FERC-0045-2

APPRAISAL REPORT

WATER RESOURCES APPRAISAL FOR HYDROELECTRIC LICENSING

PIT RIVER BASIN
CALIFORNIA

FEDERAL ENERGY REGULATORY COMMISSION
OFFICE OF ELECTRIC POWER REGULATION

September 1980

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

APPRAISAL REPORT

PIT RIVER BASIN

CALIFORNIA

SEPTEMBER 1980

E R R A T A

(10/31/80)

page 1, bottom line, should read:

. . . until the 1980 eruption of Mount St. Helens . . .

page 58, Figure 37 - Legend

Change Figure 35 to 10

page 59, Figure 38 - Legend

Change Figure 37 to 11

page 30, Table 13

Change Installed Capacity (Total kW) to 725,150
Data in Table 10 under Average Annual Energy (Generation) is the more current.

PREFACE

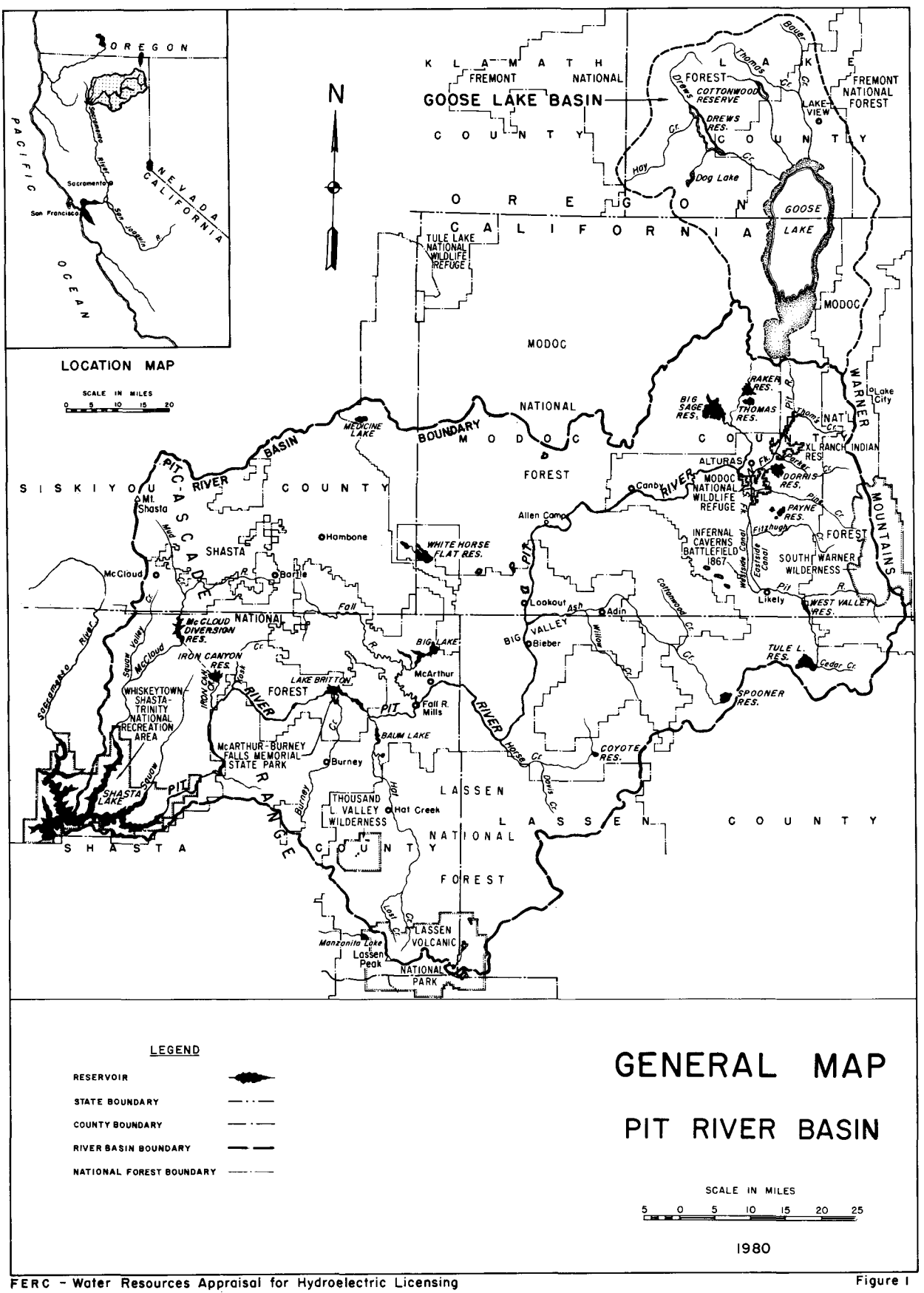
The Federal Power Act, as amended, authorized the Federal Power Commission to undertake investigations of the water resources of any region to be developed; to cooperate with the executive departments and other agencies of Federal and State governments in water resources planning; and to issue licenses to non-Federal interests for the construction, operation, and maintenance of dams, powerhouses, and appurtenances for hydroelectric power development and other purposes. The Act reserves to the United States the right to take over a non-publicly-owned project upon expiration of the license after paying the licensee's net investment in the project, not to exceed fair value of property taken, plus severance damages, if any. Projects to be licensed or relicensed must, in the judgment of the Commission, be best adapted to a comprehensive plan for improving waterways for the benefit of interstate commerce, for water power development, and for other beneficial public uses, including recreation.

On October 1, 1977, pursuant to the provisions of the Department of Energy Organization Act (DOE Act), Public Law 95-91, Stat. 565 (August 4, 1977) and Executive Order No. 12009, 42 Fed. Reg. 46267 (September 15, 1977), the Federal Power Commission ceased to exist and its functions and regulatory responsibilities were transferred to the Secretary of Energy and the Federal Energy Regulatory Commission which, as an independent commission within the Department of Energy, was activated on October 1, 1977. On December 23, 1977, the Secretary issued an order amending DOE Delegation Order No. 0204-1 further delegating to the FERC the authority, under section 4(a) of the Federal Power Act, to continue its activities as they relate to river basin appraisals.

For the purposes of this report, all references to the "Commission" when used in the context of an action taken prior to October 1, 1977, refer to the Federal Power Commission; when used otherwise, the reference is to the Federal Energy Regulatory Commission.

This report on the Pit River basin, California, has been prepared by the staff of the Federal Energy Regulatory Commission as part of a program of Water Resources Appraisals for Hydroelectric Licensing. It is intended primarily to provide information which the Commission and its staff may use or build upon, as appropriate, when considering matters related to hydroelectric licensing, relicensing, or recommendation for Federal takeover. The report is a staff study which was not prepared for adoption or approval by the Commission, and does not commit or prejudge later Commission action.

The basic material used in preparing this report has been abstracted from reports of Federal, State, and local entities and from pending applications for license and/or relicense, although several agencies and individuals have participated in discussions pertaining to the information in the report and have provided useful background data or suggestions. The plans presented, however, do not necessarily carry the endorsement of any such agency or group.



FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure I

SUMMARY

The Pit River basin, with an area of about 6,100 square miles, is located in the northeastern corner of California. The basin includes the eastern portion of Shasta Lake; extends northeasterly for about 134 miles to within 15-20 miles of the Oregon and Nevada State lines; and includes the northern half of Lassen Volcanic National Park on the southerly extreme. The drainage is bounded by the Klamath River basin on the northwest, the Goose Lake basin on the northeast, the Great basin to the east, the Feather River basin to the southeast; and the Sacramento River basin to the south and west.

Goose Lake basin, with a drainage area of about 1,200 square miles, is located in the northeastern part of the watershed, partially within the State of Oregon, but no water has passed over the rim of the outlet to the Pit River since 1862; consequently, for the water resource planning purposes of this report, it is considered to be a part of the Pit River basin to the extent of its recreational contribution only.

The Pit River basin includes parts of the Cascade Mountain Range in its northern, western, and southern provinces and parts of the Warner Mountains to the east. Peaks range upward to 10,437 feet at Mount Lassen and 14,162 feet at Mount Shasta. Approximately 3,800 square miles of the basin are mountainous; the remaining 2,300 are valley and mesa lands. The upper central portion of the basin, above Fall River, is a broad semi-arid plateau with extensive lava beds, lying between 4,000 and 5,000 feet, interspersed with mountain ridges.

The climate of the basin is characterized by hot, dry summers and mild winters with relatively light precipitation in basin floor areas, and by warm, dry summers and cold winters with heavy rain and snow in the mountainous areas.

Average annual precipitation varies with elevation, ranging from less than 15 inches on the basin floor to over 80 inches in the Cascade Range. Temperatures on the valley floor normally range from winter lows near freezing to summer highs of about 110 degrees. In mountainous areas, winter temperatures average about 30 degrees, but occasionally fall well below zero. Flood conditions occur in late spring when it rains simultaneously with spring thaws, adding to the runoff from snowmelt in the higher elevations. Water quality in the basin is generally good with no major sources of pollution.

The three-county economic study area selected to approximate the economy of the basin has a 1978 population of 137,100; although the population density of the study area is only 22.9 persons per square mile as compared to 134 persons for the State as a whole. The largest town in the basin is Alturas, the county seat of Modoc County, with a 1978 population of 2,980.

Employment in the study area is led by the wholesale and retail trade sector, followed by forest-related manufacturing; although the government sector is the leading source of personal income. Recreation is also a major income-producing industry in the basin, but agricultural pursuits which occupy a quarter of the land account for the smallest amount.

The Pit River basin has considerable recreational potential due to its many streams, forests, lakes, and scenic mountains in Shasta-Trinity, Modoc, Lassen, and Freemont National Forests; Lassen Volcanic National Park; and the Whiskeytown-Trinity-Shasta National Recreational Area, together with two wilderness areas, a

memorial and a historic park, and a wildlife refuge. These provide good wildlife refuge and management; consequently, a wealth of game and fish provide excellent fishing and hunting in the basin.

The water resources of the Pit River basin have been previously developed, for the most part, for hydroelectric power in the lower portion and for irrigation purposes in the upper portion. Shasta Lake, located partially within the lower basin, is the largest water resource development in the basin. This lake is a Federally-owned multi-purpose reservoir constructed for irrigation, hydroelectric power, domestic and municipal water supply, recreation, and other purposes by the Bureau of Reclamation (now the Water and Power Resources Service). The operation of Shasta Lake does not presently affect any existing water resource development, but studies are being made for its possible enlargement.

Pacific Power & Light Company serves customers in the northeast sector including that part of Shasta County lying within the basin. Surprise Valley Electrification Corporation purchases energy from Bonneville Power Administration via Pacific Power & Light Company and distributes power to several towns in Modoc County. The Water and Power Resources Service owns transmission lines in the basin but does not serve any customers therein.

With the exception of a 3,200-kilowatt thermal generating plant at McCloud, owned by U.S. Plywood Company, Pacific Gas and Electric Company is the sole power-producing entity in the Pit River basin. Its nine hydroelectric plants have a total nameplate generating capacity of 725,150 kilowatts. Most of the power produced is utilized outside the basin.

The nine hydroelectric developments owned by Pacific Gas and Electric Company are presently licensed by the Federal Energy Regulatory Commission as Projects No. 233, 2106, 2661, and 2687. Project No. 233 comprises Pit No. 3, 4, and 5 developments; Project No. 2106 comprises James B. Black, Pit No. 6, and Pit No. 7 developments; Project No. 2661 includes Hat Creek No. 1 and 2 developments; and Project No. 2687 comprises Pit No. 1 development. The nine hydroelectric plants are operated as an integrated system.

The scheme of hydroelectric development is such that Pit No. 1, located at Fall River Mills, uses water diverted from Fall Creek and is the uppermost plant on the main stem of the Pit River. Following in downstream order are Pit No. 3 (there being no Pit No. 2), Pit No. 4, James B. Black (formerly McCloud-Pit which is operated by diversion flows from McCloud River), Pit No. 5, Pit No. 6, and Pit No. 7. Hat Creek No. 1 and 2 are located on Hat Creek, an upper tributary.

The 50-year license for Project No. 2106 will expire on July 31, 2011; the license for Project No. 2687 was issued for a period beginning on August 1, 1946, expiring on December 31, 1995; and the license for Project No. 2661 is for a 50-year period which expires on September 30, 2000.

Project No. 233's original license has expired, and the project is being considered for a new license under section 15 of the Federal Power Act. It is subject to possible takeover by the United States under section 14 of the Act. Project No. 233 has a total installed capacity of 310,750 kilowatts at its three plants and annually generates 1,643,000 megawatt-hours of energy.

Project No. 233 comprises Pit No. 3, 4, and 5 developments and is located in Shasta County, along a 38-mile reach of the Pit River extending from the mouth of Hat Creek to the mouth of Iron Canyon Creek, as shown on figures 11 and 22. The project develops a total static head of 1,312.5 feet and is located about 50 miles

northeast of the city of Redding, in the vicinity of the communities of Fall River Mills and Burney; portions are located within Shasta National Forest. Lake Britton, the project reservoir for Pit No. 3 development, provides flow regulation for all downstream plants on the Pit River. Pit No. 3 development includes a powerhouse with three 26,730-kilowatt generators; a 112-foot-high concrete dam impounding Lake Britton; and substantial recreational facilities which have been developed around the lake. Pit No. 4 has a powerhouse containing two 45,000-kilowatt generators; a 101-foot-high dam impounding the project reservoir located 1.5 miles downstream from Pit No. 3 powerhouse; but no developed recreational facilities. Pit No. 5 consists of a powerhouse with two 38,280-kilowatt generators and two 32,000-kilowatt generators; a 67-foot-high dam impounding the project reservoir 1 mile downstream from Pit No. 4 powerhouse; and no developed recreational facilities. Project No. 233 appears to be in good operating condition and is expected to continue to be operated as an economical source of power.

Studies have shown that additional storage capacity is needed in the Pit River basin for hydroelectric power, irrigation, and flood control in the Big Valley area in the middle of the basin, and for flood control on the Sacramento River downstream of Shasta Dam.

The 1985 projected needs for Power Supply Area 46 in which the Pit River basin is located is about 1.4 times as great as the energy used in 1975. Possible future development in the basin is shown on figures 37 and 38. Possible future development in the basin includes four multi-purpose reservoirs not including hydroelectric power and six hydroelectric projects that could develop over 4,000,000 kilowatts of capacity. Two of the multi-purpose projects, Allen Camp and Round Valley, have been studied by the Water and Power Resources Service for irrigation, flood control, and recreation. According to the Water and Power Resources Service, the Allen Camp Reservoir would also benefit the five existing hydroelectric powerplants downstream on the Pit River. Neither of these two projects were found economically feasible by the Water and Power Resources Service under present conditions. The other two multi-purpose reservoirs are under investigation by local interests for flood control and recreation. These two small reservoirs, located in the headwaters, would not have any effect on downstream developments.

Of the six potential hydroelectric projects discussed in this report, three -- Upper Falls, Pit No. 2, and Big Springs No. 3 -- would produce a total of 86,000 kilowatts of conventional capacity. Only Big Springs No. 3 was found economically feasible. The remaining three projects -- Kosh Creek, Ladybug, and Soldier Mountain -- would develop 4,000,000 kilowatts of pumped storage capacity. The Kosh Creek project would utilize the existing reservoirs of the James B. Black hydroelectric project.

Except for the possible development of additional recreational facilities at Pit No. 1 and 3, modifications of existing hydroelectric developments were not found economically justifiable by the staff. However, further investigations may determine that increases in releases or stabilization of water surfaces during the spawning season would be desirable at existing hydroelectric power reservoirs.

Project No. 233 appears to be in good operating condition, and its operation is expected to continue to provide an economical source of power.

CONTENTS

	Page
PREFACE	iii
SUMMARY	v
CHAPTER I - Description of the Basin	1
Location and Drainage Area	1
Physiography	1
Geological Features	2
Climate and Hydrology	2
Water Quality	8
CHAPTER II - Prior Reports and Current Investigations	9
Prior Reports	9
Current Investigations	10
CHAPTER III - Economy of the Basin	13
General	13
Population	13
Personal Income	14
Employment	15
Agriculture	16
Manufacturing	17
Lumber Industry	17
Mining	19
Transportation	19
Electric Utility Systems	20
Recreation	24
Wildlife	25
CHAPTER IV - Existing Water and Related Land Resources Development	27
Hydroelectric Power	27
Pit No. 1 (Project No. 2687)	30
Pit No. 6 (Project No. 2106)	31
Pit No. 7 (Project No. 2106)	31
James B. Black (Project No. 2106)	32
Hat Creek No. 1 (Project No. 2661)	32
Hat Creek No. 2 (Project No. 2661)	33
Irrigation	35
Flood Control	35
Recreation	36
Fish and Wildlife	37
Water Supplies and Rights	37
Sewage Treatment Facilities	38
CHAPTER V - Project No. 233	39
History	39
Description	40
Pit No. 3 Development	40
Pit No. 4 Development	44
Pit No. 5 Development	46
Condition	48
Operation	51

CONTENTS

Page

CHAPTER VI - Need for Development of Water and Related Land Resources. . . 53
Population. 53
Electric Power. 53
Flood Control 53
Recreation and Fish 54
Irrigation Needs. 55

CHAPTER VII - Plans for Future Development 57
General 57
Basis for Economic Analysis of Project No. 233. 60
Allen Camp. 61
Pit No. 2 62
Upper Falls 63
Big Springs No. 3 63
Round Valley. 64
Shasta Lake 65
National Hydroelectric Power Resources Study. 65
Flood Control 66
Parker and Thom Creek Multi-Purpose Developments. 66
Project No. 2687 (Pit No. 1). 67
Pumped Storage Hydroelectric Power Projects 67
Continued Operation of Project No. 233 (Pit No. 3, 4, and 5). 67
Environmental Considerations. 68
Conclusions 69

APPENDIX - Project No. 233 Drawings

TABLES

Table

1. Average Monthly Climatological Data 4
2. Streamflow Data 7
3. Surface Water Quality, Pit River. 8
4. Population Trends, Economic Study Area (ESA). 14
5. Total Personal Income, ESA. 15
6. Employed Persons by Industry, ESA 16
7. Value Added by Manufacturing, ESA 17
8. Distribution of Forest Land, ESA. 18
9. Timber Production, ESA 19
10. Hydroelectric Plant Data. 23
11. Federal and State Operated Recreational Facilities. 24
12. Existing Reservoirs 27
13. Existing Hydroelectric Projects 30
14. Dam and Reservoir Data, Project No. 233 40
15. Past and Estimated Future Power Requirements, PSA 46. 54
16. Most Favorable Potential Projects 57
17. Economic Analysis, Project No. 233. 60
18. Proposed Allen Camp Project 61
19. Proposed Pit No. 2 Project. 63
20. Proposed Upper Falls Project. 64
21. Proposed Big Springs No. 3 Project. 64
22. National Hydropower Study (1979) - Corps of Engineers 65

FIGURES

Figure		Page
1.	General Map, Pit River Basin.	iv
2.	View of Mt. Shasta.	2
3.	View of Burney Falls.	3
4.	Hydrologic Map.	5
5.	Average Annual Streamflow Chart	6
6.	View of Publishers Forest Products Mills.	18
7.	Transportation System	21
8.	Principal Electric Facilities	22
9.	View of Mt. Shasta Ski Bowl	25
10.	Plan, Existing Development, Pit River Basin	28
11.	Profile, Existing Development, Pit River Basin.	29
12.	View of Pit No. 1 Powerhouse.	31
13.	View of Pit No. 6 Development	31
14.	View of Pit No. 7 Development	32
15.	View of Chute Spillway at McCloud Dam	32
16.	View of Iron Canyon Dam	33
17.	View of James B. Black Powerhouse	33
18.	View of Hat Creek No. 1 Dam	34
19.	View of Hat Creek No. 1 Powerhouse.	34
20.	View of Hat Creek No. 2 Powerhouse.	34
21.	View of Boat Launching Ramp, Lake Britton	36
22.	Project No. 233, Plan and Profile	41
23.	View of Pit No. 3 Diversion Dam	42
24.	View of North Shore Campground, Lake Britton.	42
25.	View of the Pines Picnic Area, Lake Britton	43
26.	View of Hat Creek Fish Barrier Dam.	43
27.	View of Concrete Pipe Over Rock Creek	44
28.	View of Intake for Rock Creek Diversion, Pit No. 3 Project.	44
29.	View of Pit No. 3 Powerhouse.	45
30.	View of Pit No. 4 Diversion Dam and Spillway.	45
31.	View of Pit No. 4 Powerhouse.	46
32.	View of Pit No. 5 Diversion Dam and Intake Structures	47
33.	View of Pit No. 5 Powerhouse.	48
34.	View of Interior of Pit No. 5 Powerhouse.	49
35.	View of Spalling at Pit No. 4 Diversion Dam	50
36.	View, Town of Nubieber Flood of January 1970.	54
37.	Plan, Future Development, Pit River Basin	58
38.	Profile, Future Development, Pit River Basin.	59
39.	View, Camp Allen Damsite.	62

CHAPTER I

DESCRIPTION OF THE BASIN

Location and Drainage Area

The Pit River basin is located in the northeastern corner of California as shown on figure 1. The basin covers a portion of Shasta, Siskiyou, Lassen, and Modoc Counties and has a maximum length in an east-west direction of 134 miles and a maximum width in a north-south direction of 94 miles.

The Pit River drainage is bounded by the Klamath River basin on the northwest, the Goose Lake basin on the northeast, a portion of the Great basin to the east, the Feather River basin to the southeast, and the Sacramento River basin to the south and west. The area drained by the Pit River is about 6,100 square miles, of which 3,800 miles are mountainous area and 2,300 square miles are valley and mesa land.

The Goose Lake basin which adjoins the headwaters of the Pit River and extends into Oregon lies in a shallow depression. No runoff from that basin has flowed into the North Fork Pit River since 1862. Therefore, the Goose Lake basin is not included in the area considered to be drained by the Pit River for water resources planning purposes. It is considered to be a part of the Pit River basin due to its recreational contribution, only.

Physiography

The North and South Forks of the Pit River rise on the western slopes of the Warner Mountains and join near Alturas to form the Pit River, which flows southwesterly about 170 miles through portions of the Cascade Range to its confluence with the Sacramento River in Shasta Lake about 13 miles north of Redding.

The principal tributaries of the Pit River proceeding upstream from its confluence with the Sacramento River are as follows: the McCloud River drains the southeastern slopes of Mount Shasta and joins the Pit River in Shasta Lake; Hat Creek flows from the northeastern slopes of Lassen Peak and joins the Pit River from the south; and Fall River drains a portion of the lava country in the Cascades from the north. In addition to these principal tributaries, many smaller streams drain the plateau and mountain valleys within the basin.

The western portion of the Pit River basin includes Shasta Reservoir. This portion of the Cascade province may be characterized as older foothills of lower elevation, in contrast with the higher altitudes in the valleys, mesas, and peaks to the east.

The basin is formed by the Cascade Mountain Range in its northern, western, and southern provinces with peaks ranging to 10,437 feet at Mount Lassen and 14,162 feet at Mount Shasta; by the Warner Mountains to the east; and by the Sacramento River Valley to the southwest.

The Cascade Range extends northward from the Pit River basin through Oregon and Washington, and on into British Columbia, as well as southward to its contact with the Sierra Nevada Province. The Cascade Range contains many peaks of volcanic origin separated by both broad and narrow valleys of moderate elevation. Mount Shasta, shown on figure 2, is the largest and has a top elevation of 14,162 feet. Mount Lassen, rising to 10,457 feet, is the southernmost volcano in the Cascade Range and until and 1980 eruption of Mount St. Helens in the

Figure 2. The beautiful double cone of Mt. Shasta is the largest of the Cascade volcanoes.

northern Cascades was the most recently active volcano in the contiguous 48 States, having last erupted in 1917.

The Modoc Plateau extends across the eastern half of the basin into the Warner Mountains which form the eastern edge of the basin. The plateau is bordered by volcanic peaks spaced by lava beds and other highlands of low relief. The land form of the province is largely that of nearly level basalt plains and ancient lake deposits and is filled with evidence of volcanic activity. These volcanoes appear to be related to a portion of the Cascade Range that flooded a part of the Great Basin Province.

The eastern edge of the Pit River basin is rimmed by the Warner Mountains which are part of the North Lahontan subregion of the Great Basin. The peaks of the Warner Mountains ascend to 9,883 feet elevation, while the mesa below is above 4,300 feet.

Geological Features

Throughout much of the basin, the high permeability of surface rocks results in a lack of surface drainage, while the underlying rock is much less permeable. The Cascades present a barrier to groundwater movement resulting in a water table of about 4,000 feet elevation in the Modoc Plateau. Above that elevation the surface streams lose water to the ground, while downstream they gain. Upper Burney Creek and Hat Creek and their tributaries lose large amounts of water to the lava, but the water appears again in springs in the Burney area. These springs and associated small streams add considerably to the beauty of Burney Falls, shown on figure 3. The huge springs near Fall River Mills are fed by water from Tule Lake and Clear Lake reservoir located 50 miles north through Medicine Lake Highland. Many other reservoirs, lakes, and streams also contribute to springs in lower elevations.

Another significant geological feature of the basin is the numerous hot springs related to faulting and volcanic activity. These are possible sources of geothermal power, although none in the basin has been developed so far. However, a site just east of the basin near Lake City in Surprise Valley was investigated for geothermal power by exploratory drilling in 1963. Other potential geothermal resource areas in or near the basin include Lassen and Glass Mountains in California, and Klamath Falls and Lakeview in Oregon.

Climate and Hydrology

The climate of the basin is primarily mountain-type with some arid areas in the eastern portion. The temperatures range from 116 degrees to minus 18 degrees

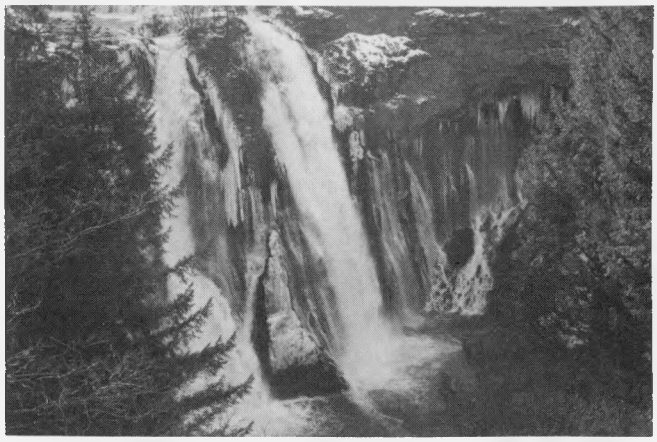


Figure 3. Burney Falls is the principal attraction in McArthur-Burney Falls State Park.

Fahrenheit at Fall River Mills and average 34 degrees in January and 71 degrees Fahrenheit in July at Hat Creek. There is an average of 126 days of growing season (at Fall River Mills), but the average range in the basin is from 80 to 180 days. The temperatures at Lakeview, Oregon (in the Goose Lake basin), range from a maximum of 108 degrees to a minimum of minus 24 degrees Fahrenheit and average 23 degrees in January and 60 degrees Fahrenheit in July. The average monthly and annual temperatures at two stations in the Pit River basin are shown in table 1.

Precipitation over the Pit River basin, in common with that throughout the State, is characterized by a wet and a dry season. Precipitation occurs as a combination of snow and rain, principally during the months from October through April. Generally, precipitation increases rapidly with abrupt increases in elevation; however, significant differences in the amount of precipitation also exist in topographically similar areas.

The prevailing southwest approach of storms causes the heaviest precipitation in the Cascade and Warner Ranges, but low-lying plateaus and valleys on the interior of the basin suffer from a deficiency of precipitation to the extent that only scattered juniper trees and sagebrush grow naturally in some areas. Precipitation in the form of snow generally occurs during the period from December to March, with occasional snowfall in April. In the area above Big Valley, approximately 65 percent of the total precipitation in the winter and spring months occurs as snow; therefore, there is little or no direct relationship between precipitation and runoff during these months. Aggravated flood runoff conditions are created when it rains simultaneously with late winter or early spring thaws, thus adding to the snowmelt from the higher elevations. During April and May the precipitation is usually in the form of rain and produces immediate runoff in the streams.

The precipitation is low in the summer months and is not adequate to sustain high yield crops without supplemental water. The annual averages are about 24 inches at the headwaters in the Warner Mountains, 15 inches in the middle reaches, and over 80 inches in the Cascade Range in the western portion. The records of precipitation at two representative locations in the Pit River basin are summarized in table 1. The distribution of precipitation is shown on figure 4.

Most of the uncontrolled runoff from winter and spring precipitation and snowmelt from the Pit River watershed above Big Valley occurs prior to April 15. The most reliable sources of water in the upper basin during the summer are the perennial springs which contribute a combined flow of about 15 cubic feet per second in the vicinity of Likely and about 17 cubic feet per second in the vicinity of Ash Valley. In the lower reaches of the Pit River, the sustained flow

Table 1

Average Monthly Climatological Data
Pit River Basin

Station	McCloud		Alturas	
Elevation 1/	3,300		4,365	
	precip. (in)	temp. ('F)	precip. (in)	temp. ('F)
Year of Record	68	68	55	52
January	10.04	33.9	1.71	28.6
February	7.78	37.1	1.35	34.0
March	5.76	39.9	1.19	38.1
April	4.12	45.9	1.00	44.5
May	2.50	53.1	1.49	52.1
June	1.38	59.6	1.24	58.8
July	0.25	66.5	0.29	66.8
August	0.39	64.4	0.41	63.8
September	0.77	59.8	0.33	57.8
October	3.62	51.0	1.09	48.4
November	7.16	41.9	1.52	38.7
December	9.00	35.9	1.65	31.9
Annual	52.77	49.1	13.27	46.9

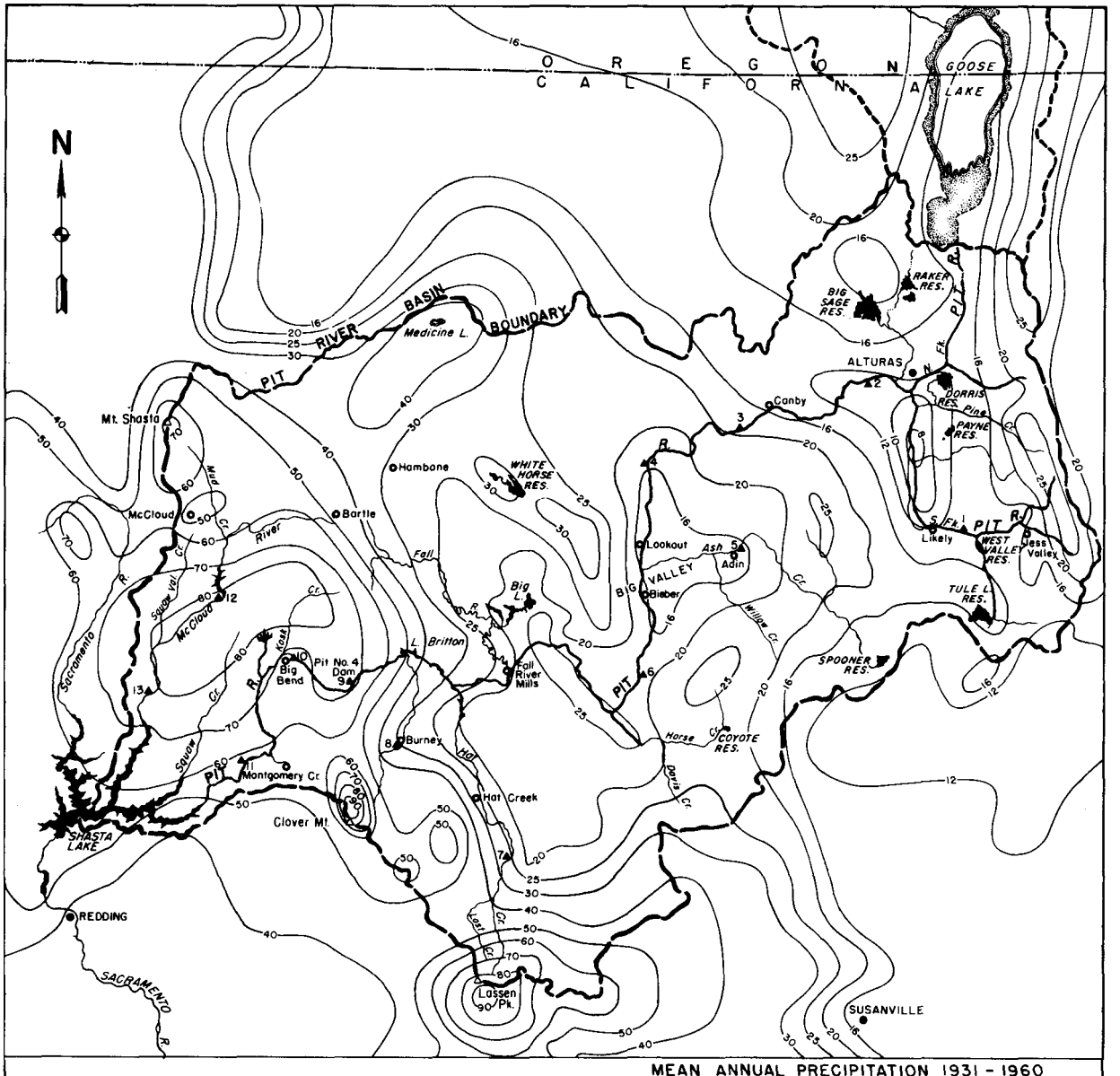
Source: U.S. Department of Commerce Climatological Data Annual Summary, 1978, Volume 78, Number 13.

