Irrigated Acres	Payment Capacity Per Acre ($)	Payment Capacity Total ($)	Annual Irrigation Requirements 1/ Per Acre (Acre-Feet)	Annual Irrigation Requirements 1/ Total (Acre-Feet)	Payment Capacity Per Ac.-Ft. ($)
Deciduous orchard	5,600	46.00	257,700	1.9	10,770	23.90
Apples	1,300	62.00	80,600	1.9	2,500	32.20
Freestone peaches	100	39.00	3,900	2.0	200	19.50
Pears	4,100	40.00	164,000	1.9	7,870	20.80
Plums	100	92.00	9,200	2.0	200	47.00
Pasture	24,260	10.70	259,580	3.5	84,230	3.10
Total	29,860		517,280		95,000	
Average		17.30		3.2		5.45

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources

TABLE IV-E

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

AUBURN FOOTHILLS SERVICE AREA

Crops	Total Irrigated Acres	Payment Capacity Per Acre ($)	Payment Capacity Total ($)	Annual Irrigation Requirements 1/ Per Acre (Acre-Feet)	Annual Irrigation Requirements 1/ Total (Acre-Feet)	Payment Capacity Per Ac.-Ft. ($)
Deciduous orchard	17,330	64.90	1,122,360	2.3	39,990	28.10
Apples	630	62.00	39,060	2.3	1,450	26.90
Freestone peaches	700	39.00	27,300	2.3	1,640	16.60
Pears	8,000	40.00	320,000	2.3	18,450	17.30
Plums	8,000	92.00	736,000	2.3	18,450	39.90
Subtropical orchard	1,580	24.00	37,920	2.4	3,730	10.20
Miscellaneous field	1,300	15.50	20,200	1.5	1,920	10.50
Milo	1,000	16.00	16,000	1.5	1,500	10.70
Corn grain	300	14.00	4,200	1.5	420	10.00
Alfalfa	1,000	20.00	20,000	2.4	3,180	6.30
Pasture	17,940	13.50	242,190	3.8	67,550	3.60
Total	39,150		1,442,670		116,370	
Average		36.80		3.0		12.40

1/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources.

TABLE IV-F

SUMMARY OF AVERAGE ANNUAL PAYMENT CAPACITIES - 1990

COLFAX RIDGE SERVICE AREA

Crops	Total Irrigated Acres	Payment Capacity Per Acre ($)	Payment Capacity Total ($)	Annual Irrigation Requirements[1] Per Acre (Acre-Feet)	Annual Irrigation Requirements[1] Total (Acre-Feet)	Payment Capacity Per Ac.-Ft. ($)
eciduous orchard	520	55.40	28,790	1.9	990	29.10
Apples	200	62.00	12,400	1.9	380	32.60
Freestone peaches	50	39.00	1,950	1.9	100	19.50
Pears	200	40.00	8,000	1.9	380	21.10
Plums	70	92.00	6,440	1.9	130	49.50
asture	230	7.00	1,610	3.2	730	2.20
otal	750		30,400		1,720	
Average		40.50		2.3		17.70

/ Data provided by the Land and Water Use Unit, Delta Branch, Department of Water Resources

TABLE V-A - 1

IRRIGATION BENEFITS
VALLEY FLOOR SUBAREA NO. 1 1/

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development 2/ (acres)	Net area supplied (acres)	Benefit per acre 3/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		34,900	34,900	0	52.80	0							
	1970-79						1,265	0.8219	1,040	25,500	103,800	40.80	10.00
1980		41,900	36,800	5,100	49.70	253							
	1980-89						3,870	0.5553	2,149	79,500	322,800	27.00	6.70
1990		47,000	36,200	10,800	48.20	521							
	1990-99						5,230	0.3751	1,962	106,000	419,900	18.50	4.65
2000		45,800	35,400	10,400	50.50	525							
	2000-09						5,265	0.2534	1,334	102,500	389,200	13.00	3.45
2010		44,400	34,300	10,100	52.30	528							
	2010-19						5,235	0.1712	896	98,000	359,000	9.10	2.50
2020		42,700	33,200	9,500	54.60	519							
Total							20,865		7,381	411,500	1,594,700		
Average					50.70 4/							17.90	4.65

1/ Area between South Honcut Creek and the Yuba River.
2/ Local development assumed to utilize safe ground water pumping only plus present diversions. Reduction in acreage made to adjust acreage for existing overdraft on ground water supply, the development of residential farms and urban encroachment.
3/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
4/ Weighted average benefit per acre based on the net area supplied by the project.

TABLE V-A - 2

IRRIGATION BENEFITS
VALLEY FLOOR SUBAREA NO. 2 1/

Year	Decade	Total irrigated acreage (acres)	Area suplied by local development 2/ (acres)	Net area supplied (acres)	Benefit per acre 3/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		41,600	29,800	11,800	46.90	553							
	1970-79						8,850	0.8219	7,274	194,500	706,000	37.40	10.30
1980		56,200	29,100	27,100	44.90	1,217							
	1980-89						14,740	0.5553	8,185	327,000	1,194,300	25.00	6.80
1990		66,100	27,800	38,300	45.20	1,731							
	1990-99						18,400	0.3751	6,902	398,000	1,524,500	17.30	4.55
2000		67,600	26,300	41,300	47.20	1,949							
	2000-09						19,965	0.2534	5,059	408,500	1,564,200	12.40	3.25
2010		64,700	24,300	40,400	50.60	2,044							
	2010-19						20,815	0.1712	3,564	400,000	1,505,100	8.90	2.35
2020		61,100	21,500	39,600	53.50	2,119							
Total							82,770		30,894	1,728,000	6,484,100		
Average					47.90							17.90	4.75

1/ Area between Yuba and Bear Rivers. Includes small portion of Sutter and Placer Counties north of the Bear River.
2/ Local development assumed to utilize safe ground water pumping only plus present diversions, and 12,000 acre-feet scheduled to be provided from the Camp Far West project. Reduction in acreage made to allow for anticipated service to residential farms and urban encroachment.
3/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
4/ Weighted average benefit per acre based on the net area supplied by the project.

TABLE V-A - 3

IRRIGATION BENEFITS
VALLEY FLOOR SUBAREA NO. 3 1/

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development 2/ (acres)	Net area supplied (acres)	Benefit per acre 3/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		76,520	70,020	6,500	45.00	292							
	1970-79						6,850	0.8219	5,630	152,500	635,500	36.90	8.90
1980		98,140	74,140	24,000	44.90	1,078							
	1980-89						14,035	0.5553	7,794	312,500	1,281,000	24.90	6.10
1990		110,200	71,700	38,500	44.90	1,729							
	1990-99						19,410	0.3751	7,280	437,000	1,793,400	16.70	4.05
2000		118,200	69,300	48,900	44.00	2,153							
	2000-09						23,545	0.2534	5,966	547,500	2,268,300	10.90	2.65
2010		126,900	66,300	60,600	42.20	2,556							
	2010-19						27,160	0.1712	4,650	654,000	2,726,200	7.10	1.70
2020		132,300	62,100	70,200	41.00	2,876							
Total							91,000		31,320	2,103,500	8,704,400		
Average					43.30 4/							14.90	3.60

1/ Area south of the Bear River.
2/ Local development assumed to utilize safe ground water pumping only plus present diversions and local projects. Reduction in acreage made to allow for anticipated service to residential farms and urban encroachment.
3/ Benefits are derived as a weighted average of the Placer and Sutter Counties portions of Valley Floor No. 3 Service Area.
4/ Weighted average benefit per acre based on the net area supplied by the project.

TABLE V-A - 3a

IRRIGATION BENEFITS
VALLEY FLOOR SUBAREA NO. 3 - PLACER COUNTY 1/

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development 2/ (acres)	Net area supplied (acres)	Benefit per acre 3/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		15,700	15,700	0	36.60	0							
	1970-79						1,030	0.8219	847	26,000	106,400	32.60	8.00
1980		25,100	19,900	5,200	39.70	206							
	1980-89						4,340	0.5553	2,410	110,500	468,000	21.80	5.10
1990		35,000	18,100	16,900	39.20	662							
	1990-99						8,495	0.3751	3,186	223,500	950,600	14.30	3.30
2000		44,000	16,200	27,800	37.30	1,037							
	2000-09						12,150	0.2534	3,079	338,000	1,431,600	9.10	2.15
2010		53,700	13,900	39,800	35.00	1,393							
	2010-19						15,450	0.1712	2,645	448,500	1,896,000	5.90	1.40
2020		60,600	10,700	49,900	34.00	1,697							
Total							41,465		12,167	1,146,500	4,852,600		
Average					36.20 4/							10.60	2.50

1/ Area south of the Bear River in Placer County.
2/ Local development assumed to utilize safe ground water pumping only plus present diversions. Reduction in acreage made to allow for anticipated service to residential farms and urban encroachment.
3/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
4/ Weighted average benefits per acre based on the net area supplied by the project.

TABLE V-A - 3b

IRRIGATION BENEFITS
VALLEY FLOOR SUBAREA NO. 3 - SUTTER COUNTY [1/]

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development [2/] (acres)	Net area supplied (acres)	Benefit per acre [3/] ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		60,820	54,320	6,500	45.00	292							
	1970-79						5,820	0.8219	4,783	126,500	529,100	37.80	9.00
1980		73,040	54,240	18,800	46.40	872							
	1980-89						9,695	0.5553	5,384	202,000	813,000	26.70	6.60
1990		75,200	53,600	21,600	49.40	1,067							
	1990-99						10,915	0.3751	4,094	213,500	842,800	19.20	4.90
2000		74,200	53,100	21,100	52.90	1,116							
	2000-09						11,395	0.2534	2,887	209,500	836,700	13.80	3.45
2010		73,200	52,400	20,800	55.90	1,163							
	2010-19						11,710	0.1712	2,005	205,500	830,200	9.80	2.40
2020		71,700	51,400	20,300	58.10	1,179							
Total							49,535		19,153	957,000	3,851,800		
Average					51.80							20.00	4.95

1/ Area south of the Bear River in Sutter County.
2/ Local development assumed to utilize safe ground water pumping only plus present diversions and local projects. Reduction in acreages made to allow for anticipated service to residential farms and urban encroachment.
3/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
4/ Weighted average benefit per acre based on the net area supplied by the project.

TABLE V-B

IRRIGATION BENEFITS
BROWNSVILLE SERVICE AREA

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development 2/ (acres)	Net area supplied (acres)	Benefit per acre 3/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		5,320	4,920	400	26.90	11							
	1970-79						180	0.8219	148	6,000	16,200	24.70	9.10
1980		9,320	8,520	800	30.70	25							
	1980-89						405	0.5553	224	15,000	46,740	14.90	4.80
1990		11,540	9,340	2,200	25.50	56							
	1990-99						700	0.3751	262	28,500	91,690	9.20	2.85
2000		12,570	9,070	3,500	23.70	84							
	2000-09						950	0.2534	240	40,500	127,650	5.90	1.90
2010		13,320	8,720	4,600	23.00	106							
	2010-19						1,110	0.1712	190	48,500	150,650	3.90	1.25
2020		13,700	8,600	5,100	22.70	116							
Total							3,345		1,064	138,500	432,930		
Average					24.20							7.70	2.45

1/ Local development assumed to utilize the specified quantity diverted from the North Yuba River, and the anticipated yield from the Virginia Ranch project. Reduction in acreage made to allow for anticipated service to residential farms and urban encroachment.
2/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
3/ Weighted average benefit per acre based on the net area supplied by the project.

Year	Decade	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]									
	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]								
	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]								
	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
2000		[illegible]	[illegible]	1,180	[illegible]	[illegible]								
	2000-09						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
2010		1,400	300	[illegible]	[illegible]	[illegible]								
	2010-19						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
2020		1,500	300	[illegible]	[illegible]	[illegible]								
Total							[illegible]		[illegible]	[illegible]	[illegible]			
Average					[illegible]								[illegible]	[illegible]

1/ Local development assumed to utilize present diversions.
2/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
3/ Weighted average benefit per acre based on the net area supplied by the project.

TABLE V-[illegible]

GRASS VALLEY SERVICE AREA

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development 1/ (acres)	Net area supplied (acres)	Benefit per acre 2/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		13,600	13,600	0	17.60	0							
	1970-79						475	0.8219	390	24,500	80,200	15.90	4.85
1980		23,350	18,450	4,900	19.40	95							
	1980-89						1,800	0.5553	1,000	90,500	288,200	11.00	3.45
1990		29,860	16,660	13,200	20.10	265							
	1990-99						3,220	0.3751	1,208	157,000	492,500	7.70	2.4[illegible]
2000		32,630	14,430	18,200	20.80	379							
	2000-09						4,245	0.2534	1,076	203,000	636,300	5.30	1.70
2010		35,580	11,180	22,400	21.00	470							
	2010-19						5,250	0.1712	899	247,500	776,000	3.65	1.15
2020		33,800	6,700	27,100	21.40	580							
Total							14,990		4,573	722,500	2,273,200		
Average					20.70 3/							6.30	2.00

1/ Local development assumed to utilize present diversions. Reduction in acreage made to allow for anticipated service to residential farms and urban encroachment.
2/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
3/ Weighted average benefit per acre based on the net area supplied by the project.

TABLE V-E

IRRIGATION BENEFITS
AUBURN FOOTHILLS SERVICE AREA

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development[1] (acres)	Net area supplied (acres)	Benefit per acre[2] ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		32,470	32,470	0	45.60	0							
	1970-79						995	0.8219	818	22,500	66,400	36.40	12.30
1980		35,090	30,590	4,500	44.30	199							
	1980-89						3,835	0.5553	2,130	89,500	261,900	23.80	8.10
1990		39,150	25,750	13,400	42.40	568							
	1990-99						7,425	0.3751	2,785	178,500	520,000	15.60	5.40
2000		43,080	20,780	22,300	41.10	917							
	2000-09						10,625	0.2534	2,692	261,000	758,200	10.30	3.55
2010		46,130	16,230	29,900	40.40	1,208							
	2010-19						13,370	0.1712	2,289	330,500	956,100	6.90	2.40
2020		47,300	11,100	36,200	40.50	1,466							
Total							36,250		10,714	882,000	2,562,600		
Average					41.10[3]							12.10	4.20

1/ Local development assumed to utilize the present diversions. Reduction in acreage made to allow for anticipated service to residential farms and urban encroachment.
2/ Benefits per acre have been reduced to reflect the returns to dry land enterprise.
3/ Weighted average benefit per acre based on the net area supplied by the project.

TABLE VI-A

RESIDENTIAL FARM BENEFITS
BROWNSVILLE SERVICE AREA

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development 1/ (acres)	Net area supplied (acres)	Benefit per acre 2/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		1,815	1,815	0	38.30	0							
	1970-79						0	0.8219	0	0	0	0	0
1980		1,940	1,940	0	42.30	0							
	1980-89						65	0.5553	36	1,500	4,500	16.80	5.60
1990		2,285	1,985	300	44.40	13							
	1990-99						255	0.3751	96	5,700	17,100	11.90	3.95
2000		3,085	2,245	840	44.90	38							
	2000-09						580	0.2534	147	12,900	38,700	8.40	2.80
2010		4,280	2,540	1,740	44.60	78							
	2010-19						980	0.1712	168	21,700	65,100	5.90	1.95
2020		5,130	2,530	2,600	45.30	118							
Total							1,880		447	41,800	125,400		
Average					45.00 3/							10.70	3.55

1/ Local development assumed to utilize the specified quantity diverted from the North Yuba River and the anticipated yield from the Virginia Ranch project. Reduction in acreage made to allow for anticipated service to urban encroachment.
2/ Benefits weighted between domestic and agricultural uses and reduced to reflect returns to dry land enterprise. Urban benefit assumed equal to rate for comparable service in Oroville-Wyandotte Irrigation District which was $3.50 per month minimum and 0.29 acre-foot per capita water requirement on 0.5 acre homesite.
3/ Weighted average benefit based on net area served by project.

TABLE VI-B

RESIDENTIAL FARMS BENEFITS
SAN JUAN RIDGE SERVICE AREA

Year	Decade	Total irrigated acreage (acres)	Area supplied by local development 1/ (acres)	Net area supplied (acres)	Benefit per acre 2/ ($)	Total net project benefit: Per year ($1,000)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of benefits per decade ($1,000)	Net area supplied by project water (acres)	Net amount supplied by project (acre-feet)	Present worth of net project benefits: Per acre ($)	Present worth of net project benefits: Per acre-foot ($)
1970		270	100	170	46.60	8							
	1970-79						115	0.8219	95	2,200	6,600	45.00	14.40
1980		400	120	280	54.50	15							
	1980-89						225	0.5553	125	4,000	12,000	31.20	10.40
1990		660	130	530	57.00	30							
	1990-99						405	0.3751	152	7,100	21,300	21.40	7.10
2000		1,020	130	890	56.80	51							
	2000-09						665	0.2534	169	11,600	34,800	14.60	4.85
2010		1,560	130	1,430	57.30	82							
	2010-19						1,080	0.1712	185	18,800	56,400	9.80	3.30
2020		2,460	130	2,330	57.60	134							
Total							2,490		726	43,700	131,100		
Average					57.00							16.60	5.50

1/ Development assumed to utilize present surface diversions and pumping from ground water.
2/ Weighted proportionately between agriculture and domestic uses.

TABLE VII

MUNICIPAL AND INDUSTRIAL BENEFITS
SAN JUAN RIDGE SERVICE AREA

Year	Decade	Total water supplied (acre-feet)	Water supplied by local sources (acre-feet)	Net water supplied (acre-feet)	Benefit per acre-foot 1/ ($)	Total net project benefit: Per year ($)	Total net project benefit: Per decade ($1,000)	Present worth factor (4%)	Present worth of net benefits per decade ($1,000)	Net water supplied by project (acre-feet)	Average present worth of net benefits per acre-foot ($)
1970		30	30	0	38.00	0					
	1970-79						0	0.8219	0	0	0
1980		40	40	0	38.00	0					
	1980-89						3.8	0.5553	2	100	20.00
1990		70	50	20	38.00	760					
	1990-99						11.4	0.3751	4	300	13.30
2000		110	70	40	38.00	1,520					
	2000-09						26.6	0.2534	7	700	10.00
2010		180	80	100	38.00	3,800					
	2010-19						58.9	0.1712	10	1,600	6.25
2020		300	90	210	38.00	7,980					
Total							100.7		23	2,700	
Average					38.00						8.50

1/ Based on charges for water from the least costly alternative.

TABLE VIII

RECREATION BENEFITS - MARYSVILLE RESERVOIR

Decade	Average annual net use		Net benefit per decade				Present worth of benefits per decade		
	Camper use (1,000)	Day use (1,000)	Camper use ($1,000)	Day use ($1,000)	Total ($1,000)	Present worth factor, 4%	Camper use ($1,000)	Day use ($1,000)	Total ($1,000)
1980-1989	98.3	870.6	2,113.4	4,353.0	6,466.4	0.8219	1,737	3,578	5,315
1990-1999	162.5	1,432.5	3,493.8	7,162.5	10,656.3	0.5553	1,940	3,977	5,917
2000-2009	244.3	2,209.2	5,252.4	11,046.0	16,298.4	0.3751	1,970	4,143	6,113
2010-2019	350.4	3,234.5	7,533.6	16,172.5	23,706.1	0.2534	1,909	4,098	6,007
2020-2029	490.2	4,591.2	10,539.2	22,956.0	33,495.3	0.1712	1,804	3,930	5,734
50-year total					90,622.5		9,360	19,726	29,086

TABLE IX

RECREATION BENEFITS - NEW BULLARDS BAR RESERVOIR

Decade	Average annual net use		Net benefit per decade				Present worth of benefits per decade		
	Camper use (1,000)	Day use (1,000)	Camper use ($1,000)	Day use ($1,000)	Total ($1,000)	Present worth factor, 4%	Camper use ($1,000)	Day use ($1,000)	Total ($1,000)
1970-1979	13.1	52.1	281.6	260.5	542.1	0.8219	231	214	445
1980-1989	23.0	62.0	494.5	310.0	804.5	0.5553	275	172	447
1990-1999	23.0	63.1	494.5	310.0	810.0	0.3751	186	118	304
2000-2009	23.0	63.1	494.5	310.0	810.0	0.2534	125	80	205
2010-2019	23.0	63.1	494.5	310.0	810.0	0.1712	85	54	139
50-year total					3,776.6		902	638	1,540

TABLE X

DERIVATION OF HYDROELECTRIC POWER BENEFITS 1/

	Units	$ per Kw-yr	Mills per Kwh
A. Data for steam-electric plants.			
1. Gross nominal capacity	990 MW		
2. Net plant capacity (excluding station use)	975 MW		
3. Net energy at 80% C.F.	6,831 Kmwh		
4. Capital cost	$ 131,625,000 2/		
5. Annual cost (excluding operating fuel)	$ 19,803,000		
6. Annual fuel cost at 80% C.F.	$ 22,141,000		
7. Annual no load fuel cost	$ 1,170,000		
B. Cost of steam-electric power at generator bus.			
1. Capacity (A5 + A7) ÷ A2		21.51	
2. Energy (A6 - A7) ÷ A3			3.07
C. Cost of steam-electric sending substation.			
1. Capital cost 3/	$ 8,463,000 3/		
2. Annual cost	$ 1,424,000		
3. Annual cost (C2 ÷ A2)		1.46	
4. Cost of stepup losses			
a. Capacity 1.01% of (B1 + C3)		0.23	
b. Energy 0.71% of (B2)			0.02

TABLE X (continued)

DERIVATION OF HYDROELECTRIC POWER BENEFITS

	Units	\$ per Kw-yr	Mills per Kwh
D. Cost of steam-electric power at high tension terminal of sending substation.			
1. Capacity (B1 + C3 + C4a)		23.20	
2. Energy (B2 + C4b)			3.09
E. Transmission lines from steam-electric plant to load center.			
1. Capital cost	\$ 6,112,000 4/		
2. Annual cost	\$ 791,000		
3. Capacity input to transmission	965 MW		
4. Annual cost ($E_2 \div E_3$)		0.82	
5. Cost of transmission losses			
a. Capacity (2.04% of D1+E4)		0.49	
b. Energy (1.21% of D2)			0.04
F. Cost of steam-electric power at end of transmission line.			
1. Capacity ($D_1 + E_4 + E_5a$)		24.51	
2. Energy ($D_2 + E_5b$)			3.13
G. Steam-electric substation at load center.			

TABLE X (continued)

DERIVATION OF HYDROELECTRIC POWER BENEFITS

	Units	\$ per Kw-yr	Mills per Kwh
1. Capital cost	\$ 1,632,000 5/		
2. Annual cost	\$ 497,000		
3. Capacity input to terminal switching E_3 - (E_3 x 2.04%)	945 MW		
4. Annual capacity cost ($G_2 \div G_3$)		0.53	
H. Cost of steam-electric power at load center after terminal switching.			
1. Capacity (F_1 + G4)		25.04	
2. Energy (F_2)			3.13
I. Hydro capacity value adjustment			
1. Capacity		1.25	
J. Value of hydroelectric power at 220 KV bus at load center.			
1. Capacity (H_1 + I_1)		26.29	
2. Energy (H_2)			3.13
K. Hydroelectric receiving station.			
1. Capital cost	\$ 1,123,000 6/		
2. Annual cost	\$ 226,400		
3. Annual cost ($K_2 \div$ 586 MW) 7/		0.39	

TABLE X (continued)

DERIVATION OF HYDROELECTRIC POWER BENEFITS

	Units	$ per Kw-yr	Mills per Kwh
L. Value of hydroelectric power at receiving terminal of hydro transmission line.			
1. Capacity $(J_1 - K_3)$		25.90	
2. Energy $(J_2)^1$			3.13
M. Transmission lines from load center to hydroelectric site.			
1. Capital cost	$ 15,340,000		
2. Annual cost	$ 761,000		
3. Annual cost $M_2 \div$ 619MW 8/		1.23	
4. Cost of transmission losses			
a. Capacity 5.5% x $(L_1 - M_3)$		1.37	
b. Energy 3.75% x L_2			0.13
N. Value of hydroelectric power at 230 KV in vicinity of lower Yuba River power project.			
1. Capacity		23.30	
2. Energy			3.00

1/ Based on the least costly alternative method assumed to be a privately financed steam-electric plant.
2/ Capital cost based on $135 per net KW.
3/ Capital cost based on $8.68 per net KW.
4/ Capital cost based on $6.33 per net KW.
5/ Capital cost based on $1.72 per net KW.
6/ Capital cost estimate assumed the installation of four positions of load center including O,C.Bs, Air Break Switches.
7/ Based on sending capacity of 625 MW from hydroelectric site.

