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THE EFFECT ON THE FISHERY OF THE NORTH FORK OF THE FEATHER RIVER,
CALIFORNIA, OF PROPOSED HYDRO-ELECTRIC DEVELOPMENTS WITH
SPECIAL REFERENCE TO CRESTA AND ROCK CREEK
PROJECTS

(Wales et al. 1952) By J. H. Wales and H. A. Hansen

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Revised July, 1951
Second revision June, 1952

F O R W A R D

It is the purpose of this report to show what effect a series of proposed hydro-electric power dams and diversions on the North Fork of the Feather River will have on fish and fishing in that stream. The development of hydro-electric power usually, if not invariably, alters stream conditions and profoundly affects natural fish life in the areas involved. At times altered water courses prove beneficial to fish populations, but in many cases the effect is detrimental.

Rock Creek Dam and Cresta Dam together with their conduits and power houses are under construction on the North Fork Feather River by the Pacific Gas and Electric Company as two major units in their series of seven proposed power units on the North Fork.

On the pages immediately following will be found the summary of important data and recommendations. The problem and investigation data are presented in Section I-IV and in Section V will be found an analysis of the problem.

The appendix section contains: 1/ a report by United States Fish & Wildlife Service, River Basin Section, entitled "A Report on Fish and Wildlife Resources in Relation to the Water Development Plan for the Proposed Feather River Basin, Rock Creek and Cresta Projects (Power Project No. 1962)" 2/ United States Forest Service Report on Feather River for Federal Power Commission--Project No. 1391; 3/ Tables 1,2,3; Maps 1 & 2 and Figures 1 & 2. and 4/ List of References.

SUMMARY OF IMPORTANT DATA

Distance or Length of Stream Altered

1. Miles of river altered by Rock Creek and Cresta projects--
16 miles.
2. Miles of river to be altered by all projects below Almanor--
56 miles.

Recreation Use

3. Number of commercial resorts affected by proposed power developments--11.
4. Number of Forest Service camps affected by proposed power developments--6.

Angling Use

5. Estimated number of angler days spent on North Fork in
1946--36,000.
6. Estimated as minimum number of trout caught from North Fork
in 1946--108,000.
7. Number of trout fingerlings from hatchery stock planted in
1945--143,800/
8. Number of resident anglers in Plumas County, 1942--2,353
1949--3,300.
9. Number of anglers fishing in Plumas County in 1942--14,750
1948--25,000
10. Calculated catch of trout in Plumas County in 1942--828,000
1948--720,000
11. Average (mean) river flow - 28 years at Big Bar, California
2,710 c.f.s.

Estimated
Catch

RECOMMENDATIONS

Exhibit 1.

Copy

March 25, 1947

Federal Power Commission
Washington, D. C.

Gentlemen:

On March 13, 1947 we wrote to you making certain recommendations for the release of water for fish life and recreational purposes in connection with the application of the Pacific Gas & Electric Co. for a water-power project (No. 1962) located on North Fork of the Feather River in Butte and Plumas Counties, California.

Subsequently, at our request, you granted an additional period to March 25, 1947 for the submission of additional recommendations. Discussion of the matter with the Pacific Gas & Electric Co. during this period has indicated that the following modified conditions with respect to fish life would be acceptable to them for inclusion in the terms of the license and they would also be satisfactory to us in lieu of the recommendation made in our letter of March 13, 1947. If the Commission therefore finds these present recommendations satisfactory for inclusion in the license our previous proposals can be disregarded.

It is our recommendation that the license for Project No. 1962 provide the following for the support of fish life and for recreation purposes on the North Fork Feather River,

A. 1. Immediately below Almanor Dam:

- (a) Provide a flow of not less than 35 c.f.s. during the summer period (May 1 to October 31).
- (b) Provide a flow of not less than 10 c.f.s. during the winter period (November 1 to April 30).

Note -- These flows will result in probably minimum flows immediately above Caribou power house of about 60 c.f.s. during the summer period and 40 c.f.s. during the winter period.

2. Immediately below Rock Creek diversion dam:

- (a) Provide a flow of not less than 100 c.f.s. during the summer period.
- (b) Provide a flow of not less than 50 c.f.s. during the winter period.
- (c) Summer flows to be reduced to not less than 50 c.f.s. on dry years.

Note -- Those flows will result in probable minimum summer flows above Bucks Creek power house of 125 c.f.s. except on dry years when they will reduce to about 75 c.f.s. above Bucks Creek plant. Bucks Creek plant would add about 200 c.f.s. during the summer period.

3. Below Cresta dam:

- (a) Provide a flow of not less than 50 c.f.s. at all times below the mouth of Grizzly Creek.
- B. Company will advance the sum of \$40,000 toward the construction of two "rough" fish barriers on the North Fork of Feather River if such are later found to be necessary; one to be located above the mouth of Yellow Creek and the other between Bucks Creek and the upper end of Cresta Diversion Reservoir. The necessity for either or both of these barriers shall be determined during the first ten years following the commencements of operation of Cresta project.
 - C. Company will provide electric fish screens at the intakes to the diversion tunnels for the Rock Creek and Cresta projects.
 - D. Company will design its structures for the release of the flows to be provided under "A" so that water will be taken from as near to the bottom of the reservoir as is practicable.
 - E. Company agrees to cooperate with the State Division of Water Resources and the Division of Fish and Game in the establishment of suitable criteria for the determination of dry years for the purpose of fixing summer water releases under Section A.
 - F. The Federal Power Commission to reserve the right to adjust said rates of flow in item A (2) and (3) if the Commission shall find after notice to interested parties and opportunity to be heard, that the rates of flow are more than necessary or insufficient for such purposes.

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Federal Power
Commission

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March 25, 1947

The Pacific Gas & Electric Co. has agreed that the preceding conditions and requirements will be satisfactory to them if they are made a part of the license for Project No. 1962.

Yours very truly,

EMIL J. N. OTT, JR.
Executive Director
California Division of Fish and Game

ACT:LG

V.

ORDER AUTHORIZING ISSUANCE OF LICENSE
(MAJOR)

Project No. 1962

Exhibit 2.
COPI

UNITED STATES OF AMERICA
FEDERAL POWER COMMISSION

Before Nelson Lee Smith, Chairman; Claude L. Draper, and
Commissioners: Harrington Wimberly.

June 17, 1947

In the matter of)
Pacific Gas and Electric Company) Project No. 1962

(1) On January 6, 1947 Pacific Gas and Electric Company, of San Francisco, California, filed an application for license under the Federal Power Act to authorize the construction, operation, and maintenance of proposed Rock Creek and Cresta hydro-electric developments, designated as Project No. 1962, on the North Fork of Feather River, in Butte and Plumas Counties, California, affecting lands of the United States within the Plumas and Lassen National Forests.