1/ Feet above mean sea level.

from springs is credited for the stable base flow of the river. The total effluent flow from groundwater storage to the Pit River above Shasta Lake has been estimated by the Water and Power Resources Service to be about 2,500 cubic feet per second, with Fall River being the principal contributor.

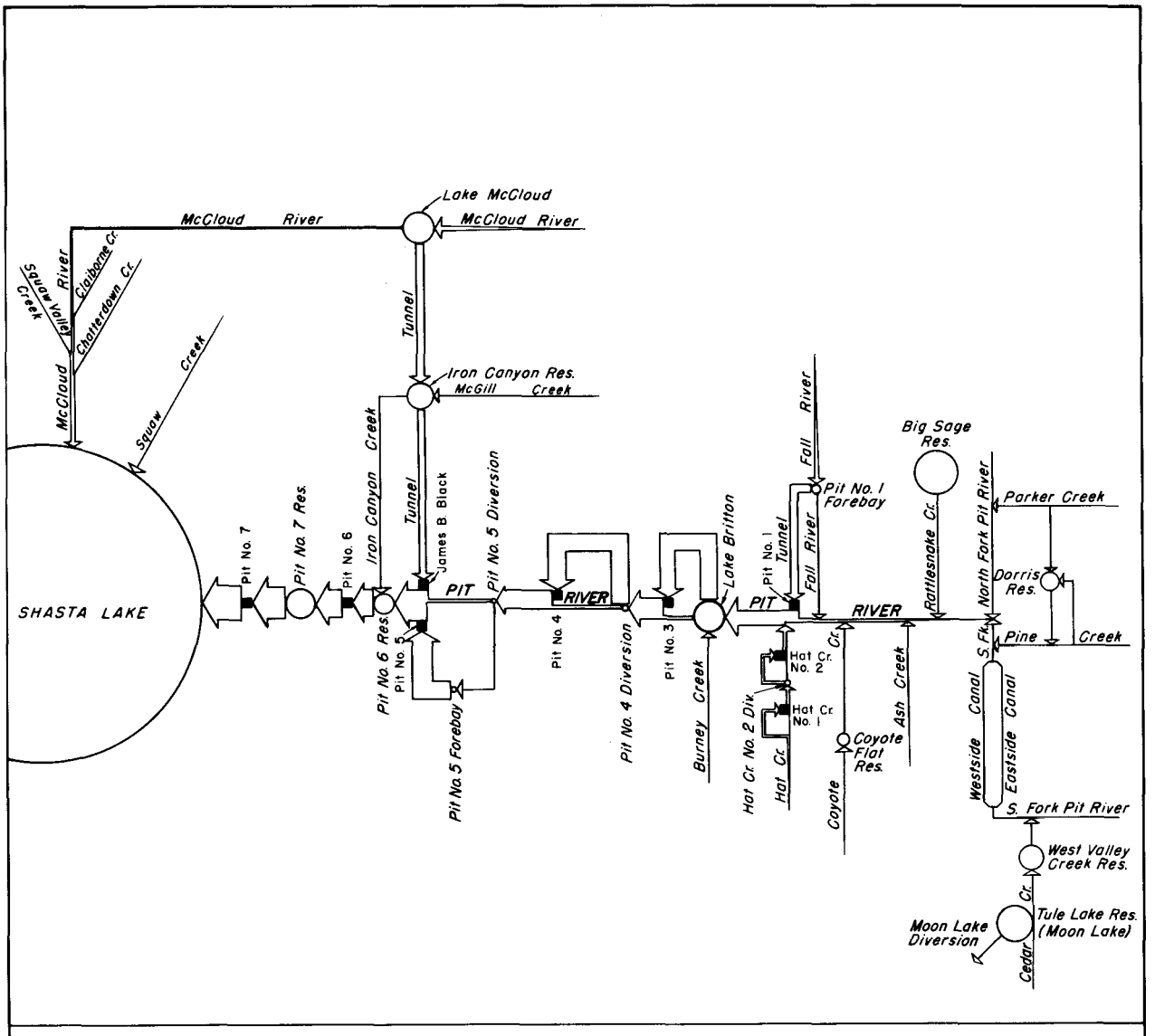
Despite an abundant water supply for the Pit River basin as a whole, the upper basin, where most of the irrigable land is situated, is an area of limited supply. Certain areas in this upper basin produce virtually no surface runoff.

Streamflow data for 12 selected locations within the basin are listed in table 2. The locations of these streamflow gaging stations are shown on figure 4. As illustrated on figure 5, some streamflows are affected by upstream diversions.



FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 4



LEGEND

RESERVOIR ○ POWERPLANT ■

RESERVOIR STORAGE
SCALE IN 1,000 A. F

100
50
25
10
5
1

ANNUAL STREAMFLOW
SCALE IN 1,000,000 A. F

0 5 10

UNDER 100,000 A. F

AVERAGE ANNUAL STREAMFLOW CHART

PIT RIVER BASIN

1980

FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 5

Table 2

Streamflow Data
Pit River Basin

ging Station	Period of Record	Drainage Area (sq mi)	Streamflow (cfs) Average	Maximum 1/	Minimum 1/
. Fk. Pit R. nr. Likely	1928-1978	247	79	1,620	0.2
: R. nr. Canby	1904-1905 1929-1978	1,431	244	13,000	0.1
: R. nr. Lookout	1929-1931 1958-1978	1,585	299	10,900	0.0
ı Cr. at Adin	1904-1905 1928-1932 1957-1978	258	75	2,950	0.0
: R. nr. Bieber	1904-1908 1921-1926 1928-1931 1951-1975	2,475	532	33,800	0.0
Cr. nr. Hat Cr.	1926-1929 1930-1978	162	140	3,320	67.0
ney Cr. nr. Burney	1911-1913 1921-1922 1958-1964 1965-1978	95	70	4,910	3.4
R. below Pit No. 4 dam	1922-1978	4,784	2,716	31,000	22.0 3/
R. at Big Bend 3/	1910-1978	4,711	2,931	49,000	34.0
R. nr. Montgomery Cr.	1944-1978	4,952	5,208 4/	73,000	30.0 2/
loud R. nr. McCloud	1931-1978	358	930	11,800	524.0
loud R. above Shasta ake	1945-1978	604	820 4/	45,500	109.0

rce: U.S. Geological Survey, "Water Resources Data for California," Part I, Volume 4, 1978.
Instantaneous unless otherwise noted.
Minimum daily.
After Pit No. 4 diversion.
After regulation by Lake McCloud and diversion to Pit River basin.

Water Quality

The mineral quality of the Pit River is generally excellent. Surface waters range from soft to slightly hard and comply with irrigation and drinking water standards. However, dark and turbid water is found in some of the upper reaches of the Pit River due to the presence of soils of volcanic origin.

Groundwater in most of the basin is suitable for most purposes. Big Valley, Round Valley, and Fall River Valley yield waters ranging from soft to slightly hard. Some areas around Alturas, however, yield groundwater high in sodium, thus limiting its use for irrigation. Some of the Alturas wells also yield water with levels of iron, sulfate, nitrate, or fluoride in excess of those concentrations set by the U.S. Public Health Service for drinking water.

There is a widespread accumulation of algae in the upper Pit River and in Lake Britton during summer low flows. This condition is probably the result of enrichment in the Pit River and its tributaries by nutrients from agricultural and other drainages. Another agriculture-related problem is the high bacteria levels in surface waters, particularly during periods of high surface runoff. This problem is principally caused by livestock feeding areas and intensive valley pasturing.

Maximum and minimum concentration values for chemical, physical, and bacteriological water quality constituents in the Pit River near Montgomery Creek are given in table 3. The Pit River near Montgomery Creek is calcium-magnesium-sodium bicarbonate in type, soft to moderately hard (suitable for most crops and meets U.S. Public Health Service standard for mineral content in drinking water). Water in the McCloud River is calcium bicarbonate in type, soft, and meets the chemical standards for irrigation and drinking water.

Table 3

Surface Water Quality for the Pit River
near Montgomery Creek and Pit No. 7 Hydroelectric Development

	Maximum	Minimum
Temperature, °F	71.0	36.0
Dissolved oxygen, mg/l	15.3	6.9
Dissolved oxygen saturated, percent	130.0	73.0
pH	8.5	7.1
Total dissolved solids, mg/l	137.0	58.0
Electro-conductivity, ohms/cm	183.0	70.0
NO3, mg/l	1.0	0.0
Boron, mg/l	0.3	0.0
Sodium, percent	35.0	15.0
Total hardness, mg/l	74.0	32.0
Carbon hardness, mg/l	33.0	0.0
Turbidity, mg/l	70.0	0.5
Coliform, MPN/ml	7,000	0.045

CHAPTER II

PRIOR REPORTS AND CURRENT INVESTIGATIONS

Prior Reports

The Pit River basin has been the subject of numerous studies and reports dating back to 1903. The first major report was published in 1915 as a result of a cooperative study by the State of California and the U.S. Reclamation Service. Since that time, a number of reports by State and Federal agencies on water and related land use in the basin have been published. The more significant of these are briefly described below.

A report to the Federal Power Commission in 1928, "Water Powers of California," by Frank E. Bonner, District Engineer, U.S. Forest Service, outlined the hydropower potential within California. The Pit and the McCloud Rivers are treated by separate sections, describing the existing and potential developments. Much of the potential on the Pit River has since been developed, while the McCloud developments did not materialize as envisioned in the report. On the McCloud, substantial but different development has occurred.

The State of California Water Resources Board published Bulletin No. 1, "Water Resources of California," and Bulletin No. 2, "Water Utilization and Requirements of California," in 1951 and 1955, respectively. Bulletin No. 1 gives an overall inventory of the water resources of the State, particularly with regard to hydrology and water quality, while Bulletin No. 2 contains statistics and mapped data of existing water developments within the State.

In May 1957, the Department of Water Resources, State of California, published Bulletin No. 3, "The California Water Plan." As a comprehensive master plan for the development of the water resources of California, this plan includes various schemes for development of the Pit and McCloud Rivers.

The "Northeastern Counties Investigation," Bulletin No. 58, and the "Upper Pit River Investigation," Bulletin No. 86, were prepared by the California Department of Water Resources in 1960 and 1964, respectively. The objectives of these two investigations were to estimate the ultimate water needs of the area and present plans for the development of water conservation projects.

Bulletin No. 98, "Northeastern Counties Groundwater Investigation," by the California Department of Water Resources, was published in February 1963. The investigation concluded that significant potential for the development exists in portions of three groundwater basins within the Pit River drainage.

A report by the U.S. Geological Survey, "Gross Theoretical Waterpower, Developed, and Undeveloped, State of California," by R.N. Doolittle and K.W. Sax, was published in May 1964. The waterpower potential in California, including the Pit River basin, is tabulated in the report. This report was superseded in 1966 by the U.S. Geological Survey Report, "Water Resources of California," by R.N. Doolittle. Undeveloped projects listed in the 1966 report are either discussed in chapter VII of this appraisal report or else the projects have been eliminated by competitive developments built since publication of the 1966 report.

The Water and Power Resources Service prepared and published "Allen Camp Unit, Pit River Division, Central Valley Project 1967, revised 1968." This report covers the proposed Allen Camp project.

Bulletin No. 160-70, "Water for California - Outlook in 1970," by the California Department of Water Resources gives a current and projected status report of the water situation in California.

A comprehensive framework study for the development and management of water and related land resources of the California Region was prepared by the California Region Framework Study Committee, under guidance of the Pacific Southwest Inter-Agency Committee. The committee was composed of representatives of the Departments of Agriculture, Army, Commerce, Health, Education, and Welfare, and Interior; the Federal Power Commission; and the States of Oregon and California. This study was completed at the end of calendar year 1972.

Current Investigations

The Water and Power Resources Service is continuing its interest in the proposed Allen Camp project. As part of the Central Valley project, the Allen Camp Unit would provide local flood control, recreation, and irrigation benefits in addition to the beneficial effects it would have on the area downstream of the Pit River basin.

The Water and Power Resources Service is considering undertaking feasibility studies for enlarging Shasta Lake of the Central Valley project. The purpose of the enlargement would be to increase water supplies and power generation for the Central Valley basin, to improve fishery and recreation conditions, and to provide additional flood control along the Sacramento River.

Local interests, and some Federal agencies including the Bureau of Indian Affairs and the Soil Conservation Service, are aware of the potential of two relatively small water related projects in the Alturas area. These two multi-purpose projects, Parker Creek and Thom's Creek, located mainly on Indian lands, would be developed primarily for recreation, in addition to flood control, irrigation, and wildlife enhancement.

The Corps of Engineers is currently studying the Pit River basin in conjunction with their Northern California Streams Investigation. While the study has not progressed to the point where recommendations can be made concerning potential projects, the studies will consider storage on the Pit River near Lake Britton and on Hat Creek, as well as possible improvements on other waterways. These improvements would offer solutions to local flood problems, and also provide additional protection to the Sacramento Valley below Shasta Dam.

The Corps of Engineers is currently conducting an assessment of the Nation's hydroelectric resources as part of the National Hydroelectric Power Study. The study is designed to provide a current and comprehensive estimate of the potential for incremental or new generation at existing dams and other water resource projects, as well as for undeveloped sites in the United States. When complete in 1981, the effort will provide a detailed evaluation of the Nation's hydroelectric resources and will assist in the future planning and development of this important renewable energy source. The National Hydropower Study addresses all conventional hydroelectric power potential at Federal and non-Federal installations and considers both large and small-scale dams and other water resource projects.

For the purpose of this report, the Federal Energy Regulatory Commission staff, with the cooperation and assistance of various Federal, State, and local entities and the Pacific Gas and Electric Company, has investigated the Pit River basin to update and supplement available data on the water resources aspects of the basin with particular emphasis on Pit Nos. 3, 4, and 5 hydroelectric projects.

CHAPTER III

ECONOMY OF THE BASIN

General

The Pit River basin lies in parts of Lassen, Modoc, Shasta, and Siskiyou Counties in the mountainous northeast corner of California. Much of the land is densely forested but there are also grazing and agricultural lands. Historically, the economy has been based on lumbering and the manufacture of wood products. Since these forest-related industries have declined, the government sector has now become the most significant. Furthermore, the trade and services sectors nearly match in importance the forest-related sector of the basin economy. Expanding recreational activities have contributed significantly to the growing economy, but agriculture continues to be relatively insignificant in the total economy.

The economic study area, considered representative of economic conditions in the basin, includes Lassen, Modoc, and Shasta Counties. Since only 15 percent of Siskiyou County is in the Pit River basin, and this part of the County has an economy similar to the latter 3 counties, it has not been included in the economic study area. The economic study area contains 7.9 million acres and 42 percent of the acreage is in the Pit River basin. The study area's two largest population centers, Redding and Susanville, are not in the basin. Thus, although these cities are relatively small, data for the three-county study area may slightly overstate the urbanization effects in the basin proper. However, the economics of the river basin and the designated study area are so closely related that the data presented in tables 4, 5, 6, and 7 for the economic study area is considered to be representative of the economy of the Pit River basin.

Population

In 1978, the population of the 3-county study area amounted to 137,100 persons which was about one-half percent of the California total (table 4). Between 1960 and 1970, the study area's population increased 23 percent while the State's population jumped 27 percent. From 1970 to 1978, this relationship reversed as the estimated population in the study area grew 37 percent while the State experienced an estimated population growth of 12 percent. Population in the economic study area has grown steadily because gains in the population of Shasta County more than compensated for the population losses during the 1950's and 1960's in Lassen and Modoc Counties. All three counties are now growing and Lassen County is almost back up to its 1950 population levels; however, Shasta County's population has almost tripled since 1950. Population trends in the study area are indicated in table 4.

The economic study area contains 8 percent of California's land area but less than 1 percent of the State's population, which reflects a relatively low population density. According to 1978 estimates, California averaged 139 persons per square mile, and the study area averaged 11 persons per square mile. However, the study area's average masks the wide variation in population densities among the three counties. The 1978 estimates indicate that Shasta County had 28 persons, Lassen had 4 persons, and Modoc had 2 persons per square mile.

In 1970, the population of the 3-county study area classified as living in urban areas also was lower than the State's 91 percent urban population. In 1970, Shasta County's population was classified 50 percent urban, Lassen's 44 percent,

Table 4

Population Trends
Economic Study Area

	Lassen County	Modoc County	Shasta County	Economic Study Area	State of California
Population					
1950	18,474	9,678	36,413	64,565	10,586,223
1960	13,597	8,308	59,468	81,373	15,717,204
1970	14,960	7,469	77,640	100,069	19,650,000
1978 1/	19,900	8,600	108,600	137,100	22,023,000
Population Change					
1960-1970 (percent)	10.0	-10.1	30.6	23.0	27.0
Land area (sq mi)	4,690	4,340	3,850	12,880	158,693
Population density					
(persons/sq mi)	4	2	28	16	139
Urban population	6,608	2,799	38,519	47,926	18,136,045
Urban population percentage	44	38	50	48	91

Sources: U.S. Census of Population, 1970.
California Statistical Abstract, 1974.
1/ Estimates.

Modoc's 38 percent, and the economic study area's 48 percent. During the 1960-1970 period, the urban population increased 33.6 percent in California, 29.5 percent in Shasta County, 18 percent in Lassen County, and decreased 0.7 percent in Modoc County.

The city of Redding, county seat of Shasta County, had a 1978 population of 42,950 persons. This is the largest community within the three-county study area. Next in size is Anderson, with a 1978 population of 7,050. Both Redding and Anderson are outside the Pit River basin. The largest city within the river basin in 1978 was Alturas with 3,040 persons. It is the county seat of Modoc County.

Personal Income

In 1970, the economic study area's personal income totaled $352 million as shown in table 5. This was less than 0.4 percent of the California total.

By 1972, although the study area's personal income had climed 22 percent to $428 million, it remained about the same percentage of California's personal income. In per capita terms, the income of the 3-county study area is 78 percent of the State's figure. In 1972, the median income reported on personal income tax returns was $9,126 in Lassen County, $7,785 in Modoc County, $8,983 in Shasta County, and $9,145 in the State as a whole.

Table 5

Total Personal Income
Economic Study Area, 1970

		$ (1,000)	% TPI 1/
I.	Total Personal Income	352,094	100
	1. Total wage & salary	221,750	63
	2. Other labor income	8,097	2
	3. Proprietors' income	26,379	7
	a. Farm	-2,943	-1
	b. Nonfarm	29,322	8
	4. Property income	48,976	14
	5. Transfer payments	61,409	18
	6. Less: social security	-14,517	-4
II.	Total Earnings	256,216	72
	1. Farm earnings	1,451	3/
	2. Nonfarm earnings	254,765	72
	a. Government	85,026	24
	Federal	35,912	10
	State & Local	49,114	14
	b. Private nonfarm	169,739	48
	Manufacturing	43,407	12
	Mining	2/	2/
	Construction	484 2/	2/
	Transportation & utilities	22,016	6
	Wholesale & retail trade	42,123	12
	Finance & insurance	5,909	2
	Services	35,934	10
	Other	2,217	1

Source: U.S. Department of Commerce.

1/ Percentages rounded; TPI is total personal income.

2/ Data not reported separately to avoid disclosure of data for individual reporting units but included in totals. The residual to be apportioned between these two categories is $17,649,000 or 5 percent of TPI.

3/ Less than 1 percent.

In 1970, the government sector accounted for 24 percent of the study area's total earnings compared to 17 percent in California. The next largest source of personal income in the study area was transfer payments which accounted for 18 percent -- this was double the percentage of transfer payments as a source of personal income in the State.

Employment

Between 1960 and 1970, employment in the 3-county study area climbed 20 percent to 33,751 workers as shown in table 6. During this period, jobs in Lassen County

Table 6

Employed Persons by Industry
Economic Study Area
1960 and 1970

	Number		Percent of Total		Percent Change
	1960	1970	1960	1970	1960-1970
Agriculture, forestry & fisheries	2,829	2,569	10.1	7.6	- 9.2
Mining	136	54	.5	.2	- 60.3
Construction	2,747	2,257	9.8	6.7	- 17.8
Manufacturing	5,158	5,142	18.4	15.2	- .3
Transportation	1,263	1,131	4.5	3.4	- 10.5
Communications, utilities, sanitary	891	1,487	3.2	4.4	66.9
Wholesale and retail trade	5,665	7,312	20.1	21.6	29.1
Insurance, real estate & finance	746	1,302	2.7	3.9	74.5
Services, except health & education	2,828	3,211	10.1	9.5	13.5
Health services & hospitals	471	1,826	1.7	5.4	287.7
Education	1,712	2,934	6.1	8.7	71.4
Welfare, religious & nonprofit	204	602	.7	1.8	195.1
Legal, engineering & professional	677	791	2.4	2.3	16.8
Public administration (government)	2,304	3,133	8.2	9.3	36.0
Industry not reported	413	--	1.5	--	--
Total	28,044	33,751	100.0	100.0	20.4

Source: U.S. Census of Population, 1960 and 1970.

rose 10 percent, in Modoc County they dropped 8 percent, and in Shasta County employment climbed 27 percent. For the study area, sectors that declined in employment for this decade were agriculture, mining, construction, manufacturing, and transportation. All other sectors gained. Leading in the number of new jobs was the wholesale and retail trade sector with 1,647 new positions. Trade was closely followed by the health services and hospitals sector with 1,355 new jobs and by education with 1,222. Also, expansion was experienced by the communications, utilities, and sanitary sector with 596 more workers and the insurance, real estate, and finance sector with 556 more persons employed.

In 1970, the study area's employment was led by the wholesale and retail trade sector with 7,312 jobs or 22 percent of total employment. Manufacturing was second in importance with 5,142 jobs or 15 percent of the study area's jobs. Next in number of workers were the services, government, and education sectors which employed 3,211 persons. Agriculture followed with almost 2,569 employed or about 8 percent of the jobs in the 3-county study area. Except for construction with 2,257 workers, the other sectors employed fewer than 2,000 persons.

Agriculture

The agricultural sector of the study area's economy contributes less than 1 percent to the study area's personal income. In 1973, gross agricultural production value was nearly $96 million for the 3-county study area. This value was about 1.3 percent of California's $7,283 million cash farm receipts for that year although the study area had over 5 percent of the farm land in the State.

The 1974 Lassen County gross agricultural production value was only $17 million. Net income after production costs was, of course, much less. Livestock (cattle) sales of $7 million and alfalfa valued at $9.5 million were the two main activities. Modoc County produced $44 million in gross value of agricultural outputs in 1974. The gross crop value was $36 million and livestock accounted for nearly $8 million in gross value. In 1973, Shasta County generated a gross crop value of $26 million. Livestock, primarily cattle, totaled over $9 million.

The number of farms fluctuates but appears to be generally declining. Farms utilize about a quarter of the study area's land area and 14 percent of these acres are irrigated. In comparison, farms use 37 percent of the State's land and irrigate 20 percent of farm land. Similarly, only 11 percent of the cropland in the study area is harvested in contrast with the 21 percent harvested in the State.

Manufacturing

The largest single category of manufacturing employment is in lumber and wood products, particularly saw mills and planing mills. Also important are printing and publishing and the stone, clay, and glass category.

In 1972, the study area had 182 manufacturing establishments, 49 of these had over 20 employees. As shown in table 7, the 1972 value added by manufacturing was $55.6 million which was less than 0.2 percent of manufacturing value added in California that year.

Table 7

Value Added by Manufacturing
Pit River Basin

Area	1958	1963	1972
	(in thousands of dollars)		
Lassen County	6,229	6,261	4,400
Modoc County	2,390	3,833	1,300
Shasta County	26,071	35,007	49,900
Economic Study Area	34,690	45,101	55,600
California	12,047,983	17,162,564	23,393,600

Source: U.S. Census of Manufacturers, 1958, 1963, 1972.

Lumber Industry

The Pit River basin contains vast forested areas including parts of Lassen, Modoc, and Shasta national forests. The national forest boundaries are shown on figure 1. In the 3-county study area, about 60 percent of the land, 4,784,000 acres, are classified as forest land as shown in table 8.

Historically, timber production and harvest have been the leading industrial economic resources of the study area (see figure 6). The economic development engendered by the forest resources was of major significance and greatly affected employment and income. At one time, Lassen County was the most important lumber producing county in northeastern California. In 1948, the county's total lumber

Table 8

Distribution of Forest Land
Pit River Basin

	California	Lassen County	Modoc County	Shasta County	Three-County Study Area
		(1,000 acres)			
Total land area	100,212	2,910	2,619	2,428	7,957
Forest land	42,416	1,297	1,297	2,190	4,784
Commercial	17,345	829	675	1,262	2,766
Public	9,253	452	458	517	1,427
Private	8,092	377	217	745	1,339
Productive Reserve	1,255	27	29	52	108
Noncommercial	23,816	441	593	876	1,910
Nonforest	57,796	1,613	1,322	238	3,173

Source: *California Statistical Abstract, 1974.*

Figure 6. Publishers Forest Products (Times Mirror) Mill located near Burney, California.

output was 361 million board feet, or nearly one-tenth of the total amount produced in California in that year. By 1972, Lassen County's timber production was less than 2 percent of the State total.

The production of timber in the study area for 1972 was 602.5 million board feet. This was 11.7 percent of the total timber production in California for that year, as shown in table 9. The total production for the 3-county economic area has decreased from 13.5 percent of the total California production in 1960 to 11.7 percent in 1972.

Probably the most important underlying reason for the decline in lumber production is that the counties' mills are unable to compete effectively with the larger and more diversified and efficient mills located in or near the Sacramento Valley. The Sacramento area mills also have a decided advantage because their transportation costs are much lower.

The long-term outlook for the lumber industry in the three-county study area is encouraging because the worst of the decline is probably over. The industry is expected to continue near its present level of activity in the future.

Table 9

Timber Production
Pit River Basin

	1960	1967	1972
	(million board feet)		
California	5136.0	5062.0	5136.0
Lassen County	98.1	74.1	97.8
Modoc County	42.3	78.9	98.8
Shasta County	552.7	441.2	405.9
Three-County Study Area	693.1	594.2	602.5
Study Area as percent of California	13.5	11.7	11.7

Source: California Statistical Abstract, 1974.

Mining

Mining activity is currently limited to prospecting in the Pit River basin. In the past, mining production included gold, silver, and miner's mercury, as well as several nonmetallic mineral commodities such as pumice, volcanic cinders, diatomite, ornamental and semiprecious rocks, and gravel. Some of these nonmetallic products are still of commercial importance. Although mineral production has not been an important factor in the basin's economic development, the total value of the mineral production of the 3-county study area in 1968 has increased almost 30 percent from that of 1963, while during the same period, the value of the State's mineral production increased about 19 percent. In 1968, the three counties produced about 0.5 percent of the total State mineral output value.

Transportation

Main line freight and passenger railway services in the basin are provided by the Southern Pacific Transportation Company, Western Pacific, and Burlington Northern Railroad Companies, and the McCloud River Company. The Southern Pacific is the prime rail carrier and provides service to the eastern half of the basin. The majority of the Burlington Northern traffic consists of through service to the Pacific Northwest. This railroad also provides connecting service with Western Pacific at Nubieber and with the McCloud River Company at Hambone. The McCloud River Company provides localized service originating at Burney and extends through the northwest section of the basin where it connects with the Southern Pacific at Mount Shasta outside the basin.

There are no commercial airlines operating within the basin. However, Hughes Air West provides commercial service to San Francisco, California, and Klamath Falls, Oregon, from the Redding Municipal Airport, located about 15 miles south of the southwest corner of the basin. The Alturas Municipal Field, within the basin, handles twin engine aircraft and charter service. In addition, there are several private and community airstrips located in the basin.

U.S. Highway 395 provides excellent access in a north-south direction along the basin's eastern boundary. Interstate 5 Freeway, although not within the basin, parallels the western boundary in a north-south direction, and provides access

to the Pacific Northwest and to southern California. State Routes 44, 89, 139, and 299 traverse the basin mainly from east to west, in addition to the network of county roads which serve the agricultural and recreational areas.

Interstate and intrastate highway bus service is provided to many areas of the basin by Pacific Greyhound, while Continental Pacific Trailways operates on Interstate 5. Intracounty bus service is provided by the Redding-Alturas Stage Line and the Mount Lassen Motor Transit Company. In addition to the bus lines, there are 17 major regularly scheduled freight truck lines serving the basin. Figure 7 shows the transportation system network.

Electric Utility Systems

Three major electric power systems, that of Pacific Gas and Electric Company (PG&E), Pacific Power and Light Company (PP&L), and the Western Area Power Administration (WAPA), and one distribution system, Surprise Valley Electrification Corporation (SUVE), operate in the Pit River basin. The principal facilities of these systems, which are located within the basin, are shown on figure 8. These three major electric power systems, in addition to the Bonneville Power Administration, are participants in the Western Systems Coordinating Council, a voluntary council open to all bulk power suppliers in the 13 western States. The purpose of this council is to promote the reliable operation for interconnected bulk power systems in the western region. It is one of nine electric reliability councils in the 48 contiguous States.

PP&L serves Bonneville Power Administration (BPA) preference customers in the northeast sector of the basin and has its own customers along the western edge of the basin. PG&E renders service to that part of Shasta County lying within the basin. SUVE purchases energy from BPA via PP&L and distributes the power in several towns, all but one of which are situated in Modoc County. WAPA owns transmission lines in the basin, but does not serve any customers therein.