APPENDIX G

DAMSITE GEOLOGY

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APPENDIX G

DAMSITE GEOLOGY

This appendix presents a discussion and evaluation of damsite geology for projects included in the proposed plan for development. Additional information on these sites, as well as for other sites investigated but not included in the plan for development, are available in department files. A bibliography of geologic office reports on damsites investigated pursuant to this investigation is presented at the end of this appendix.

Marysville Damsite

Topography of Marysville damsite is characterized by low rolling foothills on both sides of a broad, debris-choked river channel. The river channel has been modified by gold dredges that have created high mounds of gravel tailings and isolated ponds. The present river channel has been artifically created along the north side of the channel section so that the area to the south can be redredged for gold.

The right abutment is approximately 5,200 feet long and is believed to consist entirely of Calaveras metavolcanic rocks. The bedrock is moderately hard, moderately blocky and seamy, and strongly jointed. Fractures, small shears, and joint planes showing displacement are common, but no major faulting was observed.

Diamond drill hole RA-1, location of which is shown on Plate 7, gave evidence of fractured rock to a depth of 34.0 feet. Water testing indicated that the fractures were either open or loosely sealed. Consequently, the amount of grouting required will be moderately high.

Auger holes revealed that the average depth of soil cover is approximately 6 feet. The contact between fresh and weathered bedrock as indicated by the seismic survey, is approximately 50 feet deep.

Stripping depth will vary considerably over the length of the right abutment. One diamond drill hole did not provide sufficient data for an accurate estimate; however, an average stripping depth would be in the order of 3 feet with an additional 9 feet of excavation for the cutoff trench.

The channel section is approximately 5,000 feet wide at the axis of the proposed dam. The active river channel has been artifically confined to the north side of the channel section by gravel embankments that are up to 70 feet in height. The flowing water is about 300 feet wide and has a gradient of approximately 10 feet to the mile.

Basement rock beneath the proposed dam consists of meta-volcanics of the Calaveras group. Overlying the bedrock in the ancient stream channels is the Ione formation. The

Ione formation is composed of clay, sandy clay, and lenses of clayey, sandy gravel. The latter should be impervious due to the high clay content. The Ione sediments have a maximum thickness of 75 feet in the ancient Yuba River channel. From drill hole correlation, it appears that the erosional surface of the Ione formation slopes to the north at a gentle angle.

Channel fill, in the form of dredger tailings and stream alluvium, conceals the bedrock and the Ione sediments. This fill material reaches a maximum thickness of approximately 130 feet below the water table and 70 feet above the water table. It is estimated that the channel section has an average of 80 feet of fill material below the water table and an average of 20 feet above the water table. It is further estimated that the total underflow in the channel deposits beneath the damsite is 50 second-feet.

Dredger operations have separated most of the auriferous gravels into coarse and fine tailings. Additional exploration will be required to determine the exact relation and proportion of the two types of materials and the location of clay lenses.

The water table has a gentle slope of from 140 feet elevation along the north side of the channel section to approximately 120 feet elevation along the south side.

Excavation in the channel for the core trench would consist of excavating an average of 80 feet of channel fill below the water table and an average of 20 feet above. An average of 5 feet of weathered bedrock would also be excavated.

The surface of the bedrock represents an old erosional surface and after excavation will probably contain fractures and joints that are open or loosely sealed and will have a moderate grout take.

The left abutment is approximately 2,200 feet long and consists entirely of Calaveras meta-volcanics. The slope is approximately 10 to 1, slightly convex, and contains numerous exposures of bedrock. Vegetation is sparse, consisting of grassland with occasional brush and small trees.

The Calaveras meta-volcanic rocks are moderately hard, moderately blocky and seamy, and strongly jointed. Fractures, small shears, and joint planes showing displacement are common, but major faulting was not observed. Drilling was not conducted on the left abutment; however, field observations indicate that foundation conditions are slightly better than on the right abutment. The stripping depths recommended for the left abutment are: an average of 3 feet of loose soil and root zone and an additional 7 feet of excavation for the core trench. Grout takes probably will be moderate.

A gated spillway and submerged gated flood outlet works is planned for the left abutment. The depth of excavation at the control structures will vary from 65 to 100 feet below the present ground surface and should provide a firm, hard rock foundation in the greenstone of the Calaveras formation.

A wing dam with a total length of 16,200 feet, trending easterly from McCartie Hill, will be required along the south rim of the reservoir. Maximum height would be about 80 feet. The topography is gently rolling with slopes seldom exceeding 25 to 1. The foundation for the wing dam consists mainly of Calaveras meta-volcanic and meta-sediments, which are moderately hard, moderately blocky and seamy, and strongly jointed. Minor shears, fractures, and joint planes showing displacement are common, but major faulting was not observed. For a length of about 3,100 feet near the central portion of the wing dam, the Calaveras rock is overlain by the Mehrten formation, consisting of about 50 feet of conglomerate capped with 14 feet of mudflow material.

Along the wing dam, auger drilling revealed an overall average soil depth of 4 feet. The seismic survey indicated that the contact between fresh and fractured bedrock varies between 15 and 50 feet. Diamond drill hole WDD-1 showed evidence of badly fractured and weathered rock to a depth of about 15 feet. Water tests indicated that the fractures were either open or loosely sealed. Based on these data, the stripping depths would average 2 feet for the pervious section and 10 feet for the impervious section.

A small saddle dam is required on the north side of the reservoir north of Browns Valley. The foundation rock is part of the Calaveras formation, and should pose no unusual foundation problems.

The reservoir area is underlain by Calaveras meta-volcanic and meta-sedimentary rocks. Near the left abutment, Mehrten conglomerate and mudflows occur as hill cappings. Extensive deposits of alluvium and dredger tailings occur in the Yuba River channel. The rock condition should be similar to that described for the abutments and wing dam.

Leakage is not expected to be a problem, with the exception of that portion of the wing dam underlain by the Mehrten formation. Mehrten sands are known to have a high permeability rate, and the existence of a continuous sand stratum might present a leakage problem.

Reservoir silting is expected to be light, due to the trapping of sediments behind Bullards Bar Dam and Englebright Dam. The approximate amount of silting is estimated to be 140 acre-feet per year, based on a drainage area of 1,325 square miles and a sedimentation rate of 0.30 acre-feet per year per square mile of drainage area. In calculating the amount of silting, the trap efficiency and drainage area of Bullards Bar Dam and Englebright Dam were considered.

Three borrow areas are proposed for obtaining impervious material based on exploration studies conducted for Marysville and Parks Bar damsites. The first is located in parts of Sections 5, 6, 7, and 8, T15N, R5E, and consists of weathered alluvium overlying river gravel. The borrow area can be excavated to an average depth of 6 feet and would supply about 6,500,000 cubic yards of usable material. The haul distance, in a direct line, will average 3.5 miles for the main dam and 3 miles for the wing dam. The second area is located northwest of the main dam in Sections 18 and 19, T16N, R5E. The material consists of valley alluvium, can be excavated to an average depth of 9 feet, and would supply about 4,000,000 cubic yards of suitable material. The average straight line haul distance is 2 miles. The third borrow pit is a narrow valley to the south of Long Bar and consists of valley alluvium and weathered soil. It can be excavated to an average depth of 8 feet, and would supply about 2,500,000 cubic yards of material. Due to its location it would be advantageous to use this material in the wing dam where the average haul distance would be 1.9 miles.

The main dam section was designed to make use of the extensive deposits of dredger tailings located in the Yuba River channel immediately adjacent to and underlying the damsite. These deposits appear suitable for use as transition and pervious material. The U. S. Air Force, in constructing Beale Air Force Base, found the dredger tailings to be a satisfactory aggregate for concrete.

The material considered for riprap is the Calaveras meta-volcanic rock. Sufficient quantities for the entire dam can be obtained from the excavation of the spillway and flood outlet works located on the left abutment.

In summary, results of preliminary geologic studies indicate the following:

1. An earthfill dam with a height of 215 feet can be built at the Marysville site.

2. The stability and permeability of the fine channel material presents the major construction problem with respect to establishing dewatering procedures, excavation depth, cutoffs, and grouting.

3. Leakage may exist under part of the wing dam due to the possible presence of a highly permeable Mehrten sand stratum.

4. Suitable impervious material is available within 4 miles of the damsite.

5. The dredger tailings from the river channel should be suitable for use in the transition and pervious sections of the dam and as aggregate for making of concrete.

6. The Calaveras meta-volcanic rock excavated from the spillway and flood outlet works should be suitable for the riprap section.

New York Flat Damsite

New York Flat damsite is underlain by igneous rocks that have been classified as diabase and gabbro-diorite by Lendgren and Turner (1895). *

The site is located on diabase which is a dense, dark, fine-grained igneous rock that is very hard in fresh exposures. The diabase has a good joint pattern and the following joints were recorded:

Dominant Joint	N65°W, 90°
Minor Joints	N70°E, 74°SE
	N35°E, 20°SE
	N35°E, 85°SE

The stripping estimates are based on requirements for a homogeneous fill type dam with a cutoff trench and are normal to the surface.

The abutments are rather flat-lying with slopes of 10 to 15 degrees suggesting deep weathering. They are covered with residual soil and only a few outcrops are present except near the channel section where flood water has exposed fresh rock. The right abutment should be stripped of an average of 5 feet beneath the dam plus an additional 5 feet of excavation for the cutoff trench. In the cutoff trench, some hard rock excavation can be anticipated. On the left abutment, an average of 10 feet should be stripped plus an additional 10 feet of excavation for the cutoff trench.

* Geologic Atlas of the United States, Smartsville Folio, California, U. S. Geological Survey, 1895.

In the channel section, a trench has been excavated along the course of the creek, presumably to drain New York Flat. This trench is 4 to 5 feet deep and 6 to 10 feet wide. The waste from this trench has been piled up along the left side of the channel section and could be used for riprap since it consists of hard blocks of diabase. Stripping in the channel section will consist of the removal of an average of 2 feet of soil and loose rock plus the excavation of 3 feet of hard rock for the cutoff trench.

A grout curtain will be necessary and the grout take should be low to moderate depending on the degree of jointing of the foundation rock.

The spillways for both stages of the dam are planned around the left abutment and will be fully lined. Hard rock excavation can be expected below 20 feet. An estimated 75 percent of the spillway excavation should be suitable as impervious fill.

Sufficient impervious material consisting of clayey flood plain alluvium is probably available along the north side of New York Flat Reservoir within 1-½ miles haul distance. Additional impervious material is probably present in Daken Flat within 3 miles haul distance to the southwest. Weathered spillway excavation material would also be suitable for impervious material.

Pervious material and riprap can be produced from a quarry located in the igneous rock outcropping on

Ruff Hill about 1 mile from the damsite. Aggregate is available from the French Dry Creek stream channel deposits located at the confluence with New York Creek, 1,500 feet from the site. However, high water table in channel section may be the limiting factor in borrow exploration.

Based on available information, New York Flat damsite appears suitable for construction of the proposed earthfill dam.

North Columbia Damsite

Based on geologic reconnaissance and limited drilling data, the North Columbia damsite is considered suitable for a 96-foot high earthfill structure. The rock forming the foundation is a slate or phyllite of the Calaveras group. The slate trends approximately north paralleling the axis of the dam and dips nearly vertically to the east and generally upstream. With proper stripping, the foundation is suitable for an earthfill structure. A stripping depth of 6 feet on the right abutment and 4 feet on the left abutment of severely weathered slate would be required. Stripping in the channel area will require the removal of 45,000 cubic yards of waste material resulting from the operation of a sawmill located on the dam axis, plus 3 feet of severely weathered slate. Additional excavation for a small cutoff trench is recommended. A grout curtain should be provided along the axis of the dam; a low grout take is estimated.

The proposed dam is to be an earthfill structure utilizing weathered slate with a clayey silt composition, and an upstream section composed of sands and gravels. Suitable quantities of weathered slate are available adjacent to the damsite. Pervious material and aggregate are available from areas less than 2 miles from the damsite. A limited amount of quarry rock of hard slate for rirap is available within the reservoir area. Considerable waste may be encountered in establishing a suitable working face. Careful shooting may be required in order to develop the quarry site.

An auxiliary dam will be required in a saddle south of the main dam. The foundation is severely weathered slate, but no problems are anticipated for this small structure.

A spillway located south of the main dam adjacent to the auxiliary dam will be partly on soft, severely weathered slate and partly on firm or hard slate. The firm or hard slate should provide a suitable foundation for a concrete spillway structure. Lining is recommended throughout the length of the spillway cut. A gully will serve as a natural spillway channel and discharge into the stream channel 150 feet below the toe of the dam.

The outlet works will rest on firm or hard slate along the left abutment. Some rock excavation may be required.

Tertiary auriferous gravels form part of the reservoir area. Drill holes showed generally a gravelly sandy clay material with occasional small saturated zones. Due to the low reservoir head and a high clay content of the auriferous gravels, substantial leakage from the reservoir is not considered to be a problem.

Shady Creek Damsite

The Shady Creek damsite area is underlain by granitic rocks mapped by Lindgren and Turner (1895) as granodiorite of Upper Jurassic age. The rock is light gray, coarse-to-medium-grained and hard where fresh. The rock in general has been deeply weathered, with the depth of weathering varying from near the surface to depths of 25 feet.

The right abutment has a very moderate slope until it nears the channel area. The depth of weathering of the granodiorite varies from a few feet to 25 feet. It will be necessary to strip an average of 10 feet of soil, decomposed granite, and weathered rock from this abutment for the impervious fill section, and an average of 5 feet of soil cover for the pervious fill section. An additional average cutoff depth of 10 feet beneath the impervious section is estimated. The decomposed granite can possibly be used in the impervious fill section. The creek bends around a knoll where the right abutment joins the channel section. A tunnel 6 feet in diameter and 30 feet long has been driven through this knoll, and is in fresh and moderately blocky granodiorite.

The channel section is approximately 30 feet wide and is filled to an average depth of 5 feet with sand, gravel, and granitic blocks. It will be necessary to remove this material from the impervious section of the dam. No further stripping will be necessary in the channel section.

The left abutment has an average slope of 22 degrees with excellent exposures of fresh bedrock near the channel which become weathered rock with a few exposures on the upper abutment. It is estimated that the average stripping depth of weathered rock and soil beneath the impervious section will be 5 feet, with an additional 5 feet of excavation required in the cutoff trench. Three feet of stripping of soil for the pervious section will be required.

Three feet of stripping to remove the root zone and soil will be required for the two auxiliary dams, with an additional three feet of excavation required in the cutoff trench.

A grout curtain will be necessary along the axis of the main dam and the grout take should be low to moderate depending on the amount of jointing of the foundation rock.

An excellent location for the spillway is over the left abutment. Good, firm rock will be encountered at an average depth of approximately 20 feet. The waste material from the spillway can be used in the construction of the dam. It is recommended that the spillway be lined.

Sufficient impervious material appears to be present in the reservoir area within a 1 mile haul distance. This material would consist of weathered granodiorite. Sufficient pervious material of apparently suitable quality occurs upstream from the site within a 1 mile haul distance. This material is the tailings from the North Columbia diggings. It should also make excellent aggregate. Rock of suitable quality for riprap can probably be quarried from the ridge to the south within one-half mile of the damsite.

Reservoir sedimentation may be a problem. An extensive area of tailings occurs in the reservoir area. A small dam upstream from the proposed Shady Creek damsite was almost filled with tailings during the October 1962 heavy rains.

Based on the foregoing, Shady Creek damsite appears suitable for construction of the proposed fill dam.

Bloody Run Damsite

Bloody Run damsite area is underlain by a black slate or schist of the Calaveras group and is exposed as hard, fresh rock in the channel area, but is moderately weathered and jointed on the abutments. Dominant jointing parallels the foliation which generally strikes normal to the stream channel and dips steeply upstream. Andesitic mudflows and gravels of the Mehrten formation occur close to the damsite a short distance upstream and along the higher elevations of the abutments.

Average stripping depths beneath impervious and pervious sections of an earthfill dam are estimated to be 7 feet and 5 feet, respectively, for the right abutment, and 6 feet and 3 feet, respectively, for the left abutment. Stripping of the channel area will be required to remove an average of 3 feet of stream debris.

A spillway around the left abutment should be largely on firm rock with stable spillway slopes of 1 to 1. The spillway chute will require lining for its entire length.

Weathered slate or schist within one-half mile downstream from the site is available as impervious earthfill material. Rock from a granitic outcrop 1,000 feet downstream from the site should provide a sufficient but limited amount of material for rockfill, riprap and crushed aggregate.

On the basis of preliminary geologic reconnaissance, Bloody Run damsite is considered suitable for a rockfill dam up to a height of 150 feet above channel elevation.

Weaver Lake Damsite

Weaver Lake damsite area is underlain by a hard, black, columnar-jointed basalt. Exposed by a vertical cliff downstream from the site is an andesitic mudflow which underlies the basalt. The thickness of the basalt underlying the streambed is estimated at 30 feet.

Stripping at the site would be very shallow as the basalt bedrock is largely exposed along the abutments and channel area with little vegetative cover. Leakage does not appear to be a problem. Both the basalt and the andesitic mudflow appear to be of low permeability as no reservoir seepage was observed from the downstream outcrops.

Weaver Lake, a natural lake formed by glacial action, is intercepted by a 6-foot diameter tunnel which presently drains an estimated 2 cubic feet per second of lake water. This unlined tunnel, probably constructed by early miners, was driven through the andesitic mudflow beneath and west of the left abutment. The exit portal is downstream from the proposed site about 40 feet below streambed elevation. Near the reservoir edge, west of the left abutment, a vertical shaft was sunk to the tunnel close to the intake portal. Outflow occurs through this tunnel even though an attempt was made to block the tunnel at the vertical shaft. However, effective sealing of the tunnel should not be difficult.

A spillway around the right abutment would be in hard basalt. The excavated material could be used for rockfill.

For rockfill, large angular fragments of basalt of 8-inch diameter could be obtained from talus deposits or potential quarry sites located adjacent to the right abutment on the downstream side. Glacial moraine deposits on the east side of the reservoir area may provide sufficient quantities of impervious material. If glacial moraine deposits are inadequate, a concrete membrane over the upstream face of a rockfill dam would be satisfactory. Aggregate for concrete structures could be obtained nearby from crushed basaltic or granitic rock, or from stream gravels along the reservoir area.

Bitney Corner Damsite

Bitney Corner damsite is underlain by two types of bedrock. Most of the site is underlain by hard, dark, fine-grained metavolcanic rock, probably greenstone or amphibolite. The downstream portion of the dam will be underlain by a moderately coarse gray-green granitic rock. Good exposures of fresh rock of both types occur along the channel and on the abutments up to a height of about 75 feet. Above 75 feet on the right abutment, depth of weathering increases and less rock is exposed. No rock exposures were noted on the left abutment above this height. Both abutments have a heavy covering of brush and a moderate covering of trees.

The stripping estimates are for an earthfill type dam with a cutoff trench. Depths are normal to the surface.

The right abutment has an average slope of 28 degrees. About 10 feet of soil and weathered rock should be stripped. The channel section is approximately 40 feet wide and would require the removal of about 5 feet of sand

and gravel. The rock in the channel section is sufficiently hard to support a cut and cover conduit. The left abutment has an average slope of 20 degrees. Stripping of 8 feet of soil and weathered rock is recommended. In addition to the above stripping, a cutoff trench excavated to a depth of 5 to 10 feet should be provided.

The proposed spillway is around the left abutment of the dam. Any excavation below a depth of 25 feet will be in hard rock. Most of the excavated material could be used in the dam. Lining of the spillway chute for its entire length is recommended.

Sufficient amounts of suitable impervious material can probably be obtained from the flat above the left abutment and from Randolph Flat near Bitney Corner. All of this material lies within a 1-½ mile haul distance. The best pervious material is probably the tailings that occur approximately 3 miles upstream from the site. No definite source of rock for riprap was located; however, a quarry site may be found along the granitic ridges above the right abutment.

Based on the foregoing, the site appears suitable for the construction of an earthfill dam.

Anthony House Damsite

Anthony House damsite area is underlain by granitic rocks mapped by Lindgren and Turner (1895) as granodiorite of Upper Jurassic age. The rock is light gray medium-grained and hard where fresh. At the site, the granodiorite is deeply weathered with only a few outcrops on the abutments. Numerous lamphrophyric dikes cut through the rock. The contacts between the dike rock and granitic rock are tight and should not present any problems. Where the Excelsior Ditch ends, at the downstream end of the right abutment, the water from the ditch has eroded a gully 15 to 18 feet deep in the weathered granitic rock.

The channel is 50 to 100 feet in width and is covered with sand and gravel to an average depth of about 10 feet. The slopes of the abutments are 30 degrees or less. Only a few exposures of fresh rock were noted. The most prominent of these occurs along the right side of the channel. The abutments have a moderate covering of brush and trees.

Stripping of the abutments will be high due to deep weathering. All stripping depths indicated are normal to the surface. For both abutments, approximately 10 feet of clayey silty soil and root zone material should be removed. In the channel it will be necessary to remove approximately 10 feet of stream gravels. In addition, a cut-off trench would require the removal of an additional 20 feet of decomposed rock. A grout curtain along the axis of the dam is recommended.

The proposed spillway location is around the right abutment of the dam. Under the ogee section an estimated

25 feet of weathered rock will probably require removal. The spillway chute should be lined for its entire length.

Sufficient impervious material can be found in the valley area around Anthony House within 1 mile haul distance of the site. If this material proves to be unsuitable, the next nearest large source is in Penn Valley, 3 miles to the southeast. Rock of suitable quality for rockfill or riprap can probably be quarried from George Washington Hill, within one-half mile of the damsite. Gravels suitable for aggregate or fill can probably be obtained upstream in the reservoir within 1 mile. These are fairly well graded and consist predominantly of granitic material.

Based on the foregoing, the site appears suitable for construction of the proposed earthfill dam.

Clover Valley Damsite

Geologic exploration of Clover Valley damsite consisted of a surface inspection and a small amount of refraction seismograph work. The damsite and proposed reservoir area are underlain by three general rock types. They are granite, mixed sediments of the Ione formation, and volcanic mudflows of the Mehrten formation.

The granite underlies the flat channel area at the site and most of the reservoir area and is very hard where fresh, but most places near the surface it is decomposed. Overlying the granite are mixed sediments about 75 feet in thickness at the damsite. They appear to thin out toward the east and disappear in about one-half mile. The sediments consist of sandstone, siltstone, and some conglomerate in the upper part of the formation.

Volcanic mudflows appear to cap the upper part of the dam abutments and the ridges around the reservoir. The mudflows consist of hard andesite fragments, ranging in size from a few inches to several feet, embedded in a softer tuffaceous matrix.

At the right abutment there are no good rock exposures or subsurface information to determine the exact foundation conditions. It appears, however, that the abutment consists mainly of the mixed Ione sediments. The sediments horizontally overlie granite with the contact somewhere near the base of the abutment. Volcanic mudflow material which overlies the Ione sediments, may occur in the upper part of the abutment.

If a rockfill dam is constructed, there may be a differential settlement problem in the rockfill sections after the foundation is saturated with water. This problem can be handled in either of two ways. Design the impervious section large enough so that it would not be greatly affected by differential settlement in the rockfill sections. The second method of control would be to have a suitable transition zone between the foundation and the rockfill material.

Approximately 10 feet of soil and rock should be removed from under the impervious section of a zoned dam. About 4 feet of stripping will be necessary under the pervious section

For an earthfill dam an average of 3 feet of stripping would be sufficient. Some ripping will be required. Most of the material stripped from the right abutment will be wasted although it may be possible to use some of it as transition material.

No cutoff trench or grout curtain is recommended for the right abutment as the quality of rock does not improve with depth.

The <u>channel section</u> is about 600 feet wide. A small stream with a four or five second-foot flow meanders sinuously along the left side.

Granitic rocks underlie the channel. The granite exposed at the surface is decomposed except for a few isolated residual boulders lying on the surface. A limited refraction seismograph survey indicated that hard rock is located at a depth of 35 feet. Stripping depths for a rockfill dam will probably consist of about 15 feet under both the impervious and pervious sections. Less than 15 feet of stripping may be possible if additional subsurface information shows that the decomposed granite is suitable as rockfill foundation material. Most of the stripped material can be used as impervious fill. Stripping for an earthfill dam will be 5 feet. A cutoff trench about 30 feet in depth will be necessary. A grout curtain in the channel section is recommended.

At the <u>left abutment</u> the underlying rock is about the same as on the right abutment and appears to have similar physical characteristics.

Average stripping depths for the impervious section of a rockfill dam should be about 10 feet. For the pervious section, stripping depth would be about 3 feet. Stripping for an earthfill dam would be about 3 feet. These estimates are measured normal to the slope and include a 1-foot soil cover. Light ripping will probably be required for stripping operations. Most of the material stripped will be wasted.