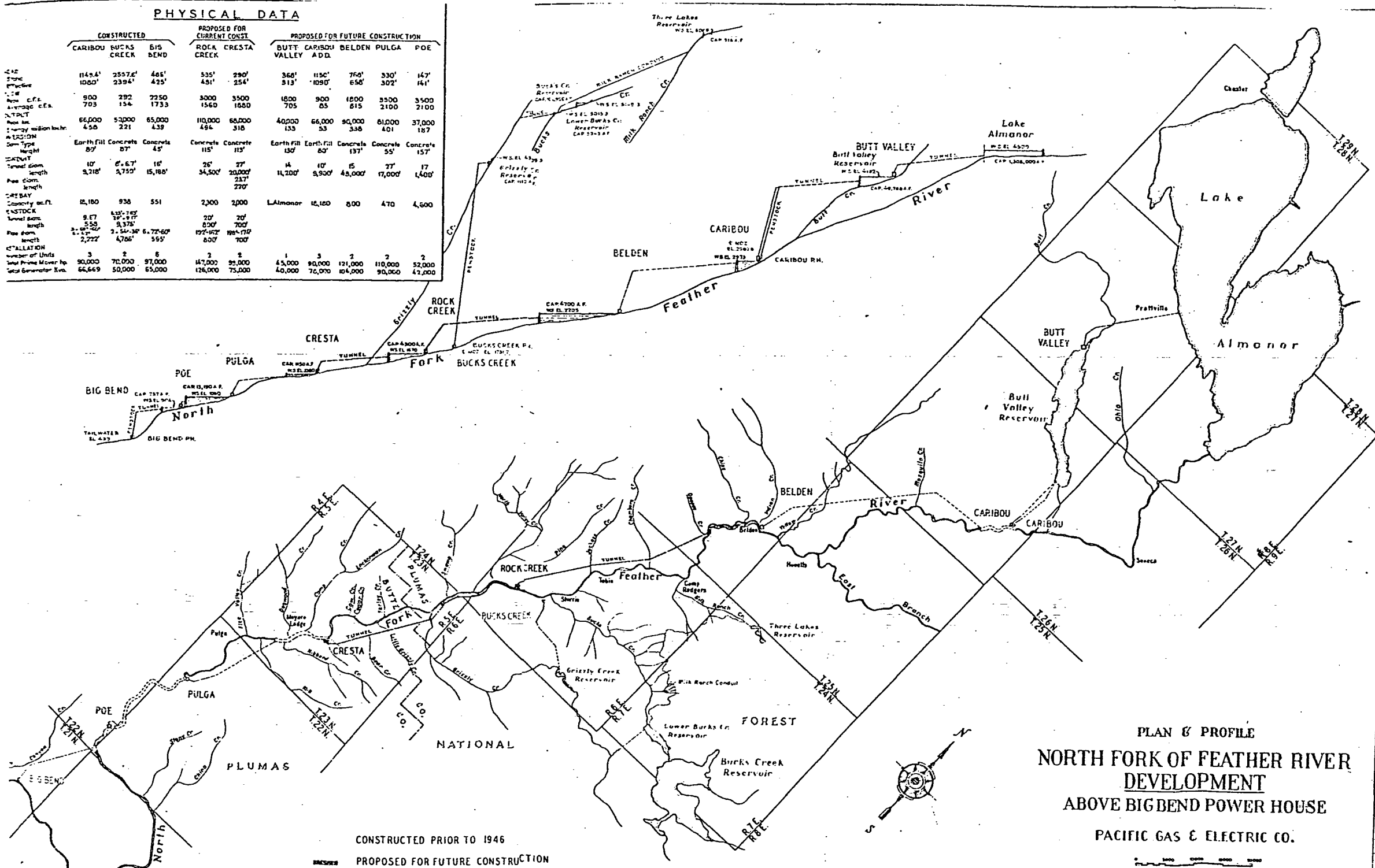
(2) The proposed developments comprise:

(a) The Rock Creek development consisting principally of a concrete gravity diversion dam about 115 feet high and about 550 feet long, creating a reservoir about 2 miles long with about 2300 acre-feet of storage; an intake structure; a pressure tunnel about 34,500 feet long; a penstock and surge chamber; a powerhouse containing two 73,500 horsepower vertical Francis turbines each direct-connected to a 63,000 Kva. generator; a substation; and two single-circuit 230-Kv. transmission lines each about 500 feet long, connecting to lines of or proposed for Project No. 737.

(b) The Cresta development consisting principally of a concrete gravity diversion dam about 113 feet high and about 360 feet long, creating a reservoir about 1 3/4 miles long with about 2000 acre-feet of storage; an intake structure; a pressure tunnel about 20,000 feet long; a penstock and surge chamber; a powerhouse containing two 46,500 horsepower vertical Francis turbines each direct-connected to a 37,500 Kva. generator; a substation; and

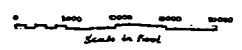
PHYSICAL DATA

	CONSTRUCTED			PROPOSED FOR CURRENT CONST.		PROPOSED FOR FUTURE CONSTRUCTION				
	CARIBOU	BUCKS CREEK	BIG BEND	ROCK CREEK	CRESTA	BUTT VALLEY	CARIBOU VALLEY ADD.	BELDEN	PULGA	POE
Canal	114,941	25,572	481	535	990	366	1150	760	330	147
Stone	10,000	23,941	425	431	254	313	1050	650	302	141
Concrete	900	292	2250	3000	3500	1800	900	1800	3500	3500
Area c.f.a.	703	154	1733	1560	1680	705	85	615	2100	2100
Output	66,000	53,000	65,000	110,000	68,000	40,000	66,000	90,000	81,000	37,000
Power in million kw-hr.	4.50	2.21	4.39	4.94	3.18	1.53	3.38	4.01	4.01	1.87
Excavation	Earth Fill	Concrete	Concrete	Concrete	Concrete	Earth Fill	Earth Fill	Concrete	Concrete	Concrete
Depth	80'	87'	45'	115'	115'	130'	80'	137'	55'	157'
Height	10'	6'-6 1/2'	16'	26'	27'	14'	10'	15'	27'	17'
Tunnel diam.	9,218'	9,750'	15,180'	34,500'	20,000'	11,200'	9,900'	48,000'	17,000'	1,400'
Flow diam.										
Length										
Cost \$	12,180	936	551	2,300	2,000	L. Almonor	12,120	800	470	4,500
Capacity ac-ft.	9.87	1.51-7.85	10'-9 1/2'	20'	20'					
Stock	558	8,378	700'	800'	700'					
Tunnel diam.	2'-0 1/2"	2'-5 1/2"	6'-7 1/2"	19'-10 1/2"	19'-11 1/2"					
Flow diam.	2'-2 1/2"	4,765'	555'	800'	700'					
Length										
Installation	3	2	6	2	2	1	3	2	2	2
Number of Units	30,000	70,000	97,000	147,000	95,000	45,000	90,000	121,000	110,000	52,000
Total Prime Mover hp.	64,669	50,000	65,000	126,000	75,000	40,000	76,000	104,000	90,000	42,000



PLAN & PROFILE
**NORTH FORK OF FEATHER RIVER
 DEVELOPMENT**
 ABOVE BIG BEND POWER HOUSE
 PACIFIC GAS & ELECTRIC CO.

CONSTRUCTED PRIOR TO 1946
 PROPOSED FOR FUTURE CONSTRUCTION



FEBRUARY 1947

NOTE: HYDRAULIC DEVELOPMENT, CRESTA CREEK DEVELOPMENT

two single-circuit 230-Kv. transmission lines each about 3,500 feet long, connecting to lines of or proposed for Project No. 737.

- (3) The applicant owns and operates the following existing projects within the North Fork drainage basin: the Caribou project, with 49,000 acre-feet of storage, licensed as Project No. 1352; the Bucks Creek plant with 106,000 acre-feet of storage, licensed as Project No. 619; the Big Bend power plant which is unlicensed, Lake Almanor reservoir licensed as Project No. 616, and transmission line Project No. 737, leading from the Bucks Creek plant. Lake Almanor reservoir, whose water storage benefits the Caribou and Big Bend plants, can conserve all of the water coming down from the drainage area above the outlet and is designed to be used for seasonal storage and for cyclic or long carry-over storage from one year to another although it is not now so used due to certain structural defects in the dam.
- (4) The Secretary of War and the Chief of Engineers have reported favorably on the application.
- (5) The Secretary of the Interior has been requested to report on the application.
- (6) The Assistant Secretary of Agriculture for the Secretary of Agriculture, who has supervision over the Plumas and Lassen National Forests, and the California Division of Fish and Game have each recommended that the license contain certain conditions for the protection and support of fish life. Since the conditions recommended are greatly at variance, provision is herein-after made whereby the Commission may hereafter prescribe reasonable conditions for the protection and support of fish life after consideration of the respective conditions of the Secretary of Agriculture, the Secretary of the Interior, and the State of California.

The Commission, having considered the application and the record thereon, finds that:

- (7) The applicant is a corporation organized under the laws of the State of California and has submitted satisfactory evidence of compliance with the requirements of all applicable State laws insofar as necessary to effect the purposes of a license for the project.
- (8) No conflicting application is before the Commission.