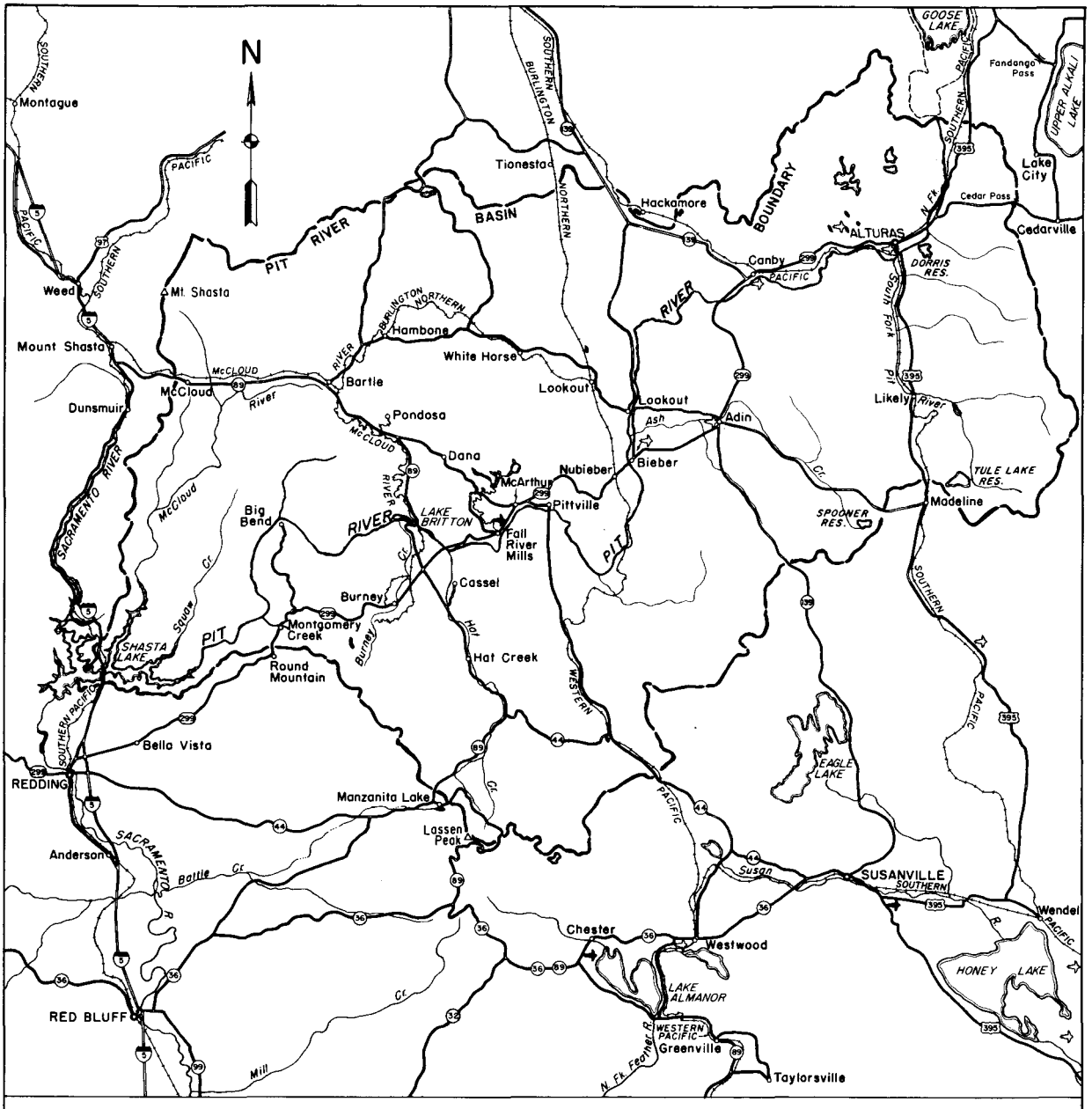
The Pit River basin is located in Power Supply Areas (PSA) 45 and 46. All the power produced in the basin by the Pacific Gas and Electric Company is used in PSA 46 where 85 percent of PSA 46's requirements are met by the Pacific Gas and Electric Company. PSA 46 encompasses most of central and northern California and the northwest quarter of Nevada.

With the exception of a 3,500-kilowatt thermal generating plant at McCloud, owned by U.S. Plywood Company, all the generating installations in the basin are hydroelectric plants, owned by Pacific Gas and Electric Company. The total nameplate generating capacity of these hydroelectric plants is 725,150 kilowatts, all of which are in nine plants listed in table 10 and shown on figure 8. The nine plants are described in chapter IV.

Power from these hydroelectric plants is delivered to PG&E's interconnected system via 60- and 230-kilovolt transmission lines. Most of the output flows southward to PG&E's Round Mountain substation, or its Cottonwood substation, via 230-kilovolt transmission lines where it's used outside of the Pit River basin.

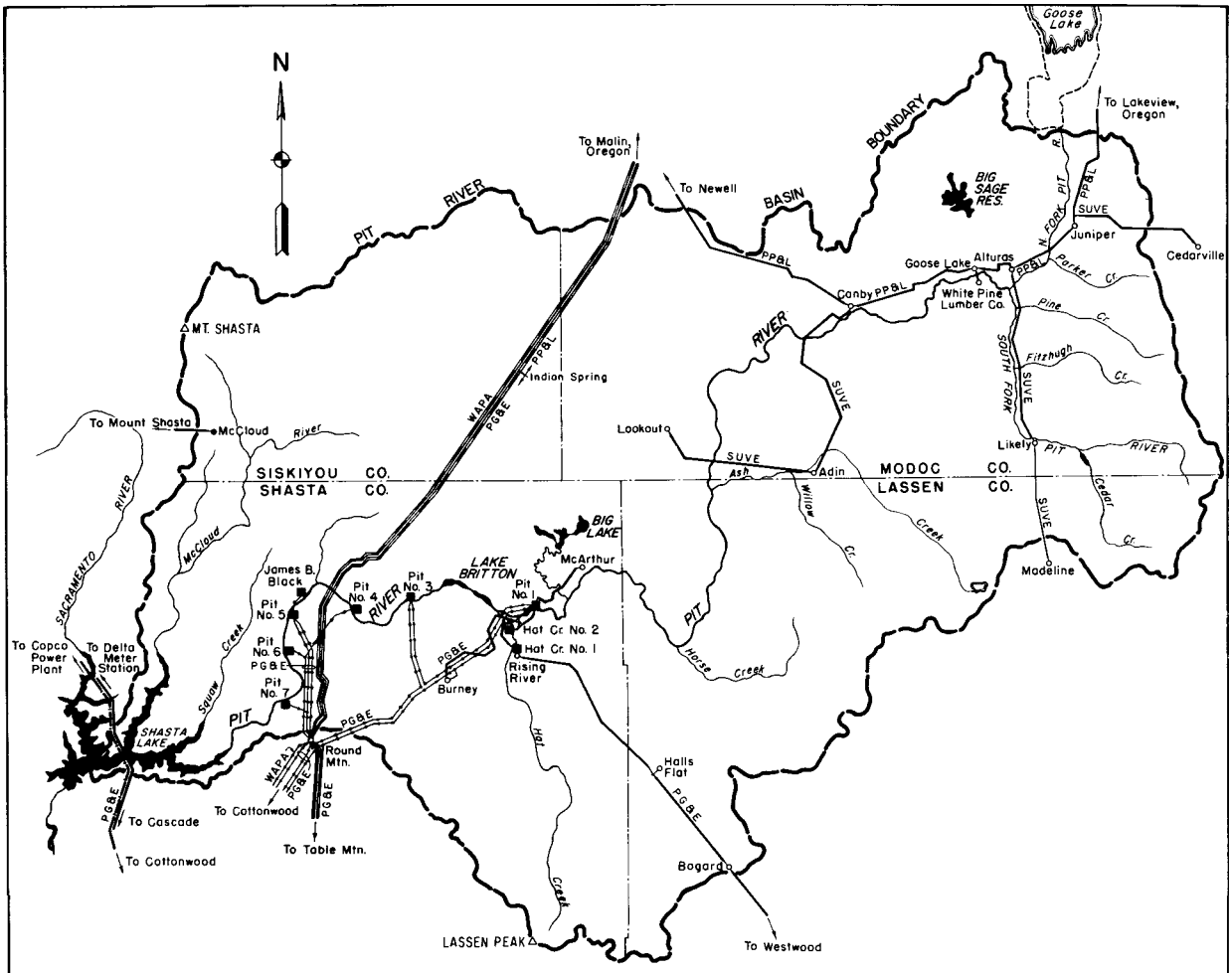
Other major transmission lines, shown on figure 8, are discussed below.

The 500-kilovolt lines of the Pacific Northwest-Southwest Intertie traverse the basin from north to south. The two transmission lines extend from the Malin



FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 7



LEGEND

HYDRO POWERPLANT ■

THERMAL POWER PLANT •

SUBSTATION OR CITY ○

TRANSMISSION LINES

500 KV

230 KV

115 KV

60 or 69 KV

13 KV

CONNECTING

CROSSOVER

UTILITY OWNERSHIP

P G & E = Pacific Gas and Electric Company

P P & L = Pacific Power and Light Company

S U V E = Surprise Valley Electrification Corporation

WAPA Western Area Power Administration

PRINCIPAL ELECTRIC FACILITIES

PIT RIVER BASIN

SCALE IN MILES

5 0 5 10 15 20 25

1980

FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 8

Table 10

Hydroelectric Plant Data
Pit River Basin

Plant Name 1/	FERC Project Number	Installed Capacity 3/	Average Annual Energy 4/
		(kW)	(GWH)
Pit No. 7	2106	104,400	549.3
Pit No. 6	2106	79,200	388.4
Pit No. 5	233 2/	140,560	964.5
James B. Black	2106	154,800	729.8
Pit No. 4	233 2/	90,000	541.6
Pit No. 3	233 2/	80,190	420.0
Hat Cr. No. 2	2661	10,000	57.9
Hat Cr. No. 1	2661	10,000	38.3
Pit No. 1	2687	56,000	293.1
Total		725,150	3,982.9

1/ All hydroelectric plants in the basin are owned by Pacific Gas and Electric Company.
2/ Application for new license pending.
3/ Nameplate rating.
4/ From 1975 PG&E Form 12, Schedule 4, Part B. Data reported under "Average of Median Flow Conditions" are determined by averaging the output from a long-term water and power operation study which gives the average annual potential output for this system.

substation in Oregon in the north to Round Mountain substation in Shasta County, California, just outside of the basin, in the south. Although PG&E operates and maintains both lines, WAPA owns the westerly line. Ownership of the other line is divided between PG&E and PP&L with PP&L owning the section north of Indian Springs, in Siskiyou County, and PG&E owning the part south of that point.

WAPA owns and operates a 230-kilovolt transmission line which extends southward from PG&E's Round Mountain substation, just outside of the basin. PG&E owns and operates all other 230-kilovolt lines in the basin and south from Round Mountain.

PG&E operates a 115-kilovolt transmission line which crosses the western edge of the basin and terminates at PG&E's Delta Metering station outside of the basin.

PP&L owns and operates a 69-kilovolt line which is utilized to serve McCloud and terminates at Delta Metering station. PP&L also has a 69-kilovolt circuit in the northeast sector of the basin to serve BPA preference customers and interconnect with SUVE at several points within the basin.

SUVE operates several 69-kilovolt transmission lines to serve its distribution customers in that portion of Modoc County lying within the basin.

All 60-kilovolt circuits within the basin are owned and operated by PG&E.

Recreation

Recreation is a major income producing industry within the Pit River basin, and it is, by far, the most dynamic. Most indicators suggest that expanding recreation may soon become the ranking revenue producer in the basin. The potential is certainly there -- the Pit River runs through some of the most scenic country in California. The remains of recent volcanic activities are spread over large areas, and these, together with other unique geological formations, attract ever increasing numbers to the basin. Scenic mountains, snowfields, natural lakes, reservoirs, outstanding trout streams, wildlife, excellent waterfowl hunting, and a very low population density also contribute significantly to the recreation potential.

A variety of public recreation facilities, as shown in table 11 are available. They include primitive camp sites, palatial lakeside resorts, and Mount Shasta Ski Bowl, a major snow ski center (see figure 9). The Federal Government, largest land owner in the basin, has provided the greatest number of facilities. The bulk of these are campgrounds in portions of Lassen, Modoc, Fremont, and Shasta-Trinity national forests and the northern part of Lassen Volcanic National Park. Federal administration also includes the following special areas: Shasta Unit; Whiskeytown-Shasta-Trinity National Recreation Area; the Thousand Lakes, Caribou, and South Warner wilderness areas; the Devils Garden Natural Area; and the Mount Shasta Scenic Area.

Table 11

Federal and State Operated Recreation Facilities
Pit River Basin

	Fremont National Forest	Lassen National Forest	Modoc National Forest	Shasta National Forest	Lassen Volcanic National Park	State of Calif.	State of Oregon	Total
Campgrounds	4	11	14	25	2	1	2	59
No. of units	31	239	245	406	191	118	60	1,290
Picnic areas	3	4	2	2	--	1	2	14
No. of units	34	17	11	15	--	50	16	143
Group camps	--	--	--	--	1	--	--	1
Boat ramps	4	--	1	8	--	1	1	15
Roadside rests	--	--	--	--	--	3	1	4

The U.S. Forest Service reports 2,200,000 recreation visitor-days used in 1979 on that portion of the Whiskeytown-Shasta-Trinity National Recreation Area located within the Pit River basin. Based on this figure, it is estimated that overall recreational use of national forest lands within the basin approached three million visitor-days during 1979.

The South Warner Wilderness in the Warner Mountains contains Eagle Peak and is located in Modoc National Forest, east of State Highway 395 and southeast of Alturas. It was set aside as the South Warner Primitive Area in 1931 and was designated a wilderness in 1964.

Thousand Lakes Wilderness, which includes Crater Peak, is located in Lassen National Forest, west of State Highway 89 and north of Lassen Volcanic National Park between Manzanita Lake and Hat Creek. It was set aside as Thousand Lakes Valley Primitive Area in 1931 and was designated a wilderness in 1964.

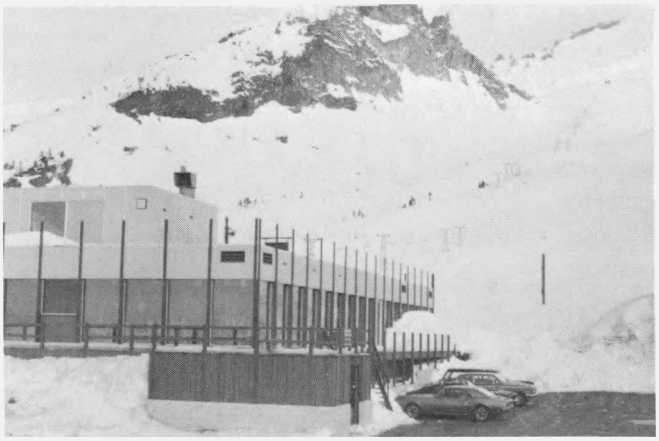


Figure 9. Mount Shasta Ski Bowl.

Lassen Volcanic National Park, established in 1916, is located in the extreme southern portion of the Pit River basin. About 93 square miles of the park's 165 square miles drain into tributaries of the Pit -- mainly, Hat Creek. The park is dominated by the 10,457-foot Lassen Peak, the last active volcano in the contiguous 48 States. A period of volcanic eruption began on May 30, 1914, and lasted for more than 7 years. Today, most evidence of recent volcanic action consists of hot springs, steaming fumeroles, and sulfurous vents. Lassen Park Road, which traverses the western portion of the park, affords many beautiful views of the park's lakes and mountains, as well as three sides of the volcano. Many examples of the volcano's destructive action can be observed from the roads and the nearly 150 miles of hiking trails within the park. Although the park is open the year-round, the main road is not maintained through the park in the winter.

Facilities in the park consist mainly of the visitor center at Manzanita Lake and a small facility near the southwest entrance. Campgrounds are located in most areas of the park. A ski area is developed near the southwest entrance. More than 38,000 visitor-use days were recorded in 1979.

Wildlife

A wide variety of small game, upland gamebirds, waterfowl, song birds, predators, and fish are present in the Pit River basin. It is estimated that more than 100,000 deer and about 800 elk inhabit the basin and the national forest lands therein. There are three wildlife refuges established by the State of California in the area. Although provided for the protection of wildlife, later studies indicate that these refuges fail to produce the desired results--mainly, because of excessive animal use of the habitat and watershed.

Big game animals located in the basin area include significant numbers of antelope, elk, deer, and black bear. Upland game is also generally abundant with the following species: turkey, sage grouse, ruffed grouse, blue grouse, California quail, mountain quail, chukar, pheasant, dove, cottontail, and brush

rabbit. Large concentrations of ducks and geese invade the area each fall and spring. Pursuit of these various game species, especially deer, provides sport for thousands of hunters. Associated predators are also common. They include mountain lion, bobcat, coyote, badger, fox, eagles (both bald and golden), and hawks.

To perpetuate popular game species, the Federal Government has established the 6,000-acre Modoc National Wildlife Refuge, and the State of California manages another three refuges in the basin, primarily for deer. The Lassen Volcanic National Park is rich with animal life. Some 50 species of mammals, 150 kinds of birds, about 12 different amphibians and reptiles, and many insect species inhabit the park.

CHAPTER IV

EXISTING WATER AND RELATED LAND RESOURCES DEVELOPMENT

The water resources in the Pit River basin include developments for hydroelectric power and irrigation, with the hydroelectric developments located in the lower basin and the water supply reservoirs for irrigation located in the upper basin. A portion of Shasta Lake, which includes power and irrigation storage among its multiple uses, extends into the Pit River basin. The basin is noted for its natural scenery and recreation potential. However, most of the recreation potential is associated with the scenic land resources and not with the water resources. A list of reservoirs and their pertinent data are shown in table 12. The locations of the reservoirs are shown on figure 10.

Table 12

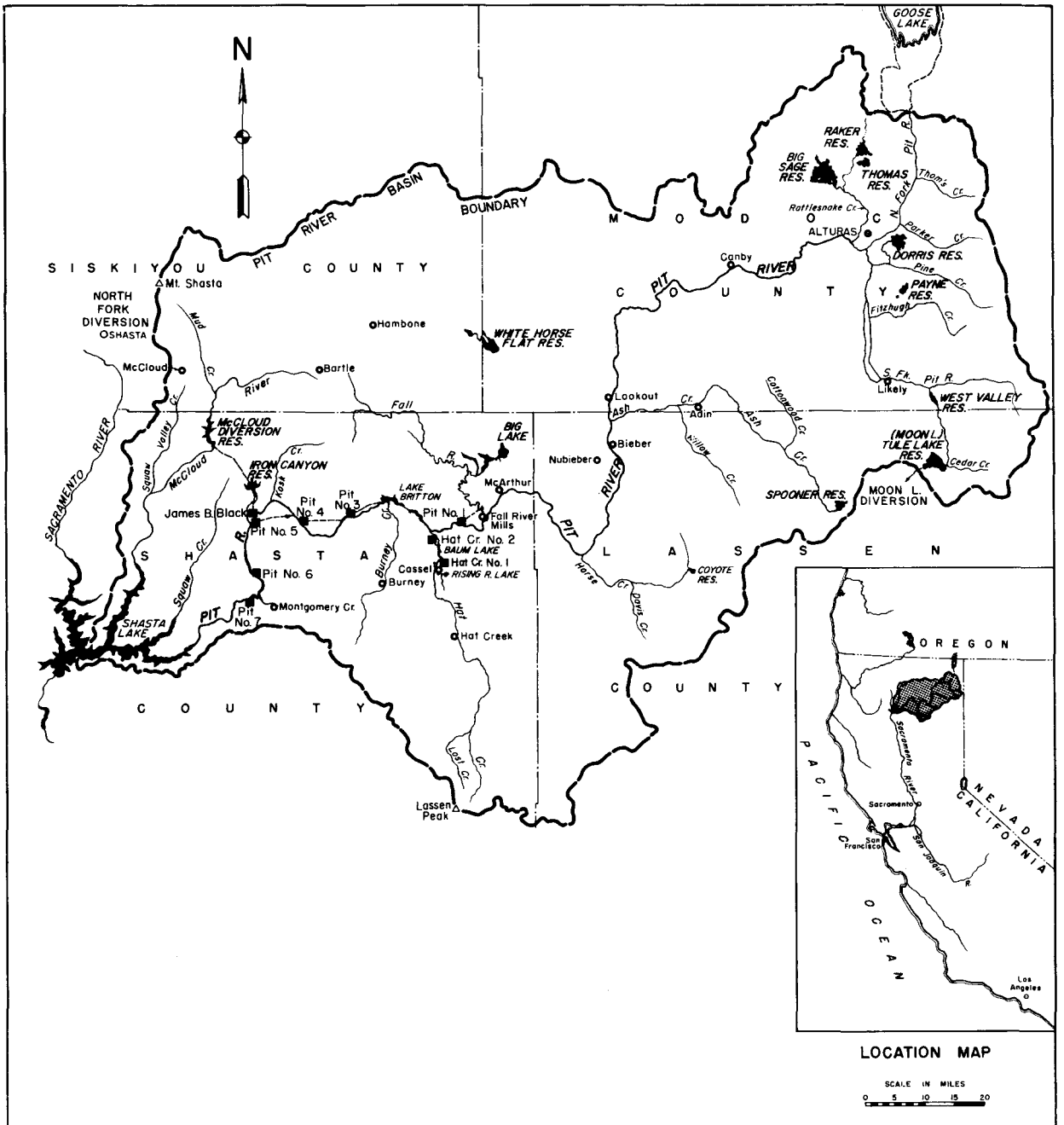
Existing Reservoirs
Pit River Basin

Name	Stream	Drainage Area (sq mi)	Owner	Use 5/	Storage Capacity usable (ac-ft)	Storage Capacity total (ac-ft)	FERC Project No.
Shasta Lake 1/	Sacramento River	6,665	Water & Power Resources Service	HP,R,FC,I	4,377,000	4,500,000	--
Lake McCloud	McCloud River	404	Pacific Gas & Electric Co.	HP,R,F&W	25,231	35,300	2106
Pit No. 7	Pit River	5,170	Pacific Gas & Electric Co.	HP,R,F&W	16,000	34,000	2106
Pit No. 6	Pit River	5,020	Pacific Gas & Electric Co.	HP,R,F&W	11,950	15,700	2106
Iron Canyon	Iron Canyon Creek	11 2/	Pacific Gas & Electric Co.	HP,R,F&W	22,700	24,300	2106
Pit No. 5	Pit River	4,900	Pacific Gas & Electric Co.	HP	315	327	233
Pit No. 4	Pit River	4,784	Pacific Gas & Electric Co.	HP	1,955	1,970	233
Lake Britton	Pit River	4,747	Pacific Gas & Electric Co.	HP,R,F&W	31,600	40,600	233
Haynes	Goose Creek	5.3	Welch & Welch	I	7,000	7,000	--
Baum Lake	Hat Creek	431	Pacific Gas & Electric Co.	HP,R,F&W	629	629	2661
Crystal Lake 3/	Hat Creek	unknown	Pacific Gas & Electric Co.	HP,R,F&W	290	380	2661
Big Lake	Fall River	unknown	Pacific Gas & Electric Co.	HP,R,F&W	unknown	unknown	2687
Coyote Flat	Coyote Creek	30	T.E. Connally	I	5,000	5,000	--
Pit No. 1	Fall River	676	Pacific Gas & Electric Co.	HP	2,450	3,210	2687
White Horse Flat	Tuft Creek	unknown	unknown	unknown	unknown	unknown	--
Spooner	Trib. Ash Creek	7	Pacific Seaboard Land Co.	unknown	unknown	3,123	--
Roberts	Trib. of Pit Rive	11	Big Va. Mutual Wtr. Co.	I	6,000	6,000	--
Big Sage	Rattlesnake Creek	107	Hot Springs Va. Irr. Dist.	I	77,000	77,000	--
Raker	Rattlesnake Creek	unknown	David J. Bayne	I	7,000	7,000	--
Dorris	Stookdill Slough	6	W.J. & P.S. Dorris	I	11,100	11,100	--
Payne	Trib. S. Fk. Pit R.	4.5	Charles E. Massae	I	unknown	2,850	--
West Valley	West Valley Creek	142	S. Fk. Irr. District	I	21,050	21,300	--
Tule Lake	Cedar Creek	80	John Collins 4/	I,R	39,500	39,500	--
Silva Flat	Juniper Creek	20	H.W. Killibrew et. al.	I	unknown	3,900	--
Duncan	Trib. of Pit River	11	F.R. Bacon, Jr.	I,S	unknown	2,575	--

1/ Only a portion of Shasta Lake extends into the Pit River basin.
2/ Does not include McCloud River drainage area.
3/ Natural uncontrolled lake that flows into Baum Lake.
4/ Pacific Seaboard Land Co.
5/ HP-Hydroelectric Power; R-Recreation; FC-Flood Control; I-Irrigation; F&W-Fish & Wildlife; S-Sedimentation.

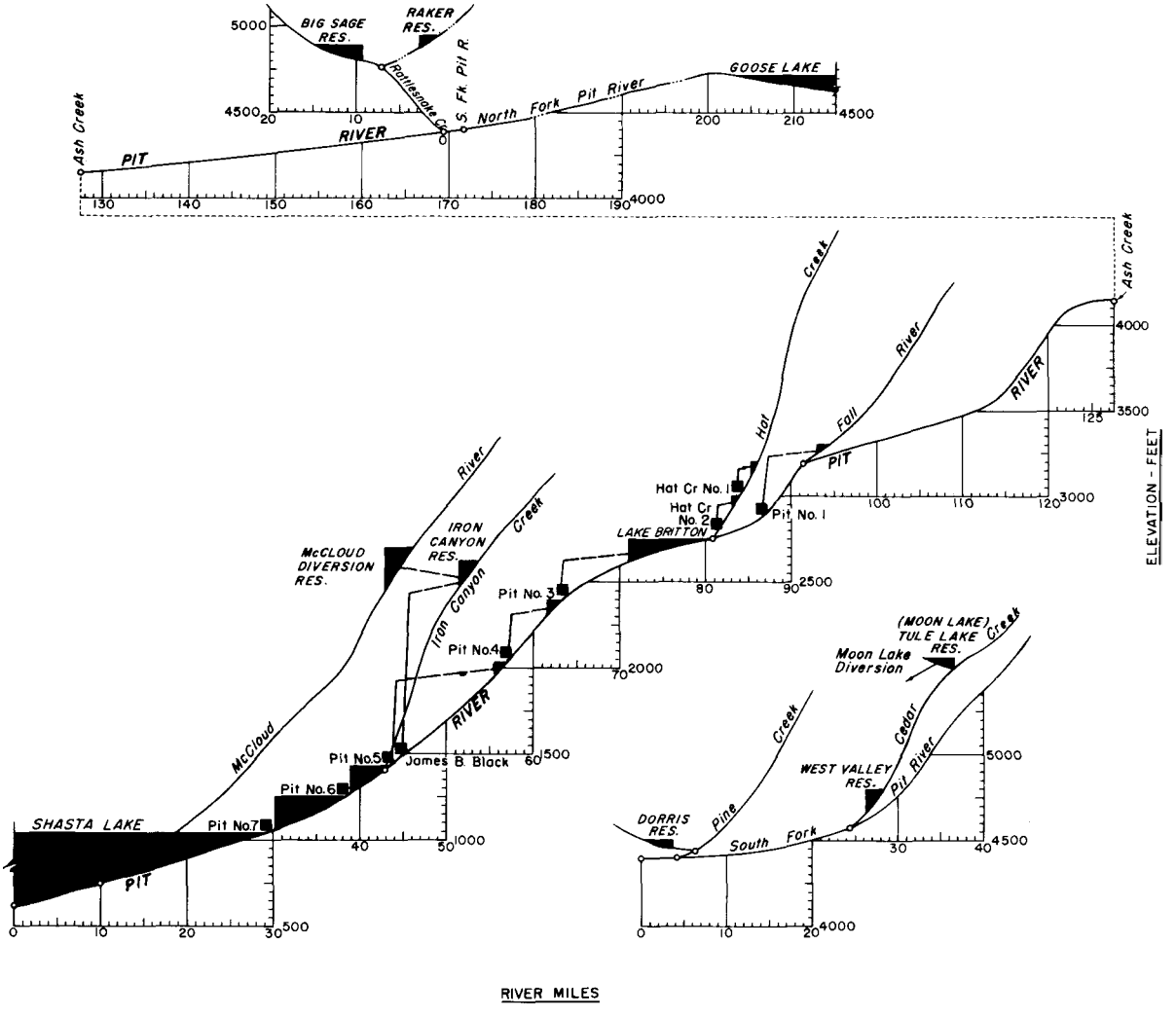
Hydroelectric Power

There are nine hydroelectric powerplants in the Pit River basin, all of which are owned by the Pacific Gas and Electric Company. The total installed capacity and the average annual generation of these plants are 725,150 kilowatts and 3,336 million kilowatt-hours, respectively. Gross reservoir storage capacity provided at the powerplants is over 157,000 acre-feet. The existing developments are shown on the existing development map and profile (figures 10 and 11), and their pertinent



FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 10



LEGEND

RESERVOIR

HYDRO POWERPLANT

TUNNEL

CONDUIT

EXISTING DEVELOPMENT
RIVER PROFILES
PIT RIVER BASIN

1980

FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 11

data are listed in table 13. Brief descriptions of these developments, except those of Project No. 233, are given in the following paragraphs. In view of the license expiration for Project No. 233 and the current considerations for relicensing or recommendation for Federal takeover of the project, the Pit Nos. 3, 4, and 5 developments are described in detail in chapter V.

Table 13

Existing Hydroelectric Projects
Pit River Basin

Plant 1/	Stream	FERC Project No.	License Expiration Date	Gross Head (ft)	Drainage Area (sq mi)	Maximum Power Pool Elev. 2/ (ft)	No. of Units	Installed Capacity (kW)	Average Annual Generation (MWh)
Pit No. 1	Pit R. 3/	2687	12/31/95	455	676 3/	3,304.8	2	56,000	264,100
Pit No. 3	Pit R.	233	10/22/73 4/	315	4,747	2,737.5	3	80,190	385,400
Pit No. 4	Pit R.	233	10/22/73 4/	382	4,784	2,422.5	2	90,000	422,200
Pit No. 5	Pit R.	233	10/22/73 4/	615	4,900	2,040.5	4	140,560	836,000
Pit No. 6	Pit R.	2106	7/31/11	155	5,020	1,425.0	2	79,200	334,600
Pit No. 7	Pit R.	2106	7/31/11	205	5,170	1,270.0	2	104,400	495,100
James B. Black	Pit R. 5/	2106	7/31/11	1,226	415 5/	2,664.0	2	154,800	539,700
Hat Creek No. 1	Hat Cr.	2661	9/30/00	212.8	400	3,188.5	1	10,000	19,300
Hat Creek No. 2	Hat Cr.	2661	9/30/00	197.9	431	2,968.8	1	10,000	39,300
							Total	732,150	3,335,700

1/ *All projects owned by PG&E.*
2/ *U.S.G.S. datum.*
3/ *Powerhouse is on Pit River; uses water diverted from Fall River.*
4/ *Project now under annual license; application pending for new license.*
5/ *Powerhouse is on Pit River; uses water diverted from McCloud River and Iron Canyon Creek.*

Pit No. 1 (Project No. 2687)

The Pit No. 1 development is located near the town of Fall River Mills and the confluence of the Fall and Pit Rivers. The development was constructed between 1920 and 1922 by Mount Shasta Power Corporation and first placed in operation September 30, 1922. A low concrete dam was constructed across Fall River creating Big Lake. Water was diverted directly into an intake channel leading to a power tunnel and penstock from there to a powerhouse on Pit River. During 1946 and 1947, the Pacific Gas and Electric Company, successor owner, constructed a 40-foot high earth dam across Fall River downstream of the diversion dam near the mouth of Fall River. The forebay created by the newer dam backs water to the downstream face of the old diversion dam, and forebay water is delivered to the power tunnel via a second intake channel. The forebay has a total storage capacity of 3,210 acre-feet; however, under normal operating conditions, the forebay is drawn down 3.3 feet which is equivalent to 600 acre-feet of usable power storage. The maximum drawdown is 6.0 feet which is equivalent to 1,159 acre-feet of storage capacity. Pit No. 1 plant is used to serve peak loads while at the same time the surface elevation of Big Lake upstream of the diversion dam can be maintained within rigid limits required by a court judgment, rendered in 1932, to protect other water users. The power tunnel is 10,070 feet long and lined with concrete. Two steel penstocks extend from the tunnel outlet to two identical units in a steel frame, reinforced concrete powerhouse with an installed capacity of 56,000 kilowatts. The units are equipped for semi-automatic operation Pit No. 1 powerhouse and penstocks are shown on figure 12.

Figure 12. Pit No. 1 powerhouse and penstocks leading up to power tunnel outlet.

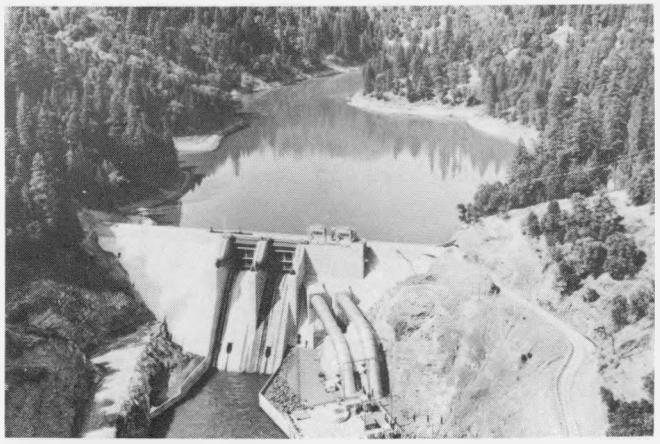


Figure 13. Pit No. 6 hydroelectric development.