A spillway could be located across the ridge forming the right abutment. The underlying rock appears to be a volcanic mudflow, and is probably suitable for the foundation of a small concrete structure. Stripping of about 5 feet should produce suitable foundation rock. The spillway should be lined from the weir to the downstream edge of the ridge.

The reservoir will be underlain mainly by granite. Near the surface, most of the granite is decomposed. Mixed sediments underlie the valley sides near the damsite. They appear to thin out and gradually disappear about one-half mile upstream. Volcanic mudflow materials cap the ridges around the reservoir area. These materials will be above the high water level except for a short distance near the damsite.

Leakage could be a problem as the above-described mixed sediments are relatively pervious. Neither permeability nor the extent of the sediments in the reservoir have been determined.

Suitable appearing materials are located within 1 mile of the site. Decomposed granite, which could be used for impervious material, is available in the reservoir area. The borrow area could be excavated to an average depth of about 10 feet. Some ripping will be necessary.

A potential quarry area for rockfill and riprap was located about three-quarters of a mile upstream in the reservoir area on the ridge forming the right abutment. This quarry contains enough rock for the proposed structure. The fines resulting from quarry operations could be used for the transition zone.

A possible source of semipervious material was located downstream about 2-½ miles. This material ranges in size from clay to boulders with approximately 50 percent sand size or less. No exploration has been done, but it is possible that large quantities could be obtained by common means. It is derived from conglomerate near the upper part of the Ione formation. The processing of this material for pervious or drain is possible; however, there may be some trouble removing clay sizes. It is covered in some places by volcanic mudflow material.

Gravel, probably suitable for filter material, is available along the American River near Folsom. The haul distance would be in excess of 8 miles.

Based on the foregoing, the site appears suitable for an earthfill or a rockfill dam.

Bibliography of Geologic Office Reports
on Major Damsites Investigated Pursuant
to Yuba and Bear Rivers Basin Investigation

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"Engineering Geology of Indian Valley and Shenanigan Damsites on North Yuba River, Sierra County, April 1959."

"Engineering Geology of New Bullards Bar Damsite on North Yuba River, Yuba County, April 1959."

"Engineering Geology of New Bullards Bar Afterbay Damsite on North Yuba River, Yuba County, April 1959."

"Engineering Geology of Freemans Crossing Damsite on the Middle Yuba River, Nevada and Yuba Counties, April 1959."

"Interim Geologic Report of North San Juan Damsite on Yuba River, Yuba and Nevada Counties, April 1959."

"Reconnaissance Engineering Geology of Upper Narrows Damsite on Yuba River, Nevada and Yuba Counties, April 1959."

"Reconnaissance Engineering Geology of Lower Narrows Damsite on Yuba River, Nevada and Yuba Counties, April 1959."

"Engineering Geology of Parks Bar Damsite on Yuba River, Yuba County, April 1961."

"Engineering Geology of Parks Bar Afterbay Damsite on Yuba River, Yuba County, April 1959."

"Engineering Geology of (French) Dry Creek Damsite, Yuba County, (Parks Bar Project) April 1961."

"Engineering Geology of Long Bar Damsite on Yuba River, Yuba County, April 1959."

"Reconnaissance Engineering Geology of Brownsville Damsite on (French) Dry Creek in Yuba County, February 1961."

"Engineering Geology of Marysville Damsite on Yuba River, Yuba County, April 1959."

"Engineering Geology of the Channel Section of Marysville Damsite on Yuba River, Yuba County, May 1961."

"Reconnaissance Engineering Geology of New York Flat Damsite on New York Creek, Yuba County."

"Engineering Geology of North Columbia Damsite on a Tributary of Grizzly Creek, Nevada County, January 1961."

"Reconnaissance Engineering Geology of Bloody Run Damsite on Bloody Run Creek, Nevada County."

"Reconnaissance Engineering Geology of Shady Creek Damsite on Shady Creek, Nevada County."

"Reconnaissance Engineering Geology of Bitney Corner Damsite on Deer Creek, Nevada County."

"Reconnaissance Engineering Geology of Anthony House Damsite on Deer Creek, Nevada County."

"Reconnaissance Engineering Geology of Weaver Lake Damsite on Weaver Creek, Nevada County."

"Reconnaissance Engineering Geology of Clover Valley Damsite on Clover Valley Creek, Placer County."

APPENDIX H

AGREEMENT BETWEEN THE

DEPARTMENT OF WATER RESOURCES AND THE

YUBA COUNTY WATER AGENCY

AGREEMENT BETWEEN THE CALIFORNIA DEPARTMENT OF WATER RESOURCES AND THE YUBA COUNTY WATER AGENCY

THIS AGREEMENT is made this 23rd day of May 1962, between the State of California, acting by and through the Department of Water Resources, hereinafter called the "DEPARTMENT," and the Yuba County Water Agency, hereinafter called the "AGENCY."

W I T N E S S E T H :

1. WHEREAS, the AGENCY is proposing to construct a multipurpose project consisting of a Bullards Bar Dam and Reservoir and other facilities, including associated power facilities and particularly a New Narrows Powerplant on the Yuba River downstream from existing Englebright Dam and Reservoir; and

2. WHEREAS, the AGENCY has requested the California Water Commission to assign to the AGENCY Application No. 5631 and Application No. 5632 filed by the State of California on July 30, 1927; and

3. WHEREAS, the DEPARTMENT has published and issued a report entitled "Progress Report on the Yuba and Bear River Drainage Basins Investigation, May 1961," which discloses that the coordinated development of the water resources of the State under the California Water Plan includes eventual construction and operation of a Marysville Dam and Reservoir located on the Yuba River

between Browns Valley Ridge and McCartie Hill having a storage capacity of approximately 1,000,000 acre-feet and a normal water surface elevation of 340 feet U.S.G.S. datum; and

4. WHEREAS, at the hearings on the assignment of Applications Nos. 5631 and 5632 held by the California Water Commission, the DEPARTMENT urged the inclusion of conditions in any assignment so that the construction of Marysville Dam would not be impaired, which conditions related to the damage or loss of power production of the AGENCY'S project due to the construction of Marysville Dam; and

5. WHEREAS, the California Water Commission indicated at its meeting on May 4, 1962, that an assignment of Applications Nos. 5631 and 5632 should be made to the AGENCY upon terms which will prevent any encroachment by the AGENCY'S project upon the possibility of ultimate construction and operation of Marysville Dam and Reservoir, and that a further hearing would be held upon the issue of such terms; and

6. WHEREAS, the AGENCY is desirous of reaching an agreement with the DEPARTMENT which, if acceptable to the California Water Commission, will avoid the necessity of an additional hearing on the AGENCY"S request for assignment of Applications Nos. 5631 and 5632; and

7. WHEREAS, the construction and operation of said Marysville Dam and Reservoir could cause loss in power head and damage to the AGENCY'S power facilities;

NOW, THEREFORE, IT IS AGREED AS FOLLOWS:

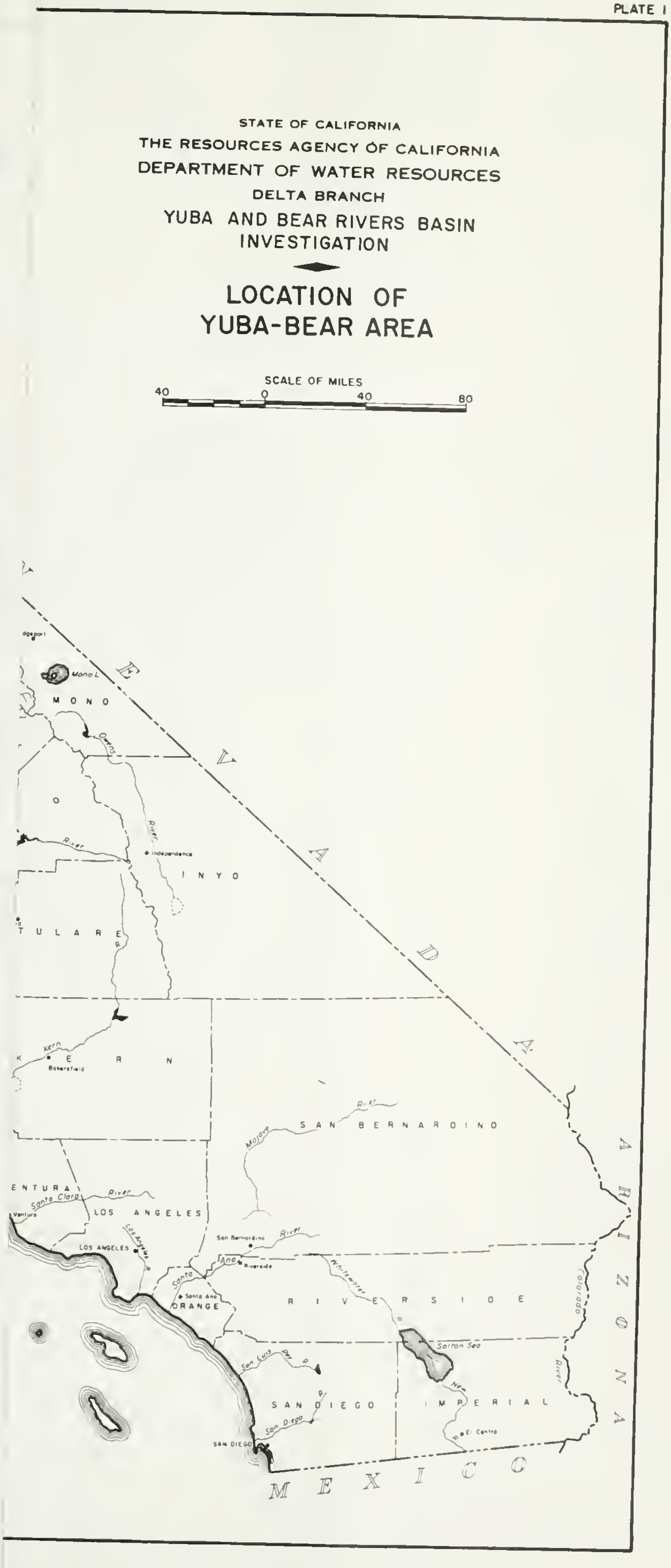
8. The AGENCY agrees to bear any loss of power head and any damages to the AGENCY'S New Narrows Powerplant facilities and any costs deemed by the AGENCY to be necessary or desirable to prevent or mitigate such loss or damages resulting from or caused by the design, construction, or operation of such Marysville Dam and Reservoir within the limits of a normal water surface elevation not in excess of 340 feet U.S.G.S. datum, and agrees that neither the State of California nor the United States of America nor any other agency designing, constructing, or operating Marysville Dam and Reservoir shall be liable for such loss of power head or damages to such New Narrows Powerplant facilities.

9. The ageement by the AGENCY to bear any loss of power head and any damages to said New Narrows Powerplant is expressly limited to the construction and operation of said Marysville Dam and Reservoir within the limits of a normal water surface elevation of 340 feet U.S.G.S. datum, and in no event shall such agreement be applicable to any other project, or division of a project or to said Marysville Dam and Reservoir if designed, constructed, and operated above a normal water elevation of 340 feet U.S.G.S. datum.

IN WITNESS WHEREOF the parties hereto have signed this agreement the day and year first above written.

APPROVED AS TO FORM	YUBA COUNTY WATER AGENCY
/s/ Alvin Landis	/s/ Ben Rose, President
Attorney for Yuba County Water Agency	/s/ E. L. Gray, Secretary
APPROVED AS TO LEGAL FORM AND SUFFICIENCY	DEPARTMENT OF WATER RESOURCES
/s/ P. A. Towner	/s/ W. E. Warne, Director
Chief Counsel Department of Water Resources	

PLATE 1



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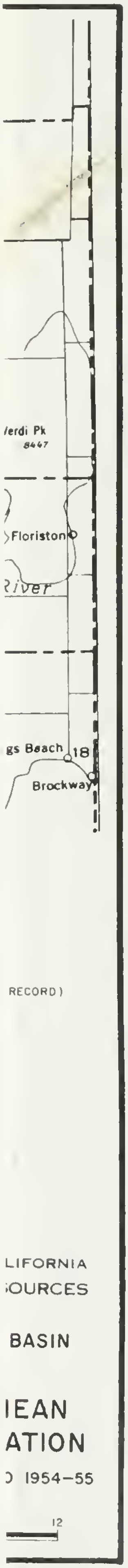

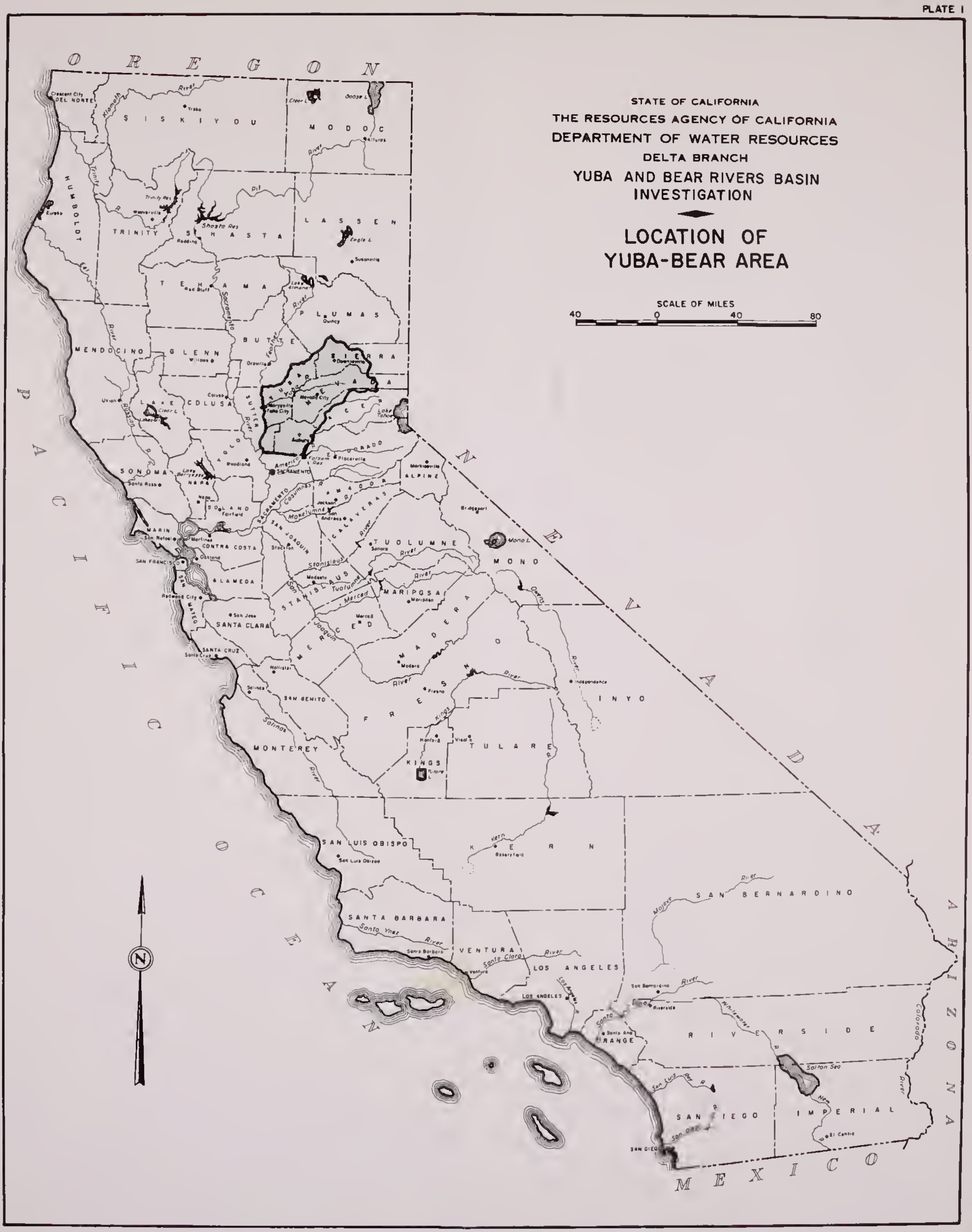
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN INVESTIGATION
LOCATION OF YUBA-BEAR AREA
SCALE OF MILES
40 0 40 80
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
LAKE
COLUSA
SUTTER
YUBA
PLACER
YOLO
EL DORADO
SONOMA
NAPA
SOLANO
SACRAMENTO
ALPINE
AMADOR
MARIN
CONTRA COSTA
SAN JOAQUIN
CALAVERAS
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
SAN BENITO
FRESNO
INYO
MONTEREY
KINGS
TULARE
SAN LUIS OBISPO
KERN
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VENTURA
LOS ANGELES
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SAN DIEGO
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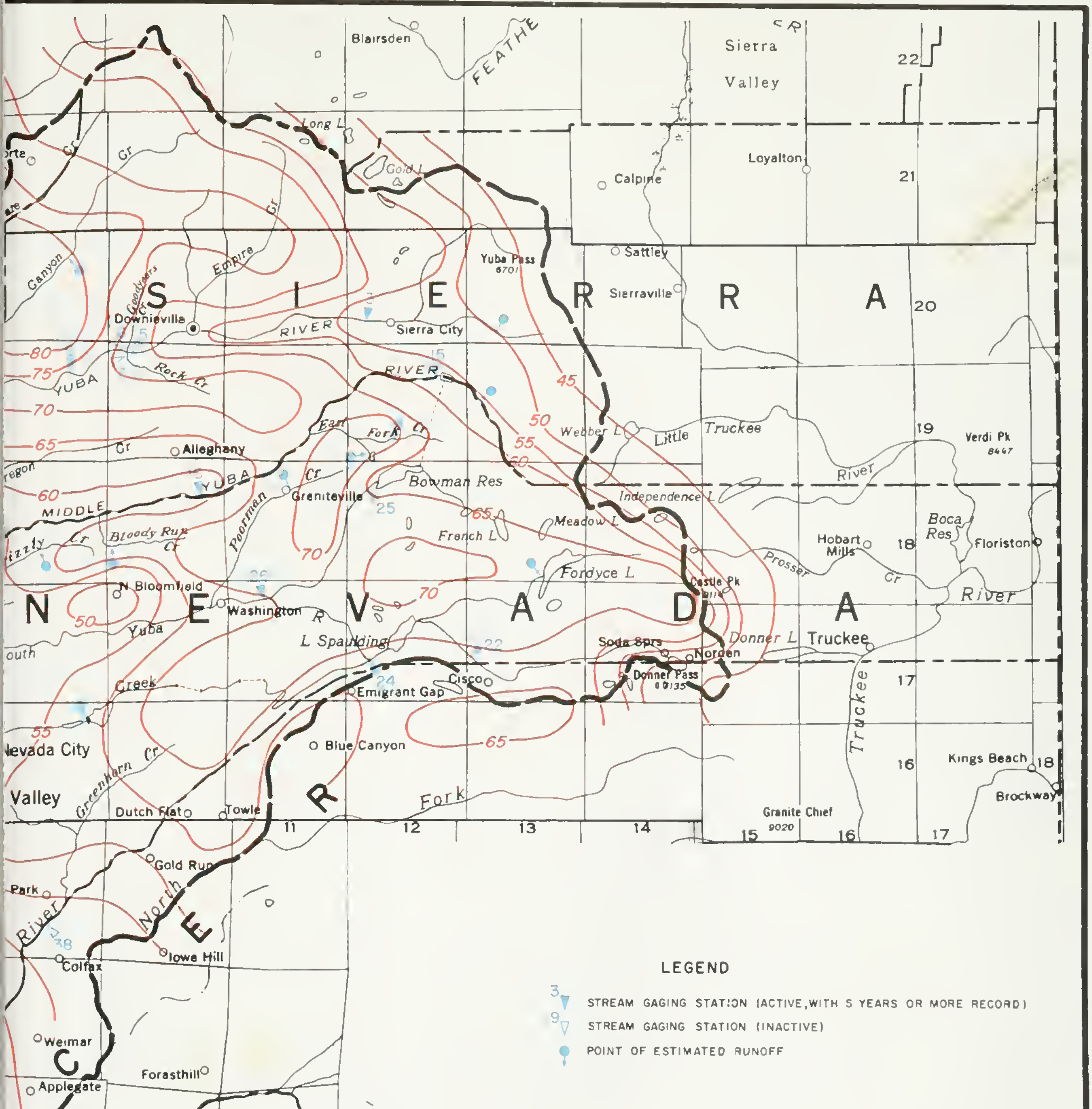


STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

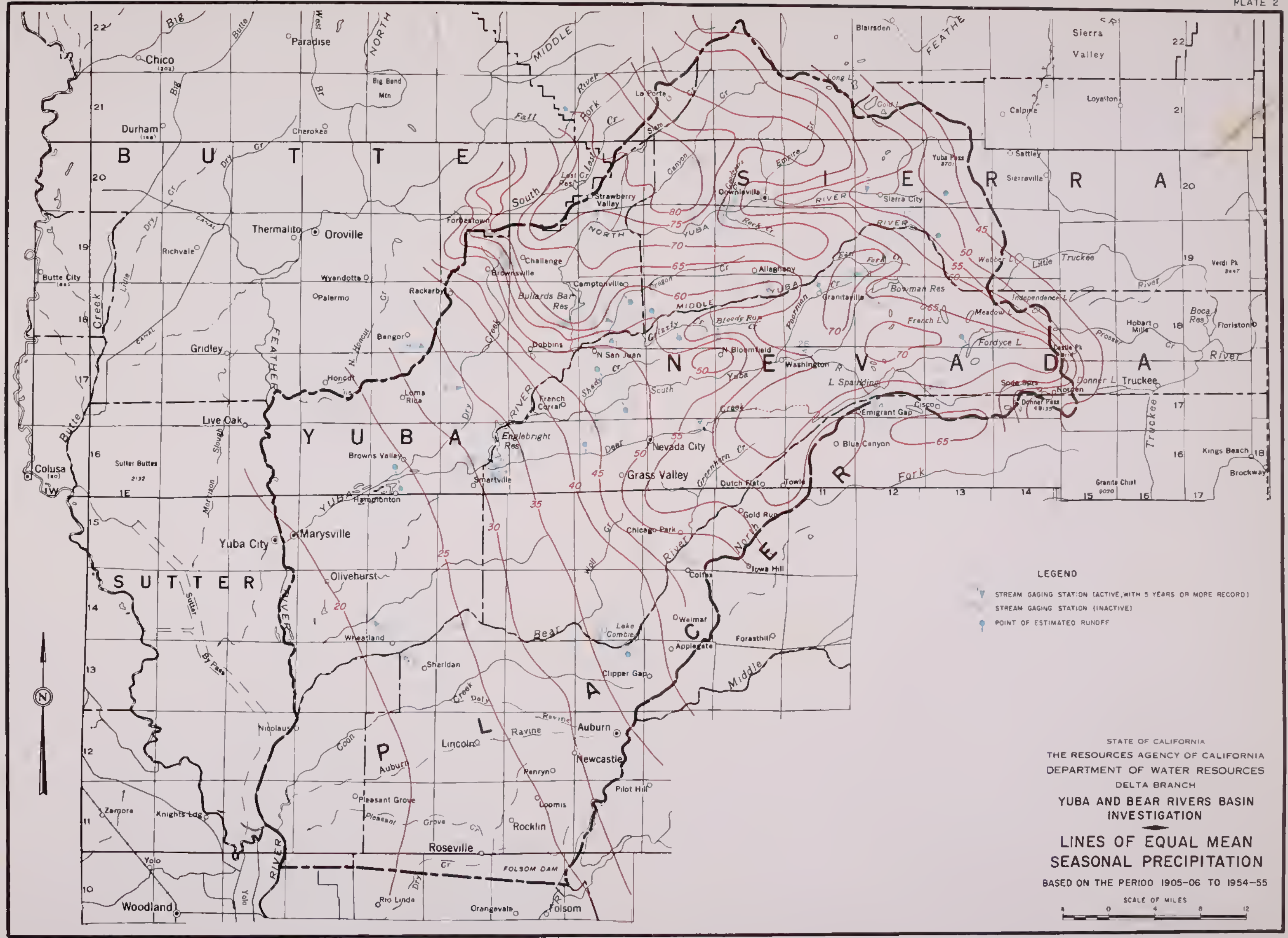
LINES OF EQUAL MEAN SEASONAL PRECIPITATION