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- (9) Public notice has been given as required by the Act.
- (10) The issuance of a license for the project, as hereinafter provided, will not interfere or be inconsistent with the purposes for which the Plumas and Lassen National Forests were created or acquired.
- (11) The project will not affect any Government dam now in existence, nor will the issuance of a license therefor, as hereinafter provided, affect the development of any water power resources for public purposes which should be undertaken by the United States itself.
- (12) The project is best adapted to a comprehensive plan for the improvement and utilization of water power development and for other beneficial public uses, including recreational purposes.
- (13) For the purpose of determining annual charges, the horsepower capacity hereinafter authorized to be installed in the project is 147,000 horsepower at the Cresta plant, making a total installed capacity of 240,000 horsepower.
- (14) The amount of annual charges to be paid under the license for the purpose of reimbursing the United States for the costs of administration of Part I of the Act, and for recompensing the United States for the use, occupancy, and enjoyment of its lands, including transmission line right-of-way, is reasonable as hereinafter fixed and specified.
- (15) In accordance with Section 10(d) of the Act, the rate of return upon the net investment in the project and the proportion of surplus earnings to be paid into and held in amortization reserves are reasonable as hereinafter specified.
- (16) The following maps, plans, specifications, and statements filed as part of the application or subsequent thereto, conform to the Commission's rules and regulations, with the exception of Sheets A1 and A3 of Exhibit L, the approval of which should be deferred for further consideration of certain details:

- Exhibit J: Sheet A1 (401419) FPC No. 1962-1
- Exhibit K: Sheet A1 to A5 inclusive (401420-401424 inclusive) FPC Nos. 1962-17 to 21 inclusive
- Exhibit K: Sheet A6 (401425) FPC No. 1962-7
- Exhibit L: Sheet A1 (401426) FPC No. 1967-8
- Exhibit L: Sheet A2 (401427) FPC No. 1962-9
- Exhibit L: Sheet A3 (401428) FPC No. 1967-10
- Exhibit L: Sheets A4 to A9 inclusive (401429-401434 inclusive) FPC No. 1962-11 to 16 inclusive
- Exhibit M: Pages 1 to 3 inclusive

It is ordered that:

- (17) A major license be issued for a period of 35 years, effective as of the first day of the month in which it is executed, to Pacific Gas and Electric Company for the construction, operation, and maintenance of the proposed Rock Creek and Cresta developments, subject to the provisions of the Federal Power Act, and the rules and regulations thereunder, said license to contain the usual conditions and provisions for licenses issued under Section 4 (e) of the Act for such projects and the following special conditions:
 - (a) The licensee shall make such reasonable provisions for the protection and support of fish life and the recreational resources of the North Fork of Feather River as the Commission may hereafter prescribe after consideration of the recommendations of the Secretary of Agriculture, the Secretary of the Interior, and the State of California.
 - (b) The licensee shall begin construction of Cresta development not later than December 31, 1947, and shall complete the same not later than July 1, 1950; shall begin construction of the Rock Creek development not later than July 1, 1948, and shall complete the same not later than July 1, 1951.
- (18) After the first 20 years of operation of the project under this license, six (6) percent per annum shall be the specified rate of return on the net investment in the project for determining surplus earnings in accordance with the provisions of Section 10 (d) of the Act for the establishment and maintenance of amortization reserves to be held until termination of the license, or in the discretion of the Commission, to be applied from time to

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time in reduction of the net investment in the project, and one-half of all surplus earnings in excess of six (6) percent per annum received in any calendar year shall be put into and held in such amortization reserves.

- (19) Subject to the provisions of Section 10 (e) of the Act and the rules and regulations of the Commission thereunder, the licensee shall, effective as of the date of the license, pay to the United States the following annual charges:

(a) For the purpose of reimbursing the United States for the costs of administration of Part I of the Act, one (1) cent per horsepower on the horsepower capacity authorized to be installed by this license (240,000 horsepower), plus two and one-half (2½) cents per 1,000 kilowatt-hours of gross energy generated by the project during the fiscal year ended June 30 of the calendar year for which the charge is made. A statement of the number of kilowatt-hours generated in both power plants during the said fiscal year, certified under oath, shall be filed with the Commission on or before September 1 following the end of said fiscal year;

(b) For the purpose of recompensing the United States for the use, occupancy, and enjoyment of its lands, exclusive of those used for transmission line right-of-way, \$474.00;

(c) For the purpose of recompensing the United States for the use, occupancy, and enjoyment of its lands for transmission line right-of-way, \$10.64;

- (20) The maps, plans, specifications, and statements referred to in paragraph (16) above as conforming to the Commission's rules and regulations are hereby approved for incorporation in the license, but approval of Sheets #1 and A3 of Exhibit L is hereby deferred.

By the Commission.

Leon M. Fuquay,
Secretary.

Date of Issuance: June 17, 1947

ORDER AUTHORIZING AMENDMENT OF
ARTICLE 13 OF LICENSE (MAJOR)

Project No. 1962

Exhibit No. 3

COPY

UNITED STATES OF AMERICA
FEDERAL POWER COMMISSION

Before Nelson Lee Smith, Chairman; Thomas C. Buchanan, Claude L.
Commissioners: Draper, Mon C. Wallgren and Harrington Wimberly.

February 14, 1950

In the Matter of)
Pacific Gas and Electric Company) Project No. 1962

Article 13 of Pacific Gas and Electric Company's license for Project No. 1962 consisting of the Rock Creek and Cresta developments on the North Fork of Feather River, California, provides that the licensee shall make such reasonable provisions for the protection and support of fish life and the recreational resources of the North Fork of Feather River as the Commission may hereafter prescribe after consideration of the recommendations of the Secretary of Agriculture, the Secretary of the Interior, and the State of California.

The Division of Fish and Game, State of California, has submitted certain provisions, hereinafter set forth, for inclusion in the license for Project No. 1962 for the support of fish life and for recreational purposes. The licensee, the Secretary of Agriculture, and the Secretary of the Interior as hereinafter provided, has each advised this Commission that the provisions proposed by the State fish and game agency are satisfactory.

The Commission orders:

Article 13 of the license for Pacific Gas and Electric Company's Project No. 1962 be amended to read as follows:

Article 13: For the protection and support of fish life and the recreational resources of the North Fork of Feather River:

A. The Licensee shall provide -

1- Immediately below Almanor Dam:

a flow of not less than 35 c.f.s. from May 1 to October 31 and a flow of not less than 10 c.f.s. from November 1 to April 30;

2- Immediately below Rock Creek Diversion Dam:

a flow of not less than 100 c.f.s. from May 1 to October 31, which flow may be reduced to

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not less than 50 c.f.s. in dry years;
and a flow of not less than 50 c.f.s.
from November 1 to April 30;

3- Below Cresta Dam:

a flow of not less than 50 c.f.s. at
all times below the mouth of Grizzly
Creek;

- B. The Licensee shall design its structures for the re-lease of the flows, provided in "A" above, so that the water will be taken from as near to the bottom of the reservoir as is practicable and suitable criteria for the determination of dry years for the purpose of fixing the May 1 to October 31 water releases provided in "A" above shall be established by the Commission.
- C. The Commission reserves the right to adjust said rates of flow in items A(2) and A(3), above, if it shall find, after notice to interested parties and opportunity to be heard, that the rates of flow are more than necessary or insufficient for such purposes.
- D. The Licensee shall provide electric fish screens at the intakes to the diversion tunnels for the Rock Creek and Cresta projects if such be found by the Commission to be justifiable;
- E. The Licensee shall advance the sum of \$40,000 toward the construction of two "rough" fish barriers on North Fork of Feather River if such are later found to be necessary: one to be located above the mouth of Yellow Creek and the other between Bucks Creek and the upper end of Cresta Diversion Reservoir. The necessity for either or both of these barriers shall be determined during the first ten years following the commencement of operation of Cresta project.
- F. The entire project area shall be open to free public access for fishing and other recreational uses, except such portions as may be reserved by the Licensee in the interest of safety, efficient operation and protection of property.

By the Commission.

Leon M. Fuquay,
Secretary.

Date of Issuance: February 15, 1950

THE EFFECT ON THE FISHERY
OF THE NORTH FORK OF THE
FEATHER RIVER, CALIFORNIA,
OF PROPOSED HYDRO-ELECTRIC
DEVELOPMENTS WITH SPECIAL REFERENCE
TO CRESTA AND ROCK CREEK PROJECTS

I. INTRODUCTION

A plan for development of hydro-electric power from run-off water in the North Fork of the Feather River has been considered by the Pacific Gas and Electric Company for many years. The first of the series of dams contemplated was built in 1912 at the lower end of Big Meadows near Prattville. It impounds a reservoir of water which has since been known as Lake Almanor. Water from Lake Almanor, is diverted through a tunnel to Butt Valley reservoir, which in turn forms the forebay of the hydro-electric power plant at Caribou power house. Water from Lake Almanor is thus diverted by tunnel to Butt Valley reservoir and thence through conduit and penstock to Caribou power house where it is again released into the stream bed of the North Fork about 10 miles below Lake Almanor dam. Water released through Caribou power house then flows unimpeded down the North Fork channel for a distance of 35 miles to Big Bend diversion dam. This dam is located at the upstream end of "The Big Bend" of the North Fork of the Feather River and its purpose is to divert water through a tunnel conduit and penstocks to the Big Bend power house about 11 miles downstream.

The two sections of the stream which have a very much reduced flow at the present time are, the portion from Almanor dam to the Caribou power house and the portion from the Big Bend dam to the Big Bend power house, a total distance of approximately 21 miles. This is roughly 33 percent of the river from Almanor dam to the mouth of the North Fork.