Pit No. 6 (Project No. 2106)

The Pit No. 6 development was constructed by the Pacific Gas and Electric Company during the period 1962 to 1966. It was first placed in operation on August 14, 1965. The development is located on the Pit River and consists of a 224-foot structural height concrete gravity dam, a reservoir with 15,700 acre-feet of total storage capacity, two steel penstocks, and a powerplant situated on the left bank near the base of the dam. The reservoir has a maximum power drawdown of 25 feet from the normal full pool elevation, which is equivalent to 5,821 acre-feet of usable power storage capacity. Two identical units in the outdoor-type powerplant have a combined installed capacity of 79,200 kilowatts. Upstream usable power storage capacity of 14,443, 25,231, and 20,541 acre-feet is provided by Lake Britton, McCloud, and Iron Canyon Reservoirs, respectively. The plant is fully automatic with supervised remote control. A view of the development is shown on figure 13.

Pit No. 7 (Project No. 2106)

Pit No. 7 development was constructed by Pacific Gas and Electric Company during the period 1962 to 1966. It was first placed in operation on September 10, 1965. Located on the Pit River, 6-1/2 miles downstream from Pit No. 6, Pit No. 7's scheme of development is identical to that of Pit No. 6. A 248-foot structural height concrete gravity dam impounds a reservoir with 34,000 acre-feet of total storage capacity. The maximum power drawdown of 25 feet is equivalent to 10,377 acre-feet of storage capacity. The two identical units at Pit No. 7 have a combined nameplate capacity of 104,400 kilowatts. Upstream usable power storage capacities of 14,443, 20,541, 25,231, and 5,821 acre-feet are

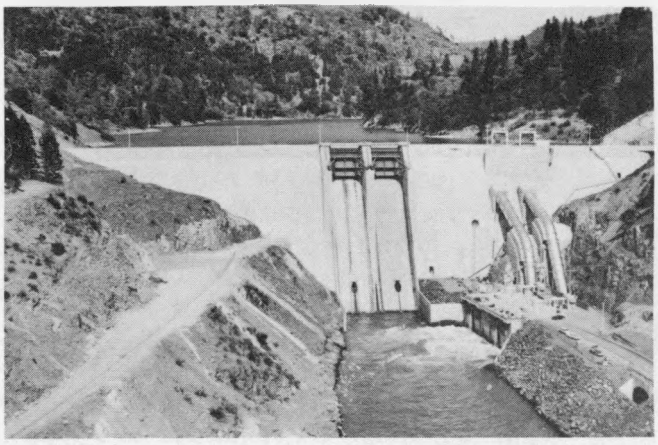


Figure 14. Pit No. 7 hydroelectric development.

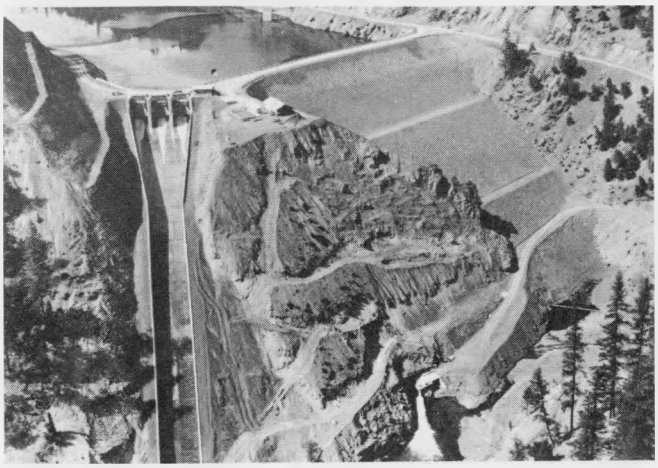


Figure 15. The chute spillway at McCloud Dam is separated from the rock and earthfill embankment.

provided by Lake Britton, Iron Canyon, McCloud, and Pit No. 6 Reservoirs, respectively. A view of the development is shown on figure 14.

James B. Black (Project No. 2106)

This development, formerly known as McCloud-Pit, is the largest in the basin and was constructed by the Pacific Gas and Electric Company during the period 1962 to 1966 and began operation on December 17, 1965. The uppermost project feature is McCloud Dam on McCloud River. The 235-foot structural height rock and earthfill dam, shown on figure 15, impounds 35,300 acre-feet of total storage capacity, of which 25,231 acre-feet are usable for power operations. A conduit of concrete-lined tunnels and connecting steel pipelines leads more than 7 miles from the dam to Iron Canyon Reservoir, the development's forebay. Iron Canyon Dam, constructed across Iron Canyon Creek, is a 210-foot structural height earthfill dam which impounds the 24,300 acre-foot forebay (figure 16). A pressure conduit of concrete-lined tunnels and connecting steel pipelines, totaling more than 4 miles in length, connects the forebay and powerplant. The maximum power drawdown of the forebay is 71 feet which is equivalent to 20,541 acre-feet of usable power storage. The James B. Black plant, shown on figure 17, is situated on the right bank of the Pit River about one-half mile upstream from Pit No. 5 powerhouse. The outdoor-type plant has an installed capacity of 154,800 kilowatts in two units. The plant is fully automatic with supervised remote control.

Hat Creek No. 1 (Project No. 2661)

The development is located on Hat Creek near the community of Cassel. It was constructed in 1920 and 1921

Figure 16. Iron Canyon Dam forms the forebay for the James B. Black hydroelectric development.

Figure 17. James B. Black outdoor-type powerhouse and penstock.

by Mount Shasta Power Corporation, and placed in operation on August 22, 1921. The project consists principally of a diversion dam, power canal, forebay, penstock, and powerhouse. The original dam was replaced in 1935 by the present 12-foot high concrete buttress dam (figure 18). The dam impounds a shallow pond of about 32 acre-feet of total storage capacity. The canal intake structure is located at the left abutment of the dam. The canal, lined in part with gunite, follows the left bank of Hat Creek for 2,270 feet to a gunite-lined, earth embankment forebay. A riveted steel penstock, about 1,600 feet long, extends from the forebay across Hat Creek to Hat Creek No. 1 powerhouse. The steel frame and reinforced concrete powerhouse, shown on figure 19, is located on the right bank a few hundred feet upstream from the mouth of Rock Creek, a tributary of Hat Creek. The plant has an installed capacity of 10,000 kilowatts in a single unit. It is equipped for semiautomatic operation to serve the base load.

Hat Creek No. 2 (Project No. 2661)

Constructed by Mount Shasta Power Corporation in 1920-1921, Hat Creek No. 2 began operating on September 28, 1921. The scheme of development is similar to Hat Creek No. 1, the principal difference being that additional water is available to Hat Creek No. 2 from Crystal Lake, a natural spring-fed lake. Crystal Lake, with a storage capacity of 380 acre-feet, flows uncontrolled into the 629-acre-foot Baum Lake which is formed on Hat Creek by Hat Creek No. 2 diversion dam. The maximum power drawdown in Crystal Lake is 3.55 feet which is equivalent to 290 acre-feet of storage. The present Hat Creek No. 2 Dam, a replacement structure built in 1943, is a

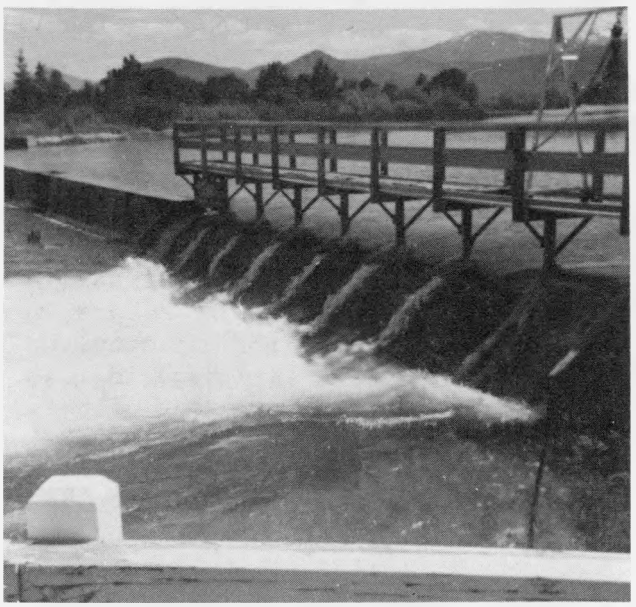


Figure 18. Hat Creek No. 1 Dam.

composite dam about 29 feet high above the streambed, consisting of a concrete gravity section with concrete wing walls and a short earthfill embankment section on the right abutment. Water is conveyed from the intake structure at the diversion dam along the left bank of Hat Creek 4,520 feet via a reinforced concrete flume to a riveted steel penstock. The existing flume is a replacement structure built in 1936. The powerhouse is a steel frame, reinforced concrete structure. The plant has an installed capacity of 10,000 kilowatts in a single unit. The plant is equipped for semi-automatic operation and normally serves the base load. Hat Creek No. 2 powerhouse is shown on figure 20.

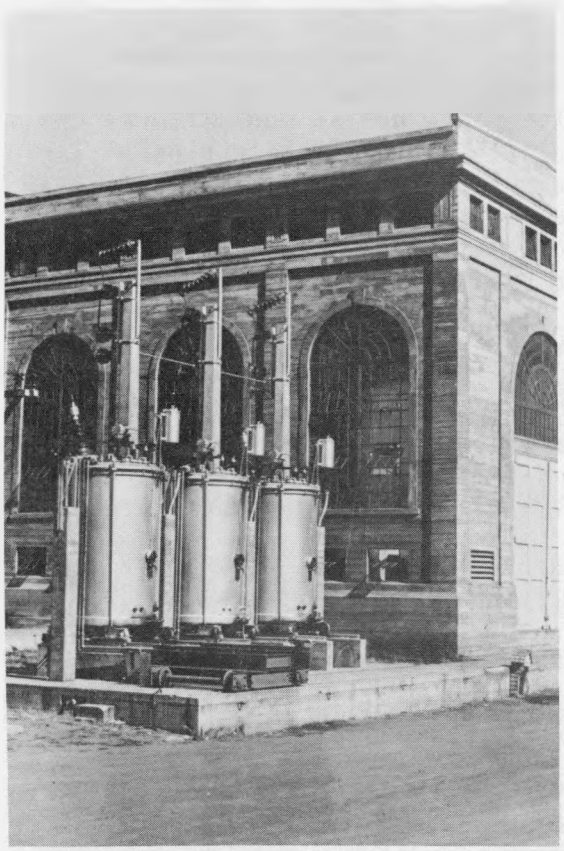


Figure 19. Hat Creek No. 1 powerhouse.

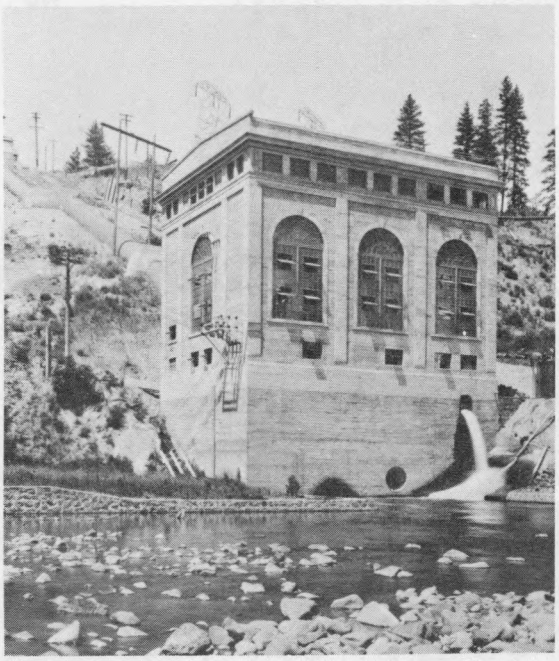


Figure 20. Hat Creek No. 2 powerhouse.

Irrigation

For agricultural purposes, the Pit River basin can be divided into two distinct hydrographic areas. The area above Fall River is water deficient. It includes about 77,300 irrigated acres or 67 percent of the presently irrigated acres in the Pit River basin and contributes about 15 percent of the basin's natural runoff. The area below Fall River has sufficient water for all present and anticipated future irrigated agricultural and other needs. There are about 38,400 irrigated acres in the basin below Fall River.

There are three irrigation districts located in the basin. Hot Springs Valley Irrigation District, located in central Modoc County along the Pit River, serves a gross area of 14,539 acres. South Fork Irrigation District serves a gross area of 12,862 acres and is located in a narrow strip along the South Fork of the Pit River in the southern part of Modoc County. Big Valley Irrigation District has a gross service area of 18,676 acres and is located along the Pit River in the northwestern part of Lassen County and a small portion is in Modoc County.

There are nine reservoirs in the Pit River basin with storage capacities greater than 5,000 acre-feet that benefit irrigation (see table 12). Big Sage Reservoir was constructed in 1921 on a tributary to the Pit River and has a capacity of 77,000 acre-feet. The water is used to irrigate lands in the Hot Springs Valley Irrigation District between Alturas and Canby. West Valley Reservoir, located near the headwaters of the South Fork of the Pit River, has a total storage capacity of 21,300 acre-feet and furnishes water to the South Fork Irrigation District. It was constructed in 1936. Roberts Reservoir was constructed in 1905 on a tributary to the Pit River in Big Valley. This 6,000-acre-foot capacity reservoir provides supplemental summer water to the Big Valley Mutual Water Company. Shasta Lake provides water supply storage capacity for irrigation of lands outside of the Pit River basin. Water is exported outside the basin for irrigation and stock watering purpose by a diversion from Tule Lake Dam on Cedar Creek in northeastern Lassen County. Cedar Creek is a tributary of South Fork Pit River. The dam was built in 1904 and creates a reservoir of 39,500 acre-feet.

The other reservoirs listed in the table which store water for irrigation are Coyote Flat with 5,000 acre-feet of total storage capacity, Dorris with 11,100 acre-feet, Silva Flat with 3,900 acre-feet, and Duncan with 2,575 acre-feet. Some of the water in these ponds and reservoirs is lost by evaporation; however, a large portion seeps underground and resurfaces in downstream rivers. These reservoirs and ponds would have little, if any, effect on hydroelectric projects in the basin.

Flood Control

The only existing flood control improvement in the Pit River basin above Shasta Lake consists of channel clearing of the North Fork in the city of Alturas. This Corps of Engineers' project was completed in 1971.

Shasta Lake, with its 1,300,000 acre-feet of flood control storage capacity, amounting to about 32 percent of the live storage capacity, furnishes a large measure of flood control protection to the Sacramento Valley below the Pit River basin.

Recreation

A variety of public recreation facilities are available (see table 11). They include primitive camp sites, palatial lakeside resorts, and Mount Shasta Ski Bowl, a major snow ski center. The Federal Government, largest land owner in the basin, has provided the greatest number of facilities. The bulk of these are campgrounds in portions of four national forests, Lassen, Modoc, Fremont, and Shasta-Trinity, and the northern part of Lassen Volcanic National Park. Federal administration also includes the following special areas: Shasta Unit, Whiskeytown-Shasta-Trinity National Recreation Area; the Thousand Lakes, Caribou, and South Warner wilderness areas; the Devils Garden Natural Area; and the Mount Shasta Scenic Area.

The boundaries of the Lassen, Modoc, Fremont, and Shasta-Trinity national forests contain more than half, or 2,184,000 acres of the Pit River basin. Recreation is an important use of the national forest lands within the basin, and the relative remoteness of the area makes it increasingly attractive to recreationists. Recreational use at over 100 developed sites in the basin amounts to more than half a million visitor-days annually. As previously stated, the U.S. Forest Service reported 2,200,000 recreation visitor-days alone on that portion of the Whiskeytown-Shasta-Trinity National Recreation Area located within the Pit River basin in 1979. Based on this figure, it is estimated that overall recreational use of national forest lands within the basin approached three million visitor-days during 1979. The U.S. Forest Service also manages the Mount Shasta Scenic Area (27,800 acres) for scenic and recreational purposes, the Warner Mountain Wilderness (21,800 acres), and the Thousand Lakes Wilderness (15,695 acres).

Lassen National Park covers 106,000 acres containing many features of volcanic origin. Within the portion of the park included within the basin are two campgrounds, a visitor center, and a portion of a winter sports area. Recreation use in 1979 exceeded 380,000 visitors.

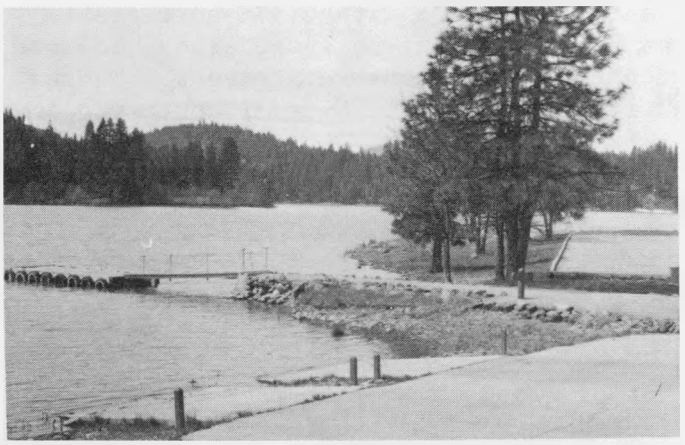


Figure 21. This boat launching ramp and loading dock, operated as part of McArthur-Burney Falls Memorial State Park, is on Lake Britton.

The Bureau of Land Management has several scattered land holdings throughout the basin which are open to recreation use. Development of facilities is minimal.

The Oregon Department of Parks operates three parks in the basin. Goose Lake State Park, located on the east side of Goose Lake, covers 64 acres with 48 trailer sites and 24 picnic tables. In 1979, the park received 37,100 visitor-use days. Fifteen miles west of Lakeside, Oregon, is Chandler State Park, containing 85 acres with a 12-unit primitive campground. Overnight camping accounted for 3,400 visitor-use days and day-time use for 65,000 in 1979. Near Chandler State Park is Booth Memorial State Park which contains a 6-unit picnic area.

The California Department of Parks and Recreation operates the McArthur-Burney Falls Memorial State Park (see figure 21) located at Lake Britton near Burney, California. This park attracted 180,000 visitor-days use in 1979. During the main summer season, thousands were turned away for lack of available camp units. Nearby, the Department recently dedicated the Lava Springs State Park. The park is under development and currently contains no facilities.

There are many other recreation facilities in the basin. The recreation needs of local residents are met through many county and local parks. Two museums have preserved the history of the basin. The Big Valley Museum is located at Bieber, and the Fort Crook Museum is located at Fall River Mills.

Private campgrounds are found throughout the basin. Pacific Gas and Electric Company is the largest private developer with facilities located at its various hydroelectric power projects. The company has built over 70 campsites and operates the largest swimming pool in the basin near the Pit No. 1 powerhouse. Recreation use at the company's facilities exceeds 150,000 visitor-use days annually.

Fish and Wildlife

Sport fishing and hunting attract substantial numbers of vacationists to the Pit River basin each year. Prior to construction of dams on the Pit and McCloud Rivers, these two streams produced some of the finest rainbow trout to be found anywhere. In fact, a fish hatchery established on the McCloud River in 1879, satisfied demands for the species throughout the Nation, and in many foreign countries, although with construction of Shasta Dam and other hydroelectric developments, the magnitude of this fishery diminished appreciably, though it still remains important. Basin streams also support good populations of brown and eastern brook trout. The last remnant of California's only native char, the Dolly Varden, is found in one reach of the McCloud River. Additionally, warm water game fish inhabit most basin reservoirs, particularly Shasta.

The 6,000-acre Modoc National Wildlife Refuge is located in the Pit River basin at the confluence of the North Fork and South Fork Pit River. The Dorris Reservoir, located just outside the refuge, is used in the operation of the refuge.

Water Supplies and Rights

The use of water for irrigation purposes within the Pit River watershed upstream from Canby is of considerable magnitude. The most important storage rights are those permitting storage of water in West Valley Reservoir and Big Sage Reservoir. In addition to the adjudicated, contractual, and major storage rights upstream from Big Valley (shown on figure 1), there are numerous minor direct diversion rights which total a small amount of water, and also a number of minor storage rights.

The water rights held by the Pacific Gas and Electric Company for operation of its powerplants downstream from Big Valley constitute a major item in the evaluation and planning of water projects for Big Valley. The company's plan for complete development called for seven powerplants. These are all now in operation.

Water is diverted from Fall River for power generation at Pit No. 1 powerplant. Use of water at the Pit No. 5 powerplant is under a claim of riparian rights. Appropriative water rights for the remaining plants are based on separate applications on file with the State Water Rights Board.

Use of the waters of the Pit River under riparian rights for irrigation in Fall River valley constitutes the major consumptive use of water between Big Valley and Shasta Reservoir. This use is affected by several diversions from the river near McArthur for irrigation on a narrow strip of land bordering the river. These rights to the use of Pit River water are not on record with the State Water Rights Board, but could be asserted against any proposed projects.

Sewage Treatment Facilities

Current sources of waste water are the relatively few industries (mostly lumber) and the many small communities in the basin. Almost all communities use individual septic tanks for waste disposal, and most of the lumber companies use millponds discharging to land or surface streams. Alturas has the only sewage treatment plant in the basin, discharging to the Pit River. However, these waste sources do not have a major impact on water quality.

CHAPTER V

PROJECT NO. 233

Project No. 233, owned and operated by the Pacific Gas and Electric Company (PG&E), is licensed by the Federal Energy Regulatory Commission. Because the license expired on October 22, 1973, the project will soon be considered by the Commission for a new license or recommendation for Federal takeover. The project, shown on figure 22, consists primarily of Pit No. 3, 4, and 5 powerplants; Pit No. 4 and 5 reservoirs, and Lake Britton; and appurtenant tunnels and penstocks. The project produces electric power, provides recreational opportunities, and is operated to preserve fish life.

History

On May 25, 1923, the Federal Power Commission issued a preliminary permit to Mount Shasta Power Corporation for a power project designated as the Pit No. 3 Unit of Project No. 233. A license was subsequently issued on October 23, 1923, and the corporation proceeded with construction. Following the issuance of the 50-year license for the Pit No. 3 Unit, a separate license was issued to Mount Shasta Power Corporation on August 3, 1926, for the Pit No. 4 Unit of Project No. 233. The license for the Pit No. 4 Unit was conditioned to terminate on October 23, 1973, simultaneously with the termination of the Pit No. 3 license. Upon application and after Commission approval, both licenses were transferred from Mount Shasta Power Corporation to PG&E effective January 1, 1936. On June 2, 1942, the licenses for Pit No. 3 and 4 Units were consolidated, and at the same time the proposed Pit No. 5 Unit was included in the project. The second phase construction of Pit No. 4 and all of the construction of Pit No. 5 took place under PG&E license. On July 15, 1955, the second generating unit of Pit No. 4 was placed in operation, completing the development of a power drop of more than 1,300 feet in a 32-mile reach of the river.

The following is a chronology of the important construction phases of Project No. 233:

November 1, 1923	-	Start of construction of Pit No. 3 development;
August 1, 1925	-	Commercial operation of Pit No. 3 powerplant;
September 1, 1925	-	Start of construction of phase 1 (diversion dam, reservoir, and tunnel stub) of Pit No. 4 development);
May 11, 1927	-	Pit No. 4 diversion dam ready for service;
October 1, 1941	-	Start of construction of Pit No. 5 development;
April 29, 1944	-	Commercial operation of Pit No. 5 powerplant;
May 1, 1952	-	Start of construction of phase 2 (tunnel and powerplant) of Pit No. 4 development;
June 9, 1955	-	Commercial operation of first unit of Pit No. 4 powerplant;
July 15, 1955	-	Commercial operation of second unit of Pit No. 4 powerplant.

In recent years there have been disputes over property rights between Pit River Indian groups and PG&E. During June 1970, a PG&E employees' recreation facility was occupied by Indians until they were removed by local law enforcement officers. Presently, the disputes are pending in the courts, as well as a claim for $5 billion from PG&E for past use of ancestral Indian lands. The Indians also petitioned to intervene in Project No. 233 new license proceedings. Other entities that have

petitioned to intervene in the project license proceedings are the California State Department of Fish and Game and California Trout Incorporated.

On October 28, 1970, PG&E filed an application with the Federal Power Commission for a new major license for Project No. 233. The license expired on October 23, 1973, and the project is now operating under annual licenses.

Description

Project No. 233 is in Shasta County, California, along a 32-mile reach of the Pit River extending from the mouth of Hat Creek to the mouth of Iron Canyon Creek, as shown on the map and profile on figure 22. The project is about 50 miles northeast of the city of Redding in the vicinity of the communities of Fall River Mills, Burney, and Big Bend. Portions of the project are located within Shasta National Forest.

The project develops a total static head of 1,312.5 feet and all but 98 feet of the elevation of the Pit River lies between Pit No. 1 development (Project No. 2687) and Pit No. 6 development (Project No. 2106). Lake Britton, a part of the Pit No. 3 Unit, provides weekly regulation for all plants. Pit No. 4 reservoir is the afterbay for Pit No. 3 plant and the forebay for Pit No. 4 powerplant. Similarly, Pit No. 5 reservoir is the afterbay for Pit No. 4 powerplant and the forebay for Pit No. 5 powerplant. Project data are summarized in table 14.

Table 14

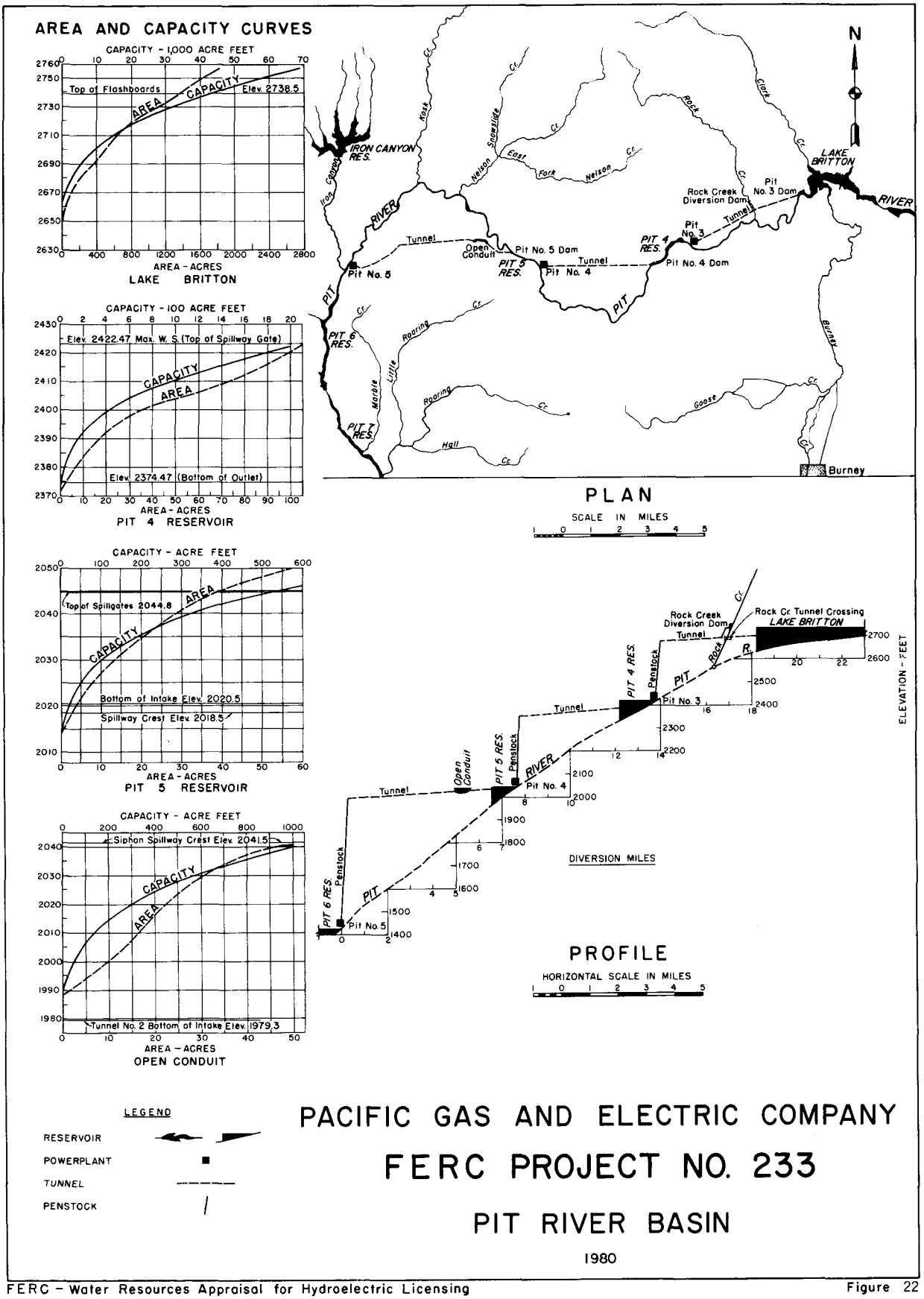
Dam and Reservoir Data
Project No. 233

	Pit No. 3 Diversion Dam (Lake Britton)	Rock Creek Diversion Dam	Pit No. 4 Diversion Dam	Pit No. 5 Diversion Dam	Pit No. 5 Open Conduit Dam
Drainage area, sq mi	4,606	unknown	4,647	4,700	1
Type of dam	concrete gravity	concrete gravity	concrete gravity slab & buttress	concrete gravity	earthfill
Elevations, ft (USGS Datum)					
Top of dam	2,750.5	2,760.47	2,438.5	2,055.5	2,045.5
Top of gates or flashboards	2,737.5	ungated	2,422.5	2,044.8	(siphon)
Spillway crest	2,732.5	2,755.07	2,408.0	2,018.5	2,041.5
Streambed (downstream toe)	2,630.5	2,747.97	2,369.5	2,007.0	1,974.0
Height of dam, ft 1/	112	7	67	45.0	61.0
Length of dam, ft	494	64	415	340	2,960.0
Total storage capacity, ac-ft	40,600	none	1,970	327 2/	1,050.0
Reservoir surface area, ac	1,264	none	105	32	50.0
Spillway					
Capacity, cfs	70,000	unknown	70,000	75,000	4,000.0
Type gate	flashboards	ungated	drum	vertical lift	ungated
Number and size of gates	none	none	2-14.5ftX68ft	4-26ft 4inX50ft	6-barrel
Number and size of outlets	3-7ftX7ft sluices	1-2ft diam sluice	3-7ft diam sluices; 1-42in diam fish-water pipe	1-30in diameter fish-water pipe	1-30 in diameter slide gate

1/ Streambed to spillway crest.
2/ At normal water surface elevation of 2,040.5.

Pit No. 3 Development

Pit No. 3 has a 4,747-square mile drainage area and includes a concrete gravity diversion dam across the Pit River forming a reservoir known as Lake Britton, a power tunnel, a low concrete diversion dam across Rock Creek, a pipeline leading



PACIFIC GAS AND ELECTRIC COMPANY

FERC PROJECT NO. 233

PIT RIVER BASIN

1980

FERC – Water Resources Appraisal for Hydroelectric Licensing

Figure 22

from Rock Creek diversion dam to the power tunnel, a surge chamber, three penstocks, an indoor-type powerhouse containing three units, a switchyard, a transmission line, and project-related recreation facilities around Lake Britton. (See the appendix: exhibits L-1, L-3, and L-4.)

Pit No. 3 dam rises 112 feet from the streambed to the crest of the central overflow spillway at elevation 2,732.5 feet. The dam is curved in plan and surmounted by a concrete bridge deck at elevation 2,764.5 feet. The crest length is 494 feet. The spillway is divided into three bays, each 84.67 feet wide and 18 feet deep, providing a total flow capacity of 70,000 cubic feet per second. Timber flashboards are installed across the spillway bays each year from April 1 to November 1, increasing the maximum water surface elevation to 2,737.5 feet. The maximum drawdown for power without flashboards is 8 feet which is equivalent to 8,396 acre-feet of storage. The maximum drawdown with flashboards is 12.6 feet which is equivalent to 14,443 acre-feet of storage.