BASED ON THE PERIOD 1905-06 TO 1954-55

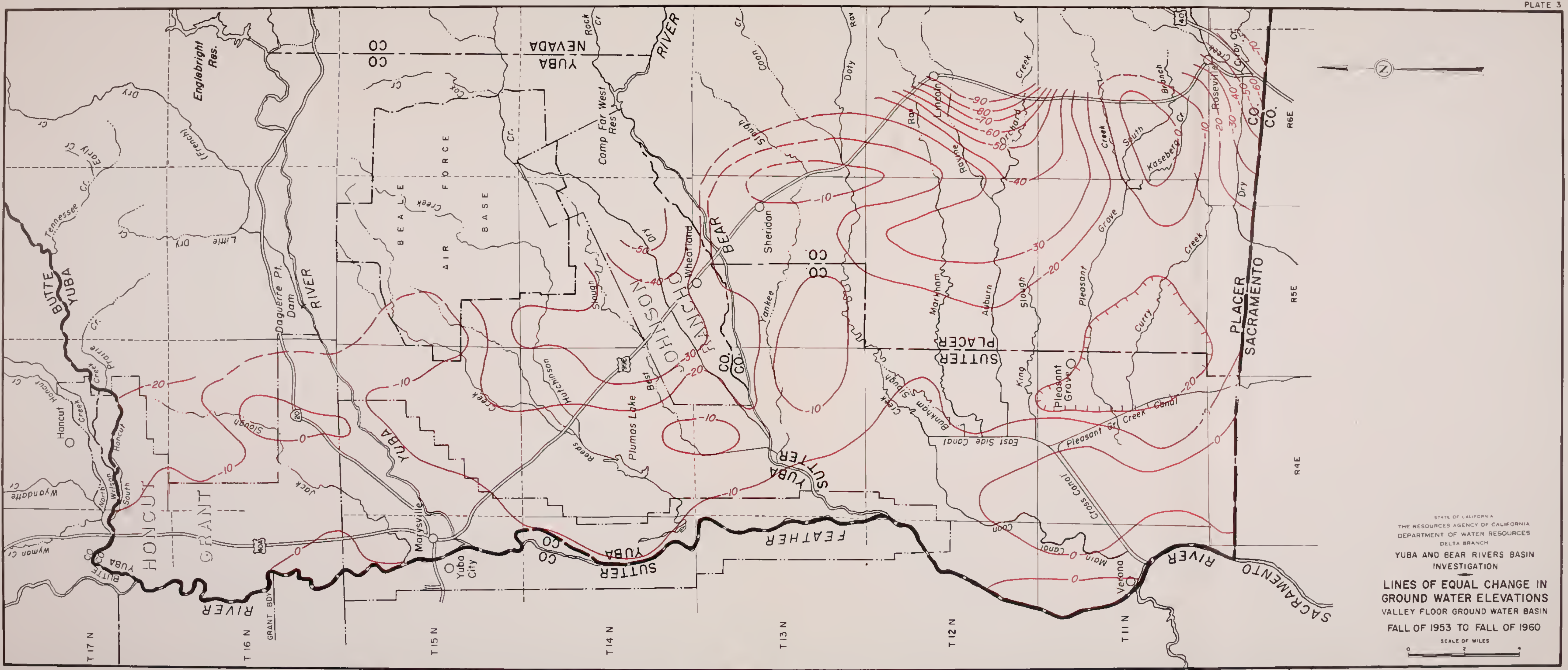
SCALE OF MILES
4 0 4 8 12

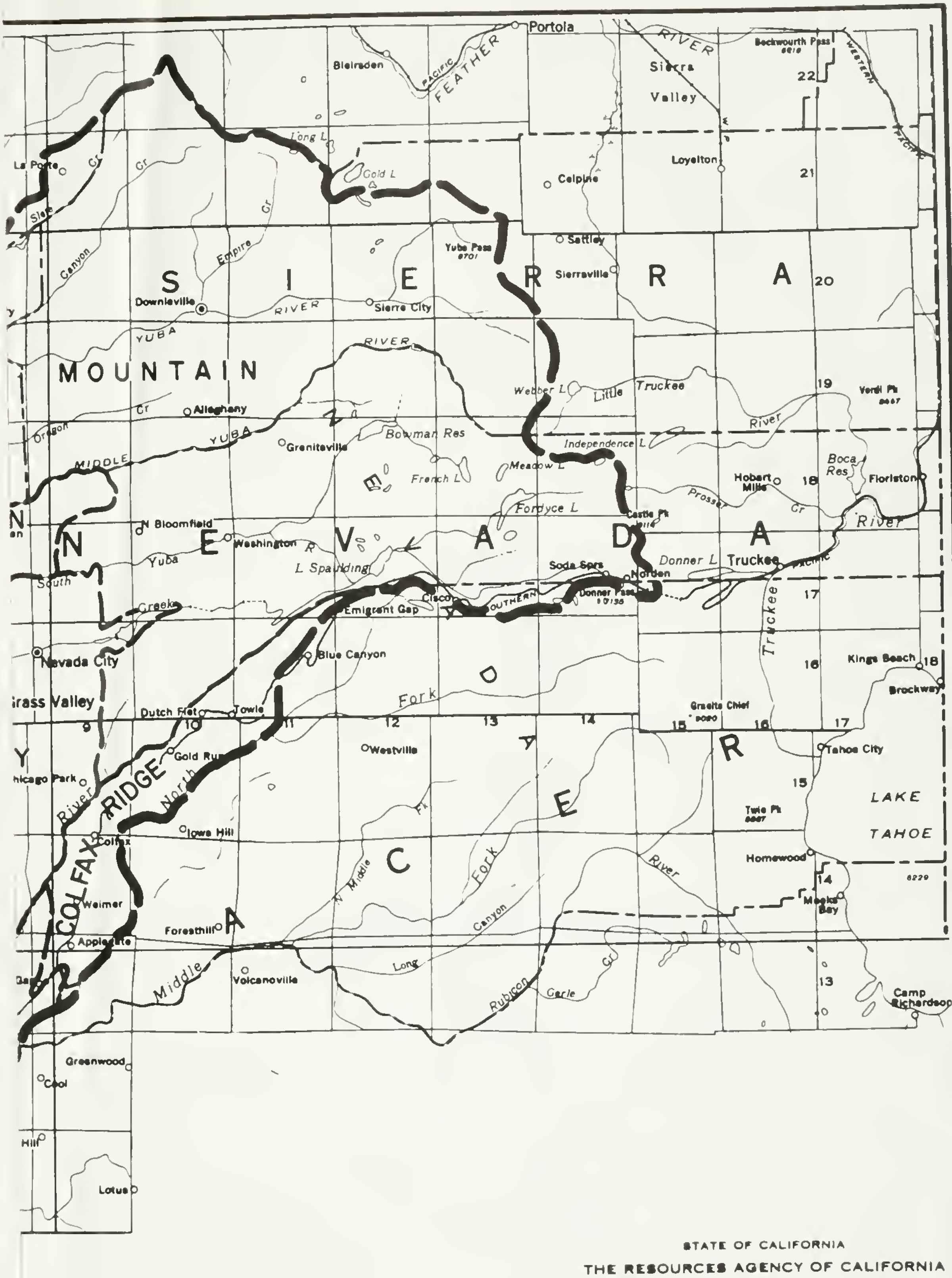
INDEX TO STREAM GAGING STATIONS

Reference number	Station
3	North Yuba River near Sierra City
4	Downie River at Downieville
5	North Yuba River at Goodyears Bar
6	Goodyears Creek at Goodyears Bar
7	Rock Creek at Goodyears Bar
8	North Yuba River below Goodyears Bar
13	North Yuba River below Bullards Bar
15	Middle Yuba River at Milton
17	Middle Yuba River above Oregon Creek
18	Oregon Creek near North San Juan
19	Middle Yuba River near North San Juan
22	South Yuba River near Cisco
24	South Yuba River at Langs Crossing
25	Canyon Creek below Bowman Lake
26	South Yuba River near Washington
29	South Yuba River at Jones Bar
30	Yuba River at Englebright Dam
33	Deer Creek near Smartville
34	Yuba River at Smartville
38	Bear River near Colfax
40	Bear River near Auburn
42	Bear River at Van Trent
43	Bear River near Wheatland
45	Dry Creek near Wheatland
46	Dry Creek near Brownsville
47	Dry Creek at Virginia Ranch
49	South Honcut Creek near Bangor




Roseville


STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN
INVESTIGATION
LINES OF EQUAL CHANGE IN
GROUND WATER ELEVATIONS
VALLEY FLOOR GROUND WATER BASIN
FALL OF 1953 TO FALL OF 1960
SCALE OF MILES
0
2
4
Marysville
Yuba City
Wheatland
Sheridan
Lincoln
Roseville
Verona
Pleasant Grove
Honcut
Englebright Res.
Camp Far West Res.
BEALE AIR FORCE BASE
JOHNSON RANCHO
HONCUT
GRANT
FEATHER
SACRAMENTO
BEAR
YUBA
RIVER
T 17 N
T 16 N
T 15 N
T 14 N
T 13 N
T 12 N
T 11 N
R4E
R5E
R6E

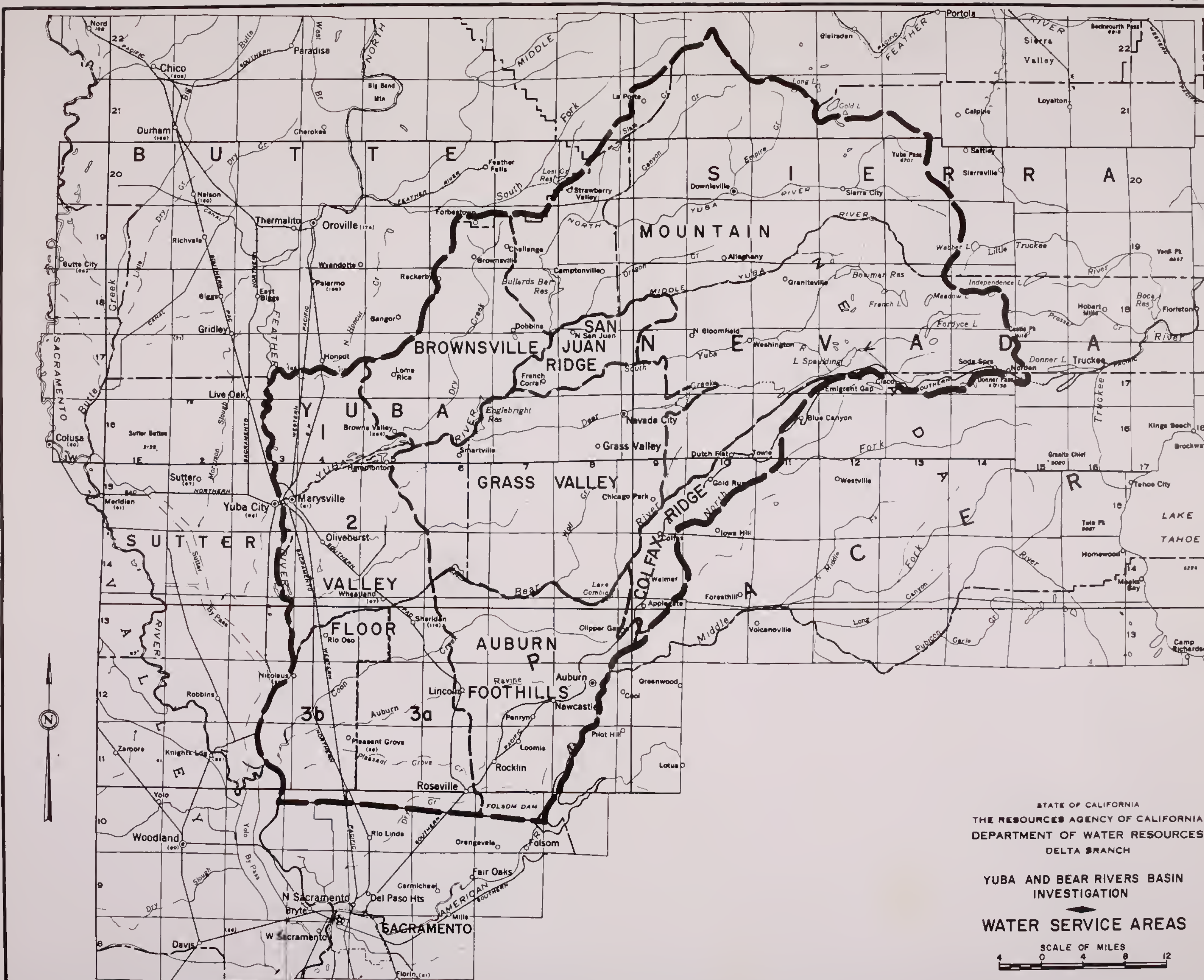


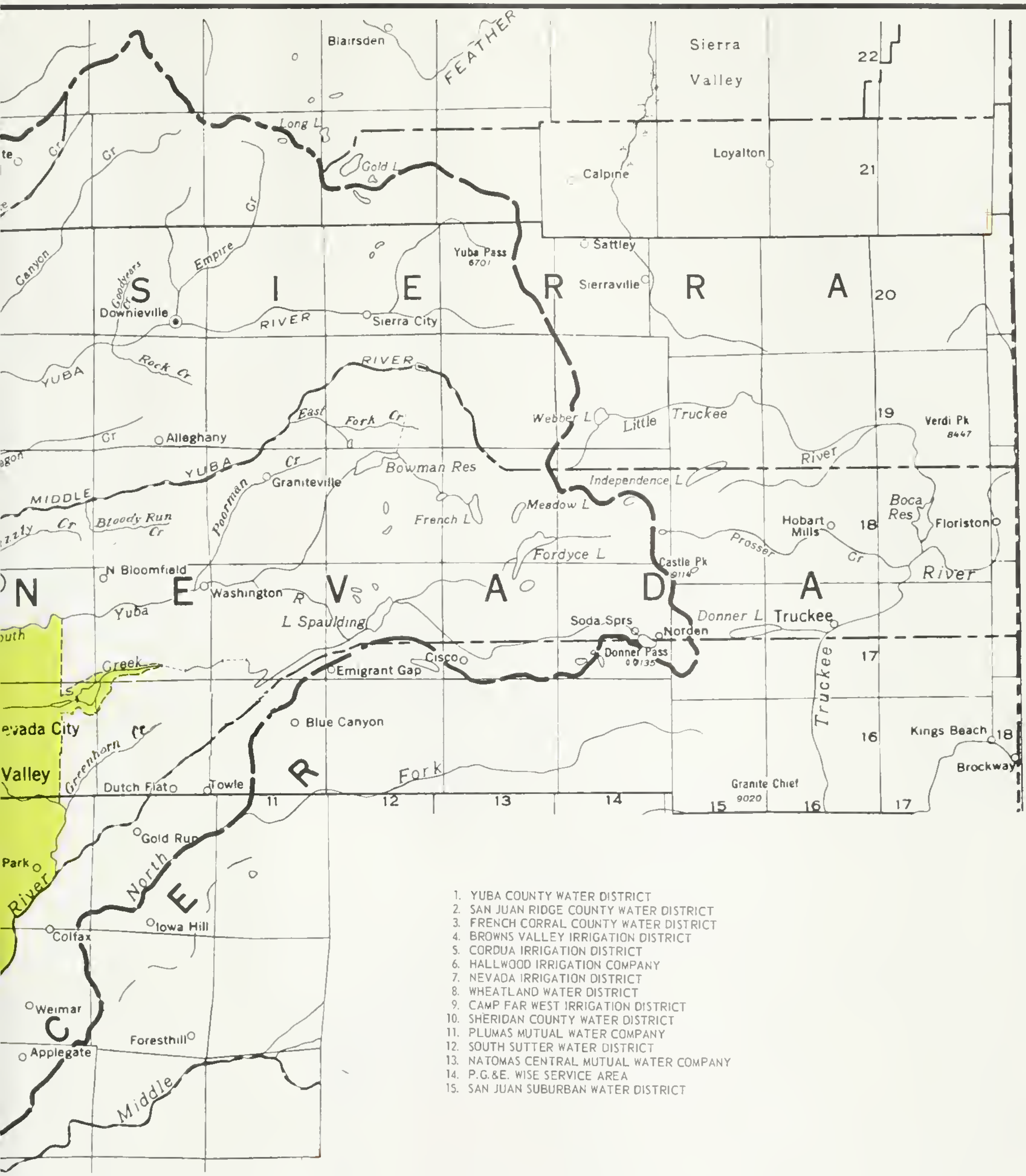
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

WATER SERVICE AREAS

SCALE OF MILES
4 0 4 8 12


BUTTE
SIERRA
MOUNTAIN
NEVADA
BROWNSVILLE
SAN JUAN RIDGE
YUBA
GRASS VALLEY
COLFAX RIDGE
SUTTER
VALLEY FLOOR
AUBURN FOOTHILLS
YOLO
PLACER
2
3a
3b
Chico
Paradise
Durham
Oroville
Thermalito
Feather Falls
Forbestown
Downieville
Sierra City
Portola
Loyalton
Truckee
Marysville
Yuba City
Gridley
Live Oak
Colusa
Nevada City
Grass Valley
Colfax
Auburn
Lincoln
Wheatland
Roseville
Folsom
Woodland
Davis
SACRAMENTO
N Sacramento
W Sacramento
Del Paso Hts
Fair Oaks
Rocklin
Newcastle
Penryn
Loomis
LAKE TAHOE
FOLSOM DAM
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN INVESTIGATION
WATER SERVICE AREAS
SCALE OF MILES
4 0 4 8 12



1. YUBA COUNTY WATER DISTRICT
2. SAN JUAN RIDGE COUNTY WATER DISTRICT
3. FRENCH CORRAL COUNTY WATER DISTRICT
4. BROWNS VALLEY IRRIGATION DISTRICT
5. CORDUA IRRIGATION DISTRICT
6. HALLWOOD IRRIGATION COMPANY
7. NEVADA IRRIGATION DISTRICT
8. WHEATLAND WATER DISTRICT
9. CAMP FAR WEST IRRIGATION DISTRICT
10. SHERIDAN COUNTY WATER DISTRICT
11. PLUMAS MUTUAL WATER COMPANY
12. SOUTH SUTTER WATER DISTRICT
13. NATOMAS CENTRAL MUTUAL WATER COMPANY
14. P.G.&E. WISE SERVICE AREA
15. SAN JUAN SUBURBAN WATER DISTRICT

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

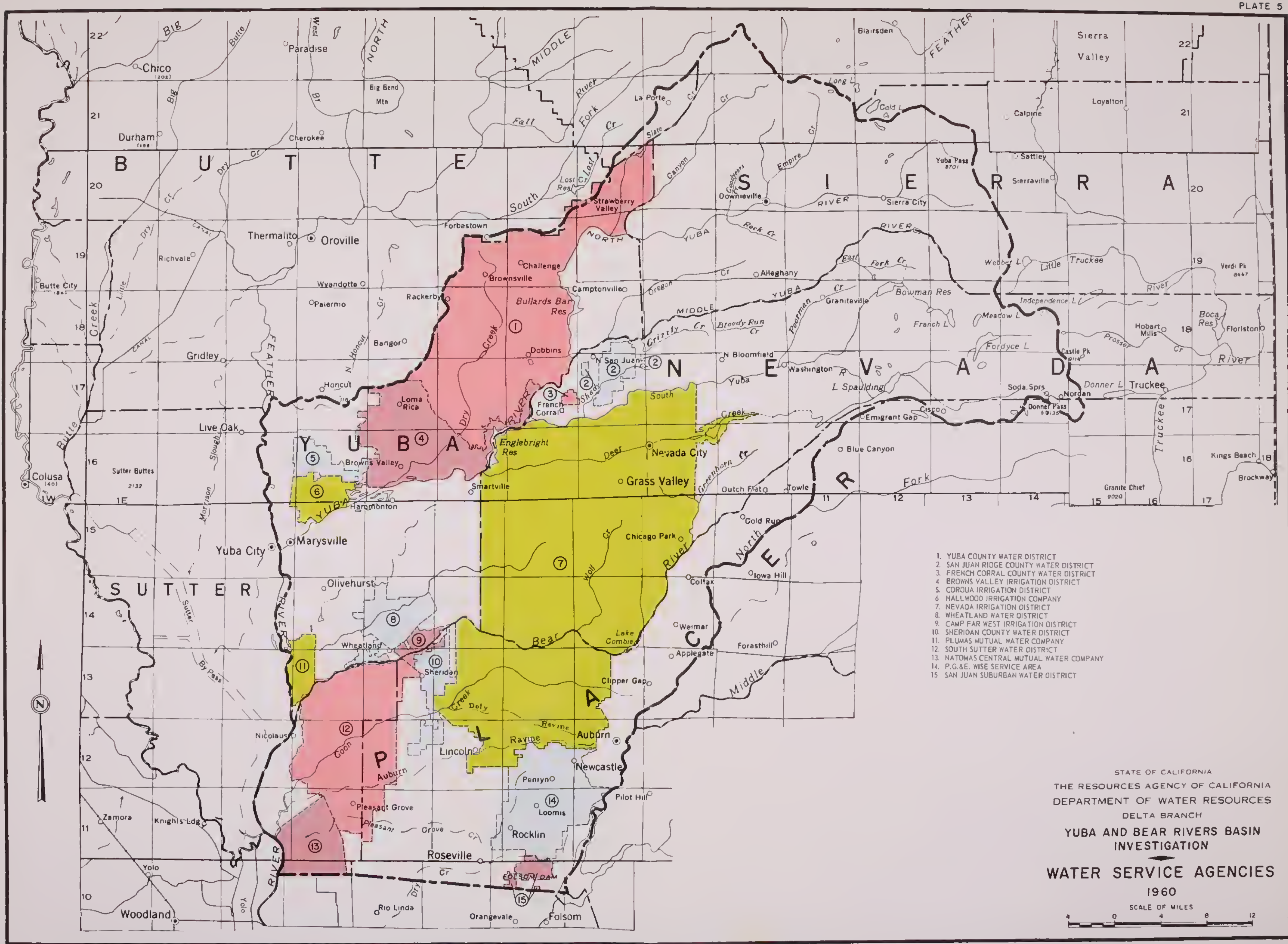
YUBA AND BEAR RIVERS BASIN INVESTIGATION