The Pacific Gas and Electric Company is contemplating immediate construction of two new units in their North Fork power development plan. These are Rock Creek and the Cresta projects (see Map #1 and Table #1, of distances, pp. 20-21.) These two projects will reduce the quantity of water in the stream to a fraction of the natural flow for several miles below each diversion dam. Rock Creek power house will be located approximately seven miles below Rock Creek dam and Cresta power house will be about four miles below its diversion dam. The sections of stream between the diversion dams and the power houses could very well become dry during part of the year. Thus, about eleven miles of the stream will, upon completion of the two new units, be altered by having the flow reduced for several months of the year.

With ultimate development of the company's plan for power generation the entire North Fork from the Almanor dam to the Big Bend power house, a distance of about fifty-six miles will be altered. Approximately forty-four and one-half miles of the stream channel may be dry at certain seasons of the year and roughly eleven and one-half miles will be covered by deep pools formed by the dams.

Along the banks of the North Fork for most of its length runs Highway 24, the "Feather River Highway", and the main line of the Western Pacific Railroad. Each offers to the traveling public, an opportunity to vacation in an area of excellent trout fishing. It is less than an hour's drive along the highway for early morning and late afternoon trout anglers from Oroville, Quincy, and other nearby towns who, for various reasons, cannot leave their duties for more extended vacation periods.

At the present time there are game fish in abundance (rainbow and brown trout) in the North Fork in the section to be altered by proposed developments. Several species of rough fish are also inhabitants of the stream.

II. THE PRESENT BIOLOGICAL PICTURE

The North Fork Feather is, at present, a partially regulated river flowing at the rate of around 1,500 cubic feet per second but with great fluctuation in times of spring runoff and floods. United States Geological Survey records show the average discharge of the stream at Big Bar gaging station to be 2,710 c.f.s. for the period from 1911 to 1944. The maximum rate for the period was 66,900 c.f.s. which occurred on December 11, 1937. The minimum recorded (regulated) flow of 235 c.f.s. occurred on October 31, 1932. Fig. 1, p.22 ; Table 2, p.23 shows the mean monthly flow from 1926 to 1944 inclusive.

The stream gradient between Big Bend dam and Belden is approximately 43 feet per mile. This is the section in which the two power developments, Cresta and Rock Creek, are proposed for immediate construction, and where two others, Poe and Pulga are planned for future development. North Fork Feather above Belden has a somewhat steeper gradient in the section from Rock Creek forebay at Belden to the proposed Belden diversion dam eight miles farther upstream. The only reservoir or "slack water" at present in the stream above Intake dam is the forebay of Big Bend powerhouse. This relatively small pool is formed by the Big Bend diversion Dam.

Fishes Present

The species of fishes present in the North Fork Feather at the present time are:

1. rainbow trout
2. brown trout
3. black bass (large & small mouth)
4. suckers
5. squawfish (Sacramento pike)

6. hardheads (also called pike)
7. carp
8. bullheads (cottoids)
9. dace

In order of importance rainbow trout ranks first and brown trout second as species most anglers prefer. Black bass are not common and are, therefore, not considered important by anglers at the present time. Rough fishes are considered by some anglers as more or less of a nuisance because they are common in the stream and are caught on trout tackle. Rough fishes are seldom utilized for food. A natural balance exists at the present time between trout and rough fish populations and the less desirable species are not considered too harmful to trout. If, however, stream flow is greatly reduced for several miles of river the natural balance becomes upset and competition between species may cause the trout to disappear from the stream. Rough fish have a greater tolerance for the type of stream formed by low flow, i.e. low velocities, high temperatures, and less amounts of dissolved oxygen.

Spawning Time

With the present stream flow in the North Fork, natural propagation of trout is providing anglers with an important part of the catch in their creels and the stream is considered a very good one in terms of spawning areas and food production. Trout spawn during the winter and spring. Brown trout lay their eggs in the gravel in October, November, and December, and rainbow trout from December to May. This is the period normally of low temperatures and high stream flow. The fry and fingerlings emerge from the gravel during the spring and begin feeding at a time when stream food organisms are in greatest abundance.

III. THE FUTURE BIOLOGICAL PICTURE

When the two power projects, Cresta and Rock Creek, proposed for immediate construction are built and when the complete plan for power development on the North Fork is ultimately developed, ^{Map #2} Figs. , pp. 24 , the biological "picture" will be very different from the present. The stream sections between each of the diversions and its corresponding powerhouse will have only a fraction amount as compared with the amount of the present quantity of water. This will mean that those sections will have water with less velocity, higher temperature, and lower oxygen content during a large portion of the year. Such conditions are inevitable results of reduced flow.

The reservoirs formed by the diversion dams will form long narrow pools. Cresta reservoir will be over three miles long and Rock Creek over two. Their widths will be about 600-700 feet. The surface layers of the reservoirs will have higher temperatures than those prevailing in the present stream. The deeper layers should have cooler water.

Fish populations will change markedly. Trout will no longer be able to use, for reproduction, the sections of stream occupied by reservoirs and therefore, a large per cent of the trout spawning areas will be automatically exterminated. Furthermore, the reservoirs will provide a much better environment for the development of most of the rough fish. For example: hardheads (Mylopharodon) are "pool" fish and develop most rapidly in large deep natural pools. Under present conditions the balance between pools and fast flowing riffles is such as to keep the population of hardheads down to competition levels with trout. When that balance is upset by

formation of several large pools connected by shallow, slow-flowing warm water riffles, the competition between trout and hardheads becomes one-sided with overwhelming odds favoring the development of hardheads and the extermination of trout. This serious situation has developed in Shasta reservoir.

IV. WATER RELEASES

In view of the increased temperatures which will accompany reduced stream flow below each diversion dam on the North Fork, it becomes necessary that releases from each impoundment be drawn from the coolest water possible if trout fishing is to be maintained in the stream. The coolest water is at the bottom of the reservoirs and, therefore, outlets for water release should be near the bottom of the dam. Water for minimum release should not be supplied from skimmer gates, weirs or spillway overflow, because the temperature of the surface water layers will, in all probability, be too high for trout to tolerate. The optimum temperature for trout growth is about 60°F. Rainbow trout can tolerate higher temperatures for short periods. Records as high as 80°F. have been taken where rainbow trout were living but such temperature is very near the limit of tolerance for the species. (Needham, 1938).

In a study of the fishes of the Willamette River System in Oregon in 1944* it was observed that no salmonoid fish was found in water of 73°F. or above but "rainbow trout, cut throat trout, and fingerling chinook salmon in healthy condition were obtained near Peoria Ferry in water of 72°F. on August 29". It was further stated, however, that "in the majority of cases, cut throat trout, rainbow trout and chinook salmon were observed and collected during August and September in waters having a temperature range of 55 to 66°F. They were always less numerous in water ranging from 67 to 72°F." (underscoring added)

* "The Fishes of the Willamette River System in Relation to Pollution" by R. E. Dimick and Fred Merryfield, Bulletin Series No. 20, June, 1945; Engineering Experiment Station, Oregon State College, Corvallis, Oregon.

trout vs
water temp
ref.

It is difficult to predict what the surface temperatures of proposed impoundments on the North Fork will be, but it is known that Lake Almanor on the North Fork has surface water temperatures approaching 80°F. and Shasta reservoir records show temperatures of 90°F. It seems reasonable to assume that the North Fork reservoirs which will lie between these two elevations will have temperatures at the surface between 80° and 90°F.

It is likewise difficult to predict what the stream temperatures below the diversion dams will be. An estimate of what might be expected when the flow below the dams is reduced may be made by comparison with a stream having the same quantity of flow. Deer Creek, a tributary entering the Sacramento River near Vina, is a stream with a flow of about 100 c.f.s. in summer. That is the approximate amount to be expected below each of the diversion dams on the North Fork. Water temperature in Deer Creek rises in late summer 7 to 9°F. while the water travels from the Deer Creek Irrigation Diversion Dam to the Stanford-Vina diversion dam, about six miles below. Thus, if 100 c.f.s. of water is released from Rock Creek or Cresta diversion dams, at about 70°F. the stream will become unsuitable for trout a few miles below. It is, however, anticipated that water in the deeper portions of the reservoirs will be cooler than 70°F. and, therefore, the stream should provide suitable environment for trout for most of the distance between diversion dams.

V. EVALUATION OF THE TROUT FISHING

Destruction of trout fishing streams in California by removal of water for power, irrigation and other purposes is proceeding at an accelerated pace. Certain of these streams are particularly important. Their trout-carrying capacity may be especially high, they may be located in especially beautiful surroundings or they may be easily accessible to many thousands of people. Only a few rivers in California have all of these advantages. Of these few, the North Fork of the Feather is an outstanding example.