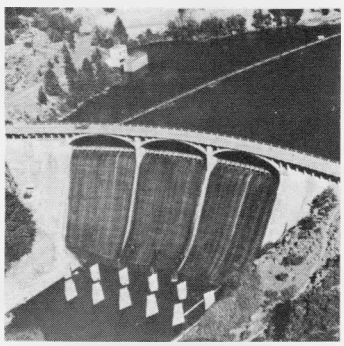


Figure 23. Pit No. 3 diversion dam. Log boom protects tunnel intake structure in upper left corner.

Baffle piers are located on the downstream apron to dissipate the energy of the spill. Reinforced concrete training walls confine the spill and prevent erosion of the canyon walls. Three 7-foot square sluice outlets, controlled by hydraulically operated slide gates, extend through the base of the dam. The operating mechanisms for the gates are located within a gate operating gallery which adjoins an insepction gallery. Ten piezometers, installed in the inspection gallery in 1968, are available to measure uplift pressures. A view of Pit No. 3 diversion dam is shown on figure 23.

Lake Britton has a surface area of 1,264 acre and a total storage capacity of 40,600 acre-feet at maximum water surface elevation of 2,737.5 feet. The total recreation resources of Lake Britton and its immediate surrounding are a regional attraction. Some of the publi recreation facilities which contribute to the attractiveness of Lake Britton are located on lands included within Project No. 233. Along the north shore, within the project boundary, are the 30-unit North Shore campground; the 10-unit Pines picnic area; and the Jamo Point boat ramp, loading dock, and parking area. O the south shore, on project lands adjacent to McArthur-Burney Falls Memorial State Park, th State of California operates and maintains a swimming beach, a parking area, and a boat launching ramp with docking facilities. The lands have been leased to the State by PG&E. Only the North Shore campground and the Pines picnic area have been development solely by PG&E. Figures 24 and 25 are views of these two recreation areas.

Figure 24. The North Shore campground on Lake Britton is a popular recreation locale.

gure 25. The Pines picnic area is on Lake Britton.

:gure 26. The Hat Creek fish barrier dam.

Parts of Lake Britton and adjacent project lands are also used for various non-project purposes. A ferry crossing, used for logging purposes, is located about a half-mile upstream of Pit No. 3 dam. Areas on the north shore are leased to a rancher for cattle grazing. A crossing of PG&E's Canadian gas line consisting of two pipes is about 1 mile upstream from the mouth of Hat Creek. There are two private recreation areas, known as Camp Britton and Camp Shasta, which are operated and maintained for the private use of PG&E's employees and their families. A fish barrier dam on Hat Creek is maintained by the State of California. The dam is shown on figure 26. The purpose of the fish barrier dam is to prevent rough fish from migrating from Lake Britton to Hat Creek. The reach of Hat Creek between PG&E's Hat Creek No. 2 powerplant and the barrier dam is being managed so that it will become a self-sustaining wild trout fishery.

The intake for the power tunnel is located on the west bank of Lake Britton about 300 feet upstream from the dam. It is a reinforced concrete structure containing two motor-operated slide gates at the tunnel entrance. A log boom on the reservoir and a trash rack on the intake structure keep debris from entering the tunnel.

The power tunnel, extending 21,203 feet to the penstock manifold, is made up of two 19-foot-diameter concrete-lined tunnel sections connected by a 19-foot diameter cast-in-place concrete pipe over Rock Creek (figure 27). A pipeline from Rock Creek diversion dam conveys water to the power tunnel at a connection at the upper end of the Rock Creek pipe crossing.

The Rock Creek diversion dam is 12.5 feet high and about 64 feet long. The concrete gravity structure has an ungated central overflow spillway,

Figure 27. Concrete pipe over Rock Creek.

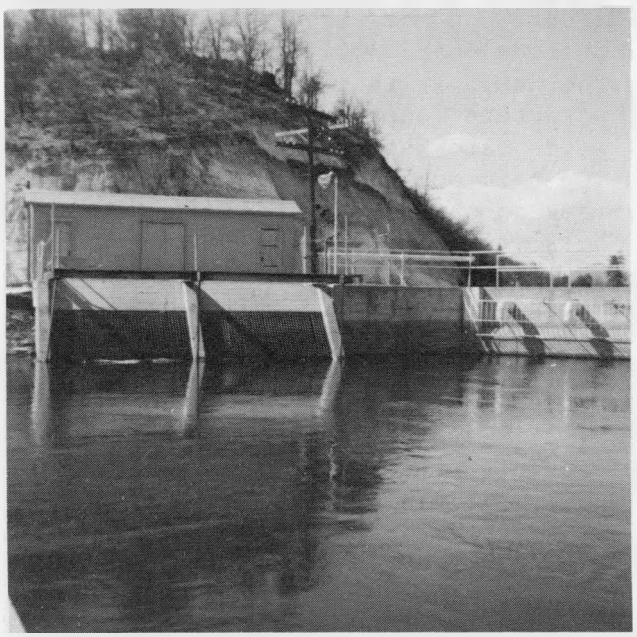


Figure 28. Intake for Rock Creek diversion, Pit No. 3 development.

19 feet 5 inches long. The intake for the diversion pipe is shown on figure 28. The intake is protected by grizzly bars and controlled by a manually-operated slide gate. A 24-inch riveted steel diversion pipeline follows the general course of Rock Creek along the east bank for 2,700 feet to the Rock Creek pipe crossing.

The surge chamber is offset 100 feet from the power tunnel by a connecting tunnel. The chamber, excavated in rock and lined with concrete, is 79 feet deep.

The power tunnel terminates in a trifurcation manifold. The three penstocks are riveted steel pipes, each about 590 feet long. The 10-foot-diameter penstocks are protected by butterfly valves and standpipes at the manifold.

The penstocks serve three vertical shaft Francis-type turbines connected to three vertical shaft generators. The generators are rated at 26,730 kilowatts each, giving a total plant installed capacity of 80,190 kilowatts. Plant equipment is housed in a steel frame, reinforced concrete powerhouse, located on the north side of the Pit River about 6.25 river miles downstream from Pit No. 3 dam. The powerhouse is shown on figure 29. Three outdoor transformer banks step up the plant output from 11,500 to 230,000 volts. Power is transmitted over 2, 230-kilovolt transmission lines which cross the river and extend about 8.5 miles southerly to a connection with PG&E's Pit No. 1 Vaca-Dixon transmission line.

Pit No. 4 Development

Pit No. 4 has a 4,784-square mile drainage area. Pit No. 4 diversion dam is a concrete structure about 1.5 miles downstream from Pit No. 3 powerhouse. A view of the dam is shown on figure 30 and in the

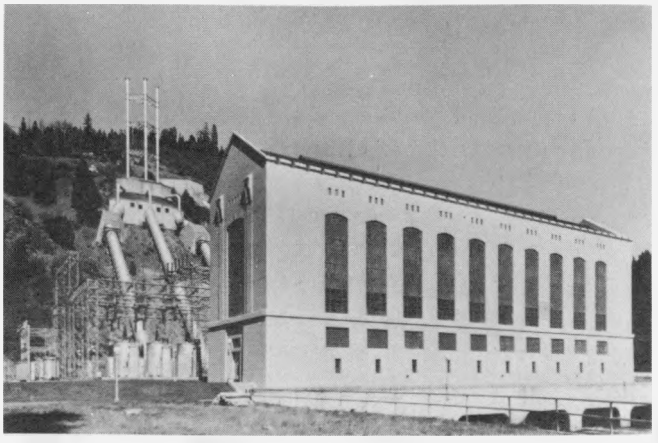


Figure 29. Pit No. 3 powerhouse.

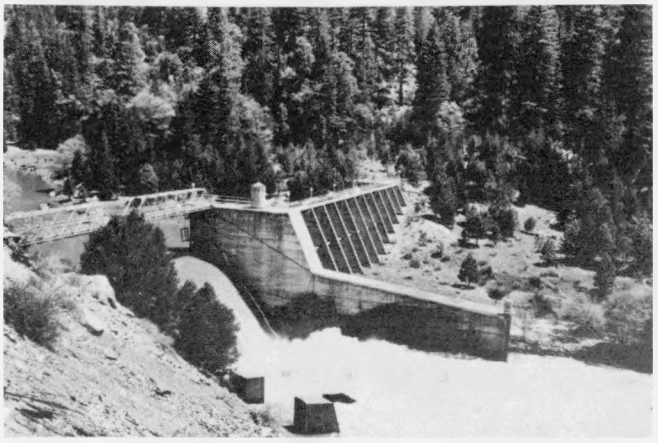


Figure 30. Pit No. 4 diversion dam and spillway.

appendix: attached structural drawing exhibit L-5. The right portion of the dam is a gravity section, 203 feet long, containing two spillway bays with drum gates. As measured from the streambed, elevation 2,369.5 feet, the gravity section is 38.5 feet high to the crest of the spillway, 53 feet high to the top of the gates, and 69 feet high to the top of the dam. The gravity section extends some 39 feet below the streambed to bedrock. Each drum gate, controlled by water pressure, is 14.5 feet high and 68 feet wide. The total spillway capacity is 70,000 cubic feet per second. An energy dissipator, consisting of a concrete apron and nine baffle piers, is located at the downstream toe of the dam. Three 7-foot-diameter sluiceways are provided below the left spillway bay. The sluices are controlled by slide gates which are motor-operated from within the gate operating gallery in the dam. A 42-inch-diameter fish-water release pipe is located at the far right side of the dam. The outlet is controlled by a 42-inch-diameter slide gate at the intake.

The left portion of the dam is a slab and buttress section 212 feet long and 58 feet high. The upstream face of the section is a sloping reinforced concrete slab, supported by 11 reinforced concrete buttresses. A concrete cutoff wall extends from the upstream toe to bedrock.

Pit No. 4 reservoir has a surface area of 105 acres, a total storage capacity of 1,970 acre-feet, and a usable power storage capacity of 1,198 acre-feet from 14.5 feet of drawdown. Upstream regulation is provided by Lake Britton. Peak flows from Pit No. 3 powerplant are reregulated at Pit No. 4 reservoir to produce more uniform flows in the downstream reaches of the river. There are no recreation facilities at Pit No. 4 reservoir.

A tunnel intake structure is located approximately 80 feet upstream from the dam on the right bank. The reinforced concrete structure contains a 15-foot by 19-foot gate. The bellmouth entrance is protected by a steel trashrack. The power tunnel extends 21,464 feet from the reservoir to the head of the penstocks. The tunnel is a concrete-lined 19-foot high horseshoe shaped section for 9,306 feet, a concrete-lined 19-foot-diameter circular section for 11,807 feet, and a concrete with steel liner 18.5-foot-diameter circular section for 315 feet to a 36-foot long wye transition. A concrete-lined, differential-type surge chamber is located 213 feet upstream from the tunnel portal. Two 12-foot-diameter penstocks, with a butterfly valve and standpipe at the upper end, extend 820 feet from the wye to the Pit No. 4 powerhouse.

Pit No. 4 powerhouse (shown on figure 31 and in the appendix on exhibits L-6 and L-7) is located on the right bank of the river about 7.5 river miles downstream from Pit No. 4 dam. It is a steel frame, reinforced concrete structure containing two vertical shaft Francis-type turbines connected to vertical shaft generators. The generators provide a total installed capacity of 90,000 kilowatts. Three transformers step up the plant output from 13,800 to 230,000 volts for transmission. A single-circuit transmission line extends 6.7 miles southwesterly to a junction with Pacific Gas and Electric Company's interconnected transmission system.

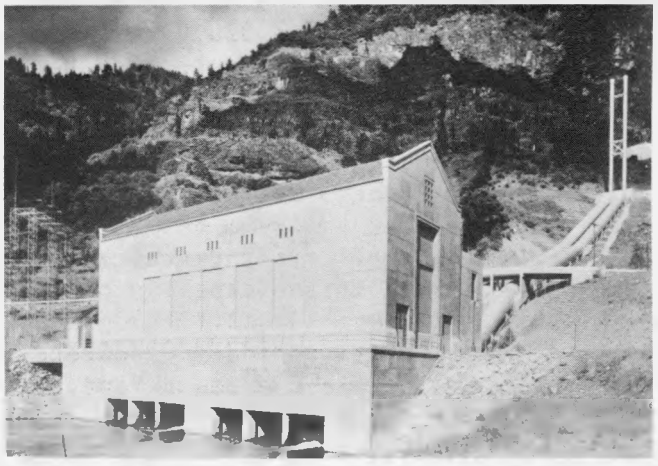


Figure 31. Pit No. 4 powerhouse. Standpipes are at upper end of penstocks.

Pit No. 5 Development

Pit No. 5 has a 4,900-square mile drainage area and takes advantage of a 9.5-mile long bend of the Pit River to develop a static head of 615 feet by means of 6.2 miles of power waterway. Pit No. 5 diversion dam shown in the appendix on exhibit L-8, situated across the Pit River about 1 mile downstream from Pit No. 4 powerplant, impounds a 327-acre-foot reservoir which serves both an afterbay for Pit No. 4 plant and as a forebay for the Pit No. 5 plant. The water from Pit No. 5 reservoir is conveyed to Pit No. 5 powerplant via two tunnel sections connected by an open conduit and steel penstocks. The forebay has 214 acre-feet of usable power storage capacity.

Pit No. 5 diversion dam is a concrete-gravity overflow structure controlled by four vertical lift spillway gates, each 26 feet high by 50 feet wide. There is a bridge deck at the top of the dam 48.5 feet above the streambed. The four spillway bays have a total flow capacity of 75,000 cubic feet per second. A 30-inch diameter outlet pipe through the left abutment serves as a fish-water release. The pipe is controlled by a 30-inch vertical lift slide gate at its intake end.

The reservoir formed by Pit No. 5 diversion dam is a long, narrow impoundment which, for the most part, is contained within the natural banks of the Pit River at normal water surface elevation of 2,040.5 feet. However, usable upstream storage capacity is provided at Lake Britton. There are no recreation facilities along the reservoir or on adjacent lands.

Figure 32. Upstream view of Pit No. 5 diversion dam shows intake structure at left and spillway gate structure with control house at right.

A tunnel intake is located near the left abutment of the diversion dam. A 15-foot by 19-foot gate controls the flow into Tunnel No. 1. Tunnel No. 1 is concrete-lined to a finished circular section 19 feet in diameter and extends 5,126 feet to an open conduit. The open conduit, 2,955 feet in length, has a surface area of 48 acres and a total storage capacity of 1,000 acre-feet. The open conduit is formed across a natural draw by Pit No. 5 open-conduit dam. A view of the open conduit and dam is shown in the appendix, exhibit L-9, and on figure 32. The dam is an earthfill embankment, 67.4 feet high at its maximum section and 2,825 feet long. The open conduit has a usable storage capacity of 645 acre-feet. The spillway, located at the upstream end of the embankment, is a six-barrel concrete siphon with a flow capacity of 4,000 cubic feet per second. A 30-inch-diameter pipe encased in concrete extends through the embankment to serve as a low level outlet.

The project area 500 feet north of the open conduit contains a 17-cabin recreation development, known as Camp Pit. The camp is reserved for PG&E employees and their families.

Water from the open conduit enters Tunnel No. 2 through a reinforced concrete intake structure which is protected by a grizzly screen. A gage and float-well house is located above the intake. Tunnel No. 2 is 19 feet in diameter and 23,279 feet long. A portion of the length of the concrete-lined tunnel is circular and a portion is horseshoe shaped. A differential-type surge chamber is provided 298 feet from the end of the tunnel.

Four penstocks form within the tunnel about 44 feet upstream from the downstream tunnel portal. At the portal there is a combined anchor and valve house structure containing four butterfly valves and their controls. A standpipe is installed in each penstock below the valves. The welded steel penstocks extend 1,380 feet to Pit No. 5 powerhouse.

Pit No. 5 powerhouse, shown on figure 33 and in the appendix, exhibits L-11 and L-12, is a steel frame, reinforced concrete structure located on the left bank of the

river. It houses four vertical shaft Francis-type turbines (figure 34) connected to generators with a total installed capacity of 140,560 kilowatts. The output of the plant is stepped up from 11,500 to 230,000 volts and transmitted over two single circuits 4.8 miles to PG&E's interconnected transmission system.

Figure 33. View of Pit No. 5 powerhouse.

Condition

The major structures of Project No. 233 have been in service from 18 to 48 years. Although the physical condition of the project structures, in general, is good, there is a marked disparity in the condition of the older and newest concrete structures. It is quite evident that the concrete used during the period 1923-1927 does not possess the same resistance to disruptive weathering action as does the concrete used since 1941.

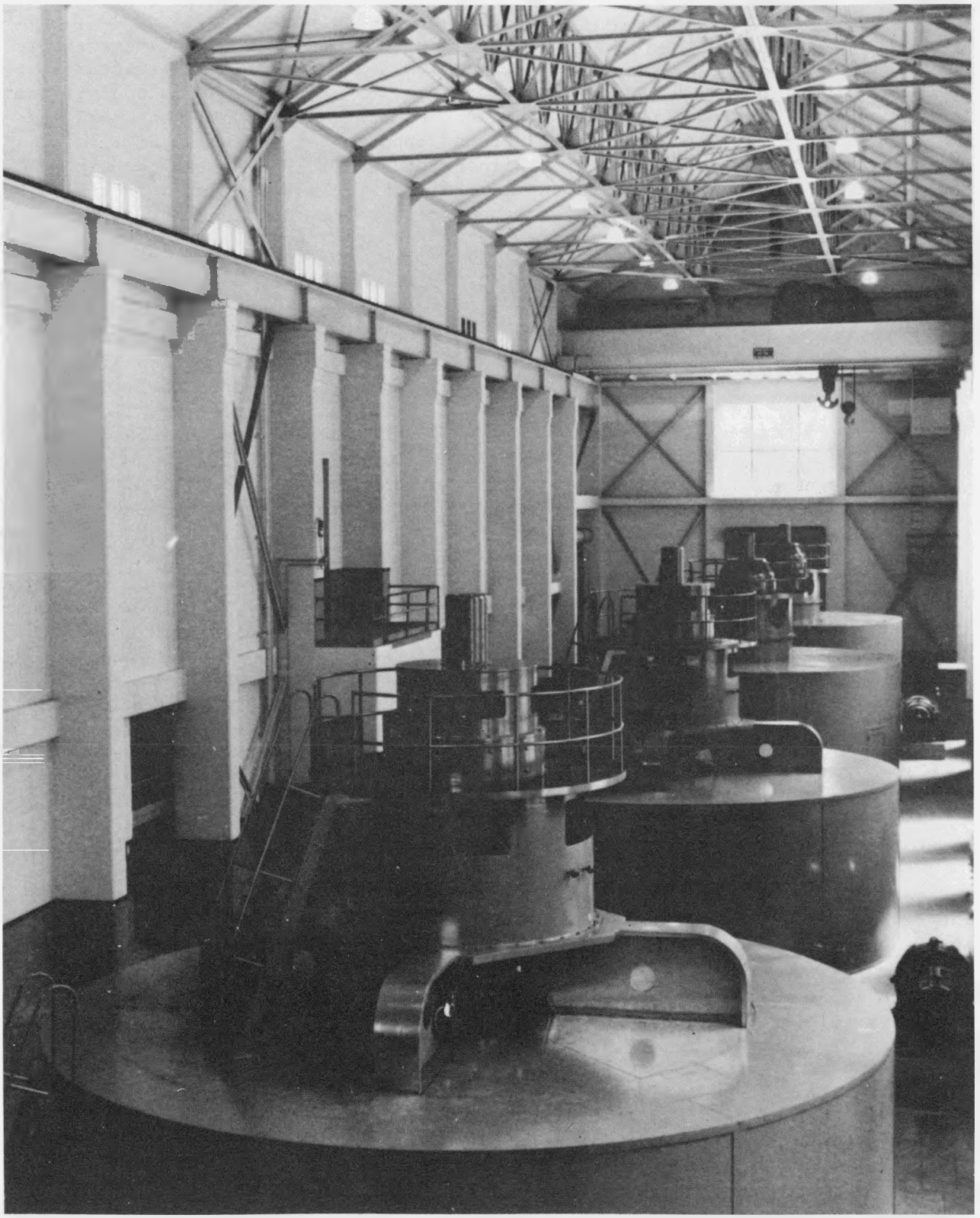


Figure 34. Interior of Pit No. 5 powerhouse contains four vertical shaft Francis-type turbines.

The major project structures were inspected and reported on by independent engineering consultants during the past 5 years in accordance with requirements of part 12 of Federal Energy Regulatory Commission Regulations. The structures inspected were Pit No. 3, 4, and 5 diversion dams, and Pit No. 5 open conduit dam. The consultants concluded that the dams were structurally sound, that each had an adequate spillway, and that there were no apparent or potential deficiencies which might endanger public safety. With regard to Pit No. 5 open conduit dam, however, the consultants recommended that a further check be made on its margin of stability. Based on recently completed soils tests and piezometric data, PG&E has confirmed that there is an adequate factor of safety in the stability of that dam.

Figure 35. Spalling at Pit No. 4 diversion dam.

Throughout the life of Pit No. 4 diversion dam, there has been progressive deterioration of exposed concrete surfaces as evidenced by wide-spread spalling. To a lesser extent, the same has been true at Pit No. 3 diversion dam, the anchors and footings of Pit No. 3 penstocks, and the intake structure to Pit No. 4 tunnel. By 1966, the deterioration at Pit No. 4 diversion dam required extensive repairs. The horizontal surfaces and the buttress extensions on the face slab were repaired by removing from 4 to 6 inches of deteriorated concrete and replacing it with a topping of fresh concrete followed by an epoxy coating. Most of the vertical surfaces were merely cleaned and protected with an epoxy coating. The epoxy treatment has failed, especially on vertical surfaces, and spalling is continuing as shown on figure 35.

The several tunnels are reported to be in good condition. The penstocks for Pit No. 3 and 4 powerplants are well maintained and have not required extraordinary expenditures for repairs or maintenance. The penstocks for Pit No. 5, however, experienced excessive vibration during the spring of 1968. The trouble was corrected by reinforcing the penstock footings.

The three powerplants and the plant equipment have been well maintained over the years, and repairs and replacements have been made when required. In recent years, all three generators at the Pit No. 3 plant have been rewound, and at the same time their capacities were increased. The turbine runner of one unit at the Pit No. 3 plant has been replaced. Two generators at Pit No. 5 plant have also been recently rewound and uprated. The more recently completed Pit No. 4 powerplant has not yet required major maintenance or repair work.

Operation

Of the several special conditions contained in the present license, only two have significant effects on project operation. Article 34 as amended by Commission Order dated February 14, 1957, and Article 24 as amended by Commission Order dated November 19, 1946, prescribe the flows to be released by the Pit No. 4 and 5 diversion dams, respectively, for the preservation of fish life in the Pit River. The flow requirements are as follows:

At U.S.G.S. Gage Below Pit No. 4 Diversion Dam

May 1* through September 30	-	150 cfs	minimum
October 1 through October 31	-	100 cfs	minimum
November 1 through November 30	-	75 cfs	minimum
December 1 through March 31	-	50 cfs	minimum
April 1 through April 30**	-	100 cfs	minimum

* Opening day of fishing season if not May 1, but not earlier than April 27.

** Day before opening day of fishing season, but not later than May 3.

At U.S.G.S. Gage Below Pit No. 5 Diversion Dam

May 1 through October 31	-	100 cfs	--
November 1 through November 30	-	50 cfs	--
December 1 through April 30	-	50 cfs	minimum

The license does not prescribe a minimum flow for the reach of the Pit River between Pit No. 3 dam (Lake Britton) and Pit No. 4 dam.

PG&E's Pit No. 3, 4, and 5 plants are 3 of 80 generating plants (65 hydroelectric, 11 fossil-fueled steam-electric, 2 diesel-electric, 1 nuclear-fueled steam-electric, and 1 geothermal) which were operated in 1970 to supply electric power in the company's service area. The 80 plants had a total installed capacity of 10,787 megawatts as of December 31, 1978. The Pit No. 3, 4, and 5, installed capacity of approximately 311 megawatts, represent 2.8 percent of that total. In 1978, the gross generation from Project No. 233 plants represented about 4.2 percent of PG&E's main system generation. Project No. 233 plants' average annual net generation for the years 1966 through 1978 is approximately 2,100 gigawatt-hours.

The output of Project No. 233 is delivered to PG&E's interconnected system at Round Mountain substation, and ultimately to either Cottonwood or Table Mountain substations, via 230-kilovolt transmission lines. Most of the output of Project 233 is sent to PG&E's interconnected system and the energy is utilized outside of the basin area.

Pit No. 6 and 7 developments of PG&E's Project No. 2106 are located downstream of Project No. 233. Therefore, those developments benefit from regulation provided by Project No. 233.

CHAPTER VI

NEED FOR DEVELOPMENT OF WATER AND RELATED LAND RESOURCES

This sparsely populated basin has a limited amount of economic activity and is not expected to change substantially in the foreseeable future. Much of the population growth will come from recreation and the development of summer home sites. The exports of hydroelectric power, water, and agricultural products are greatly in excess of the proportionate needs for these commodities in the basin. More reservoir storage is needed for local irrigation and for downstream flood control and irrigation needs. The expanding population will need additional water supply which is available for development. More attention should be placed on correction of the deteriorating quality of surface water.

Population

The population of the basin counties has not increased as rapidly as that of the rest of the State because of its remoteness. The largest single factor affecting population in the basin is the decline in the lumber industry. The historical population of the basin counties to 1978 is shown in chapter III. Based on the assumption that increased use of recreation facilities will create new employment opportunities, the following are expected to occur: The lumber industry will remain at a fairly constant production level with no sizable decrease in annual timber cut; the amount of production of agricultural land will increase; and the population of the basin counties is expected to increase about 30 percent in the 12 years from 1978 to 1990 while the State's population is expected to expand by about 50 percent. Population densities in the Pit River basin will remain low in comparison to most areas of the State. The population increase in the basin is expected to be somewhat less than that of the three counties because the largest town, Redding (Shasta County), which is expected to have a rapid increase, is not within the basin.

Electric Power

The power requirements of the basin itself are small when compared to the generating capability of the various plants within the basin. It is appropriate to relate the projected power requirements of the basin and power produced by those developments in Licensed Project No. 233 to Power Supply Area (PSA) 46 since most of the basin lies within PSA 46. PG&E not only supplies most of the power requirements of the basin, but also over 85 percent of the requirements of PSA 46. Although the Pit River basin extends into PSA 45, all of the power produced at PG&E plants in the basin is used in PSA 46. The other principal power systems of the 22 electric utilities operating in PSA 46 are the Sacramento Municipal Utility District and Central Valley Project of the Water and Power Resources Service. Past and estimated future power requirements of PSA 46 are shown in table 15.

Flood Control

Studies of the Pit River and its tributaries have been made on several occasions by the Corps of Engineers, in some instances with the primary objective of reducing floodflows in the Sacramento River below Shasta Dam. The Water and Power Resources Service has also studied the basin in conjunction with the proposed Allen Camp project and the possible enlargement of Shasta Lake, as previously discussed.

Table 15

Past and Estimated Future Power Requirements
FERC Power Supply Area 46

Year	Energy for Load (GWh)	Non-Coincident Peak Demand (MW)	Annual Capacity Factor (%)
1960	30,105	5,551	61.7
1965	42,660	7,777	62.6
1970	58,592	10,516	63.6
1975	77,304	14,138	62.4
1978	79,727	15,886	57.3
1980	86,975	17,088	57.9
1985	104,685	20,615	58.0
1990	133,000	25,050	58.5

Note: 1960-1978 recorded; 1980-1990 estimated.

Figure 36. A view of the town of Nubieber which was flooded in January 1970.

These studies have indicated a nee for flood control improvements, particularly in Big Valley area, which includes such populated areas as Bieber and Nubieber. It is also reported that, in addition to these two communities, Alturas, Burney, and certain outlying areas of Fall River Mills have had flooding problems in recent years. The 1970 flood at Nubieber is shown on figure 36.

Lake Shasta cannot fully control the large portion of runoff from the Pit and McCloud Rivers. Since the Corps of Engineers has stated that main stem storage on the Sacramento River downstream is not contemplated at this time, the Pit River basin could be developed to help alleviate the downstream need in the Sacramento Valley and areas farther south.

Recreation and Fish

Thousands of people were turned away from McArthur-Burney Falls Memorial State Park at Lake Britton for lack of available camp units in 1979. Generally speaking, however, development of the recreation potential of the Pit River basin has kept abreast of demand. This unusual situation is due primarily to the remoteness of

the area. The basin is relatively distant from large population centers and is not traversed by major highways and, therefore, receives little use by transients. It is a destination area. An accelerated increase in recreational use of the basin is not anticipated until the areas nearer the metropolitan centers become saturated.

All suitable waters within the drainage are now being managed to maximize a sport fishery. Any improvements would undoubtedly involve increased water releases below dams and stabilized reservoir water surface elevations during the spawning season.

Irrigation Needs

Approximately 94,300 acres of land in Big Valley are classified as irrigable, but only 55,400 acres are forecast for eventual development because of the limited water supply. Even the land now under irrigated use needs more water. The area is within a low precipitation belt where most the the precipitation falls as snow during the winter months. There is scarcely any rain during the summer, and water for irrigation is normally in short supply, or not available during the months of July, August, and September. Upstream storage facilities are badly needed for storage control and management of water for summer irrigation use. There is also a need for a more detailed study of the underground water potential in some areas for irrigation development.

CHAPTER VII

PLANS FOR FUTURE DEVELOPMENT

General

The Federal Energy Regulatory Commission license for Pacific Gas and Electric Company's Project No. 233 expired October 23, 1973, and the project is now operating under annual licenses. The Commission, under the Federal Power Act, must decide whether to issue a new license to the original licensee, to a new licensee, or to recommend takeover by the Federal Government. This chapter provides information on future development and utilization of the water resources in the Pit River basin that will aid the Commission and its staff in making decisions relating to this matter. Development plans of others were reviewed and additional studies were made by the Commission staff for possible future developments.

Planning studies have considered potential water resource developments that could assist in meeting future needs. These developments would provide hydroelectric power, irrigation water conservation and regulation, flood control, and water-oriented recreation. Other future benefits could include water quality control, municipal and industrial water supply, and fish and wildlife enhancement.

Possible future hydroelectric power development discussed in this chapter includes five new projects, the enlargement of Shasta Lake, the construction of multi-purpose projects in the Alturas area, and the possible construction of pumped storage projects.