WATER SERVICE AGENCIES

1960

SCALE OF MILES

4 0 4 8 12



1. YUBA COUNTY WATER DISTRICT
2. SAN JUAN RIDGE COUNTY WATER DISTRICT
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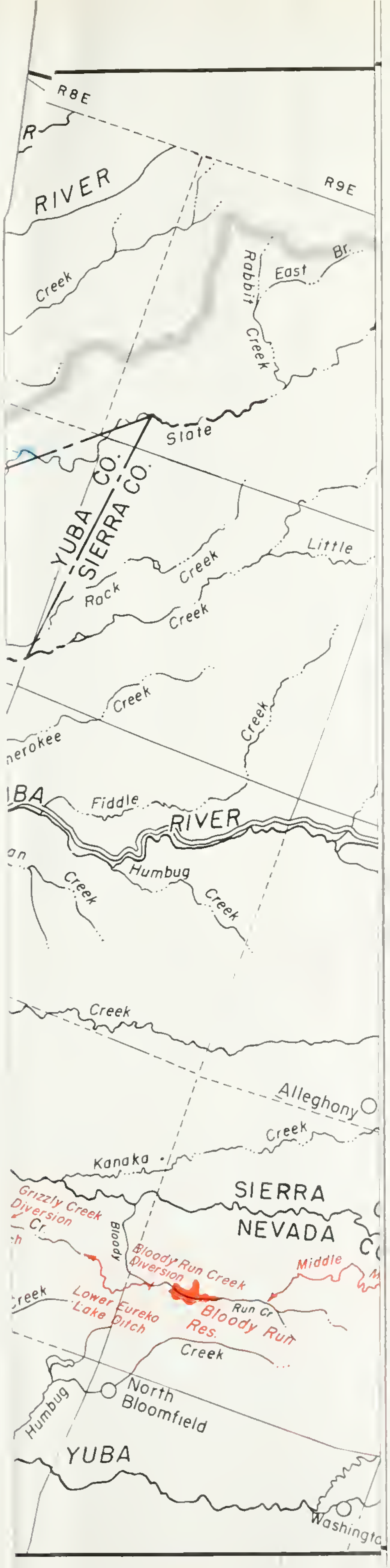
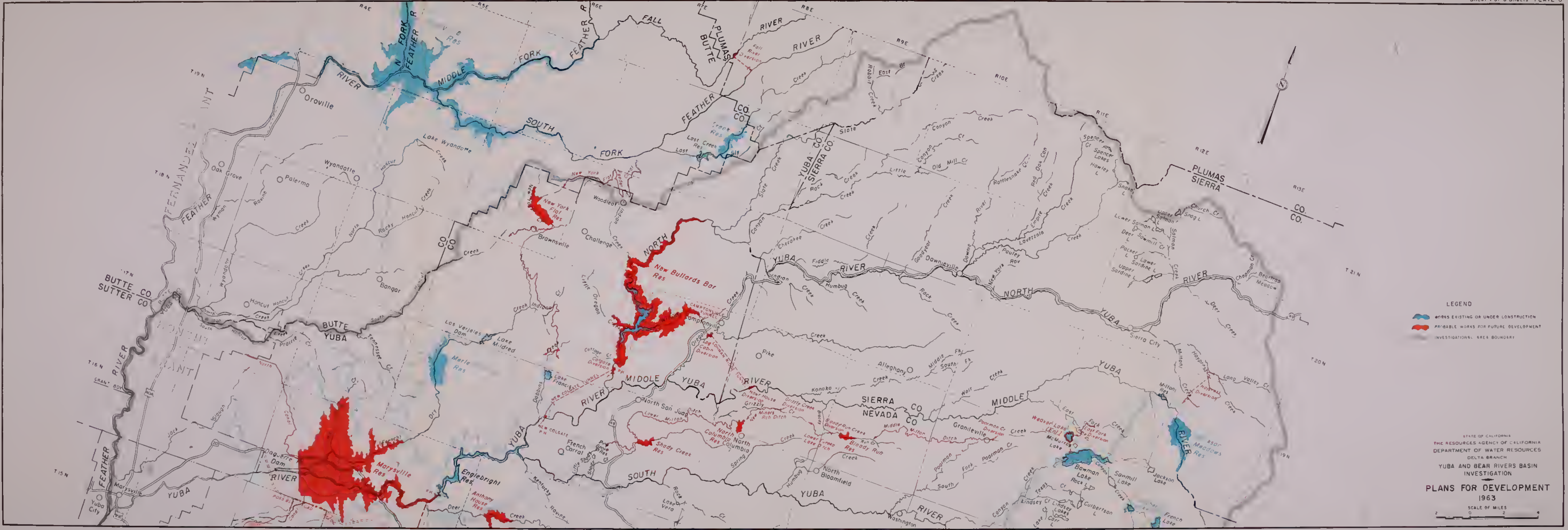
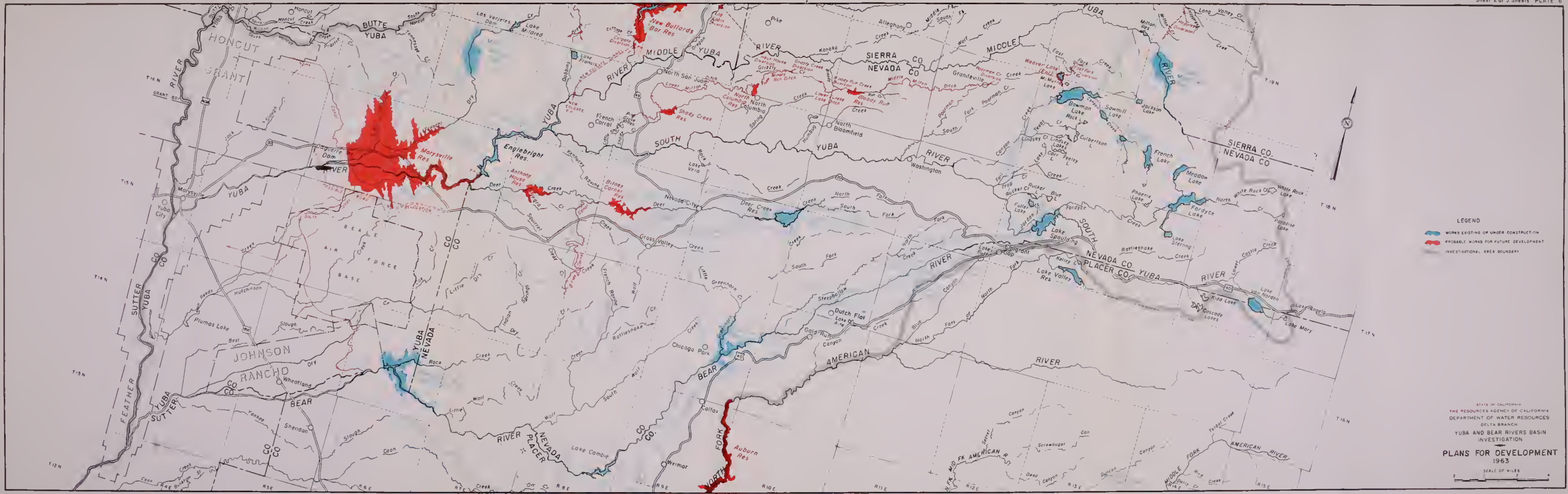
4. BROWNS VALLEY IRRIGATION DISTRICT
5. CORDUA IRRIGATION DISTRICT
6. HALLWOOD IRRIGATION COMPANY
7. NEVADA IRRIGATION DISTRICT
8. WHEATLAND WATER DISTRICT
9. CAMP FAR WEST IRRIGATION DISTRICT
10. SHERIDAN COUNTY WATER DISTRICT
11. PLUMAS MUTUAL WATER COMPANY
12. SOUTH SUTTER WATER DISTRICT
13. NATOMAS CENTRAL MUTUAL WATER COMPANY
14. P.G.&E. WISE SERVICE AREA
15. SAN JUAN SUBURBAN WATER DISTRICT
BUTTE
SIERRA
NEVADA
YUBA
SUTTER
PLACER
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN INVESTIGATION
WATER SERVICE AGENCIES
1960
SCALE OF MILES
4 0 4 8 12



R8E
R
RIVER
R9E
Creek
Rabbit
Creek
East
Br.
Slate
YUBA CO.
SIERRA CO.
Little
Creek
Rock
Creek
Creek
Creek
nerokee
BA
Fiddle
RIVER
an
Creek
Humbug
Creek
Creek
Alleghony
Creek
Kanaka
SIERRA
NEVADA
Grizzly Creek
Diversion
Cr.
Bloody
Bloody Run Creek
Diversion
Middle
reek
Lower Eureka
Lake Ditch
Run Cr
Bloody Run
Res.
Creek
North
Bloomfield
Humbug
YUBA
Washingto


LEGEND
WORKS EXISTING OR UNDER CONSTRUCTION
PROBABLE WORKS FOR FUTURE DEVELOPMENT
INVESTIGATIONAL AREA BOUNDARY
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN
INVESTIGATION
PLANS FOR DEVELOPMENT
1963
SCALE OF MILES
Oroville
Oak Grove
Palermo
Wyandotte
Lake Wyandotte
Woodleaf
Challenge
Brownsville
New York Flat Res
New Bullards Bar Res
Camptonville
Bangor
Moncut
Los Verjeles Dam
Lake Mildred
Merle Res
Lake Francis
Pike
Alleghany
Downieville
Sierra City
Marysville Res
Englebright Res
Marysville
Yuba City
Daguerre Dam
Anthony House Res
North San Juan
North Columbia
North Columbia Res
Shady Creek Res
Bloody Run Res
French Corral
North Bloomfield
Graniteville
Washington
Lake Vera
Bowman Lake
Sawmill Lake
Jackson Lake
Jackson Meadows Res
Milton Res
Culbertson L
French Lake
McMurray Lake
Weaver Lake
Lindsey Lakes
FEATHER RIVER
NORTH FORK FEATHER RIVER
MIDDLE FORK FEATHER RIVER
SOUTH FORK FEATHER RIVER
FALL RIVER
NORTH YUBA RIVER
MIDDLE YUBA RIVER
SOUTH YUBA RIVER
YUBA RIVER
BUTTE CO
SUTTER CO
YUBA CO
SIERRA CO
PLUMAS CO
NEVADA CO
BUTTE YUBA
PLUMAS SIERRA

Kanaka
Grizzly Creek
Diversion
Cr.
Bloody
Bloody Run Creek
Diversion
Creek
Lower Eureka
Lake Ditch
Bloody
Res.
Creek
North
Bloomfield
Humbug
YUBA
20
North
Creek
South
Scotts Flat
Creek
Fork
South
Steephollow
Dutch Flat
Lake
Alta
Gold Run
Canyon
AMERICAN


LEGEND
WORKS EXISTING OR UNDER CONSTRUCTION
PROBABLE WORKS FOR FUTURE DEVELOPMENT
INVESTIGATIONAL AREA BOUNDARY
New Bullards Bar Res
Marysville Res
Englebright Res.
Anthony House Res
Bitney Corner Res
Shady Creek Res
Deer Creek Res
Auburn Res
Lake Spaulding
Bowman Lake
Jackson Lake
French Lake
Meadow Lake
Fordyce Lake
Lake Valley Res
Lake Van Norden
Cascade Lakes
Kidd Lake
Lake Mary
Lake Angela
Daguerre Dam
Marysville
Yuba City
Nevada City
Grass Valley
North San Juan
North Columbia
North Bloomfield
Washington
French Corral
Dutch Flat
Gold Run
Colfax
Chicago Park
Wheatland
Sheridan
Weimar
Emigrant Gap
SIERRA CO
NEVADA CO
PLACER CO
YUBA CO
SUTTER CO
BUTTE
YUBA RIVER
MIDDLE YUBA RIVER
SOUTH YUBA RIVER
BEAR RIVER
AMERICAN RIVER
NORTH FORK
FEATHER RIVER
HONCUT
JOHNSON RANCHO
BEALE AIR FORCE BASE
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN INVESTIGATION
PLANS FOR DEVELOPMENT
1963
SCALE OF MILES

LEGEND

WORKS EXISTING OR UNDER CONSTRUCTION

PROBABLE WORKS FOR FUTURE DEVELOPMENT

INVESTIGATIONAL AREA BOUNDARY

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

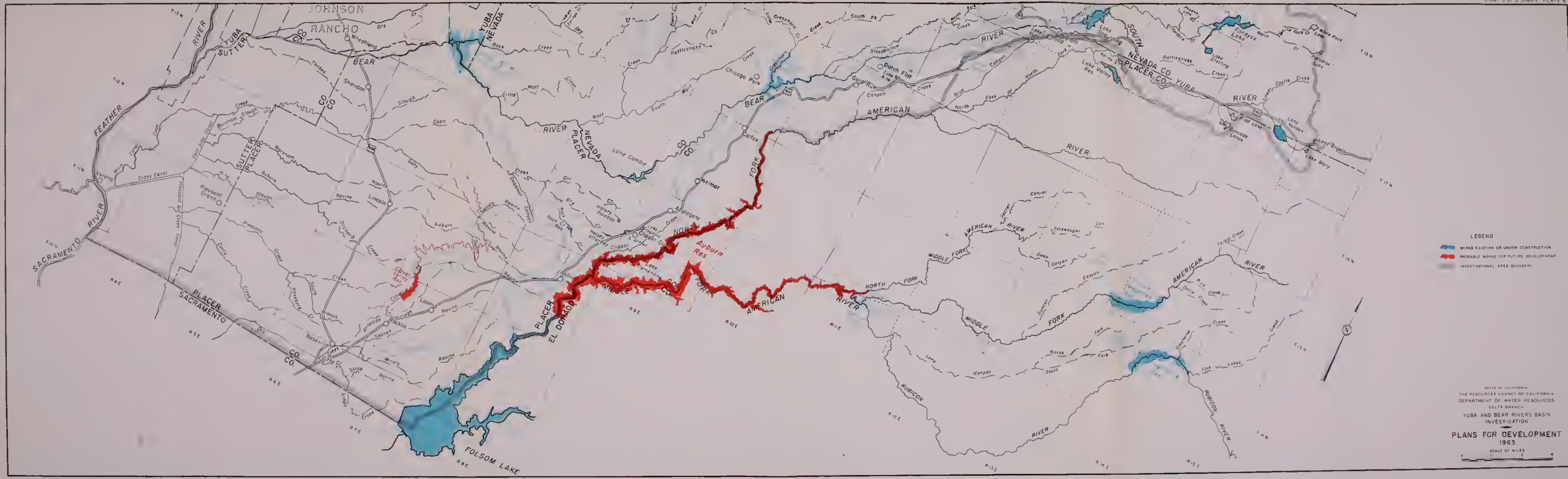
YUBA AND BEAR RIVERS BASIN INVESTIGATION

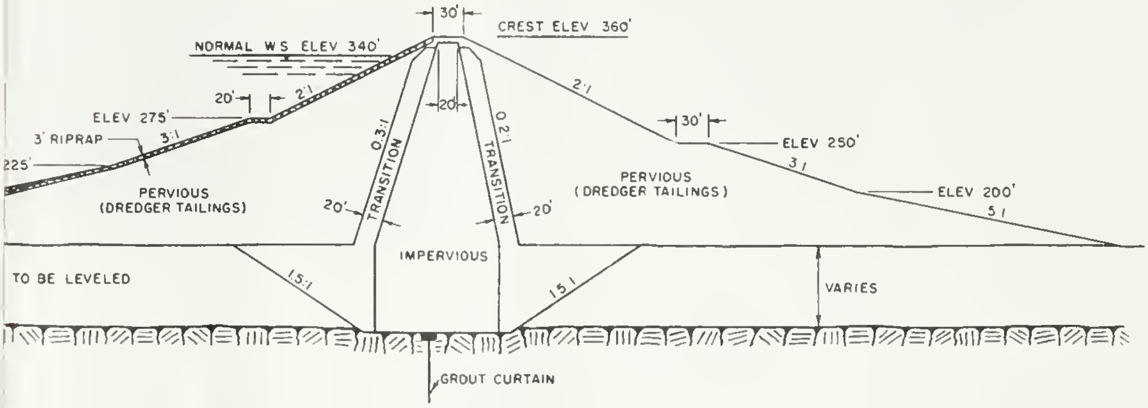
PLANS FOR DEVELOPMENT

1963

SCALE OF MILES

2 0 2 4


JOHNSON
RANCHO
FEATHER RIVER
SACRAMENTO RIVER
YUBA
SUTTER
BEAR RIVER
NEVADA
PLACER
SACRAMENTO
EL DORADO
Wheatland
Sheridan
Lincoln
Roseville
Rocklin
Loomis
Auburn
Applegate
Weimar
Colfax
Dutch Flat
Gold Run
Auburn Res
NORTH FORK
MIDDLE FORK
AMERICAN RIVER
RUBICON RIVER
FOLSOM LAKE
Lake Spaulding
Fordyce Lake
Lake Sterling
Lake Valley Res
YUBA RIVER
NEVADA CO.
PLACER CO.
LEGEND
WORKS EXISTING OR UNDER CONSTRUCTION
PROBABLE WORKS FOR FUTURE DEVELOPMENT
INVESTIGATIONAL AREA BOUNDARY
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN
INVESTIGATION
PLANS FOR DEVELOPMENT
1963
SCALE OF MILES



TYPICAL CHANNEL SECTION
OF MAIN DAM

SCALE OF FEET
0 100 200

TS

TS
ULDERS

, AND CONGLOMERATE

BEDDED META-SEDIMENTS

HERE INFERRED

N

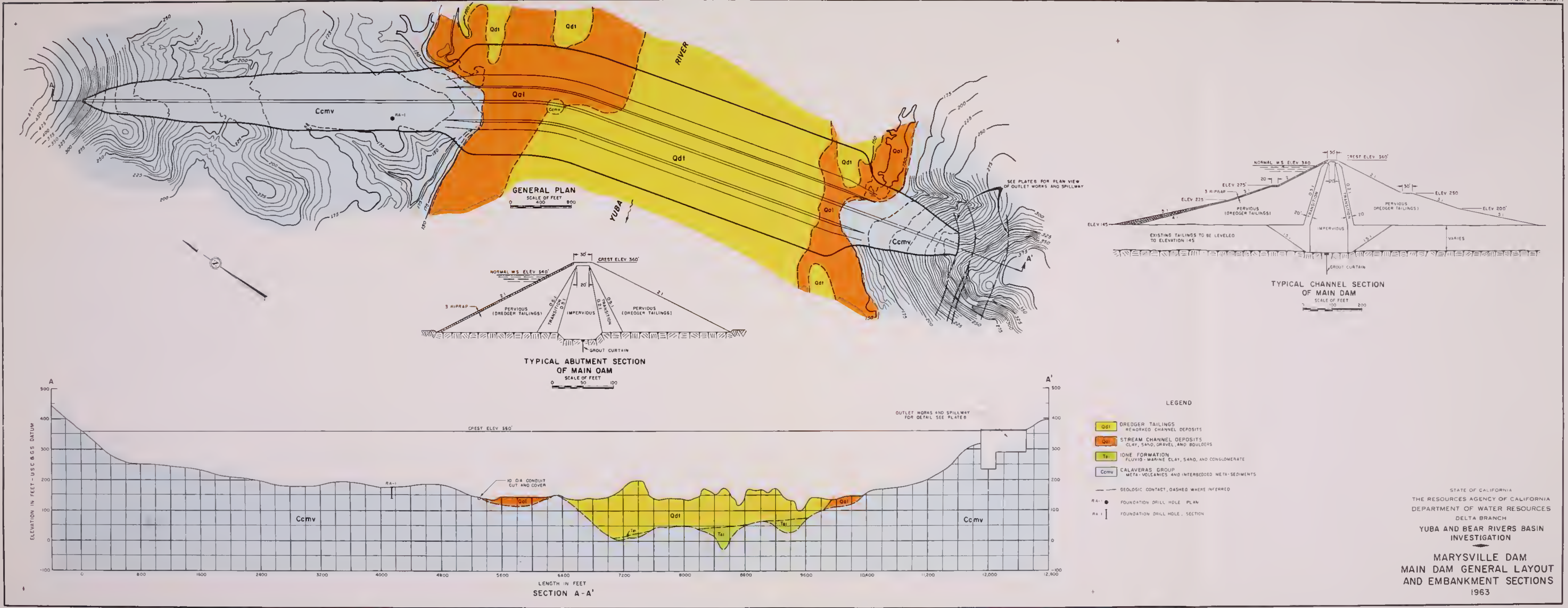
TION

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

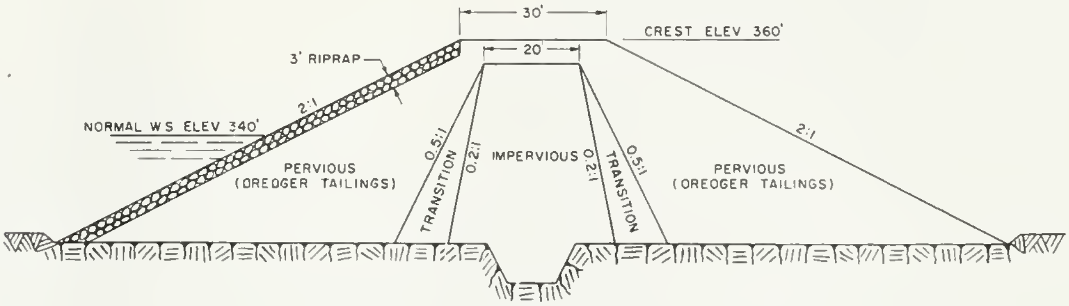
YUBA AND BEAR RIVERS BASIN
INVESTIGATION

MARYSVILLE DAM
MAIN DAM GENERAL LAYOUT
AND EMBANKMENT SECTIONS

1963



GENERAL PLAN
SCALE OF FEET
0 400 800
YUBA
RIVER
Ccmv
Qdt
Qal
RA-1
SEE PLATES FOR PLAN VIEW OF OUTLET WORKS AND SPILLWAY
A
A'
TYPICAL ABUTMENT SECTION OF MAIN DAM
SCALE OF FEET
0 50 100
CREST ELEV 360'
NORMAL W.S. ELEV 340'
30'
20'
2:1
3' RIPRAP
PERVIOUS (DREDGER TAILINGS)
TRANSITION
IMPERVIOUS
GROUT CURTAIN
TYPICAL CHANNEL SECTION OF MAIN DAM
SCALE OF FEET
0 100 200
CREST ELEV 360'
NORMAL W.S. ELEV 340
ELEV 275'
ELEV 225
ELEV 250
ELEV 200'
ELEV 145
3' RIPRAP
PERVIOUS (DREDGER TAILINGS)
EXISTING TAILINGS TO BE LEVELED TO ELEVATION 145
IMPERVIOUS
VARIES
GROUT CURTAIN
SECTION A-A'
ELEVATION IN FEET - USC & GS DATUM
LENGTH IN FEET
CREST ELEV 360'
10' DIA CONDUIT CUT AND COVER
OUTLET WORKS AND SPILLWAY FOR DETAIL SEE PLATE 8
Tai
LEGEND
Qdt DREDGER TAILINGS
REWORKED CHANNEL DEPOSITS
Qal STREAM CHANNEL DEPOSITS
CLAY, SAND, GRAVEL, AND BOULDERS
Tai IONE FORMATION
FLUVIO-MARINE CLAY, SAND, AND CONGLOMERATE
Ccmv CALAVERAS GROUP
META-VOLCANICS AND INTERBEDDED META-SEDIMENTS
GEOLOGIC CONTACT, DASHED WHERE INFERRED
RA-1 FOUNDATION DRILL HOLE, PLAN
RA-1 FOUNDATION DRILL HOLE, SECTION
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN INVESTIGATION
MARYSVILLE DAM
MAIN DAM GENERAL LAYOUT AND EMBANKMENT SECTIONS
1963