Map No. 2 with its insert map shows the central location of the Feather River. The map also shows the famous Feather River Highway and the Feather River Route of the Western Pacific Railroad. (See page 24).

Not only is the North Fork canyon a particularly favorable route through the mountain range but it is an ideally located recreation ground. At present the Feather River canyon is inadequately supplied with resorts and public camp grounds. If fishing could be maintained, construction of additional facilities could be expected which would make the North Fork of the Feather even more popular than it is at present.

Commercial resorts on the North Fork within the area to be affected by the proposed power developments (Almanor dam to the mouth of the North Fork) are listed below:

1. Belden
2. Yellow Creek Inn
3. Guy's Place
4. Tobin

Commercial Resorts on the East Branch of the North Fork are:

1. Keddie
2. Rainbow's End
3. Feather River Hot Springs

4. Twain
5. Grays Flat (Mill, Store, P.O.)
6. Pine Aire Motel
7. Jack's Place at Virgilia

Following are listed the United States Forest Service Campgrounds on the North Fork:

- | | |
|-----------------------|------------------------------------|
| 1. Queen Lily | 13 camp facilities |
| 2. North Fork | 23 camp facilities |
| 3. Belden Public Camp | 23 camp facilities |
| 4. Indian Jim | 12 camp facilities |
| 5. Gansner Bar | Intended to become a trailer camp. |
| 6. Hallstead Flat | (on E. Branch)-25 camp facilities |

An attempt has been made to determine the number of anglers who used the resorts and campgrounds listed above. Estimates were also made of the number of anglers from nearby cities who fished the North Fork and also the number of fishermen among the local residents. These figures and estimates are almost certainly below the actual numbers.

The Belden Resort at Belden estimates that the guests of the resort spent approximately 3,000 angler days on the river and on its few tributaries. The Belden Resort is the largest resort on the North Fork within the area to be affected by the power developments.

Col. J. W. McCrellis, owner of the Belden Resort, also estimated that the Yellow Creek Inn, Guy's Place, and Tobin's combined had about the same patronage as that of the Belden resort. We, therefore, assume from these resorts another 3,000 angler days for 1946.

In addition to these, on the North Fork within the area being considered, there are seven resorts on the East Branch of the North Fork (see the list above and also the accompanying maps). The guests at these resorts spend part of their angling effort on the North Fork proper. A conservative estimate

of this time would be 2,500 angler days.

U. S. Forest Service Campgrounds

The Plumas Forest Headquarters at Quincy estimated that during the 1946 season 8,500 campers used the six campgrounds in the North Fork Feather River canyon. The average stay was 5 days per person or 42,500 man days. Roughly 50% of the campers were anglers though these anglers probably did not fish each day. It would be conservative to say that 20,000 angler days were expended by the fishermen in this group.

U. S. Forest Service Picnic Grounds

The Plumas Forest Headquarters at Quincy estimated that during 1946 2,500 picnickers used the picnic facilities in the North Fork Feather River canyon. Possibly one-third of the picnickers were also fishermen, making about 800 angler days.

Residents of Nearby Towns

Between six and seven thousand people live in the cities of Oroville and Quincy which lie at either end of the Feather River area. It is only a 45-minute drive from either Oroville or Quincy to the most productive sections of the North Fork. The number of anglers who drive to the river and back again the same day cannot be accurately estimated but 3,000 angler days is probably very conservative. It was estimated that on May 1, 1946 2,000 anglers fished the North Fork.

Residents of the North Fork Feather River Canyon

It was estimated by J. W. McCrillis of the Belden resort and by the Forest Service in Quincy that between 600 and 700 people make their homes in the canyon for a large part of the year. Probably 150 of these fish

the river frequently, accounting for roughly 4,000 angler days.

TABLE NO. 2 - SUMMARY OF ANGLING INTENSITY

<u>Category of Anglers</u>	<u>Angler Days Expended</u>
Visitors to Commercial Resorts	8,500
Visitors to Forest Service Camp Grounds	20,000
Picnickers at Forest Service Picnic Grounds	800
Residents of Nearby Towns	3,000
Residents of Feather River Canyon	4,000
Total Angler Days	<u>36,300</u>

Angling Values

For the purpose of this report it would be desirable to place a monetary value on the estimated 36,000 angler days spent on the North Fork or upon the estimated 108,000 trout caught.* Unfortunately this type of calculation is one of the most complex.

There are two distinctly different matters to consider in such an evaluation:

1. Fishing as a business stimulant.
2. Fishing as a psychological stimulant.

Obviously the first can be assigned monetary values even though no two persons will agree. Fishing as a psychological stimulant is well recognized, but no one has ever been able to place a satisfactory value upon it.

* Estimated 3 trout per angler day.

The effect of trout fishing in the North Fork upon business can be divided into two parts:

1. Increased business relating to travel.
 - a. Increased automobile, stage or railroad business.
 - b. Increased food and lodging expenses.
 - c. Increased expenditures for luxuries.
2. Increased sales of angling paraphernalia.

The tangible benefit of this business increase is largely local but ramifies into a much greater zone.

Naturally we cannot take the entire living costs and fishing gear costs of the average fisherman on the North Fork and multiply that by the number of anglers involved anymore than one can take the monetary value of the electricity produced at the North Fork powerhouse without making complex modifications.

The hydro-electricity produced on the North Fork will have a definite value to the company producing it but it would make little difference to the consumers whether it was generated on some other river or by a steam turbine located nearer the area of use. Similarly, if there were no trout fishing on the Feather River, the anglers and vacationists might go to the ocean or any one of many places for their fishing and recreation.

The power company or the local chamber of commerce can assign values to electricity and to fishing. Such values may appear quite real to those doing the figuring, but they cannot bear up under critical analysis.

Presuming that there were roughly 36,000 angler days spent on the North Fork in 1946, if fishing on this river were ruined by power developments, could the State multiply 36,000 by the \$2.00 angling fee and say

that it had lost \$72,000 in 1946? Obviously this would be a gross exaggeration for most of these anglers would simply go elsewhere to fish. They would still buy their angling licenses and instead of patronizing the local business houses and resorts they would spend their money elsewhere in the State.

Similarly if the proposed power developments on the North Fork of the Feather were ruled out the same electricity could and would be generated elsewhere. It might work an appreciable hardship on the power company but similarly an appreciable hardship would be worked on those seeking recreation if the North Fork were even partially ruined for trout fishing.

In conclusion, we claim that it is impossible to compare the money involved when hydro-electricity is not generated on a river with the money involved when fishing is impossible on that river.

If we rule out the comparison of monetary values we have left some interesting but highly theoretical considerations.

With a nation of people suffering from nervous disorders, and the suffering is becoming increasingly acute, could it not be said that the recreational value of fishing is just as important as increased business through cheap power.

Relaxation through trout fishing is widely recognized as being an important remedy for the nervous strain of modern life. However, this relaxation might be obtained in other ways if the North Fork Feather were ruined by complete utilization of the water for electricity.

How often is it said that the relaxation and the sport of trout fishing and the beauties of these mountain streams need not be ruined by power developments, that this same electricity can be generated at only slightly

greater cost in steam turbines?

We recognize hydro-electrical developments as part of our modern business world, we would not contend that they should be abandoned simply to provide more fishing but we do strongly believe that power developments should not be allowed to completely ruin even one stream or river. It is our contention that there is room for both power development and trout fishing in the waters of California.

Although the immediate power development program calls for only two plants (Cresta and Rock Creek) the plan for five new power houses on the North Fork has been submitted. The present evaluation of trout fishing on this river would be incomplete if it were to consider the Cresta and Rock Creek developments alone. In asking for protection to the fish and fishing we must recognize that it will be but a short time until the remaining three developments are undertaken.

At present the entire sixty-two and one-half mile section of the North Fork, from Almanor Dam to its mouth is trout fishing water. When all five power plants have been installed the normal flow of this section will be altered as follows:

TABLE 3

	<u>Miles</u>	<u>Percent</u>
River below diversion dams containing only controlled water	44.5	73%
Impoundments	11.5	18%
"Normal" river flow	6.5	9%
Total	<u>62.5</u>	<u>100%</u>

Assuming that the release water flow below the proposed diversion dams (Belden, Rock Creek, Cresta, Pulga, and Poe) were similar to the present

release from the Almanor Dam (minimum 3.2 c.f.s. in 1944), how seriously will this effect the value of the present trout fishery and the potential fishery?