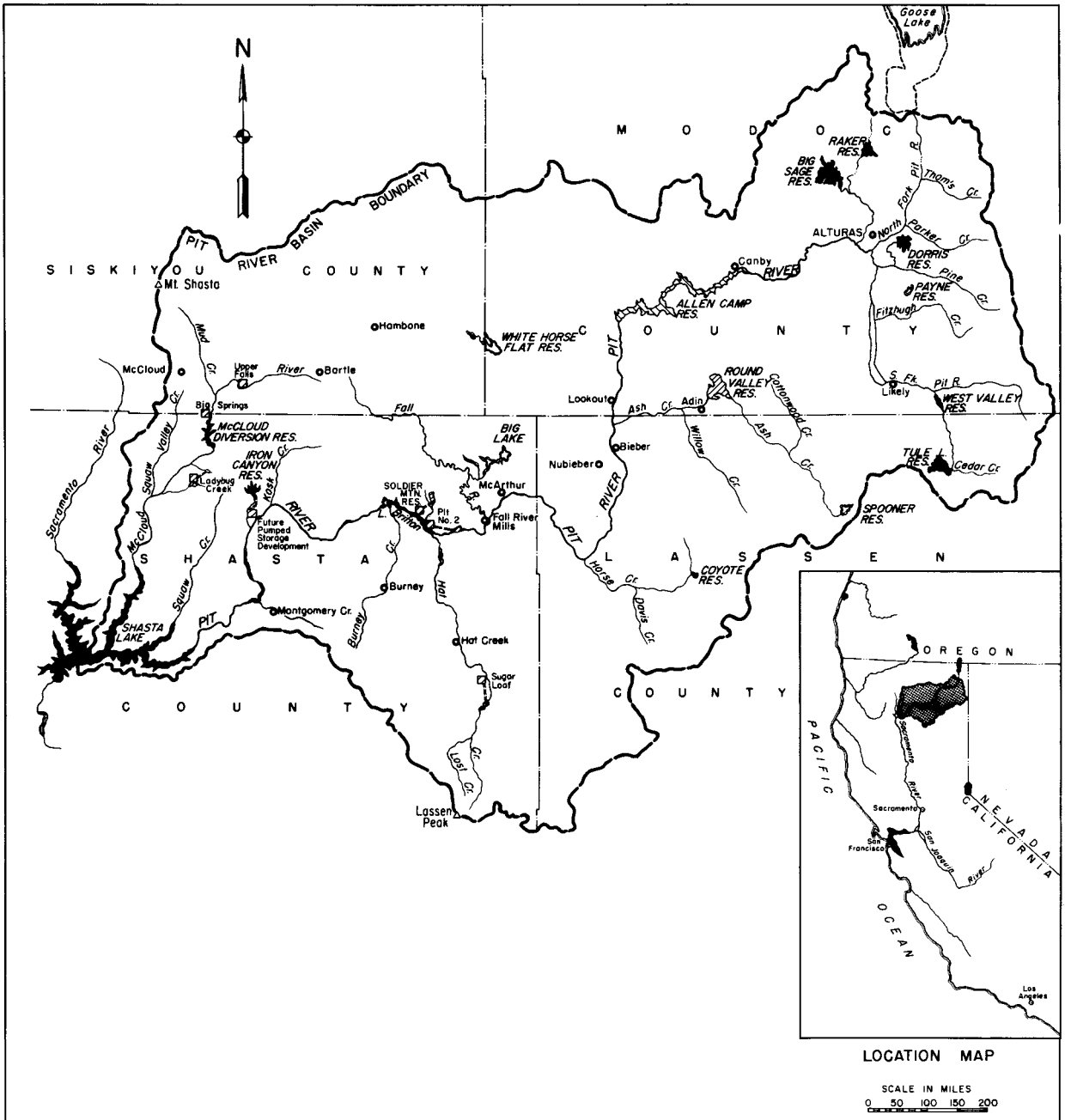
The locations of possible future developments in the basin are shown on figures 37 and 38. Those projects which are considered the most favorable and which are described in more detail in this chapter are listed in table 16. Those projects which are discussed only briefly in this chapter are Round Valley, Parker Creek, Thom Creek, enlargement of Lake Britton, adding recreation facilities to Pit No. 1, and the following hydroelectric pumped storage projects: Kosh Creek, Ladybug, and Soldier Mountain. In addition, the Corps of Engineers in its National Hydroelectric Power Resources Study, Volume 2, July 1979, has developed a preliminary inventory of hydropower resources. There are 12 sites identified in the basin with a potential for hydropower development. Nine of the sites are at existing projects. Additional data for these projects are shown in table 22.

Table 16

Most Favorable
Potential Projects

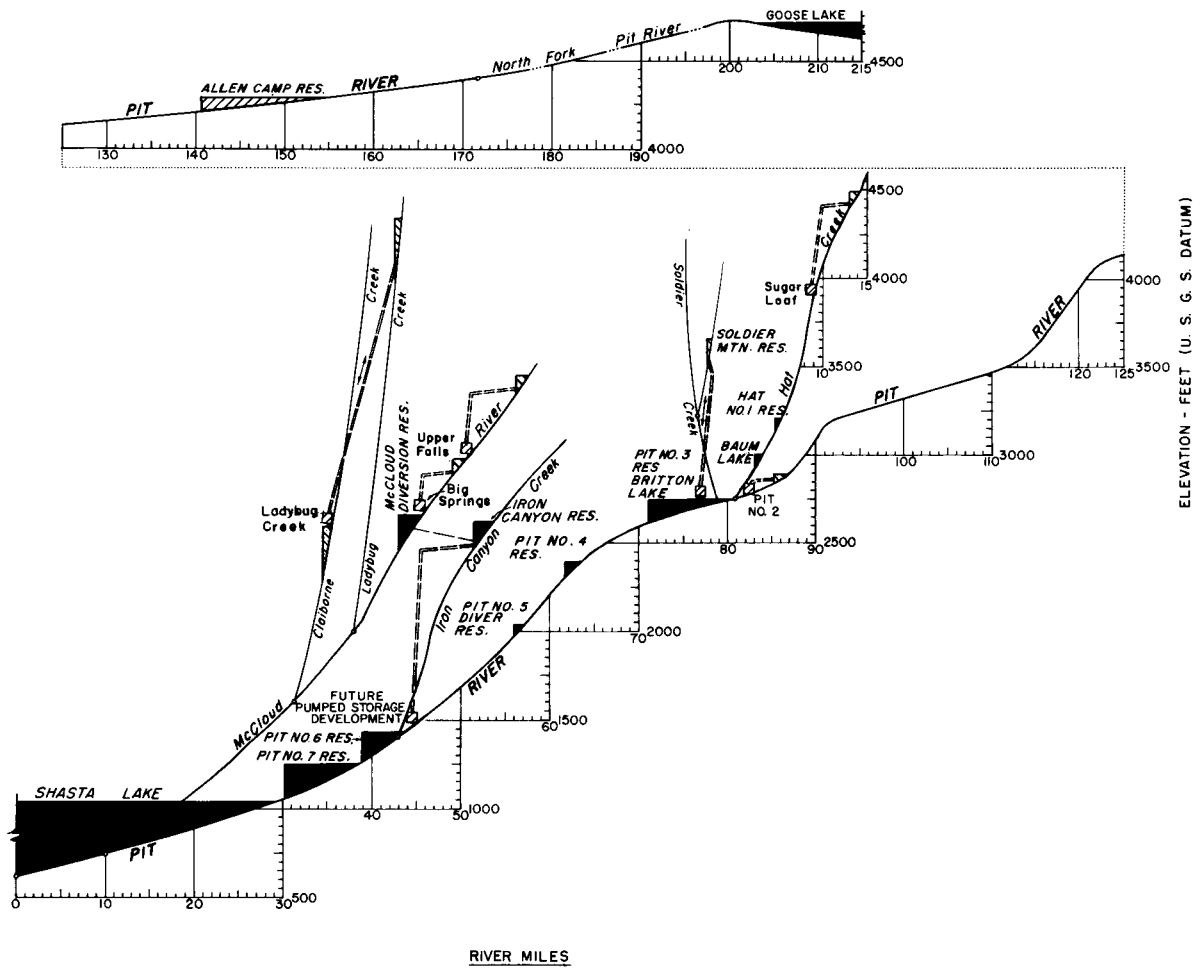
Project Name	Stream	Drainage Area (sq mi)	Usable Storage Capacity (ac ft)	Installed Capacity (kW)	Average Annual Generation (MWh)
Allen Camp	Pit River	1,550	189,200	none	none
Pit No. 2	Pit River	4,150	1/	14,000	95,000
Upper Falls	McCloud River	264	1/	18,000	79,000
Big Springs No. 3	McCloud River	369	1/	31,000	65,000

1/ *Under 1,000 acre-feet.*



FERC - Water Resources Appraisal for Hydroelectric Licensing

Figure 37



LEGEND

	EXISTING DEVELOPMENT	POSSIBLE FUTURE DEVELOPMENT
RESERVOIR		
POWERPLANT	(SEE FIGURE 37)	
CONDUIT	(SEE FIGURE 37)	
TUNNEL		

FUTURE DEVELOPMENT
RIVER PROFILES
PIT RIVER BASIN

1980

FERC - Water Resources Appraisal for Hydroelectric Licensing — Figure 38

Basis for Economic Analysis of Project No. 233

Investment cost estimates are derived from data obtained from the Water and Power Resources Service, the Corps of Engineers, Pacific Gas and Electric Company, the license applications by the California-Oregon Power Company, and staff reconnaissance-level cost estimate studies. The cost estimates were updated by the staff to January 1, 1979, price levels except as otherwise indicated.

Costs of capital are based on private financing at 10.5 percent interest and non-Federal public financing at 7 percent interest. Table 17 shows the annual fixed charges for each type of financing.

Table 17

Economic Analysis
Project No. 233

Net investment value 1/	52,817,000

Fixed Charges Schedule

Item	Non-Federal Public Financing Specific Power Facilities	Private Financing Specific Power Facilities
Interest	7.00	10.50
Amortization, 100 yrs	0.010	0.001
Interim replacements	1.25	1.25
Insurance	0.20	0.20
Taxes	1.08	4.13
Totals	9.540	16.081

Annual Costs	
Total fixed charges 2/	7,803,000
Total production expenses 3/	905,000
Total annual costs	8,708,000
Annual Benefits	
Capacity value	42,580,000
Energy value	12,282,000
Total annual benefits	54,862,000
Benefit-to-cost ratio	5.84

1/ *Estimated project cost minus the estimated project depreciation at the time of expiration of the original license.*

2/ *Computation of fixed charges based on composite financing at the ratio of 80 percent private/20 percent public, non-Federal for an effective annual rate of 14.773 percent.*

3/ *"Hydroelectric Plant Construction Cost and Annual Production Expenses, 1978"; DOE/EIA-0171 (78), November 1979.*

Annual costs of operation and maintenance, administrative, and general expenses are based on the most recent available cost data for similar hydroelectric facilities.

Power benefits for conventional hydroelectric projects are based on the value of power from an alternative nuclear steam-electric plant. The values are based on January 1, 1979, price levels, with private financing at a 10.5 percent interest rate and non-Federal public financing at 7 percent interest with a composite financing of 80 percent private and 20 percent non-Federal public.

Hydroelectric Powerplant Power Values at Site 1/
(Generalized costs as of January 1, 1979

	Capacity $/kW-yr	Energy mills/kWh
Conventional Hydroelectric Plants		
Composite financing 2/	137	6
Pumped-Storage Hydroelectric Plants		
Composite financing 2/	34	44

1/ At high voltage terminals of hydro plant sending station.
2/ 80 percent private and 20 percent public, non-Federal financing.

Allen Camp

The Water and Power Resources Service, in its report of April 1965, recommended construction of the Allen Camp Reservoir, primarily to irrigate 22,000 acres of land adjacent to the Pit River. The dam would be located at the head of Big Valley on the Pit River. The location of the Allen Camp Reservoir is shown on the map and profile on figures 37 and 38, and a list of project data is given in table 18. The project would consist of a rolled earth and rockfill dam 129 feet high with 190,000 acre-feet of total storage capacity, a concrete diversion dam 24 feet high, two well fields, 67 miles of conveyance facilities, pumping plants, river improvements and drainage facilities, and a 7,000-acre national wildlife refuge. In addition to irrigation, the project would provide recreation, fish and wildlife enhancement, flood control, area redevelopment and, possibly, headwater power benefits to the five downstream hydroelectric projects on the Pit River owned by the Pacific Gas and Electric Company.

Table 18

Allen Camp Project

Drainage area, sq mi	1,550
Dam height, ft	129
Dam crest length, ft	1,970
Maximum water surface elevation, ft msl	4,286
Minimum pool elevation, ft msl	4,198
Usable storage capacity, ac-ft	189,200
Area at normal full pool, ac	5,000

The 60,000 acre-feet of flood control storage capacity would benefit parts of Big Valley, including communities of Adin, Bieber, Lookout, and Nubieber, with a total population of less than 1,000.

Figure 39. View of Allen Camp damsite looking upstream.

The proposed Allen Camp Reservoir would provide the major source of storage which would be augmented by pumping from groundwater wells and by reuse of irrigation return flows. As proposed by the Water and Power Resources Service, substantially all releases from the reservoir would be made during the spring and summer irrigation months. Furthermore, during critical drought periods, the drawdown of the reservoir would amount to more than two-thirds of the total depth. With this operation, little or no firm at-site hydroelectric capacity could be developed. Because of existing upstream development that would be affected, enlarging the size of the reservoir for hydroelectric power development would not be justified. Topography of the immediate area surrounding the reservoir is not particularly suitable for pumped storage development. A view of the damsite is shown on figure 39.

Overall flow depletions caused by the Allen Camp project would cause a slight reduction in power output at the downstream Shasta and Keswick Reservoirs and power projects operated by the Water and Power Resources Service. This is accounted for in the proposed assignment of a portion of Central Valley project costs to the Allen Camp project. Despite the reduction in streamflow, regulation of flows by the Allen Camp Reservoir would, according to the Water and Power Resources Service's studies, benefit the existing Pacific Gas and Electric Company's Pit River powerplants No. 3, 4, 5, 6, and 7, which are operated under Federal Energy Regulatory Commission licenses as Project Nos. 233 and 2106. If such headwater benefits are provided, payments to the Federal Government would be required pursuant to section 10(f) of the Federal Power Act.

The 1965 study by the Water and Power Resources Service showed a favorable benefit-cost ratio. However, the Service has found that present-day high costs and interest rates reverse this favorable ratio. The Service has stated that further processing of the report depends on the development of new benefit evaluation procedures.

Pit No. 2

This project would utilize the only remaining unused head on the Pit River between Pit No. 1 and Shasta Lake. It was originally included in the Pacific Gas

and Electric Company's plans for overall development of the Pit River by diversion from the potential Pit No. 1 afterbay. A 1,000-foot tunnel connecting to a 13,000-foot long canal would carry the water from the afterbay to a forebay. The forebay would have a total storage capacity of 2,800 acre-feet and a usable storage capacity of 330 acre-feet. From the forebay, a 270-foot long penstock would lead to the powerhouse developing a gross head of 117.5 feet. An automatic, remotely supervised outdoor-type powerhouse would have an installed capacity of 30,000 kilowatts, producing an average annual generation of 95 million kilowatt-hours. Although basically a run-of-river plant, the operation would be dependent on the operation of Pit No. 1 immediately upstream. Pertinent data for the project are given in table 19 and its location is shown on figures 37 and 38. The benefit-cost ratio was estimated to be 0.80 for private financing.

Table 19

Pit No. 2 Project

River Mile (damsite)	80
Drainage area, sq mi	4,150
Gross head, ft	117.5
Maximum water surface elevation, ft msl	2,837
Usable storage capacity, ac-ft	330
Installed capacity, kW	14,000
Average annual energy, MWh	95,000

Upper Falls

This project was proposed by the California-Oregon Power Company in their application for a preliminary permit dated December 12, 1951. The application was dismissed March 3, 1957, by the Federal Power Commission, and the development is no longer under active consideration. The project would consist of a small rockfill diversion dam on the McCloud River, 7,300 feet of tunnel, 1,000 feet of closed conduit connecting to a 2,000-foot long penstock, and a fully automatic and remotely supervised powerhouse with an installed capacity of 18,000 kilowatts. The reservoir formed by the diversion dam would have a usable storage capacity under 1,000 acre-feet. The powerhouse would be located on the McCloud River about 2 miles upstream of the McCloud Reservoir. With a gross head of 450 feet, the project would generate an average of about 79 million kilowatt-hours annually. Pertinent data for the project are given in table 20. Staff studies indicate that the project is economically infeasible. The benefit-cost ratio, based on private financing, was estimated to be 0.64.

Big Springs No. 3

Big Springs No. 3 was proposed by the California-Oregon Power Company in their application for a preliminary permit dated December 12, 1951. The application was dismissed March 3, 1957, by the Federal Power Commission, and the development is no longer under active consideration. The powerhouse would be located on the McCloud River immediately upstream from the existing McCloud Reservoir. Nearly 3 miles of concrete-lined canal and wood flume sections would lead from a small rockfill diversion dam on the McCloud River to a 360 acre-foot earthfill

Table 20

Upper Falls Project

River Mile (damsite)	43
Drainage area, sq mi	264
Gross head, ft	450
Maximum water surface elevation, ft msl	3,450
Usable storage capacity, ac-ft	1/
Installed capacity, kW	18,000
Average annual generation, MWh	79,000

forebay on the McCloud River, to provide about 3 hours peaking pondage twice daily. Total storage capacity would be under 1,000 acre-feet. A 1,600-foot long penstock from the forebay to the powerhouse would develop 297 feet of gross head. An outdoor-type powerhouse, automatically operated and remotely controlled, would have an installed capacity of 31,000 kilowatts, producing an estimated average annual generation of 65 million kilowatt-hours. Pertinent data for the project are given in table 21. Staff studies indicated that the project is economically feasible.

Table 21

Big Springs No. 3 Project

River Mile (damsite)	36
Drainage area, sq mi	369
Gross head, ft	297
Maximum water surface elevation, ft msl	2,971
Usable storage capacity, ac-ft	360
Installed capacity, kW	31,000
Average annual generation, MWh	65,000

Round Valley

The Round Valley Project was investigated by the Water and Power Resources Service as part of the development of the comprehensive water plan for Big Valley and as a second step if the Allen Camp Project was built. As shown on figure 37, the damsite is located on Ash Creek where the creek passes through the main ridge which separates Big Valley and Round Valley. Features associated with the Round Valley project are the dam and appurtenant structures, the Willow Creek Canal, the Ash Creek channel improvement program, the distribution system, and the recreation facilities. Primary project benefits would be derived from firm water supply, lessening flooding and erosion, and recreation. Construction of the Round Valley Dam would necessitate a major relocation of U.S. Highway 299. A 1964 Water and Power Resources Service study indicated that the benefit-cost ratio would not be favorable.

Shasta Lake

Enlargement of the Federally-owned Shasta Lake, possibly up to three or four times its present size of 4,552,000 acre-feet, is one of the limited number of possibilities for increasing the future water and hydropower supply for the Central Valley basin vicinity in California. Shasta Lake could be enlarged either by: 1. Adding to the height of the existing concrete dam, or 2. Constructing a new earth and rockfill dam immediately downstream. The choice between the two possibilities would be made following more detailed studies. The Water Resources and Power Servcie is awaiting funding for a feasibility study in cooperation with the California Department of Water Resources. Raising the existing reservoir by 200 feet would inundate the Pacific Gas and Electric Company's 112-megawatt Pit No. 7 powerplant. A further raise would also affect Pit No. 6 powerplant. Other alternatives are to be studied, including new reservoirs downstream of Shasta Lake.

National Hydroelectric Power Resources Study

The Corps of Engineers in its National Hydroelectric Power Resources Study has identified 12 sites in the basin with a potential for hydropower development. The projects were screened for economic feasibility from a larger inventory. Eight of the sites are at existing projects. Eleven sites have a potential installed capacity of 2 megawatts or less. The Big Valley project on the Pit River in Lassen County would have an installed capacity of 185 megawatts and generate 283 gigawatt-hours of energy per year. Table 22 is a tabulation of the pertinent data for 12 projects.

Table 22

National Hydropower Study - Corps of Engineers 1979
Pit River Basin Projects

Name	Stream	Owner	Drainage Area (sq mi)	Gross Head (ft)	Installed Capacity (MW)	Average Annual Generation (GWh)
Big Valley	Pit River	--	2,900	840	185.0	283.0
Little Valley	Horse Creek	--	59	52	0.4	2.0
Coyote Flat Res. (Exist.)	Coyote Creek	T.E. Connoly	30	36	1.0	6.0
Tule Lake (Exist.)	Cedar Creek	Occidental Pet. L. & D.	82	0	0.1	0.1
Allen Camp Dam	Pit River	--	1,550	70	2.0	8.0
Round Valley	Ash Creek	--	258	74	2.0	4.0
Big Sage (Exist.)	Rattlesnake Creek	Hot Spring Valley Irrig. Dist.	107	34	0.3	0.8
West Valley (Exist.)	West Valley Creek	South Fork Irrig. Dist.	135	44	0.6	1.0
McBrien (Exist.)	Pit River	Amanda Hagge	1,087	9	0.2	0.7
Essex Reservoir (Exist.)	Tri Pit River	Pelissa and Hale	5	31	0.1	0.2
Lindaur Concrete (Exist.)	Pit River	W.E. & C.O. Rouse	1,150	5	0.1	0.4
Dorris Dam (Exist.)	Parker & Pine Creeks	DOI BSFW	39	19	0.2	0.4

Flood Control

The Corps of Engineers has investigated flood control sites in the Pit River basin. They studied the possibility of enlarging Lake Britton with an earthfill dam, but reconnaissance studies indicated that other sites are more promising.

Consideration by the FERC staff was given to utilizing Lake Britton, with a total storage capacity of 40,600 acre-feet, for flood control. However, the annual benefits that would be derived from flood damage reduction on the Sacramento River between Shasta Dam and Sacramento, if Lake Britton was utilized for flood control purposes, would be far less than the annual benefits presently derived from power production.

The Corps has studied the feasibility of diverting flood waters from Hat Creek into nearby lava beds, but the study found that such development was economically infeasible. The Corps is currently studying the feasibility of implementing a flood control project for the town of Burney on Burney Creek. This feasibility study is expected to be completed in 1981.

The Flood Control Appendix of the 1972 Comprehensive Framework Study for the California Region suggests the construction of the following flood control structures in the Sacramento River region above Shasta Dam:

Reservoirs	When Needed	Stream	Flood Control Capacity (ac-ft)	Drainage Area (sq mi)
6 detention structures	1966-1980	various	14,000	182
Allen Camp	1981-2000	Pit River	60,000	1,550
4 detention structures		various	13,000	913
3 detention structures	2001-2020	various	9,000	180

Parker and Thom Creek Multi-Purpose Developments

With the exception of the proposed projects by the Water and Power Resources Service, no large-scale developments are presently being considered in the Pit River basin. Local interests in the Alturas area have been exploring the possibilities of constructing multi-purpose reservoirs on Parker and Thom Creeks just northeast of Alturas, California. Each reservoir would be created by the construction of a small earthfill dam, impounding about 7,400 acre-feet at Parker and 6,700 acre-feet at Thom Creeks. Reservoir surface areas would be about 372 and 228 acres, respectively.

Recreation would be the primary purpose, although flood control, irrigation, and wildlife enhancement would be included. Since most of the reservoir areas would be located on Indian lands, it is thought that economic benefits to the local Indian population would accrue from the influx of recreationists to the reservoirs and nearby areas, and from added employment opportunities during the construction period.

The Bureau of Indian Affairs and the Soil Conservation Service concur in the potential of the two reservoirs. Funding for construction would be sought through a variety of sources, including the Federal Small Business Administration and the State of California's Davis-Grunsky Act. The immediate problem, however, is to obtain funding for a feasibility study of these projects.

Project No. 2687 (Pit No. 1)

An application for amendment of the license for Project No. 2687 was filed May 8, 1972, to supplement Exhibits R and S. The Pacific Gas and Electric Company plans initially to construct a 5-unit campground with a water system and sanitary facilities. Later improvements would include enlarging the parking area, constructing a viewing platform, and constructing additional boat launching facilities when needed. The company also plans to improve the wildlife habitat on Big Lake.

Pumped Storage Hydroelectric Power Projects

Studies by the Commission staff of the existing James B. Black project indicate that the two upstream project reservoirs, McCloud and Iron Canyon, together with Pit No. 6 Reservoir as the afterbay, could be used in the potential Kosh Creek pumped storage installation. In addition to the storage capacity of this afterbay, flows from Pit No. 5 would also be available for pumped storage.

Based on a 6-hour daily peaking operation, a 2,000,000-kilowatt capacity plant consisting of 8 reversible units could be constructed without major modifications to the existing reservoirs. A new tunnel would parallel the existing power tunnel from Iron Canyon Reservoir and connect with penstocks leading to the powerplant, which would be located adjacent to the James B. Black powerhouse. With a rated head of about 1,200 feet, the average annual generation, based on a 20 percent capacity factor, would be 3,504,000 megawatt-hours. The required pumping energy is assumed to be 150 percent of the average annual generation. The location of this proposed development is shown on figure 38.

Two other potential pumped storage sites in the basin are included in a reconnaissance investigation by the Commission's San Francisco Regional Office, of potential pumped storage sites in the Pacific Southwest. These two sites, Ladybug and Soldier Mountain, are shown on figure 38. As shown, the Ladybug site would consist of an upper reservoir located on Ladybug Creek, connected by a 2-mile long tunnel to a powerhouse and lower reservoir on Claiborne Creek. The Soldier Mountain site would utilize the existing Lake Britton as the lower reservoir. A 2-1/2-mile long tunnel would connect to an upper reservoir on Soldier Creek. Each site would have a capacity of 1,000,000 kilowatts.

It should be noted that all 3 pumped storage projects have been evaluated with a generation output based on a 20 percent average annual capacity factor. Both the Ladybug and the Soldier Mountain projects would be capable of 12 hours continuous full generation output, while the Kosh Creek project would be limited to a 6-hour full generation period without spilling the lower reservoir.

Continued Operation of Project No. 233 (Pit No. 3, 4, and 5)

An application was filed with the Federal Energy Regulatory Commission by Pacific Gas & Electric Company for a new license to operate and maintain Project No. 233 (Pit No. 3, 4, and 5). The original license expired on October 22, 1973, and the project is presently operating under annual licenses.

Project No. 233 began operating in 1925 with the completion of Pit No. 3 powerplant. Pit No. 4 and 5 began operating in 1955 and 1944, respectively. The structures and equipment are presently in good condition and well maintained, and the project is operating efficiently.

The project is expected to be capable of continuing to produce power for the foreseeable future. Our economic analysis indicates that continued operation of the project would be favorable, as the project costs have been amortized. Fixed charges on the project's net value and estimated operating costs would be less than the annual value of project power.

The project's net value of $52,817,000 is considered to be the estimated project cost minus the estimated project depreciation at the time of expiration of the original license. Under procedures prescribed in Order No. 387, issued by the Commission on August 4, 1969, for the determination of the net investment component of a takeover price, the net value would be subject to a maximum potential further deduction of the balance accumulated in the project section 10(d) (Federal Power Act) amortization reserve account.

The licensee, in its application for a new license, proposes to develop a swimming beach, an additional access to the shoreline, and camping facilities at Lake Britton to accommodate 100 people. The California Department of Parks and Recreation plans to develop a 50-unit campground, a sanitary dump station, and a floating 16-unit boat dock.

Because of the relatively high capacity factor, most of the plants appear to warrant investigation for enlargement. However, Pit No. 4, 5, 6, and 7 form a stair-step development which would preclude reservoir enlargement without inundating existing developments. Pit No. 1, 3, 4, and 5 have long tunnels which would be costly to enlarge, and Hat Creek No. 1 and 2 have too little water to make enlargement feasible.

Environmental Considerations

In the overall comprehensive planning for water and related land resource uses and development, consideration is given not only to developing storage and diversions for power, irrigation, flood control, recreation, and similar uses, but also to the possibility of foregoing development in order to preserve, protect, or enhance the natural environment, scenic and historic areas, wilderness, primitive areas, wildlife habitats, and ecologically fragile provinces. To give proper protection to the natural environment, specific areas have been established in the basin where man's use is extremely limited. However, there are no known water resource projects that have been precluded from development because of these established areas. Furthermore, there are no known potential hydroelectric projects in these areas. These areas include Lassen, Shasta, Fremont, and Modoc national forests, Lassen Volcanic National Park, Modoc National Wildlife Refuge, Shasta National Recreation Area, forest reserves of the California State Division of Forestry, McArthur-Burney Falls Memorial State Park, and other small parks, sites, points of interest, monuments, and game refuges.

In accord with long-range plans of the licensee, recreation facilities at the projects will be expanded as the need develops. Other similar recreational developments in the basin are planned for the future by both public and private entities.

The quality of water in the upper portion of the basin could be improved by sewage treatment by the small communities and industries that now have minimal or no treatment facilities.

Most of the power generated within the basin is exported to help meet the large growing electric loads in the interconnected systems of the Pacific Gas and Electric Company and other utilities. Hydroelectric power from this basin would likely be less expensive, more efficient, and do less damage to the total environment than power from alternative sources.

Under the National Environmental Policy Act of 1969 (Public Law 91-190), Federal agencies are required to consider implications of all major Federal actions. In evaluating proposals for relicensing or alternative uses of the Pit No. 3, 4, and 5 developments, the following factors are appropriate for consideration:

1. Since plants of the Pit No. 3, 4, and 5 developments have been in operation for over 25 years, issuance of a new license for power operation should not have a significant impact on the existing environment.

2. The continued operation of the developments would not create any new adverse environmental effects. The existing operation is generally in accord with existing fish and wildlife needs. The operation would not change greatly if upstream storage proposed by other entities is built.

3. There are several alternative courses of action available to the Commission. It could issue a new license for continued power operation, either by the present licensee or by another; it could provide for continued operation of parts of the developments for other purposes, but without power generation; it could recommend Federal takeover of the developments; or it could require that the developments' facilities be dismantled and removed from the area. There appears to be no advantage in eliminating power operations in favor of other purposes.

4. The Pit No. 3, 4, and 5 developments have now become a fixed part of the environment and its ecology. Continued operation would have less effect on the surroundings than any change. The general esthetics are now established for these reaches of the river.

5. Issuance of a new license for continued operation of Project No. 233 would not appear to involve any new irreversible or irretrievable commitments of resources.

Conclusions

Project No. 233, which includes Pit No. 3, 4, and 5 powerplants, and for which a new license application is under consideration, is generally in good operating condition and with continued maintenance is expected to continue to provide an economic source of power. Except for possible additional recreation facilities at Lake Britton, formed by Pit No. 3 development, no substantial modifications to this licensed project are necessary.

It does not appear that continuation of the existing reservoirs, as presently operated, would have any significant adverse effects on the environmental aspects of the basin. However, in connection with the management of sport fishery waters in the basin, possible changes in the operation of existing reservoirs, including increased water releases below dams, and stabilization of water surfaces during spawning seasons are under consideration.

Flood control capacity is needed in the Pit River basin to alleviate flooding downstream on the Sacramento River. However, it would not be economical to modify or use the existing hydroelectric projects in the basin for flood control storage capacity. Further, if any of these existing hydroelectric projects were eliminated or used for some other purpose, the alternative source of power would probably have greater undesirable environmental effects.

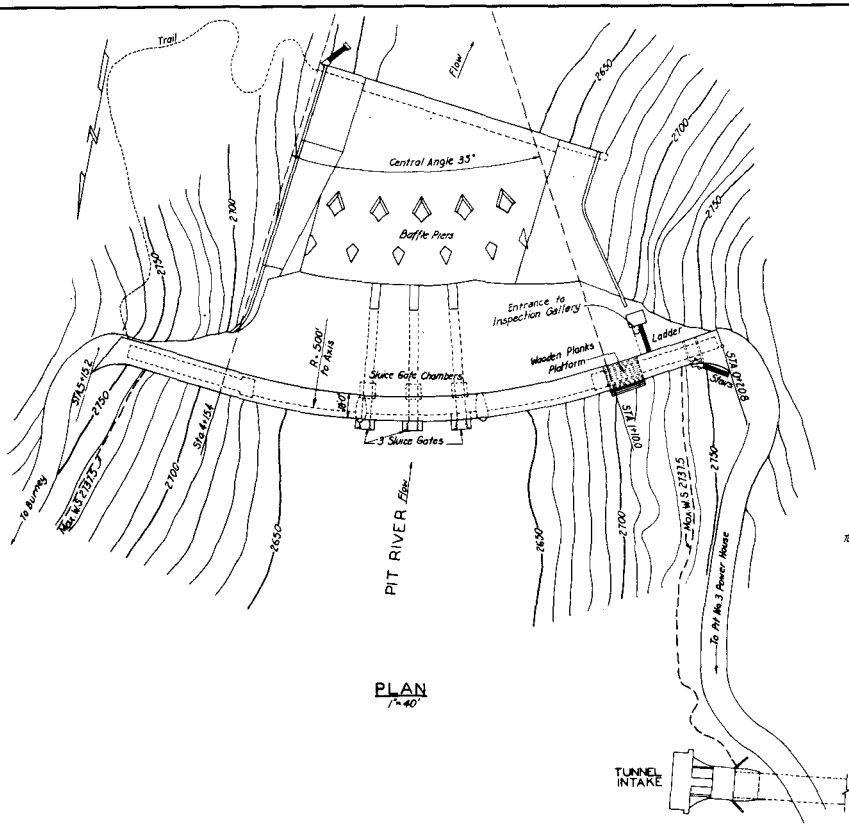
The Allen Camp project, as identified in this report, would provide benefits from irrigation, recreation, flood control, power, fish and wildlife enhancement, and area development and would possibly provide headwater improvements to hydroelectric power at the five downstream powerplants. The Round Valley project was also proposed as a second step after Allen Camp to provide benefits from recreation, water supply, and flood control. However, although the Water and Power Resources Service study of 1965 found the Allen Camp project economically feasible, present-day high costs and interest rates have reversed that favorable benefit-cost ratio. The Round Valley project was also found to have an unfavorable benefit-cost ratio.