TYPICAL SECTION OF
WING DAM

SCALE OF FEET
0 20 40

LEGEND

Tmag MEHRTEN FORMATION
AGGLOMERATE

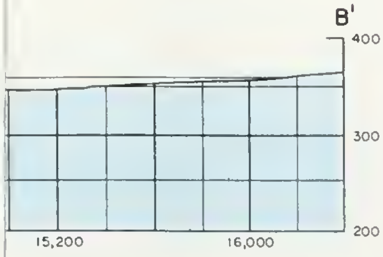
Tmcg MEHRTEN FORMATION
CONGLOMERATE

Ccmv CALAVERAS GROUP
META-VOLCANICS AND INTERBEDDED META-SEDIMENTS

GEOLOGIC CONTACT, DASHED WHERE INFERRED

WDD-1 ● FOUNDATION DRILL HOLE, PLAN

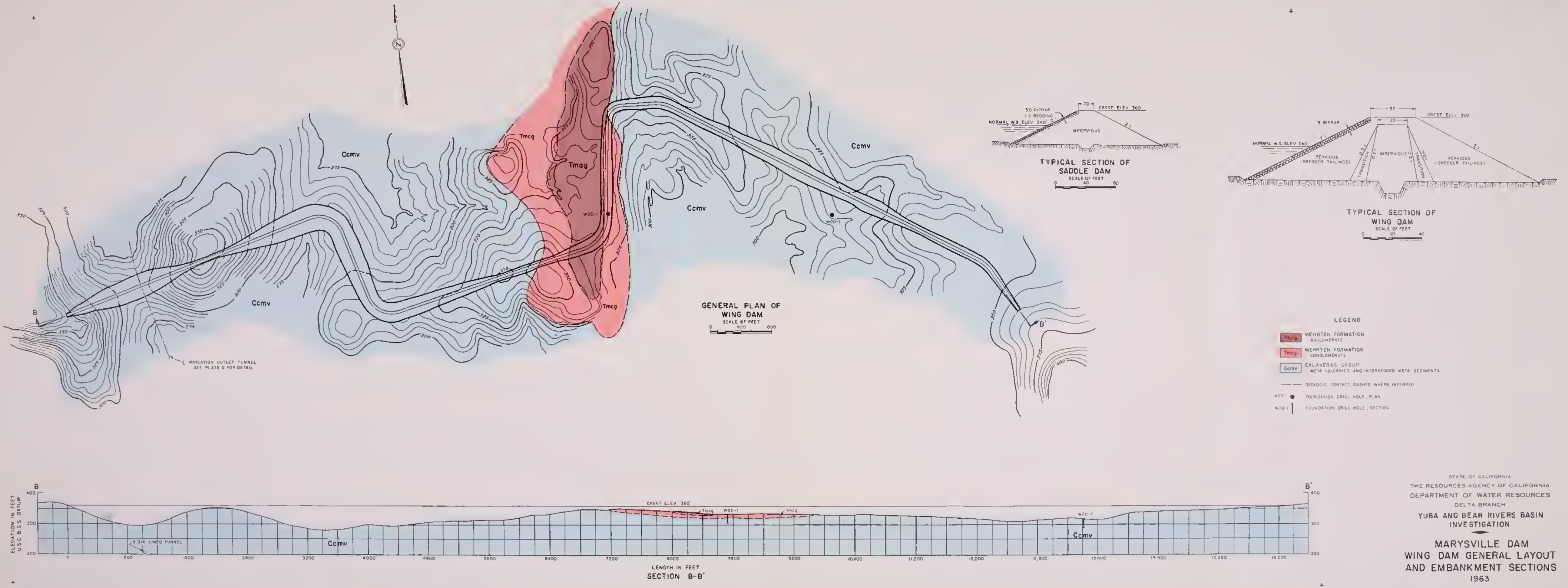
WDD-1 I FOUNDATION DRILL HOLE, SECTION



STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN
INVESTIGATION

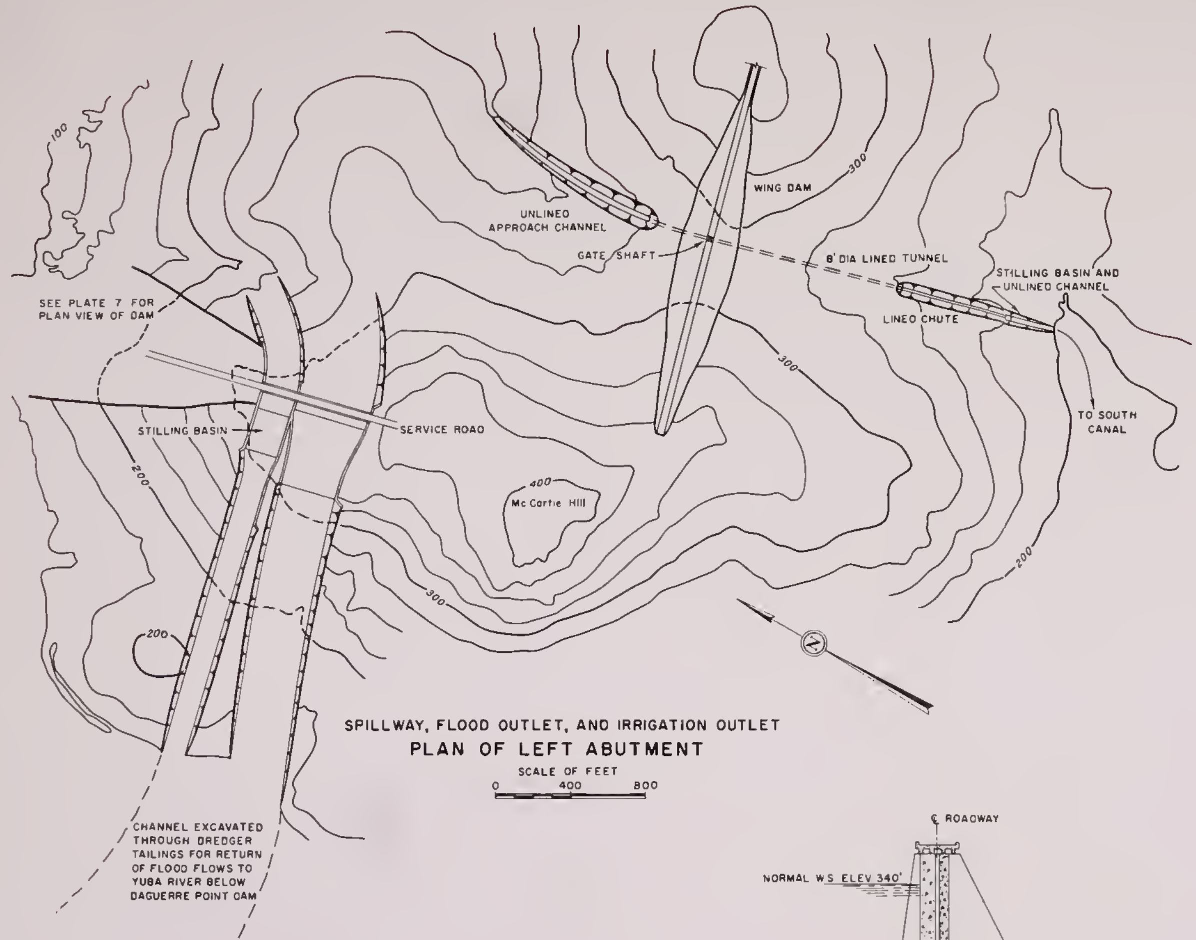
MARYSVILLE DAM
WING DAM GENERAL LAYOUT
AND EMBANKMENT SECTIONS
1963



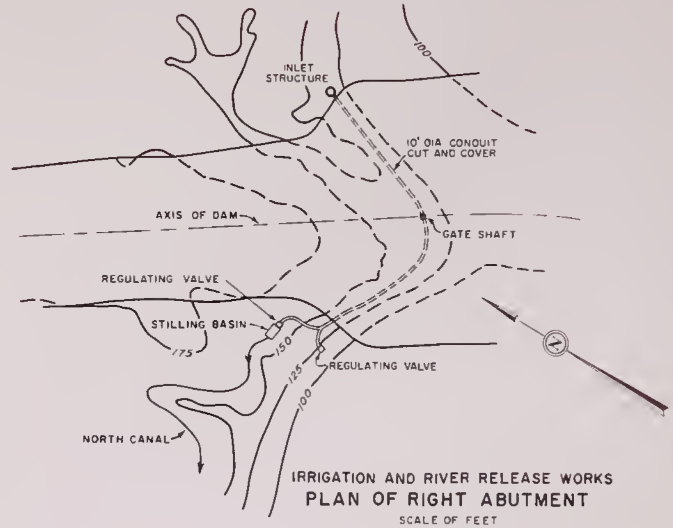
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN
INVESTIGATION

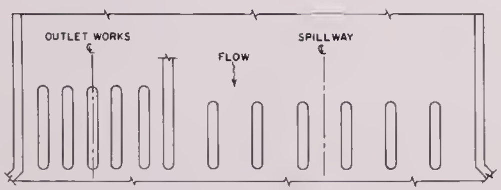
MARYSVILLE DAM
WING DAM GENERAL LAYOUT
AND EMBANKMENT SECTIONS
1963



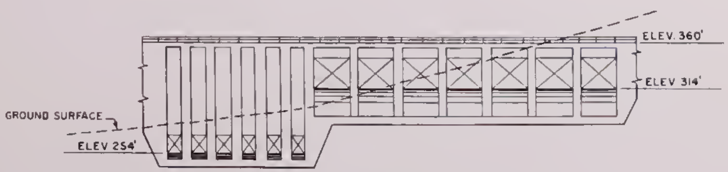
SPILLWAY, FLOOD OUTLET, AND IRRIGATION OUTLET
PLAN OF LEFT ABUTMENT
SCALE OF FEET
0 400 800



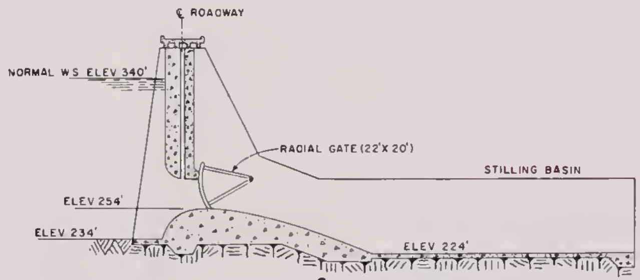
IRRIGATION AND RIVER RELEASE WORKS
PLAN OF RIGHT ABUTMENT
SCALE OF FEET
0 400 800



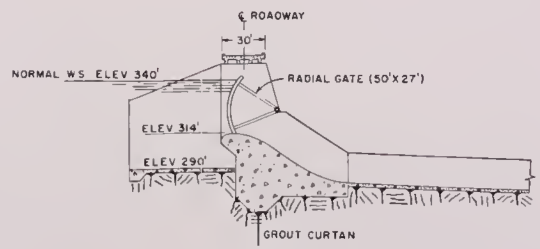
PLAN
NO SCALE



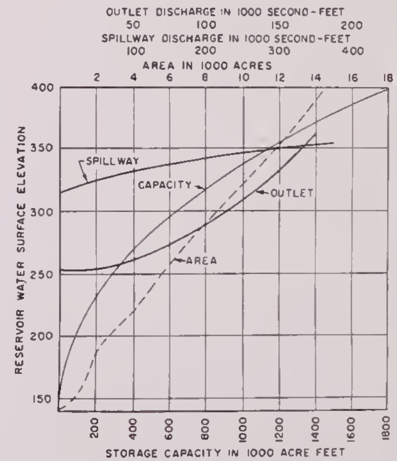
ELEVATION OF DOWNSTREAM FACE
OUTLET WORKS AND SPILLWAY
NO SCALE



SECTION ON ℄ OF OUTLET WORKS
NO SCALE



SECTION ON ℄ OF SPILLWAY
NO SCALE



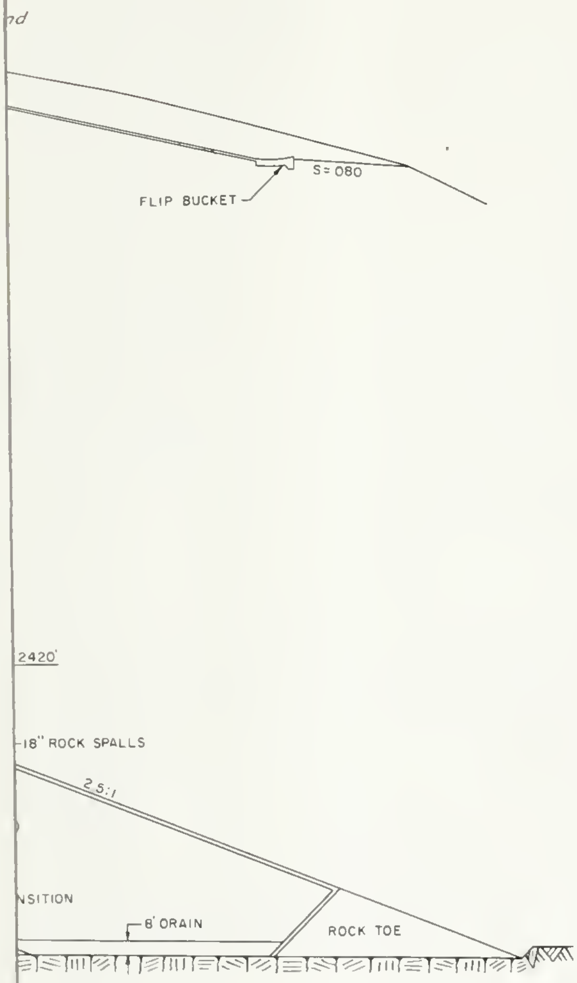
AREA - CAPACITY - DISCHARGE - CURVES

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

MARYSVILLE DAM DETAILS

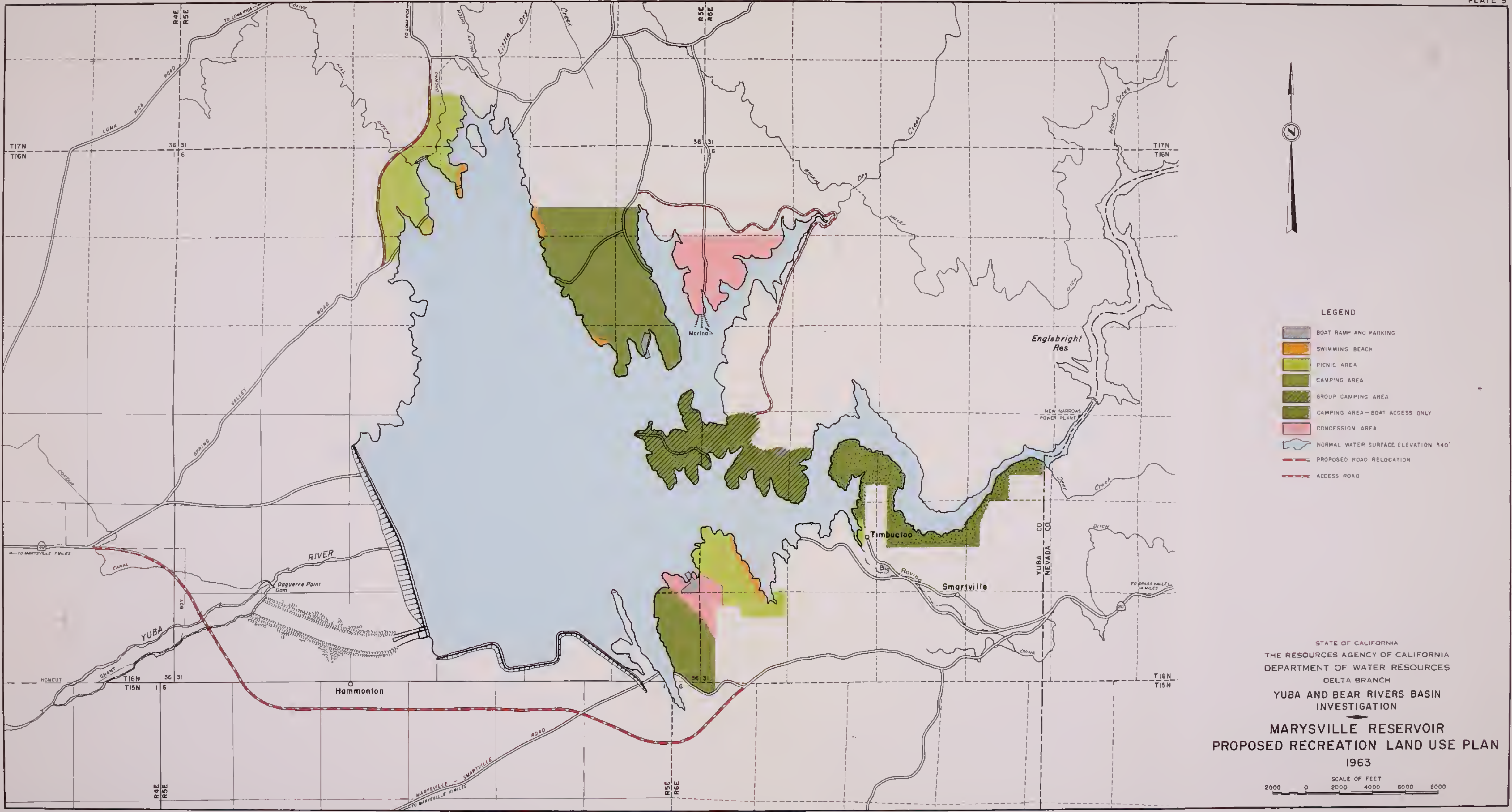
1963



STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

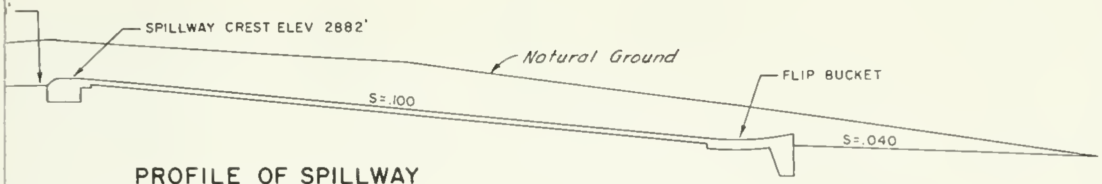
YUBA AND BEAR RIVERS BASIN
INVESTIGATION

NEW YORK FLAT DAM
ON NEW YORK CREEK
INITIAL AND FINAL STAGE
1963



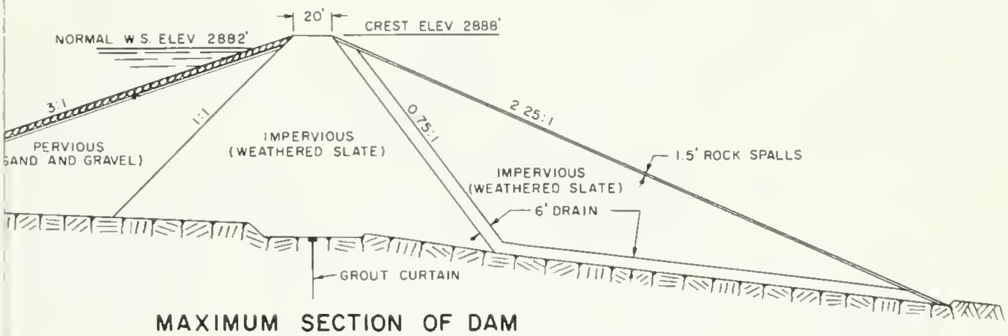
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH
YUBA AND BEAR RIVERS BASIN INVESTIGATION

MARYSVILLE RESERVOIR
PROPOSED RECREATION LAND USE PLAN
1963



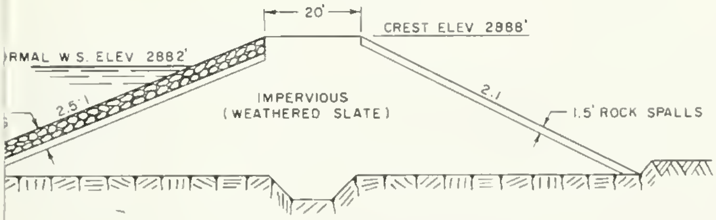
PROFILE OF SPILLWAY

SCALE OF FEET
0 20 40



MAXIMUM SECTION OF DAM

SCALE OF FEET
0 50 100



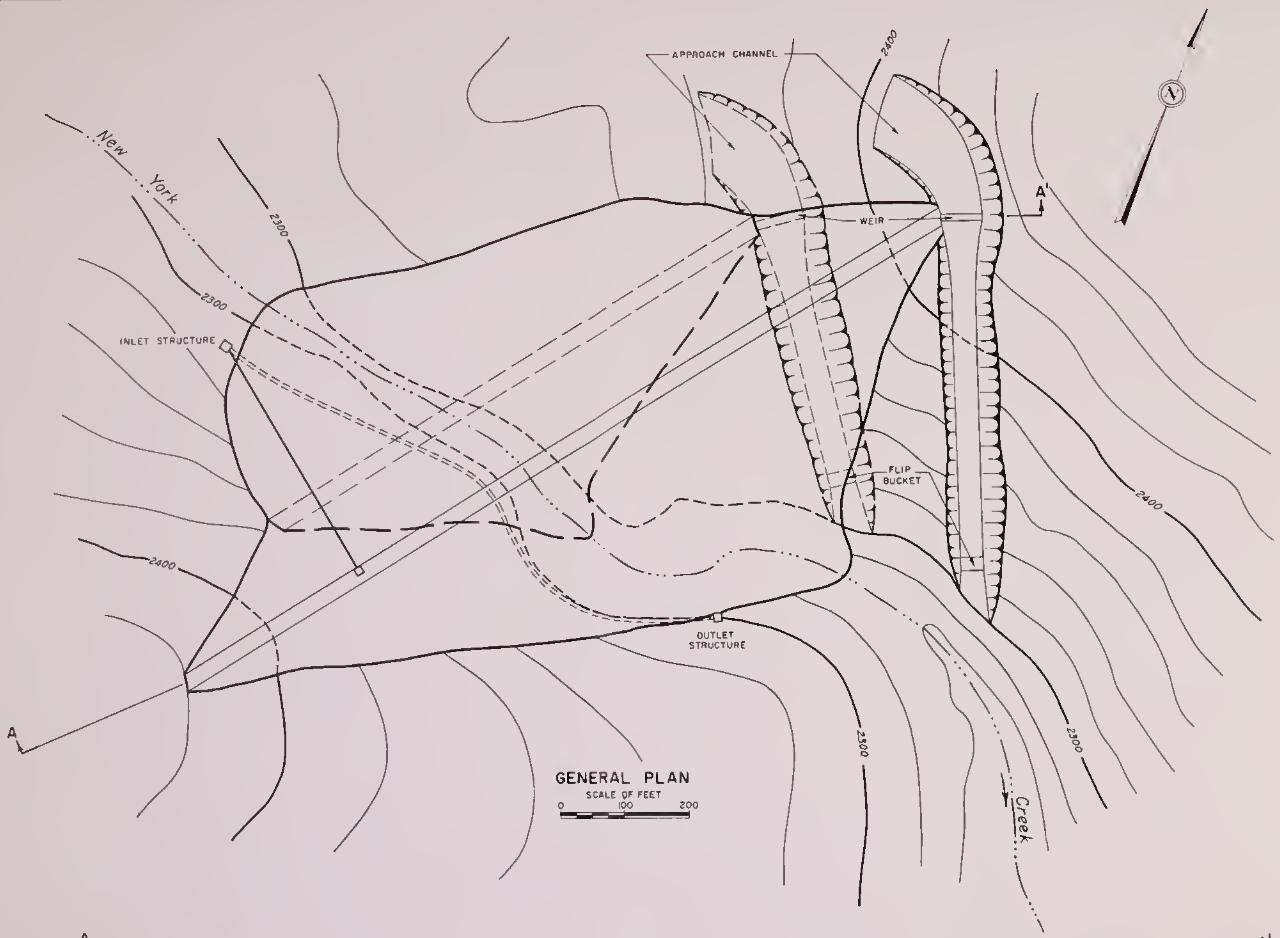
MAXIMUM SECTION OF SADDLE DAM

SCALE OF FEET
0 20 40

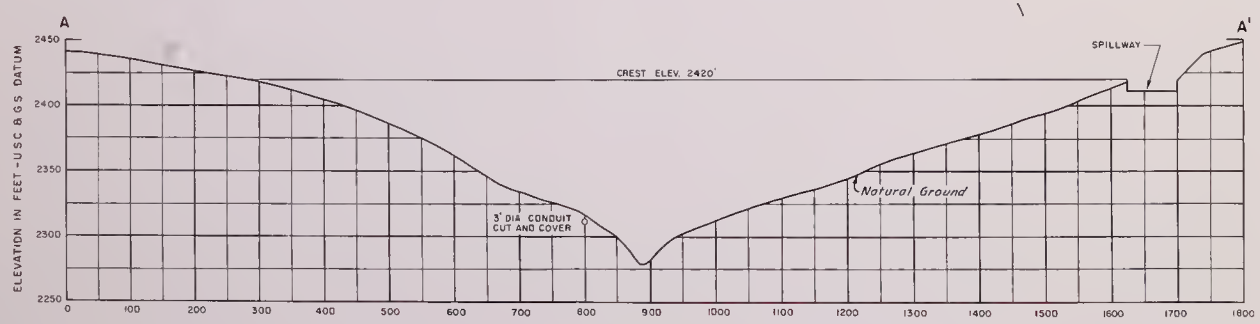
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

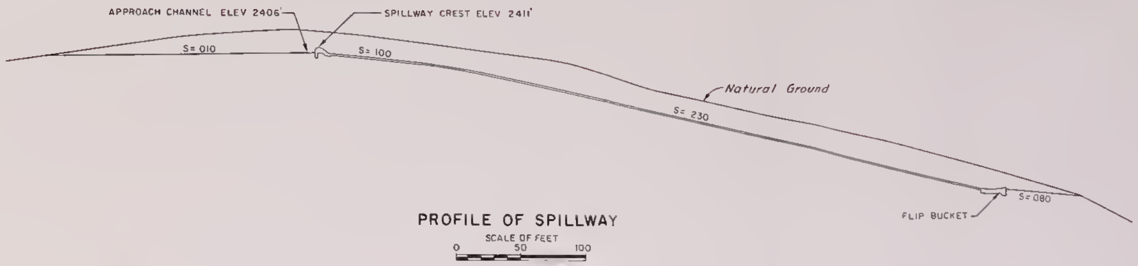
NORTH COLUMBIA DAM
ON
TRIBUTARY TO GRIZZLY CREEK
1963



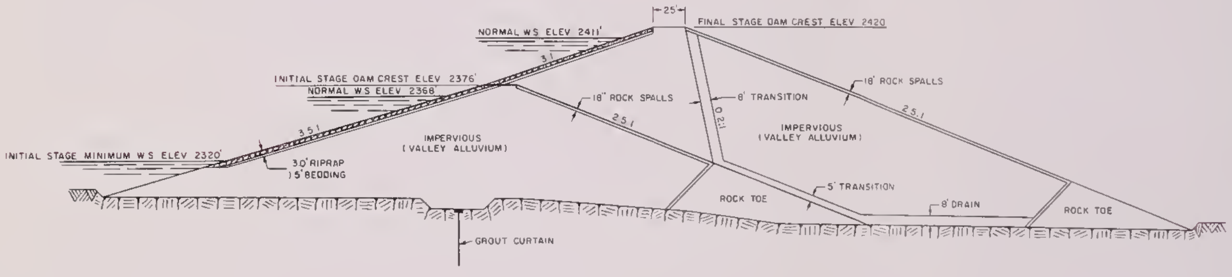
GENERAL PLAN
SCALE OF FEET
0 100 200



LENGTH IN FEET
SECTION A-A'