Due to the highly accessible location of the North Fork it would be inevitable that without power development it would eventually become one of the most heavily fished trout streams in California. The recreational value of this canyon would rank well up among similar areas in the State. The beauties of the Feather River Route have been publicized throughout the nation by the Western Pacific Railroad. To a very large extent this reputation is due to the beauty of the river itself. As the normal flow of the river is reduced its beauty and its trout carrying capacity will be reduced. The greater the flow of water, the greater the number of trout it will support. If the release from these proposed diversion dams has the same minimum as that from Almanor dam, the Feather River will be reduced to a series of ponds with an unimportant trickle of water between them. The minimum flow from Almanor dam, at present 3.2 c.f.s., would constitute a modest brook in surroundings proportional to that flow, but when spread out over the broad, boulder-strewn bed of the North Fork it is scarcely worth consideration. A river canyon formed to carry an average of about 2,710 c.f.s. is barely wet when carrying only 3.2 c.f.s. or even several times that amount.

In the published "1946 Annual Traffic Count" by G. T. McCoy, State Highway Engineer, it will be seen that at Belden Junction-Highway 21-A, the east bound traffic was as follows:

	<u>1945</u>		<u>1946</u>
July 15	- 487 cars	July 14	- 891 cars
July 16	- 373 cars	July 15	- 581 cars

Sunday gain of 1946 over 1945 - 87.80%

Monday gain of 1946 over 1945 - 73.39%

The normal year-by-year increase in traffic over the Feather River highway would bring a several-fold increase in the angling pressure if the trout catch would increase proportionally. To meet this increased pressure and provide the increased catch would require heavy additional planting of artificially reared trout. However, fish cannot be planted beyond the point where the volume of water and its fish food supply will permit. Regardless of fish planting a small flow of water will only support a small number of fish. The future of this river depends upon the amount of water released through the diversion dams.

It will be stated that the ponds formed by the diversion dams will produce more fishing than the "normal" river would produce. We believe that this would not be the case. In fact the impoundments might be less productive, mile for mile because in summer the surface temperatures may be too high for trout. Such high temperatures can be expected to encourage the rough fish which will feed upon both the small trout and the trout's food.

The foregoing statements should not be taken to mean that we favor the abandonment of the proposed power developments on this river. It is assumed by all that hydro-electric power plants are a necessary part of our business development but it is also assumed that there must be a compromise

between the power companies and the fishermen. How much water can the power company afford to release below its diversion dams on the North Fork? How much trout fishing can the people of the State afford to have them destroy?

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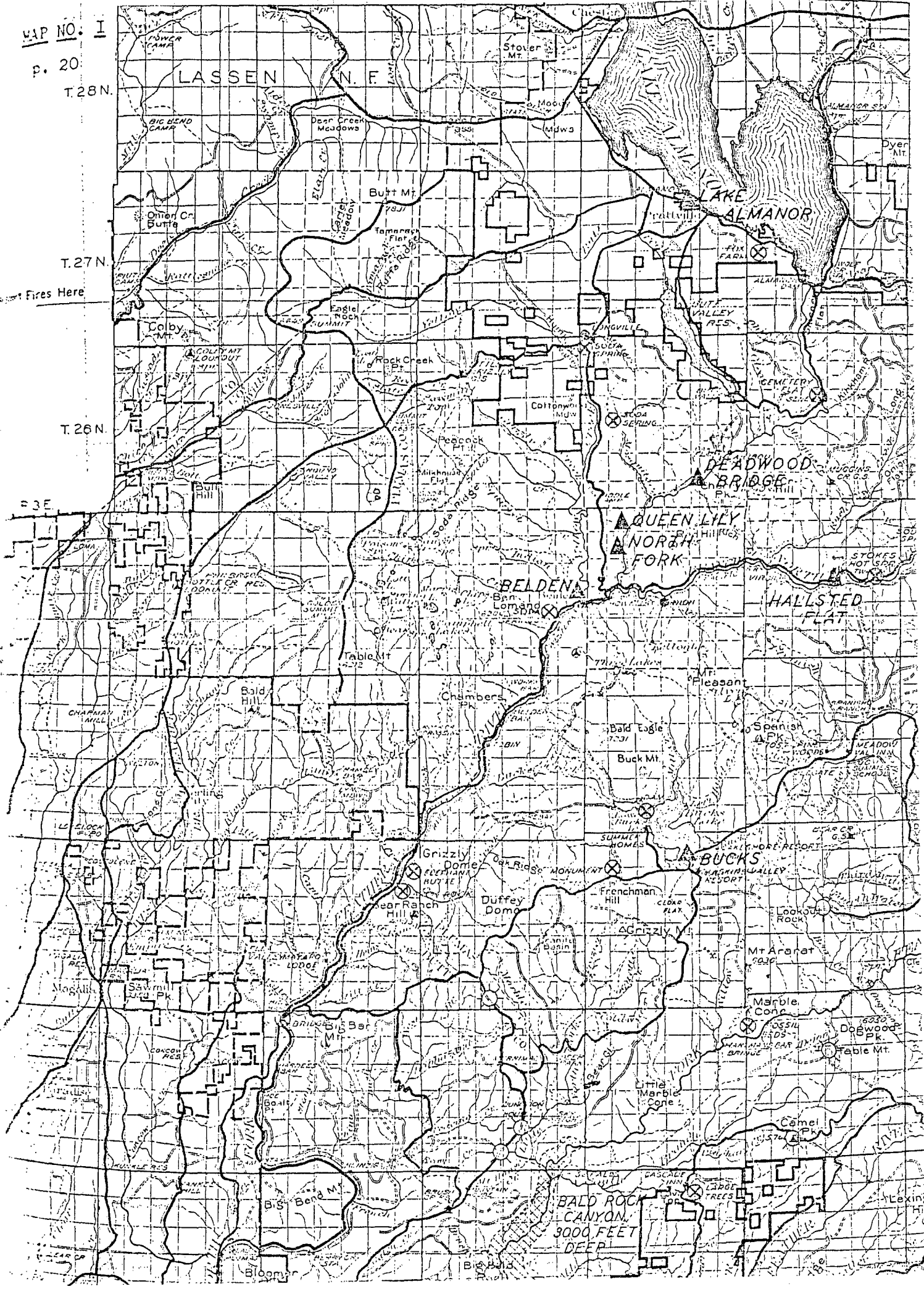