Three potential conventional hydroelectric power sites (Pit No. 2, Upper Falls, and Big Springs No. 3) are described in this report. However, only Big Springs No. 3 is expected to be economically favorable for development. Further, there are three potential pumped storage developments, Kosh Creek, Ladybug, and Soldier Mountain, in the basin with a total projected installed capacity of 4 million kilowatts and with an average projected annual generation of over 7 million megawatt-hours.

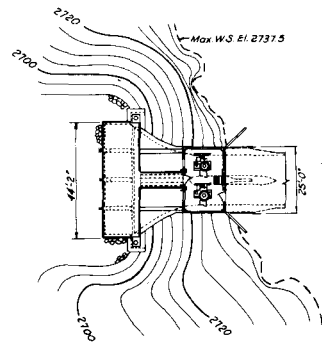
Many scenic and wildlife areas in the basin have been identified to preserve them for their scenic and wildlife value. However, the establishment of these areas has not precluded the development of any known water resources projects. Further, there are no known potential hydroelectric developments in these scenic or wildlife areas.

Local interests in the Alturas area are exploring the possibility of construction of small multi-purpose reservoirs without hydroelectric power on Parker and Thom Creeks just north of Alturas. These two projects, if developed, would not have any significant effect on any downstream projects.

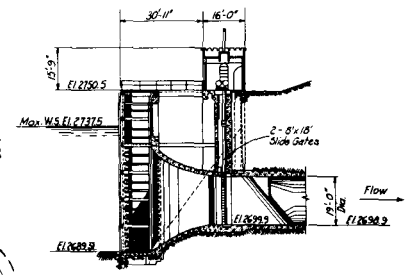
APPENDIX



PLAN
1" = 40'

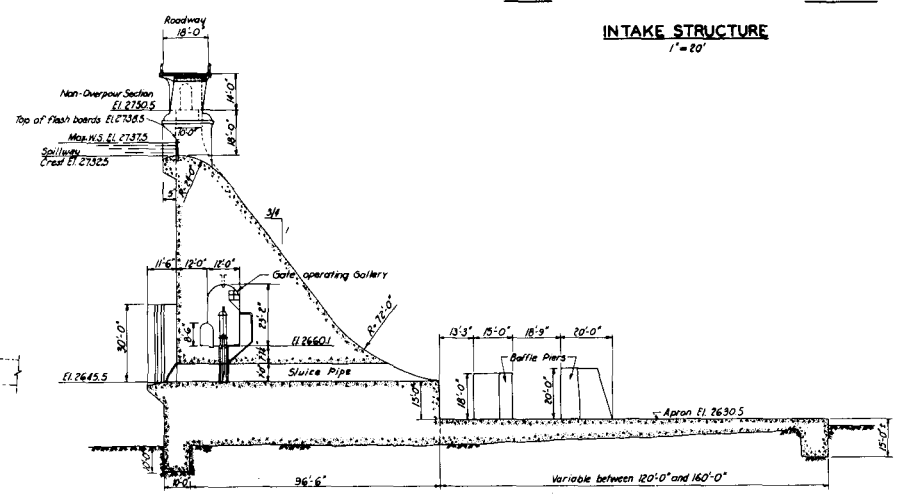


PLAN

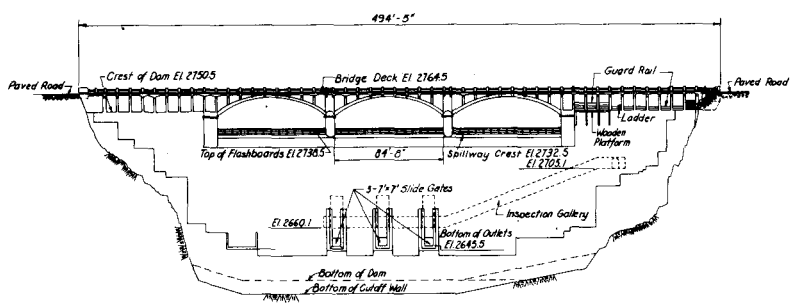


SECTION

INTAKE STRUCTURE
1" = 20'



SECTION THRU OUTLET
1" = 20'



ELEVATION
(Developed View)
1" = 40'

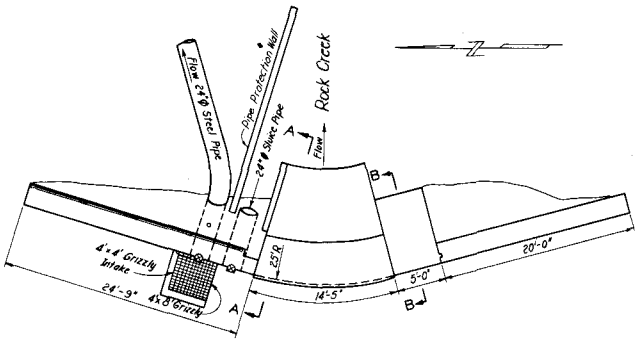
Elevations are on U.S.G.S. Datum

This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

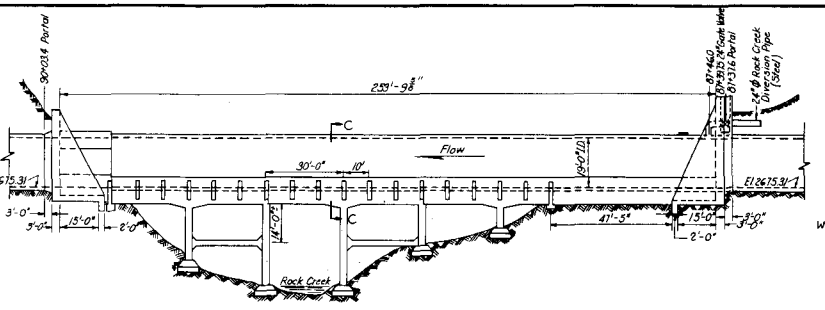
By J. D. Waddington
VICE PRESIDENT - ENGINEERING

EXHIBIT L-1
PIT 3 DAM AND INTAKE
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.
0 1 2 SCALE AS NOTED 4 5 6 INCHES

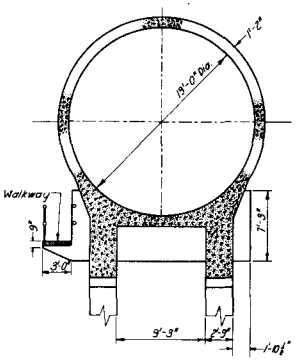
444409



PLAN
$\frac{3}{16}$"=1'-0"

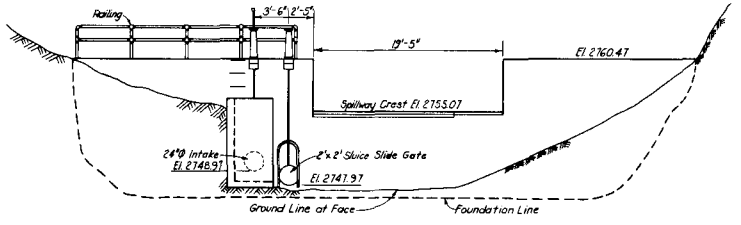


ELEVATION OF CROSSING
1"=20'

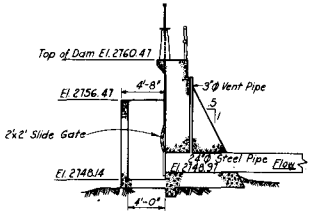


SECTION C-C
$\frac{3}{16}$"=1'-0"

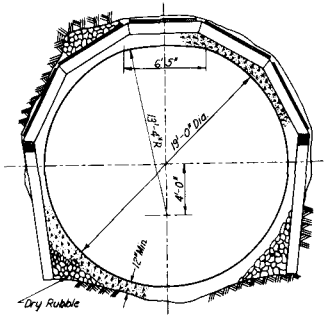
ROCK CREEK TUNNEL CROSSING



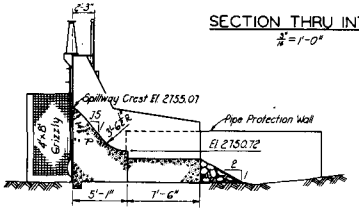
ELEVATION
$\frac{3}{16}$"=1'-0"



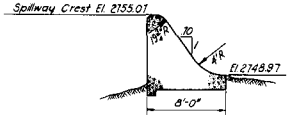
SECTION THRU INTAKE
$\frac{3}{16}$"=1'-0"



TUNNEL SECTION
$\frac{1}{4}$"=1'-0"



SECTION A-A
$\frac{3}{16}$"=1'-0"



SECTION B-B
$\frac{3}{16}$"=1'-0"

ROCK CREEK DIVERSION DAM

Elevations are on U.S.G.S. Datum.

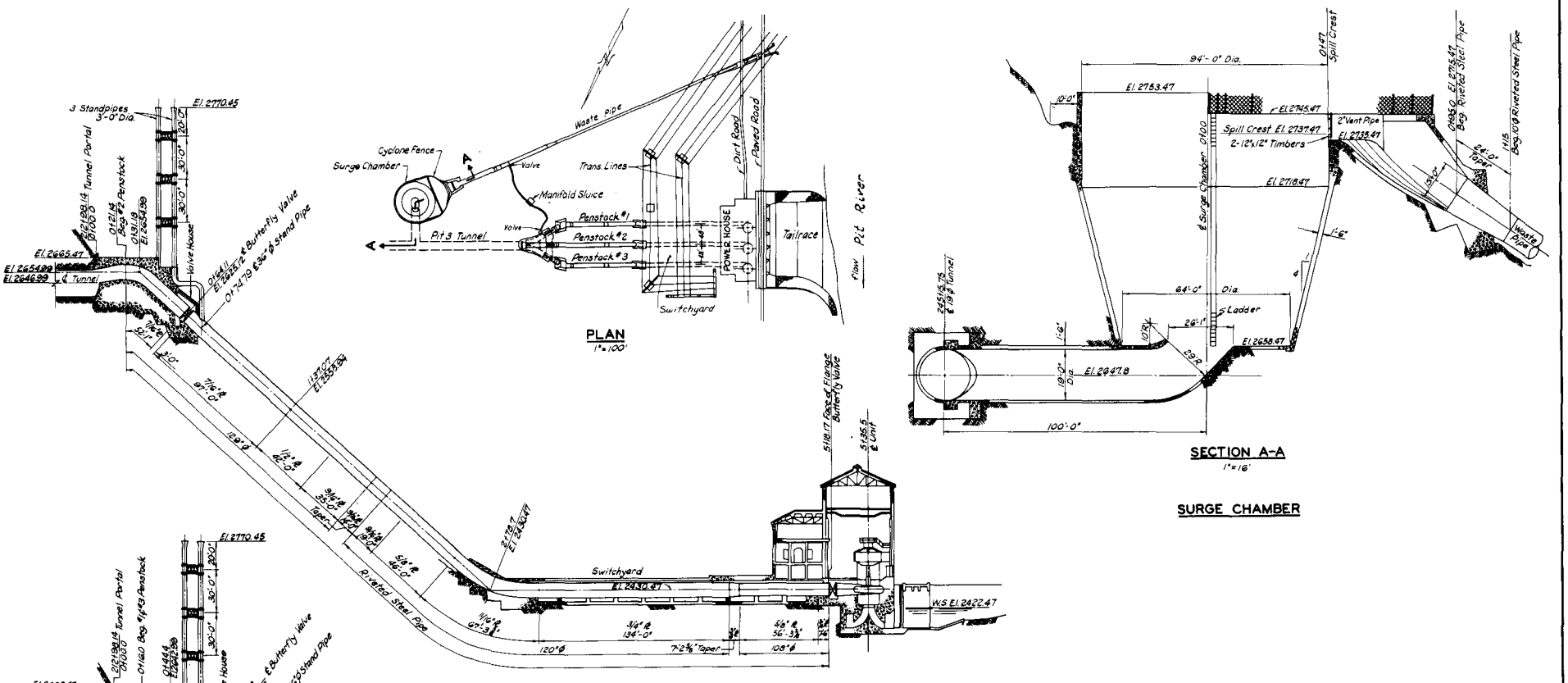
This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

By J. D. Watt
VICE PRESIDENT - ENGINEERING

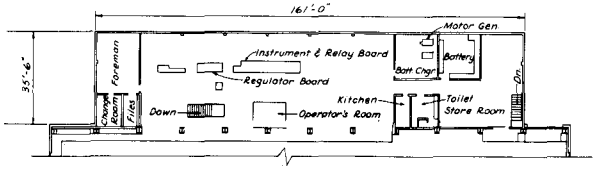
EXHIBIT L-2
ROCK CREEK DIVERSION DAM, TUNNEL CROSSING, AND PIT 3 TUNNEL SECTION
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.

0 1 2 SCALE AS NOTED 4 5 INCHES

444410

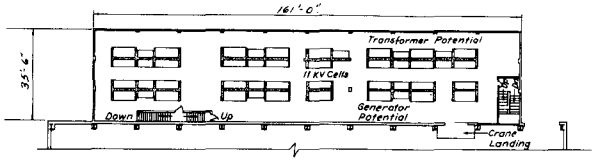

3 Standpipes 3'-0" Dia.
El. 2770.45
Tunnel Portal
Penstock
Valve House
El. 2665.47
El. 2654.89
El. 2646.89
℄ Tunnel
Butterfly Valve
Stand Pipe
Cyclone Fence
Surge Chamber
Waste pipe
Valve
Trans. Lines
Manifold Sluice
Dirt Road
Paved Road
Penstock #1
Penstock #2
Penstock #3
Pit 3 Tunnel
POWER HOUSE
Tailrace
Switchyard
Pit River
PLAN
1" = 100'
94'-0" Dia.
El. 2753.47
Spill Crest
El. 2745.47
Spill Crest El. 2737.47
2-12"x12" Timbers
2" Vent Pipe
El. 2735.47
℄ Surge Chamber
El. 2718.47
64'-0" Dia.
Ladder
El. 2658.47
Dia.
El. 2647.8
100'-0"
Waste Pipe
SECTION A-A
1" = 16'
SURGE CHAMBER
Riveted Steel Pipe
Switchyard
El. 2430.47
W.S El. 2422.47
Butterfly Valve
℄ Unit
PROFILE OF PENSTOCK NO. 2
1" = 30'
PROFILE OF PENSTOCKS NO. 1 AND NO. 3
1" = 30'
NOTE
Stations for Penstocks are on ℄ of No. 2 Penstock.
Elev. are on U.S.G.S. Datum.
This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.
By
VICE PRESIDENT - ENGINEERING
EXHIBIT L-3
PIT 3 SURGE CHAMBER AND PROFILE OF PENSTOCKS
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.
SCALE AS NOTED

444411



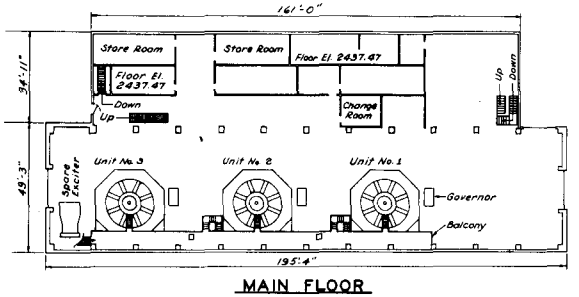
THIRD FLOOR

Scale: 1" = 20' approx.



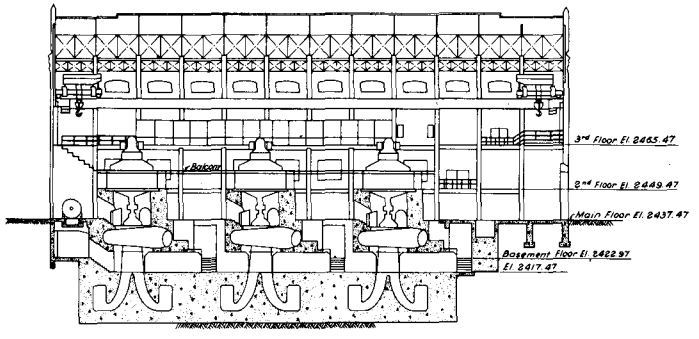
SECOND FLOOR

Scale: 1" = 20' approx.



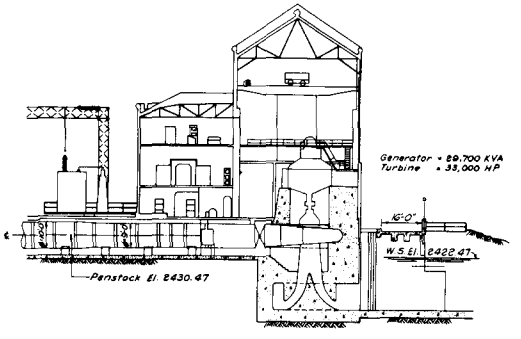
MAIN FLOOR

Scale: 1" = 20' approx.



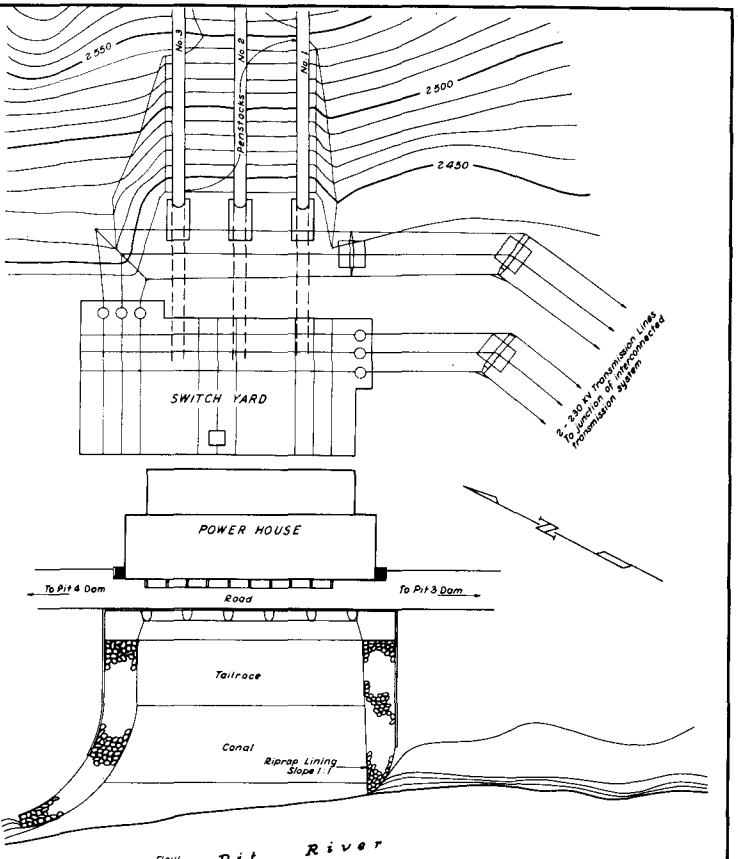
LONGITUDINAL SECTION

Scale: 1" = 20' approx.



TRANSVERSE SECTION

Scale: 1" = 20' approx.



GENERAL ARRANGEMENT OUTDOORS

Scale: 1" = 40'

Elevations are on U.S.G.S. datum.

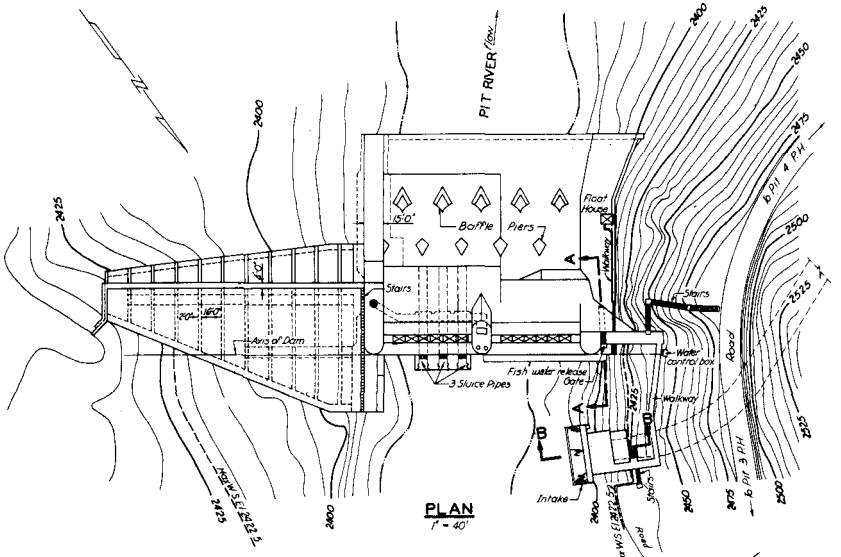
This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

By J. D. Worthington
VICE PRESIDENT - ENGINEERING

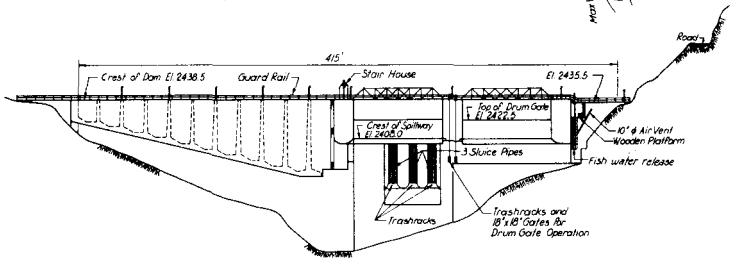
EXHIBIT L - 4
PLAN AND SECTIONS
PIT 3 POWER HOUSE
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.

0 1 2 SCALE: AS NOTED 4 5 6 INCHES

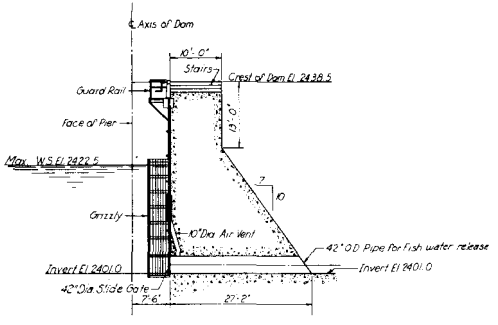
444412



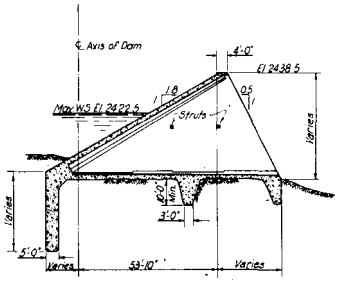
PLAN
1" = 40'



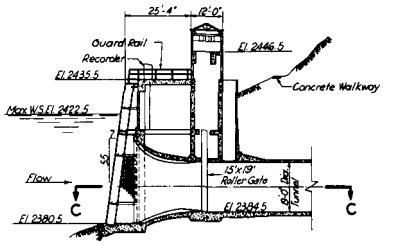
ELEVATION
1"=40'



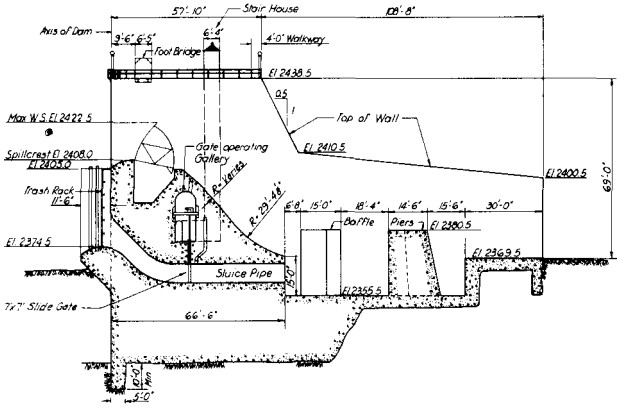
SECTION A-A
1" = 10'



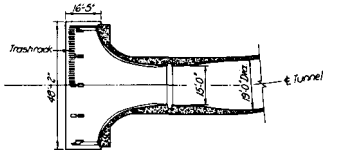
TYPICAL BUTTRESS SECTION
1" = 20'



SECTION B-B
1" = 20'



SECTION THRU OUTLET
1" = 20'



SECTION C-C
1" = 20'

INTAKE STRUCTURE

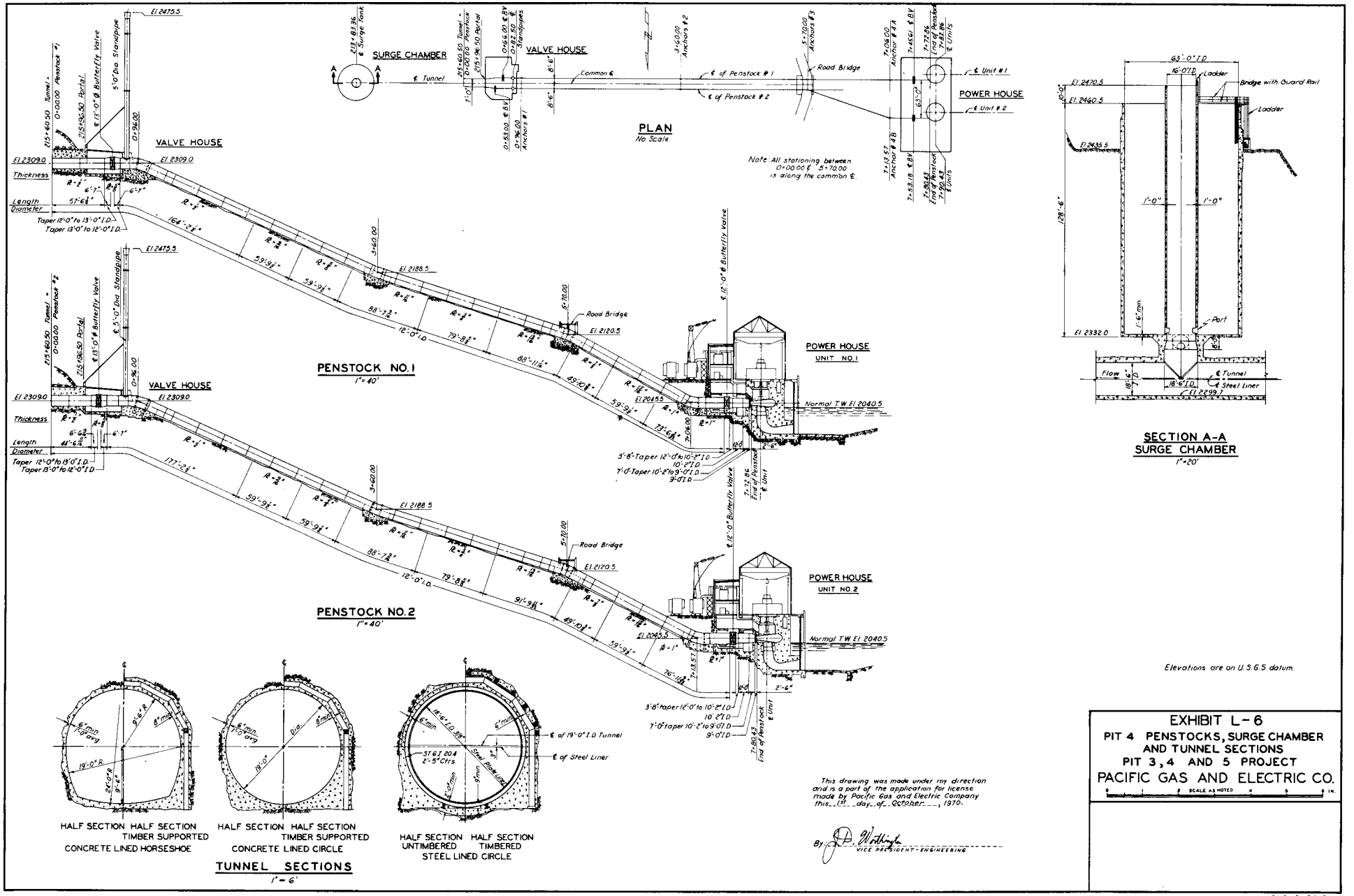
Elevations are on U.S.G.S. datum.

This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

By D. J. Watkins
Vice President - Engineering

EXHIBIT L-5
PIT 4 DAM AND INTAKE
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.
0 1 2 SCALE AS NOTED 4 5 6 IN.

444413



This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

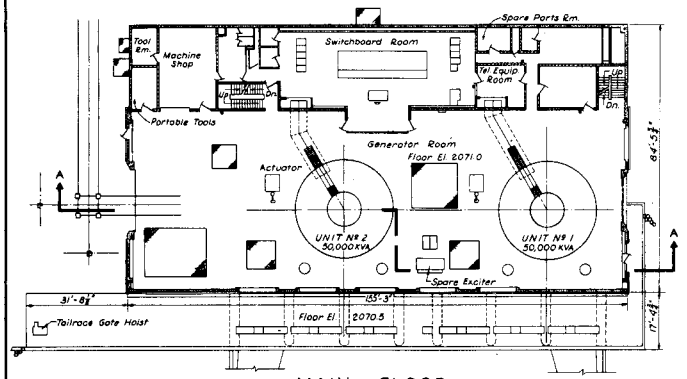
By J. D. Wright
VICE PRESIDENT-ENGINEERING

EXHIBIT L-6

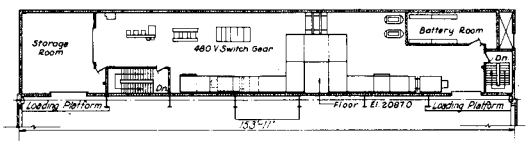
PIT 4 PENSTOCKS, SURGE CHAMBER AND TUNNEL SECTIONS
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.