PROFILE OF SPILLWAY
SCALE OF FEET
0 50 100

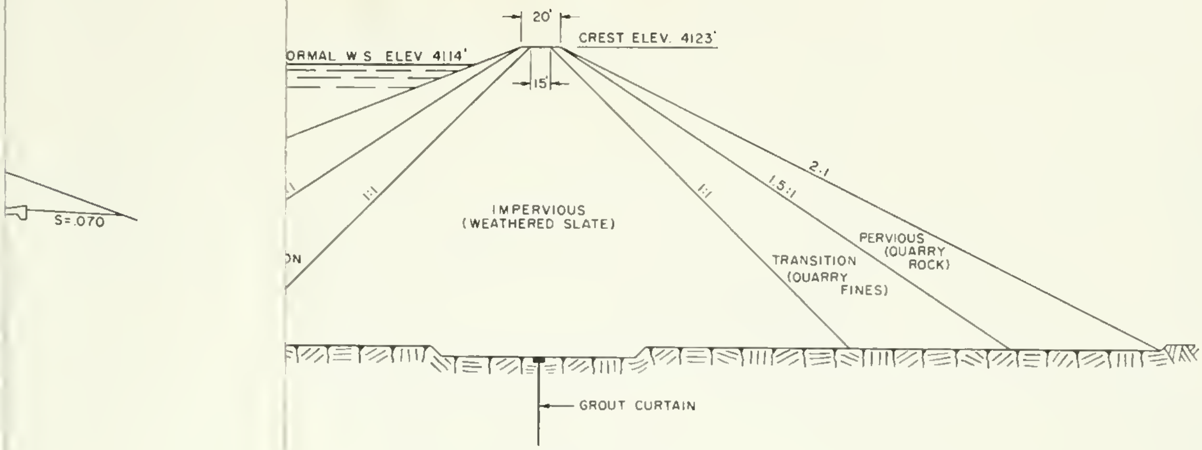


MAXIMUM SECTION OF DAM
SCALE OF FEET
0 50 100

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

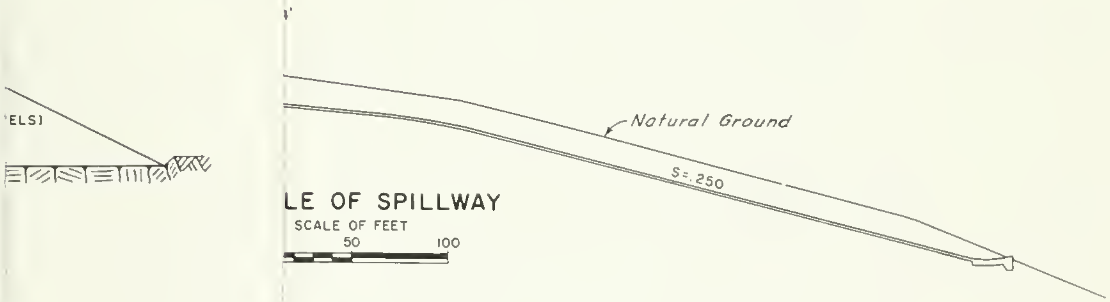
YUBA AND BEAR RIVERS BASIN
INVESTIGATION

NEW YORK FLAT DAM
ON NEW YORK CREEK
INITIAL AND FINAL STAGE
1963



MAXIMUM SECTION OF DAM

SCALE OF FEET
0 50 100



LE OF SPILLWAY

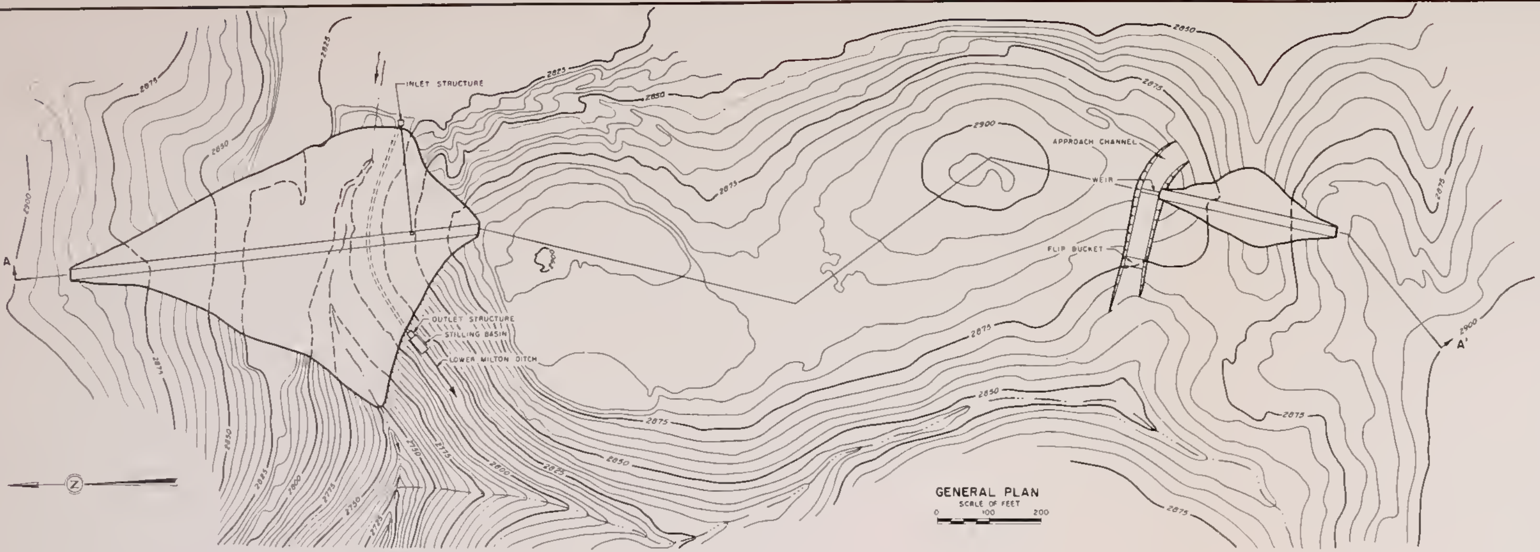
SCALE OF FEET
50 100

ALLS

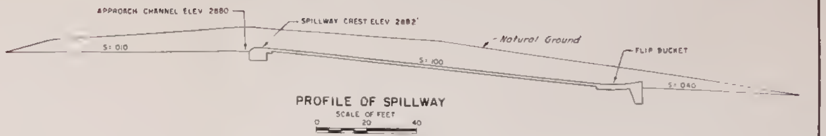
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN
INVESTIGATION

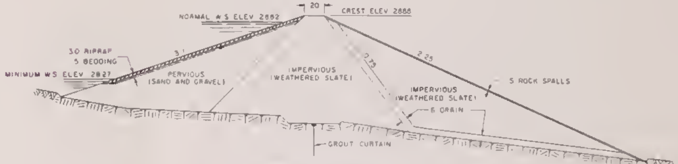
SHADY CREEK DAM ON
SHADY CREEK
AND
BLOODY RUN DAM ON
BLOODY RUN CREEK
1963



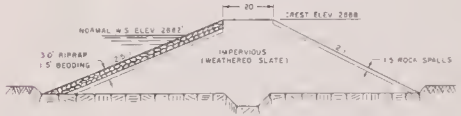
GENERAL PLAN



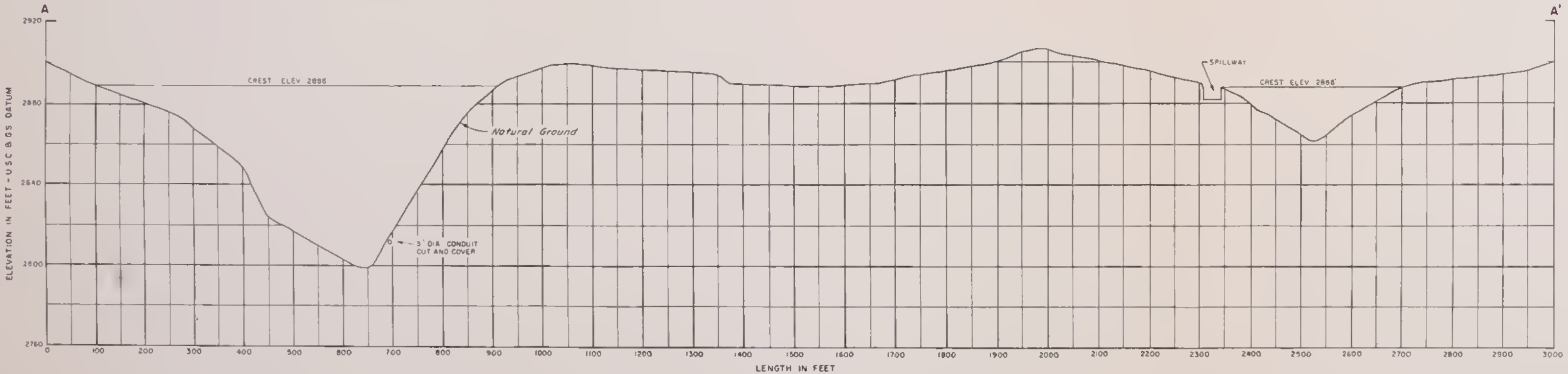
PROFILE OF SPILLWAY



MAXIMUM SECTION OF DAM



MAXIMUM SECTION OF SADDLE DAM

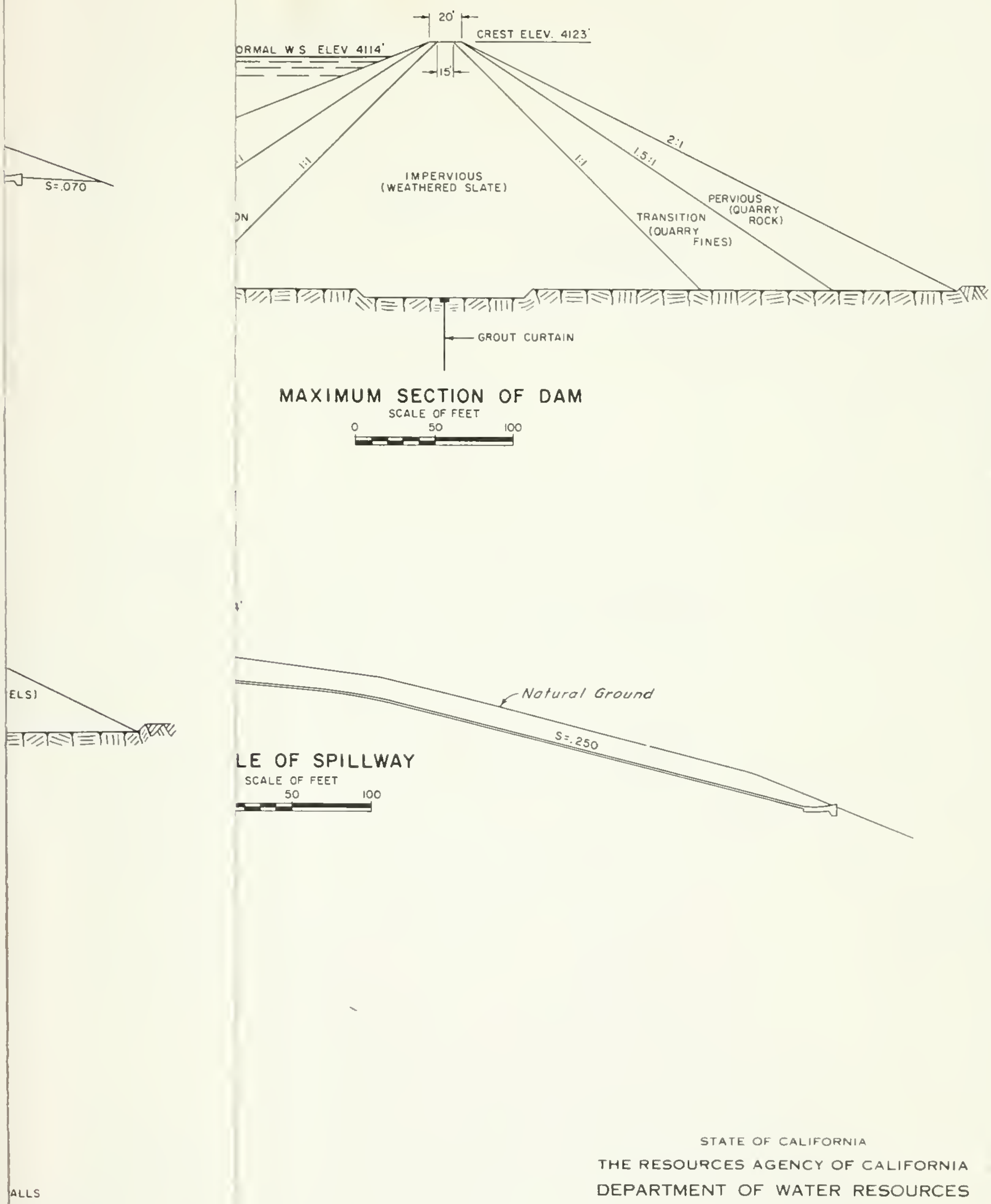


SECTION A-A'

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

NORTH COLUMBIA DAM
ON
TRIBUTARY TO GRIZZLY CREEK
1963

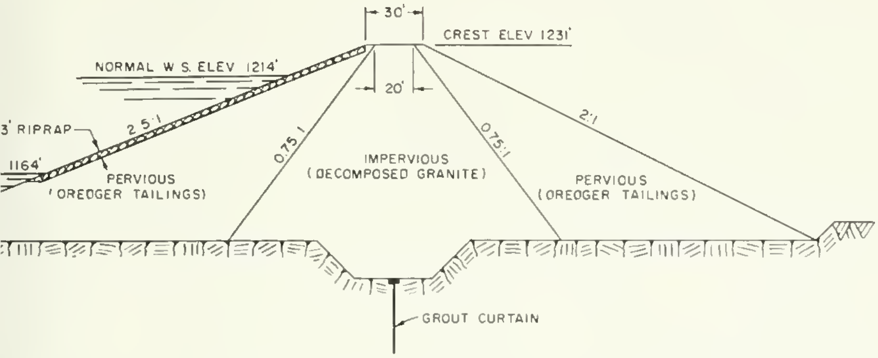


STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

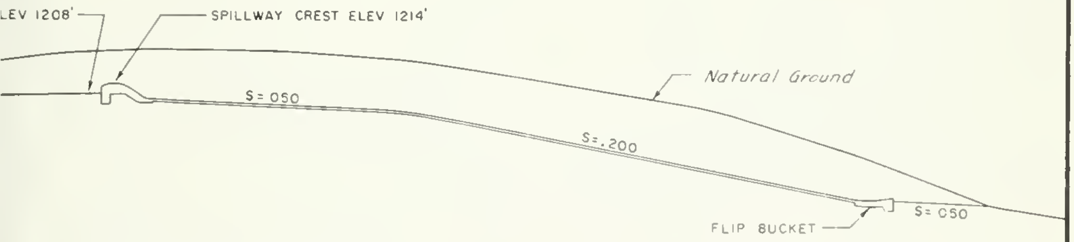
SHADY CREEK DAM ON SHADY CREEK AND BLOODY RUN DAM ON BLOODY RUN CREEK

1963



MAXIMUM SECTION OF DAM

SCALE OF FEET
0 50 100



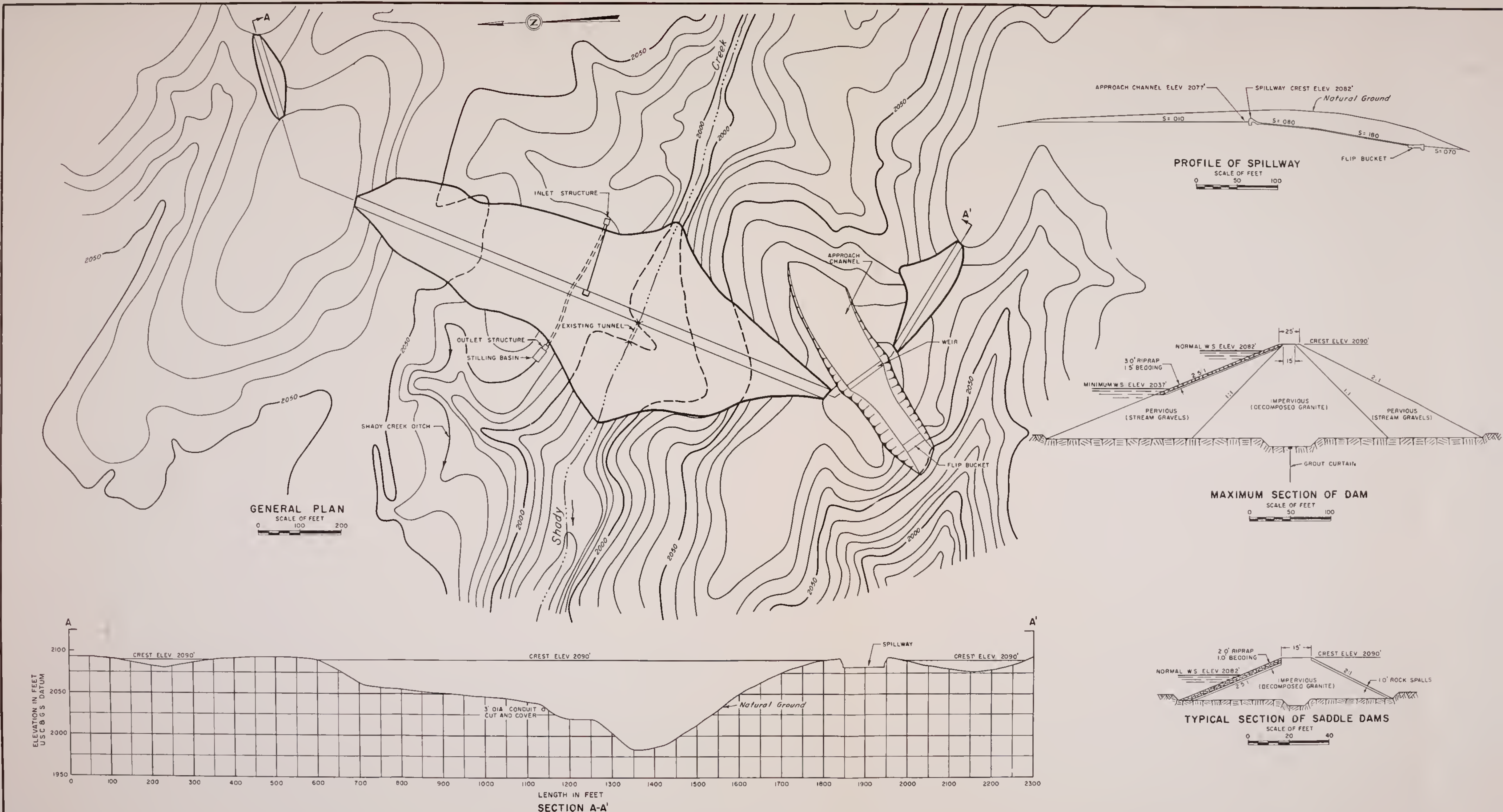
PROFILE OF SPILLWAY

SCALE OF FEET
0 50 100

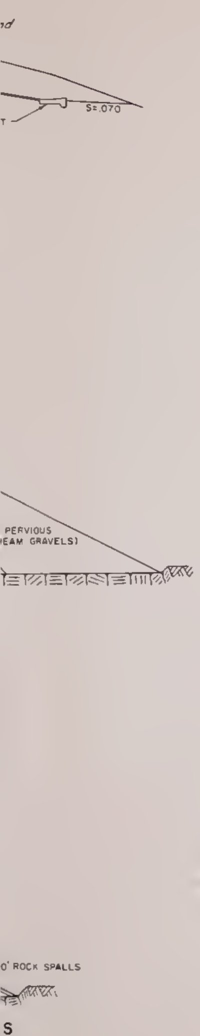
STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

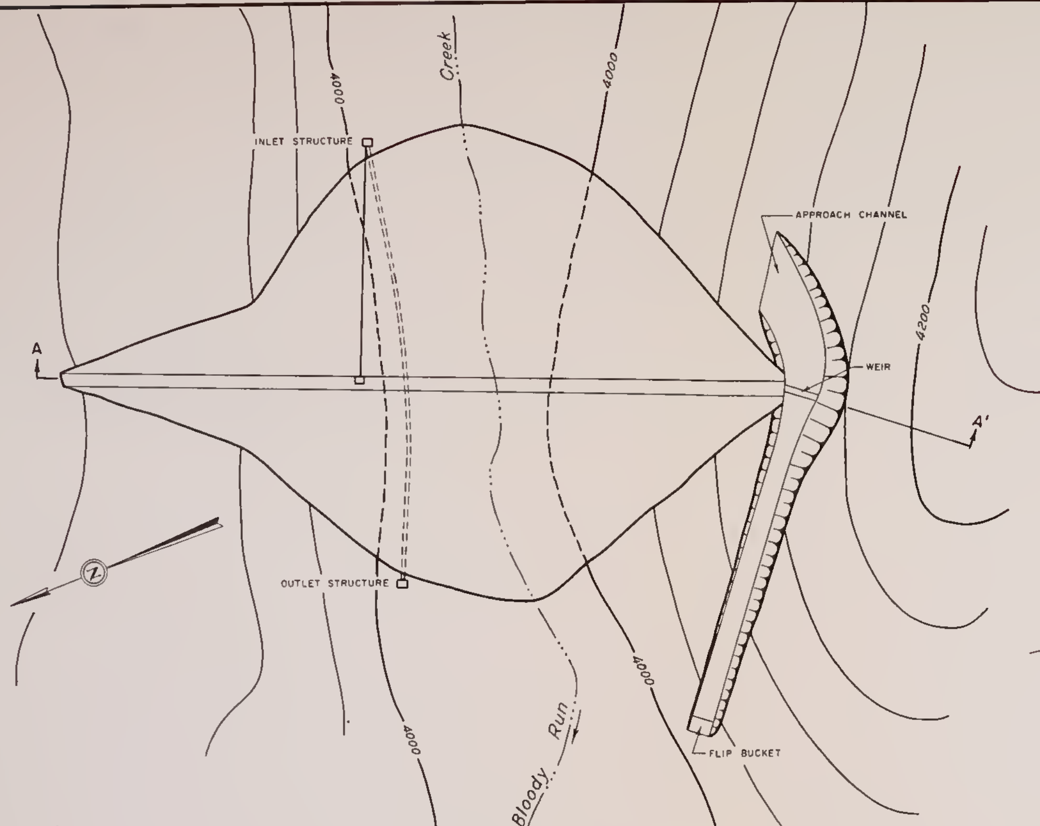
YUBA AND BEAR RIVERS BASIN INVESTIGATION