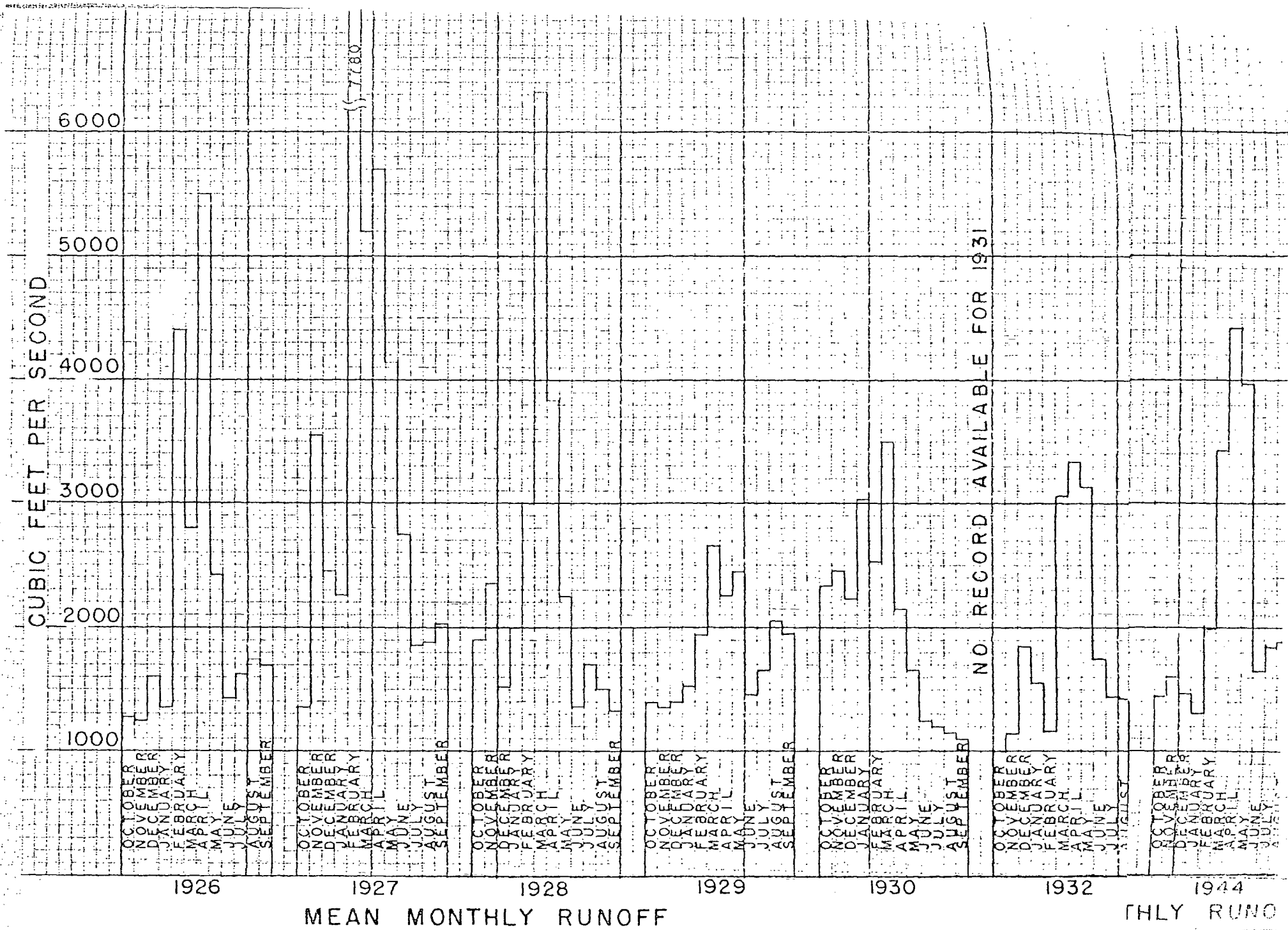
TABLE NO. I
NORTH FORK FEATHER RIVER

Breakdown of Distances Between
Existing and Proposed Power Developments

MILESTONES	LOCATION	MILES	FUTURE WATER CONDITIONS
0	Almanor dam	0	
10.0	Caribou power house	10	Control Flow
10.0	Head of Belden reservoir	0	
11.0	Belden diversion dam	1	Reservoir
19.0	Belden power house site	8	Control Flow
19.0	Head of Rock Creek reservoir	0	
21.0	Rock Creek Diversion dam	2	Reservoir
28.0	Rock Creek power house site	7	Control Flow
28.0	Head of Cresta reservoir	0	
31.0	Cresta diversion dam	3	Reservoir
35.0	Cresta power house site	4	Control Flow
35.0	Head of Pulga reservoir	0	
36.5	Pulga diversion dam	1.5	Reservoir
40.5	Pulga power house site	5	Control Flow
43.5	Poe diversion dam	3	Reservoir
44.0	Poe power house	.5	Control Flow
45.0	Big Bend diversion dam	11	Reservoir
56.0	Big Bend power house	11	Control Flow
62.5	Mouth of North Fork Feather	6.5	Normal river flow
	TOTAL	<u>62.5</u>	

SUMMARY OF RIVER TYPES BETWEEN
ALMANOR DAM AND MOUTH OF NORTH FORK

Control flow below diversion dams	44.5	73%
Reservoir water	11.5	18%
Normal river flow	6.5	9%
TOTAL	<u>62.5 miles</u>	



MEAN MONTHLY RUNOFF

MONTHLY RUNOFF

TABLE NO. 2

MEAN MONTHLY DISCHARGES IN CUBIC FEET PER SECOND
 NORTH FORK FEATHER RIVER, BIG BAR, CALIFORNIA

	1926	1929	1930	1932	1933	1934	1936	1937	1940	1941	1942	1943	1944
October	1270	1390	2340	1000	479	1400	1498	1572	1233	2063	1515	2039	1446
November	1260	1370	2470	1140	572	1410	1298	1155	958	1758	1682	2125	1604
December	1600	1400	2220	1850	1110	1490	1808	1047	1267	4735	5656	3016	1468
January	1380	1530	3020	1580	1490	1850	4392	992	3995	5319	6302	6266	1309
February	4400	1940	2530	1160	1310	1980	6104	1200	8034	8894	8844	4886	1998
March	2790	2650	3510	3060	1530	1770	4985	2706	10320	7263	4538	9426	3418
April	5500	2280	2170	3310	2050	1730	4194	5123	8668	6353	8462	7434	4405
May	2430	2430	1680	3130	2110	1460	3634	4178	4005	8371	7394	4036	3974
June	1420	1450	1270	1740	1530	1340	2390	2030	1965	3663	4790	3066	1633
July	1640	1650	1230	1440	1320	1430	1844	1649	1515	1866	2098	1644	1845
August	1750	2040	1180	1410	1390	1410	1895	1314	1570	1591	1751	1651	1886
September	1700	1990	1120	898	1130	1310	1935	1378	1944	1486	1973	1395	1441
Minimum	924	1070	950	448	235	890	917	355	259	620	1280	1270	765
Maximum	20500	4490	8440	6300	2940	5700	25000	8630	50900	28400	31500	24500	6290