SCALE AS NOTED

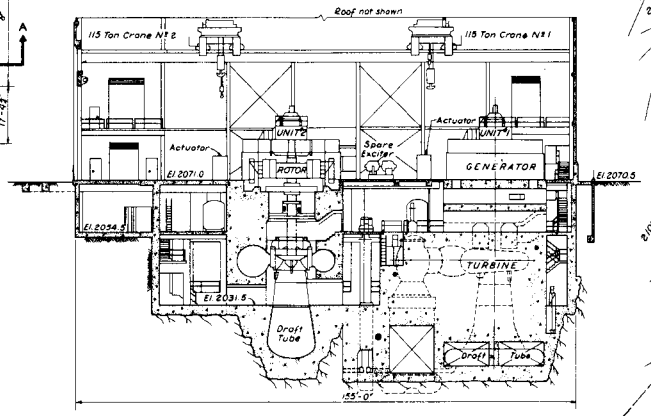
444414



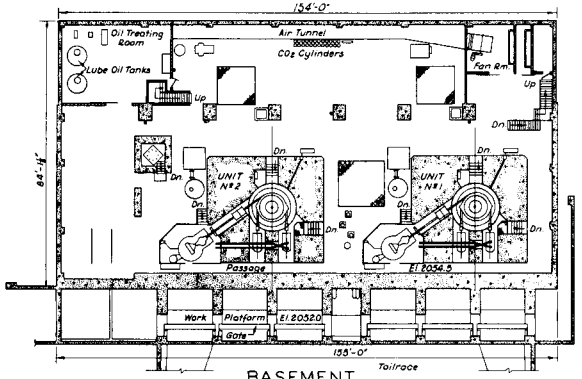
MAIN FLOOR
1/8" = 1'-0"



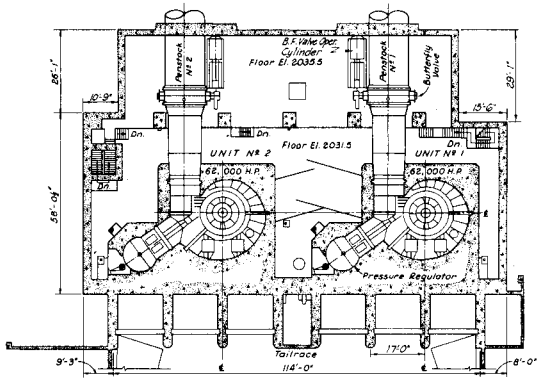
SECOND FLOOR
1/8" = 1'-0"



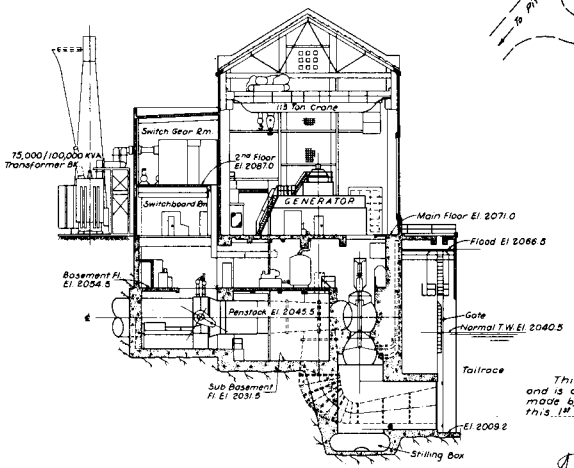
LONGITUDINAL SECTION A-A
1/8" = 1'-0"



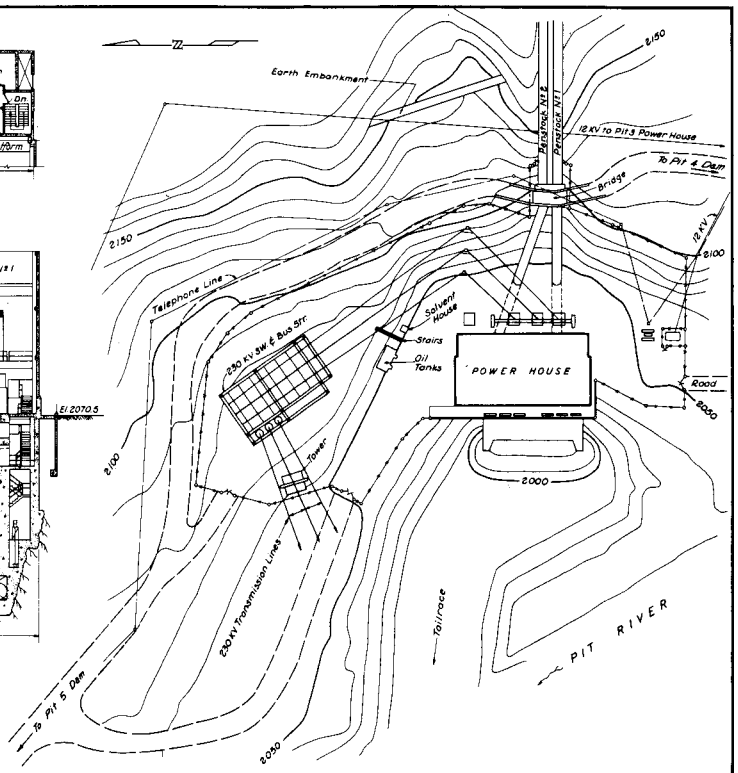
BASEMENT
1/8" = 1'-0"



SUB BASEMENT
1/8" = 1'-0"



TRANSVERSE SECTION
1/8" = 1'-0"



GENERAL ARRANGEMENT OUTDOORS
1" = 40'

Elevations are on U.S.G.S. datum.

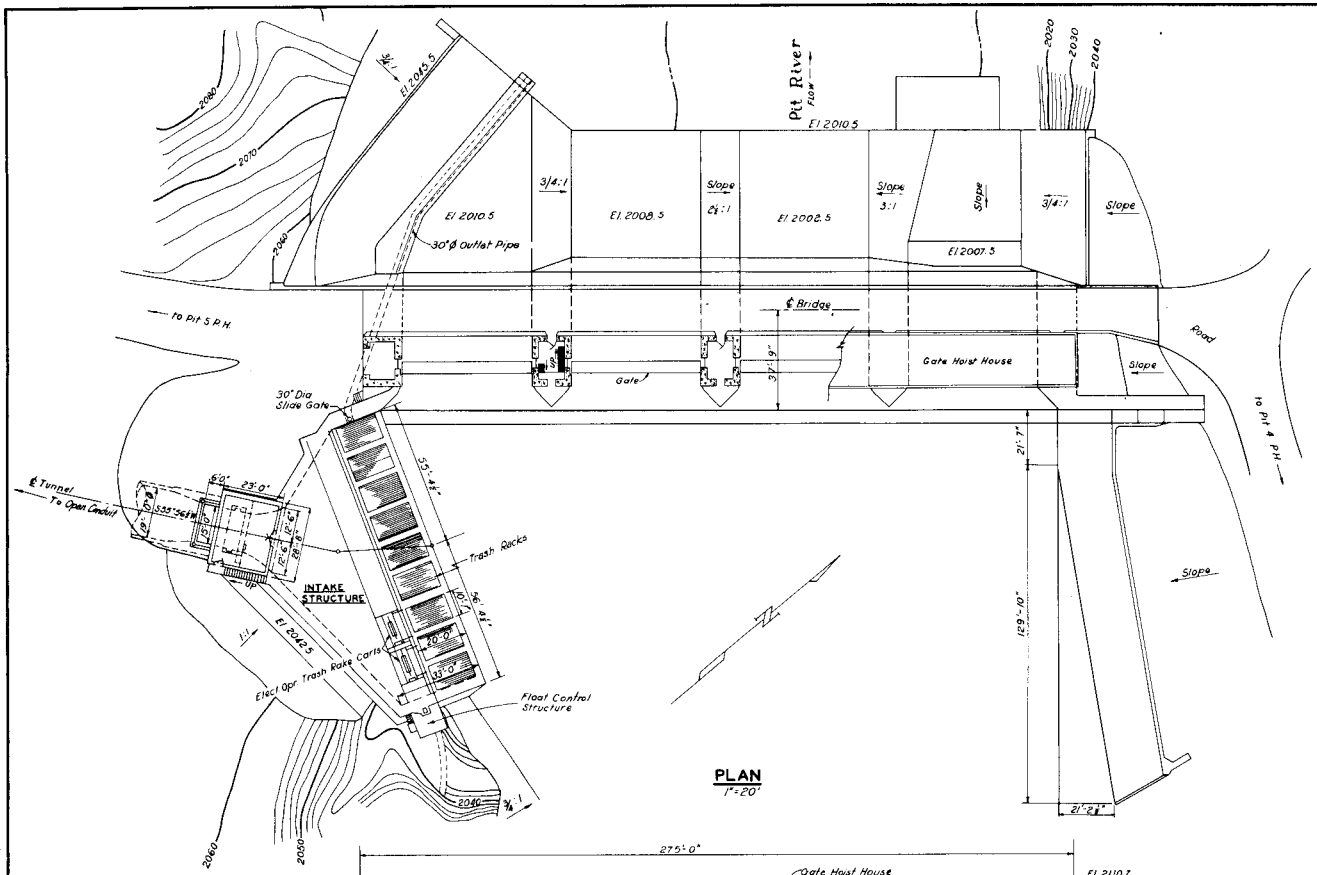
This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

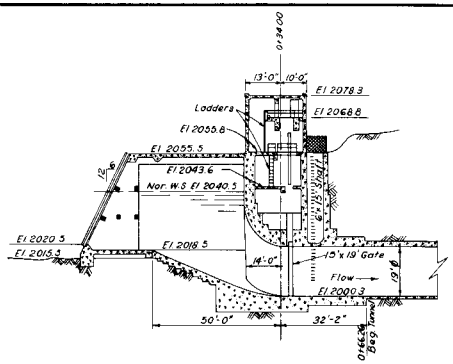
By J. D. Worthington
VICE PRESIDENT - ENGINEERING

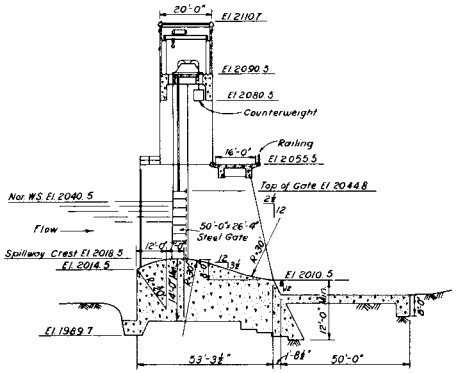
EXHIBIT L-7
PIT 4 POWER HOUSE
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.

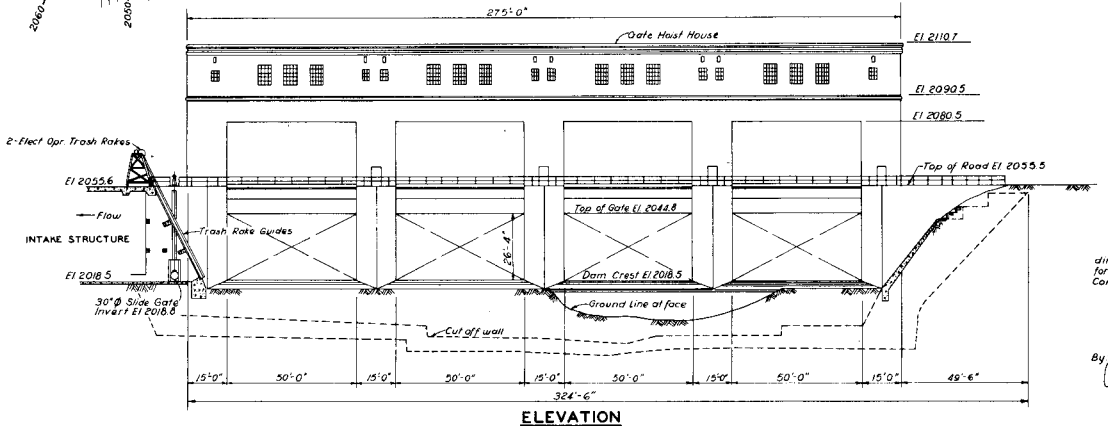
0 1 2 SCALE AS NOTED 4 5 6 INCHES

444415









Elevations are on U.S.G.S. Datum

This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

By J. D. Wollitz
VICE PRESIDENT-ENGINEERING

EXHIBIT L-8

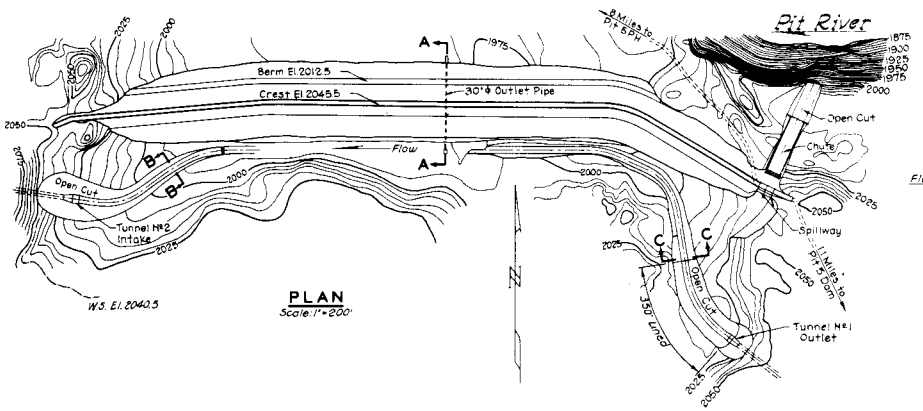
PIT 5 DIVERSION DAM AND INTAKE STRUCTURE

PIT 3, 4, AND 5 PROJECTS

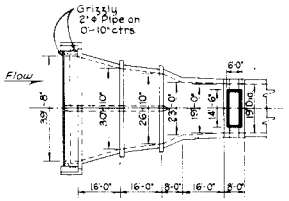
PACIFIC GAS AND ELECTRIC CO.

0 1 2 SCALE AS SHOWN 4 5 6 IN.

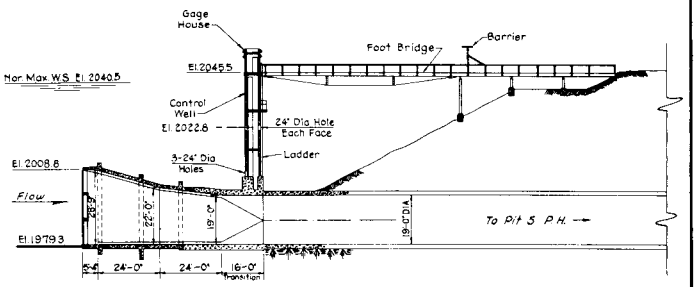
444416



PLAN
Scale: 1" = 200'

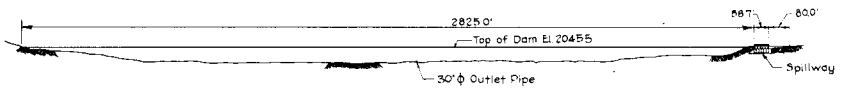


PLAN

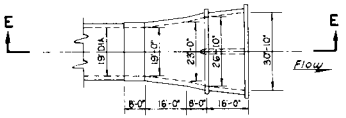


SECTION

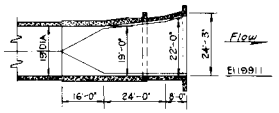
INTAKE, TUNNEL Nº 2
Scale: 1" = 20'



ELEVATION
Scale: 1" = 200'

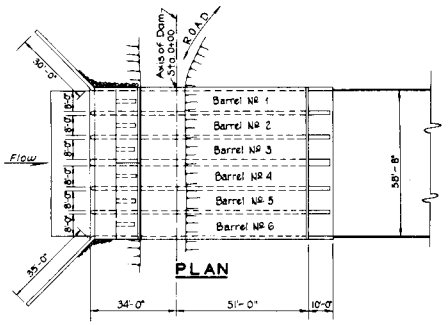


PLAN

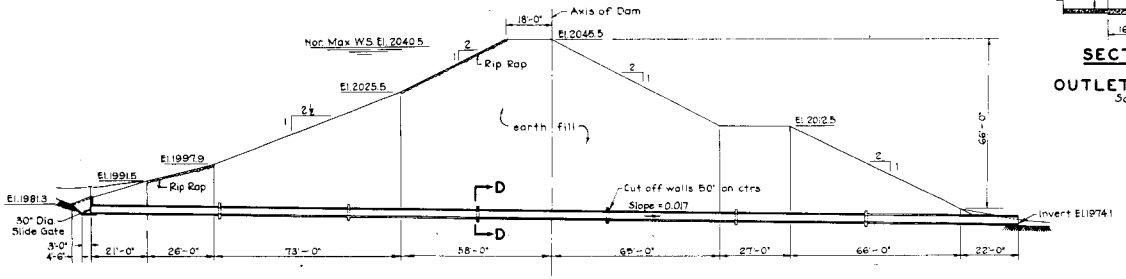


SECTION E-E

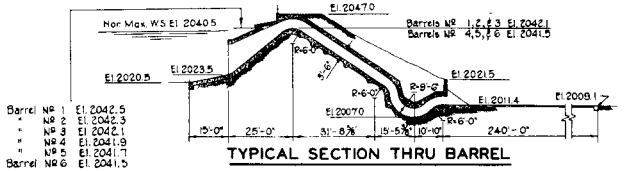
OUTLET, TUNNEL Nº 1
Scale: 1" = 20'



PLAN



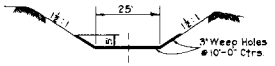
SECTION A-A
Scale: 1" = 20'



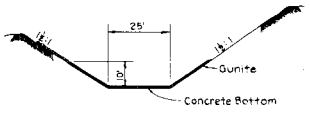
TYPICAL SECTION THRU BARREL

SPILLWAY
Scale: 1" = 20'

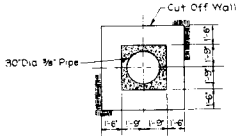
Elevations are on U.S.G.S. Datum



SECTION B-B
Scale: 1" = 20'



SECTION C-C
Scale: 1" = 20'



SECTION D-D
Scale: ½"=1'-0"

This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 15th day of October, 1970

By: VICE PRESIDENT - ENGINEERING

EXHIBIT L-9

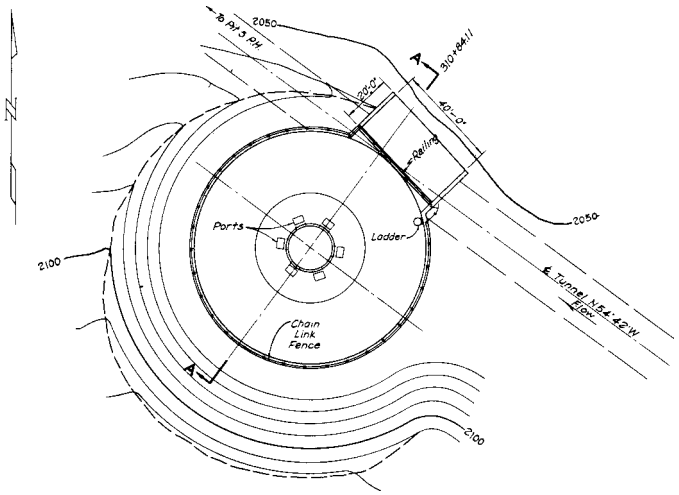
PIT 5 OPEN CONDUIT DAM

PIT 3, 4, AND 5, PROJECT

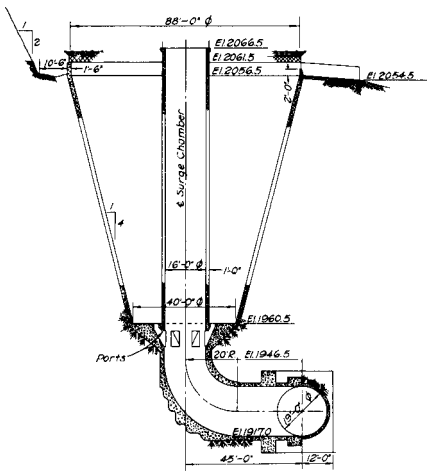
PACIFIC GAS AND ELECTRIC CO.

SCALE AS SHOWN

444417

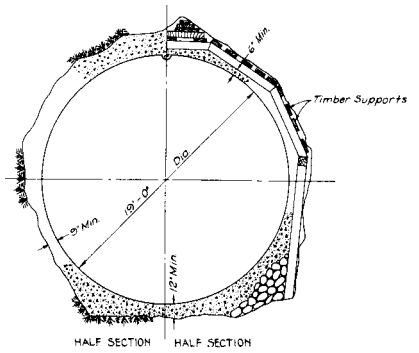


PLAN
Scale: 1" = 20'

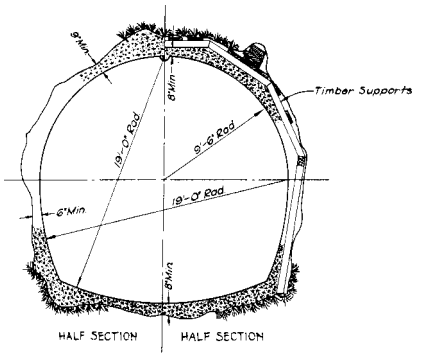


SECTION A-A
Scale: 1" = 20'

SURGE CHAMBER



CONCRETE LINED CIRCULAR
Scale: ⅛" = 1'-0"



CONCRETE LINED HORSESHOE
Scale: ⅛" = 1'-0"

Elevations are on U.S.G.S. datum.

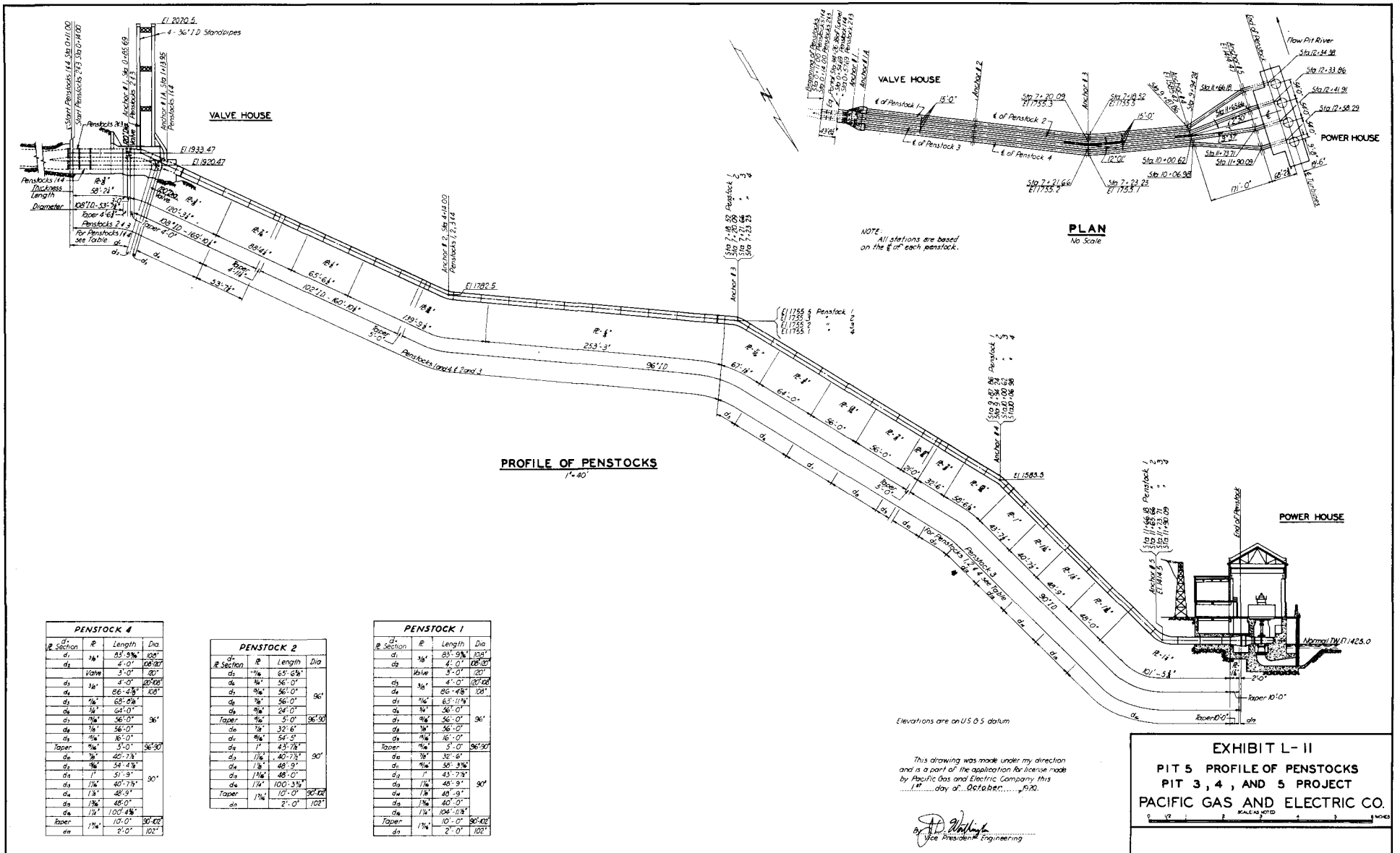
This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970

By: J. D. Whitaker
VICE PRESIDENT - ENGINEERING

EXHIBIT L-10
PIT 5 SURGE CHAMBER AND TUNNEL SECTIONS
PIT 3, 4 AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.

0 2 SCALE AS NOTED 4 8 IN

444418



PENSTOCK 4			
d_1 & R Section	R	Length	Dia
d_1	3/8"	83'-9 3/16"	108"
d_2		4'-0"	108"-120"
	Valve	3'-0"	120"
d_3	3/8"	4'-0"	120"-108"
d_4		86'-4 3/8"	108"
d_5	7/16"	65'-6 1/4"	
d_6	3/4"	64'-0"	
d_7	15/16"	56'-0"	96"
d_8	7/8"	56'-0"	
d_9	15/16"	16'-0"	
Taper	9/16"	5'-0"	96"-90"
d_{10}	3/4"	40'-7 1/2"	
d_{11}	9/16"	54'-4 3/8"	
d_{12}	1"	51'-9"	90"
d_{13}	1 1/16"	40'-7 1/2"	
d_{14}	1 1/8"	48'-9"	
d_{15}	1 3/16"	48'-0"	
d_{16}	1 1/4"	100'-4 3/8"	
Taper	1 7/16"	10'-0"	90"-102"
d_{17}		2'-0"	102"

PENSTOCK 2			
d_1 & R Section	R	Length	Dia
d_5	7/16"	65'-6 1/4"	
d_6	3/4"	56'-0"	
d_7	15/16"	56'-0"	96"
d_8	7/8"	56'-0"	
d_9	15/16"	24'-0"	
Taper	9/16"	5'-0"	96"-90"
d_{10}	3/4"	32'-6"	
d_{11}	9/16"	54'-5"	
d_{12}	1"	43'-7 1/8"	
d_{13}	1 1/16"	40'-7 1/2"	90"
d_{14}	1 1/8"	48'-9"	
d_{15}	1 3/16"	48'-0"	
d_{16}	1 1/4"	100'-3 1/8"	
Taper	1 7/16"	10'-0"	90"-102"
d_{17}		2'-0"	102"

PENSTOCK 1			
d_1 & R Section	R	Length	Dia
d_1	3/8"	83'-9 3/16"	108"
d_2		4'-0"	108"-120"
	Valve	3'-0"	120"
d_3	3/8"	4'-0"	120"-108"
d_4		86'-4 3/8"	108"
d_5	7/16"	63'-11 3/4"	
d_6	3/4"	56'-0"	
d_7	15/16"	56'-0"	96"
d_8	7/8"	56'-0"	
d_9	15/16"	16'-0"	
Taper	9/16"	5'-0"	96"-90"
d_{10}	3/4"	32'-6"	
d_{11}	9/16"	55'-3 3/16"	
d_{12}	1"	43'-7 1/8"	
d_{13}	1 1/16"	48'-9"	90"
d_{14}	1 1/8"	48'-9"	
d_{15}	1 3/16"	40'-0"	
d_{16}	1 1/4"	104'-11 3/8"	
Taper	1 7/16"	10'-0"	90"-102"
d_{17}		2'-0"	102"

This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970.

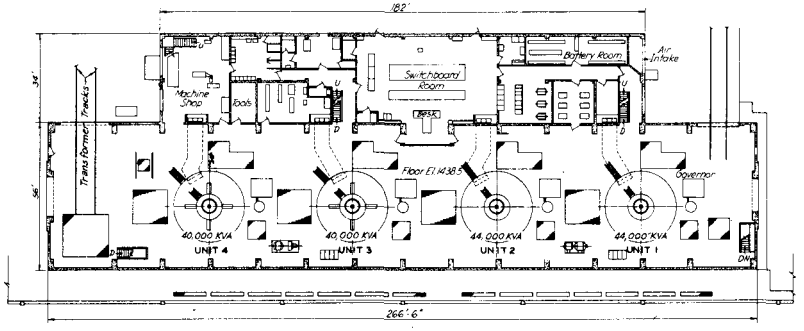
By D. D. Wallington
Vice President - Engineering

EXHIBIT L-11

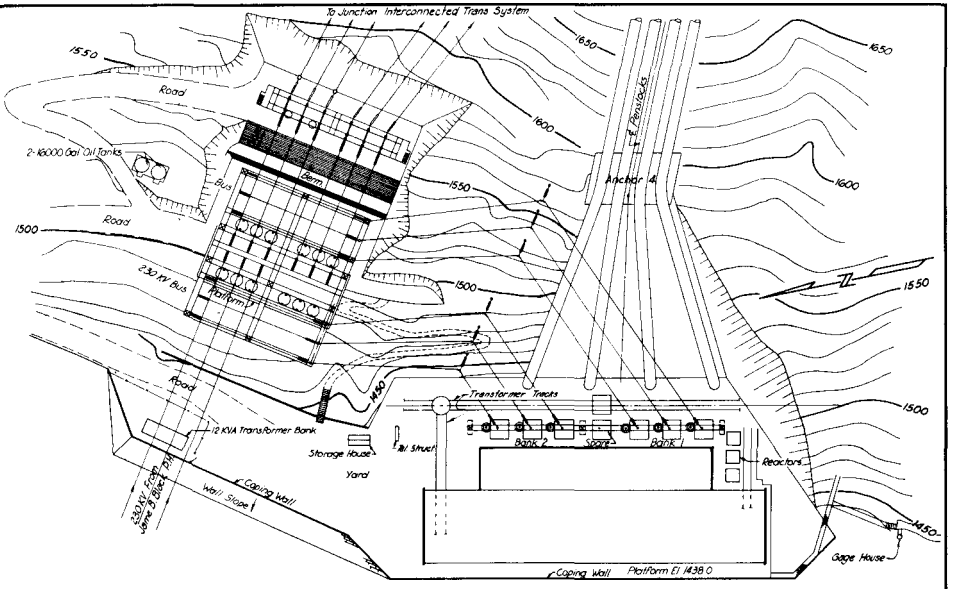
PIT 5 PROFILE OF PENSTOCKS
PIT 3, 4, AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.

SCALE AS NOTED 0 1/2 1 2 3 4 5 6 INCHES

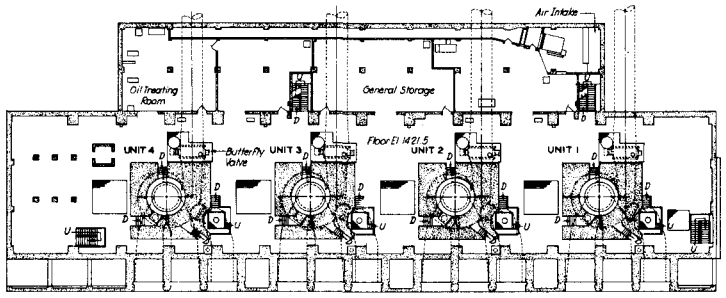
444419



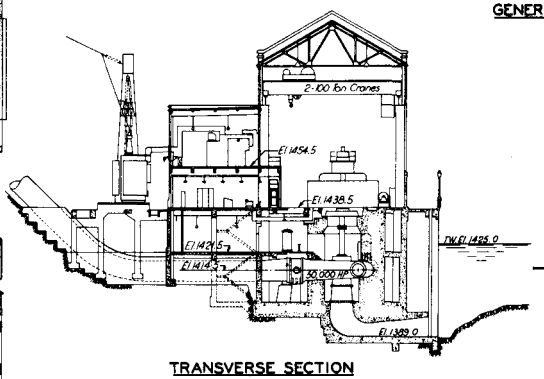
MAIN FLOOR PLAN
1" = 20'±



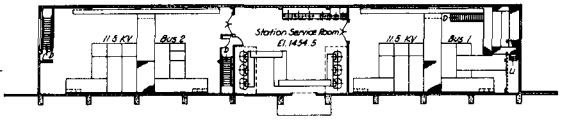
GENERAL ARRANGEMENT OUTDOORS
1" = 40'



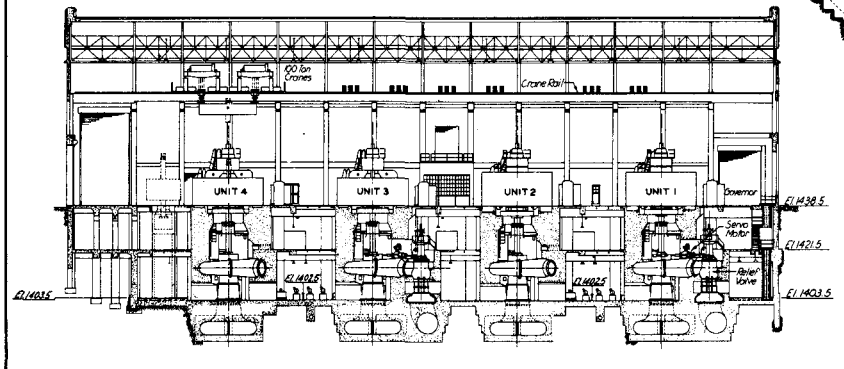
BASEMENT PLAN
1"-20'±



TRANSVERSE SECTION
1"-20'±



SECOND FLOOR PLAN
1"-20'±



LONGITUDINAL SECTION
1"-20'±

Elevations are on U.S.G.S. datum.

This drawing was made under my direction and is a part of the application for license made by Pacific Gas and Electric Company this 1st day of October, 1970

By J. D. Williams
VICE PRESIDENT - DIVISIONS

EXHIBIT L-12

PLAN AND SECTIONS PIT 5 POWER HOUSE
PIT 3, 4, AND 5 PROJECT
PACIFIC GAS AND ELECTRIC CO.

SCALE AS NOTED

444420