BITNEY CORNER DAM
AND
ANTHONY HOUSE DAM
ON
DEER CREEK
1963

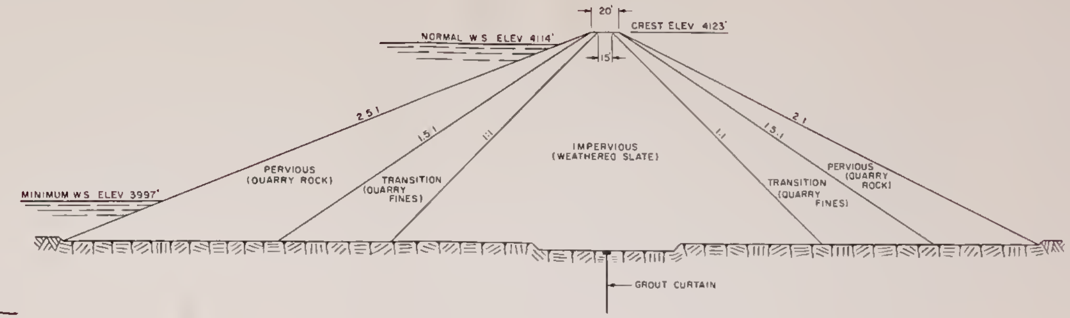


SHADY CREEK DAM

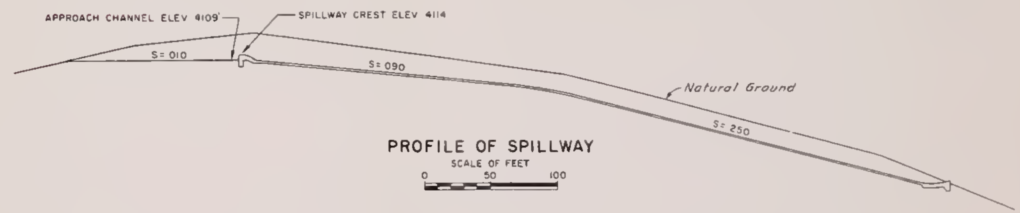




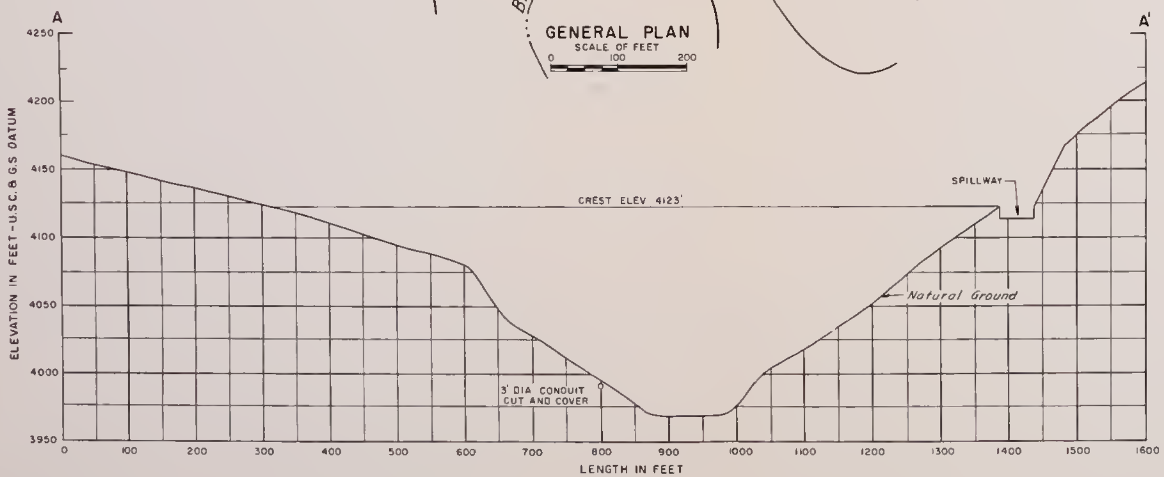
GENERAL PLAN
SCALE OF FEET
0 100 200



MAXIMUM SECTION OF DAM
SCALE OF FEET
0 50 100



PROFILE OF SPILLWAY
SCALE OF FEET
0 50 100



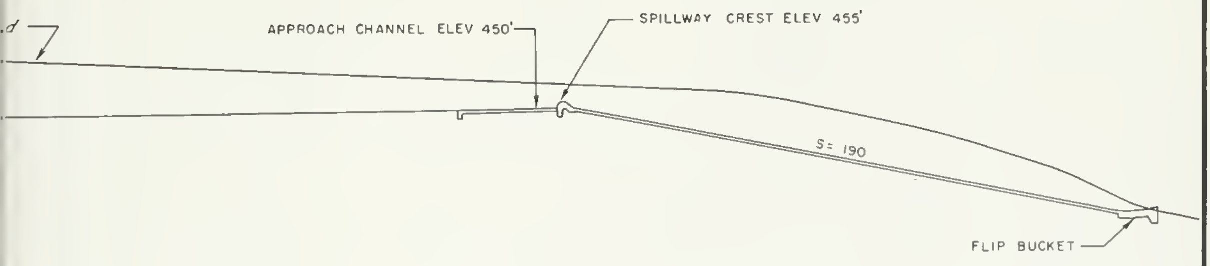
SECTION A-A'

BLOODY RUN DAM

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

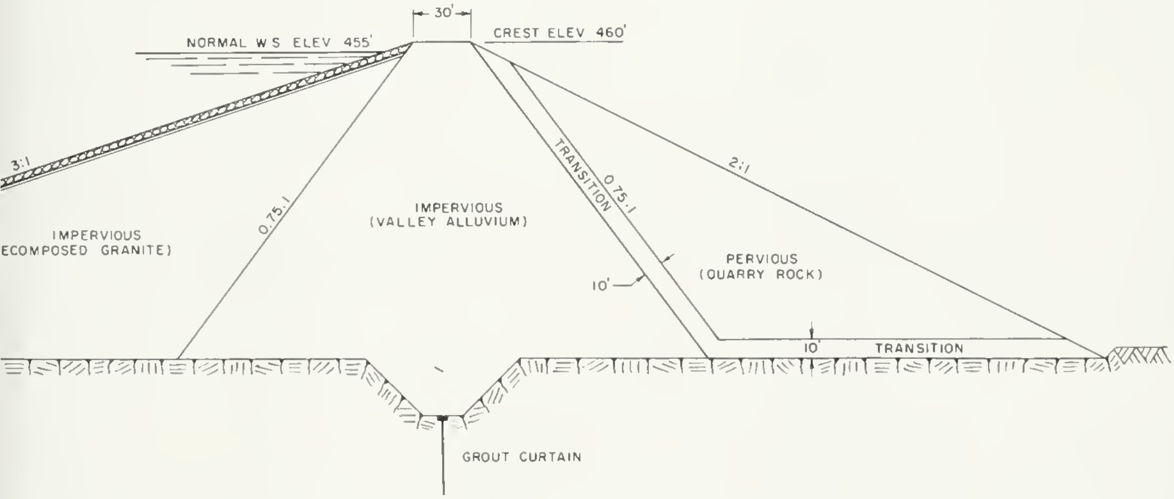
YUBA AND BEAR RIVERS BASIN INVESTIGATION

SHADY CREEK DAM ON SHADY CREEK
AND
BLOODY RUN DAM ON BLOODY RUN CREEK
1963



PROFILE OF SPILLWAY

SCALE OF FEET
0 50 100



MAXIMUM SECTION OF DAM

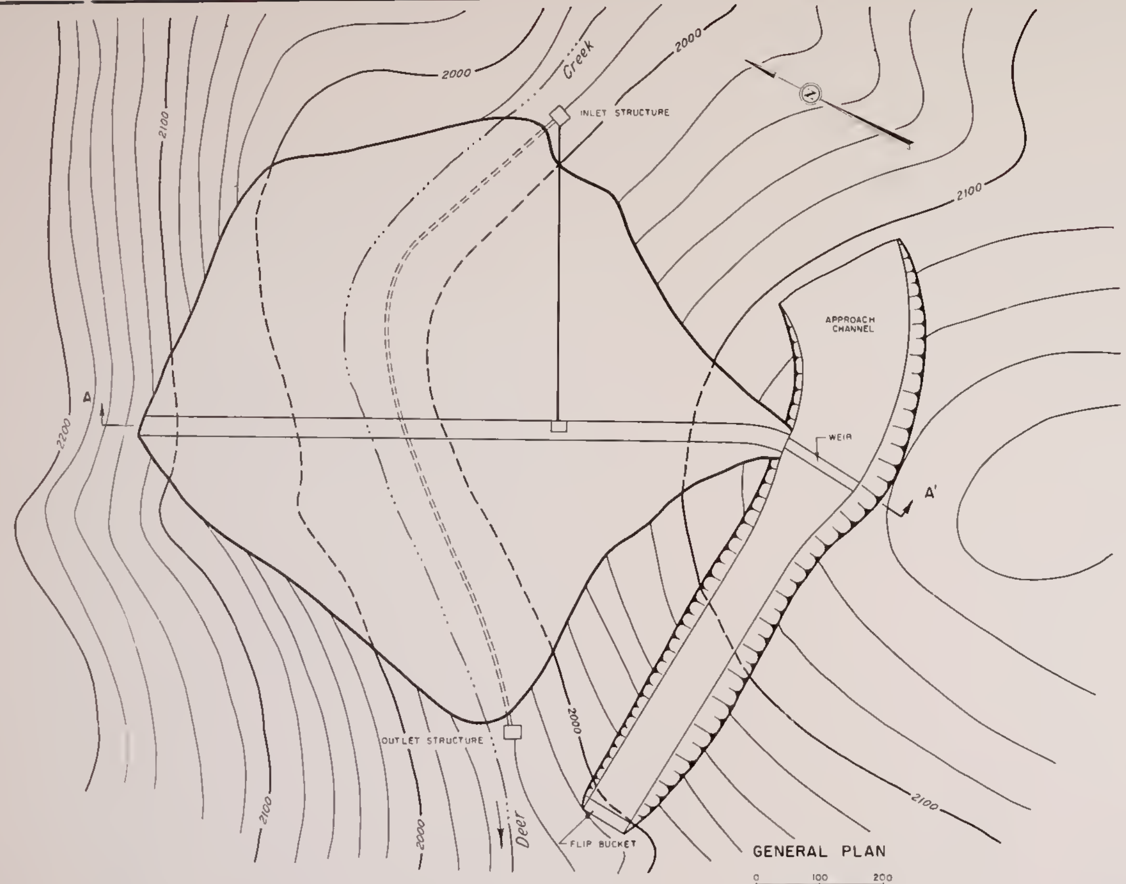
SCALE OF FEET
0 50 100

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

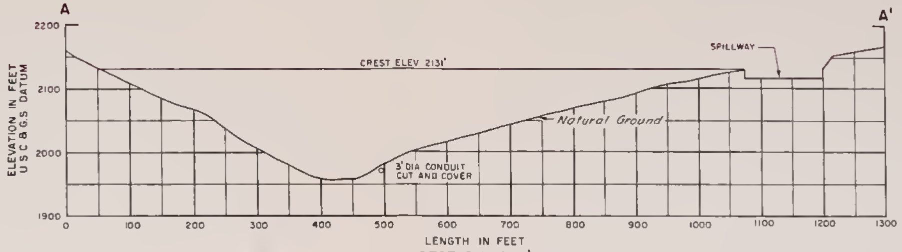
CLOVER VALLEY DAM
ON
CLOVER VALLEY CREEK

1963

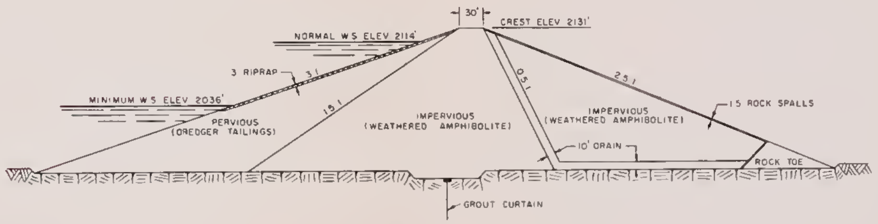


GENERAL PLAN

0 100 200



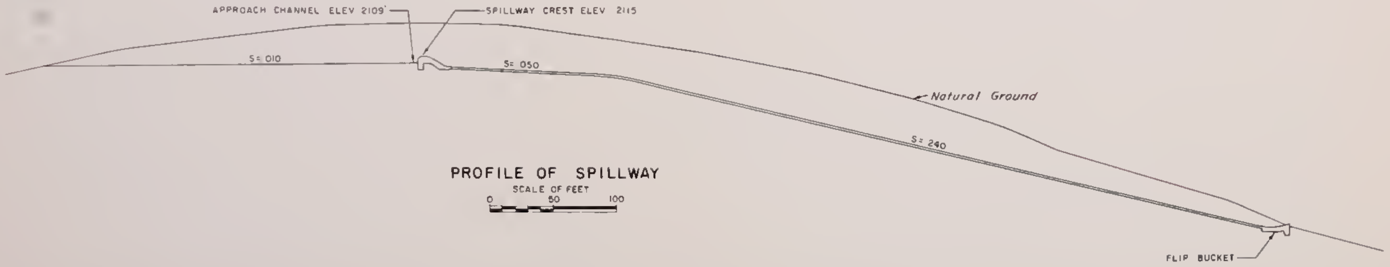
SECTION A-A'



MAXIMUM SECTION OF DAM

SCALE OF FEET

0 80 160

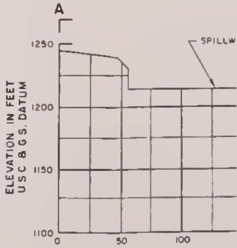


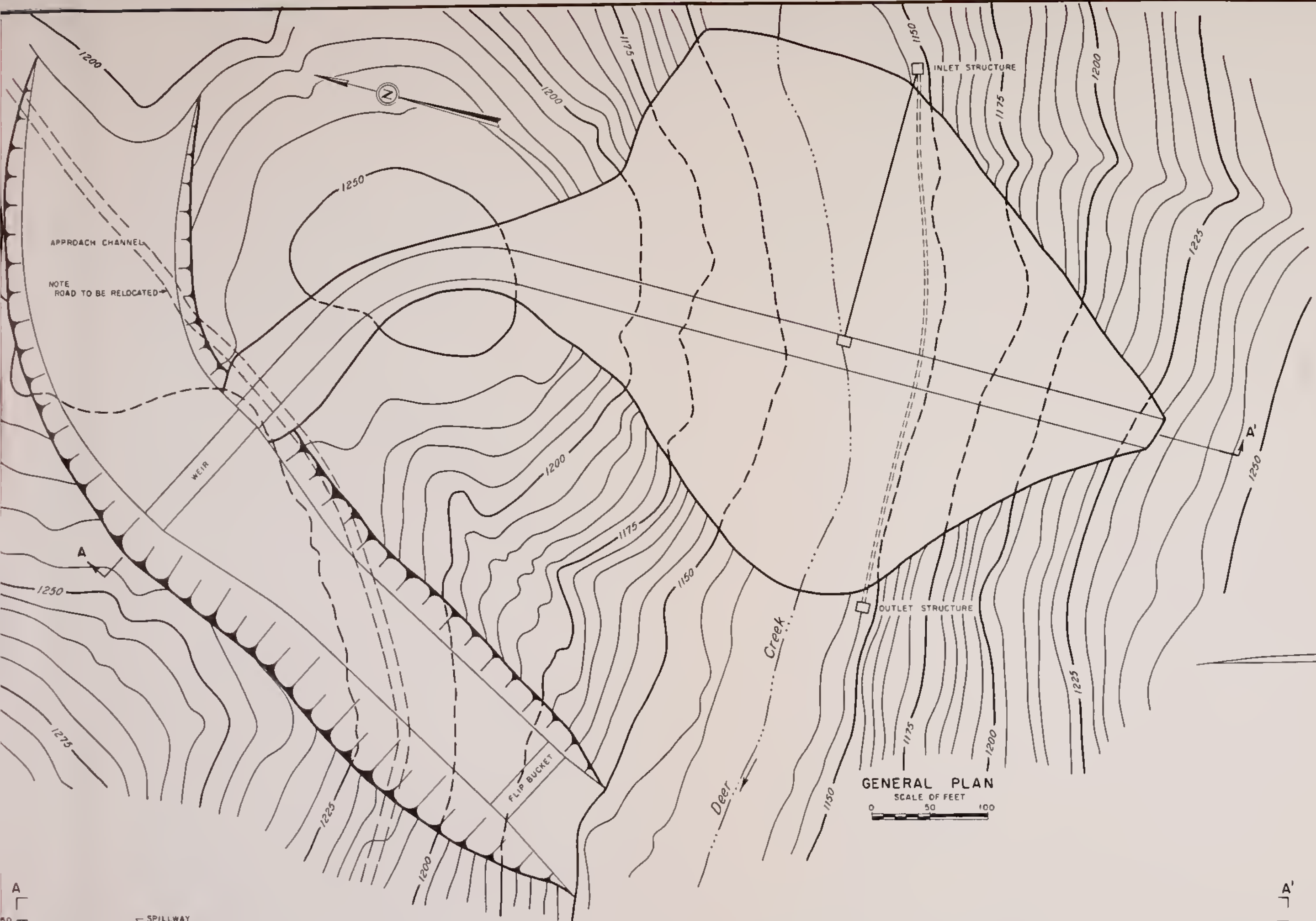
PROFILE OF SPILLWAY

SCALE OF FEET

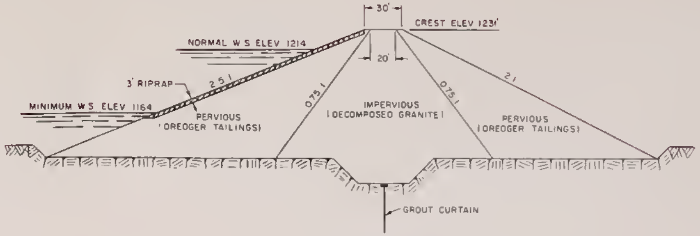
0 50 100

BITNEY CORNER DAM

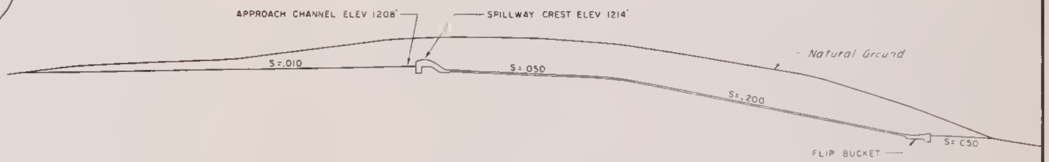




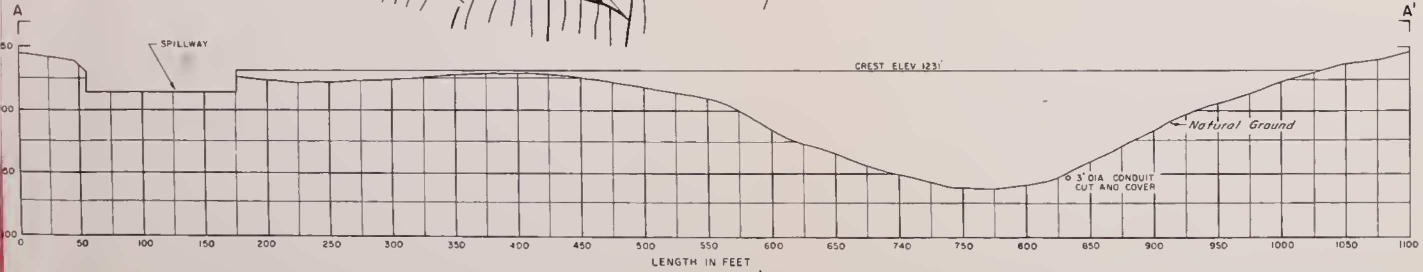
GENERAL PLAN
SCALE OF FEET
0 50 100



MAXIMUM SECTION OF DAM
SCALE OF FEET
0 50 100



PROFILE OF SPILLWAY
SCALE OF FEET
0 50 100



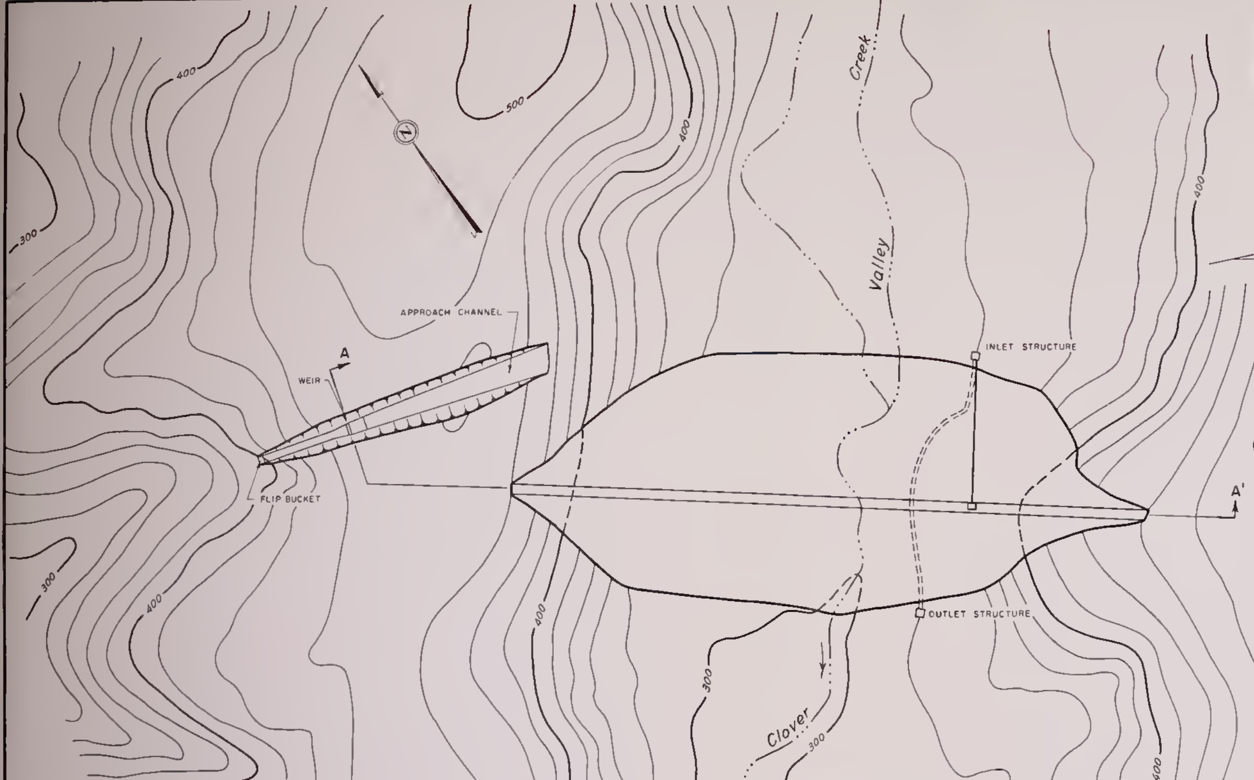
SECTION A-A'

ANTHONY HOUSE DAM

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

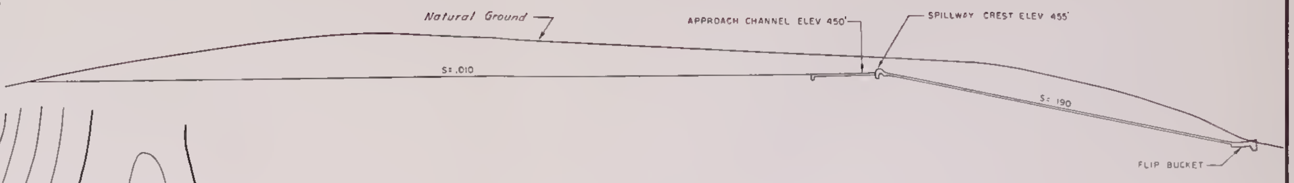
BITNEY CORNER DAM
AND
ANTHONY HOUSE DAM
ON
DEER CREEK
1963



GENERAL PLAN

SCALE OF FEET

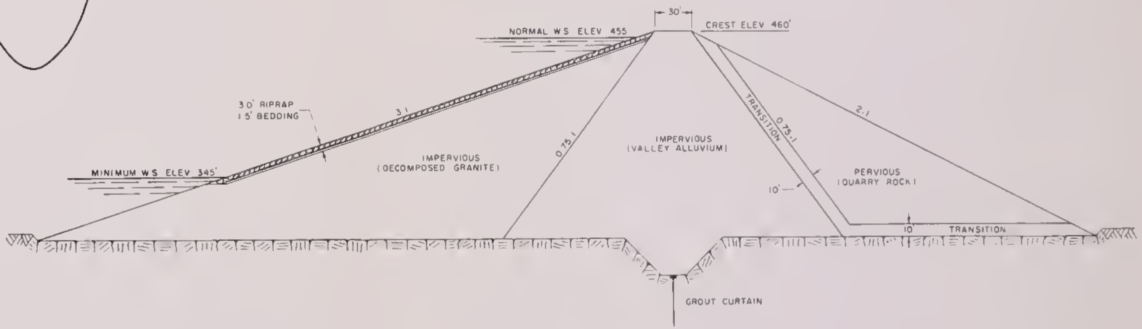
0 200 400



PROFILE OF SPILLWAY

SCALE OF FEET

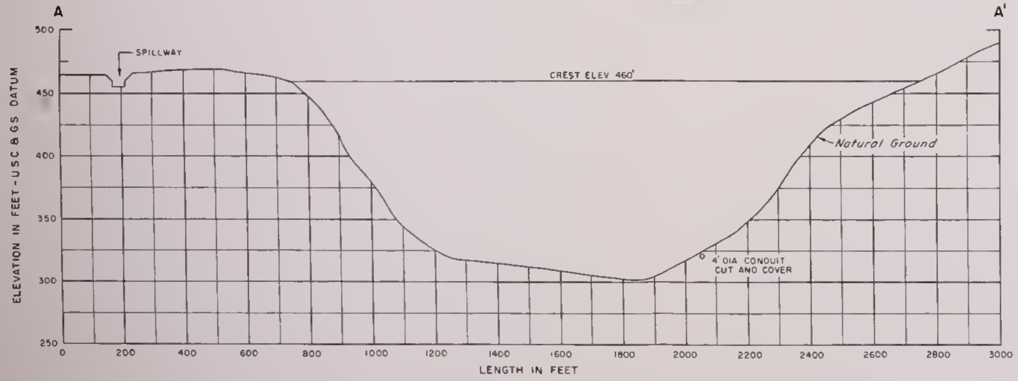
0 50 100



MAXIMUM SECTION OF DAM

SCALE OF FEET

0 50 100



SECTION A-A'

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DELTA BRANCH

YUBA AND BEAR RIVERS BASIN INVESTIGATION

CLOVER VALLEY DAM
ON
CLOVER VALLEY CREEK
1963