RUN OFF IN ACRE FEET
IN NORTH FORK OF FEATHER RIVER AT ALMANOR DAM AND BIG BAR

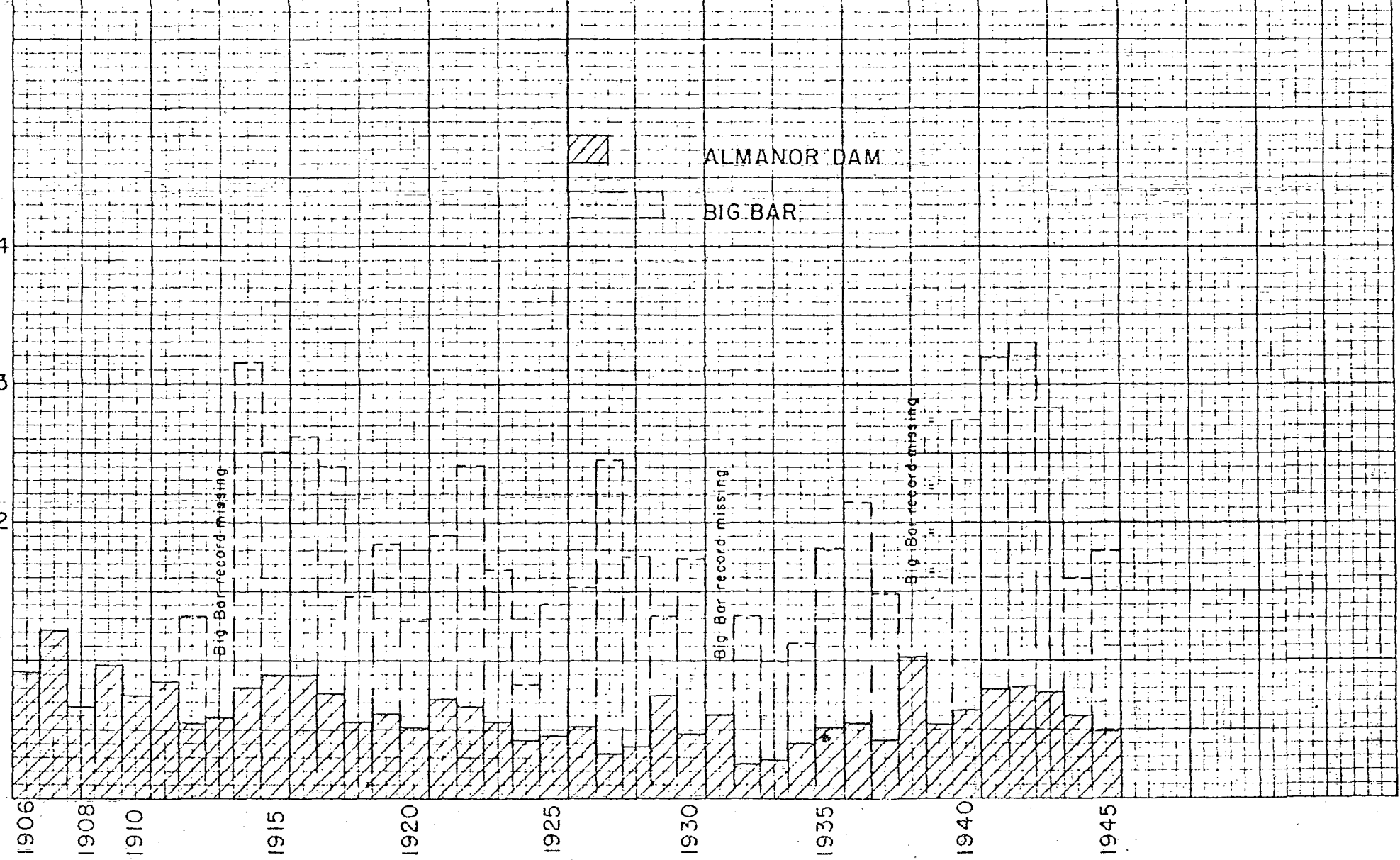


TABLE 3

ANNUAL RUNOFF IN ACRE FEET IN NORTH FORK, FEATHER RIVER

Unit - 1000 acre feet

<u>End of Water Year</u> <u>Sept. 30</u>	<u>Gage at Lake</u> <u>Almanor Dam</u>	<u>Per cent release</u> <u>@ 35 c.f.s.</u> (25294.5 acre ft. per year)	<u>Big Bar</u> <u>Gage</u>	<u>Per cent release</u> <u>@ 50 c.f.s.</u> (36190. acre ft. per year)
1906	931.3	2.7		
1907	1227.5	2.0		
1908	691.9	3.6		
1909	985.6	2.5		
1910	757.1	3.3		
1911	P 864.1	2.9		
1912	527.2	4.8	1311.6	2.7
1913	588.0	4.3		
1914	824.5	3.1	3166.5	1.1
1915	897.2	2.8	2506.7	1.4
1916	904.4	2.8	P 2614.7	1.4
1917	778.9	3.2	2416.0	1.5
1918	567.0	4.5	1483.0	2.4
1919	613.4	4.1	1852.8	1.9
1920	510.5	5.0	1288.2	2.8
1921	734.1	3.4	P 1906.5	1.9
1922	680.8	3.7	2412.1	1.5
1923	556.8	4.5	1662.8	2.2
1924	440.8	5.7	802.5	4.5
1925	455.7	5.6	1423.6	2.5
1926	524.1	4.8	1622.8	2.2
1927	308.5	8.2	2448.6	1.5
1928	387.7	6.5	1769.2	8.2
1929	768.7	3.3	1333.5	2.7
1930	477.1	5.3	P 1740.5	2.1
1931	608.1	4.2		
1932	254.3	9.9	1316.8	2.7
1933	278.1	9.1	967.1	3.7
1934	407.4	6.2	1119.7	3.2
1935	528.0	4.8	1820.5	2.0
1936	565.2	4.5	2168.5	1.6
1937	427.9	5.9	1489.1	2.4
1938	1131.2	2.2		
1939	542.2	4.7		
1940	655.6	3.9	2737.6	1.3
1941	791.0	3.2	3201.7	1.1
1942	803.8	3.1	3295.8	1.1
1943	785.1	3.2	2832.3	1.3
1944	611.1	4.1	1599.1	2.3
1945	510.7	5.0	1797.8	2.0

Note: P -- Partial record, --percent is somewhat above actual.

The release at each gaging station would have been the amount of water provided for fish protection expressed as percentage of the total annual runoff, if the two projects, Rock Creek and Cresta, had been in operation during the period from 1906 to 1945.

REPORT NO. 1

UNITED STATES DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service
River Basin Studies
Portland 18, Oregon

A Report on Fish and Wildlife Resources in Relation to the
Water Development Plan for the
Proposed Feather River Basin, Rock Creek and Cresta Projects
(Power Project No. 1962)^{1/}

Sponsor : Pacific Gas and Electric Company,
California

Sponsor's Status of Project : The project is in planning stage.
Plan for same has been submitted to
the Federal Power Commission.

Location : Butte and Plumas Counties, California

Source of Engineering Data : Pacific Gas and Electric Company.
Application to Federal Power Commis-
sion for License for Power Project
No. 1962.

Field Investigation : February, March, and April, 1947.

Report Prepared : May, 1947. Revised December, 1947
Revised February, 1948.

^{1/} Field work and report by River Basin Studies Staff, Fish and Wildlife Service, Region one, Portland, Oregon.

SUMMARY

The present application of the Pacific Gas and Electric Company (Power Project No. 1962) proposes the development of two units (Rock Creek and Cresta) of a comprehensive plan that will fully utilize the flow and gradient of North Fork of Feather River for the production of hydro-electric power. The entire plan includes ten units exclusive of Lake Almanor. Three units, Caribou, Buck's Creek, and Big Bend, have been constructed and are in operation; two, Rock Creek and Cresta, are proposed for present construction; and five, Butt Valley, Caribou Addition, Belden, Pulga, and Poe are proposed for future construction. Completion of all of the units of the plan will place the entire flow of North Fork in tunnels and conduits, except for diversion dam fore-bays, flood spill, and minor contributions of tributary inflow.

It is of the greatest importance to the valuable fishery resources of North Fork and to its general recreational attractiveness as well, that the present application be considered not only on its own merit, but also in terms of the ultimate development of the entire stream. Decisions that are made at this time in consideration of the Rock Creek and Cresta Projects will unquestionably establish precedent for all subsequent units of the comprehensive plan of development as proposed by the sponsor.

In its present application, the sponsor makes no provision whatsoever for minimum flows for the protection and maintenance of fish life in North Fork. The only flow that would remain in 12.3 miles of North Fork would be minute quantities of inflow from tributaries, an unknown, but slight amount resulting from leakage around the dams, and flood spills of short duration during periods of heavy run-off. This condition would virtually eliminate present fish populations in this section of North Fork for all time. The power potential and fishery resources of the stream are the property of the people of the State of California specifically and of the United States generally. These and all other resources that might be involved in any water development plan must be considered before making far-reaching decisions in favor of certain beneficiaries who would profit thereby.

The State of California Division of Fish and Game estimated that in 1946, 36,000 angler-days were spent on North Fork of Feather River, and that a minimum of 108,000 trout were caught. The Division further commented that the stream had long been recognized as an outstanding trout stream and that destruction of any appreciable amount of it would have far-reaching consequences. The California State Chamber of Commerce estimates the annual average expenditure of a California angler to be \$120. Estimates made by the Division of Fish and Game, based on catch records, indicate that anglers average 10-12 fishing days per year which would place the per day expenditure at about \$10. On the basis of these estimates, the value of the fishery resources of North Fork is sufficiently high to warrant the expenditure of \$360,000.00 annually by anglers to fish it.

The above estimates apply to 35.85 miles of North Fork from Lake Almanor downstream to the site of the proposed Cresta powerhouse. Operation of the Rock Creek and Cresta projects will affect the lower 16.35 miles of this section. The estimated annual fishery value of these affected sections (\$315,000) is based on a per second-foot-mile value of approximately \$50 as calculated from the total second-foot-miles from Lake Almanor to the proposed Cresta Powerhouse. Under the plan as proposed by the sponsor, this value would be reduced to \$33,000 greater than those based on the sponsor's plan but would be at least \$155,000 less than under present conditions.

CONCLUSIONS

Construction of the proposed project as presently planned would result in annual losses to the fishery resources of the North Fork of Feather River of approximately \$280,000. If Recommendations 1a and 1b are followed, the net annual loss would be \$155,000. Partial compensation for this loss would be possible through provision of greater releases from Almanor Dam to provide flows suggested in Recommendation 1c. The annual fishery value from Lake Almanor to Rock Creek Reservoir would thus be increased by \$85,000. The net annual loss for the entire stream would be reduced to \$70,000.

It is requested that the Fish and Wildlife Service be advised of all changes in construction and operational plans so that a reconsideration of the effects may be made.

RECOMMENDATIONS

It is recommended that:

- (1) Minimum flows be maintained at all times in sections of North Fork as follows:
 - a. Not less than 200 second-feet in the 7.5-mile section from Rock Creek Dam to the head of Cresta forebay to be measured at the point of release from the dam.
 - b. Not less than 200 second-feet in the 4.8-mile section from Cresta Dam to Cresta powerhouse tailrace to be measured at the point of release from the dam.
 - c. Not less than 100 second-feet in the 10.0-mile section from Lake Almanor Dam to Caribou powerhouse tailrace, the flow to be released from Lake Almanor and measured at a point approximately 0.5 mile upstream from the Caribou plant.

- (2) A minimum flow of not less than 200 second-feet be established as a part of any license that may be granted to the Pacific Gas and Electric Company for construction of any project on the main stem of North Fork of Feather River.
- (3) Rock Creek and Cresta dams be constructed with outlet facilities located as low as possible to assure the release of cool water for fish life.
- (4) Further study be given the possibility of constructing an afterbay dam to smooth flow irregularities occasioned by the operation of Caribou power plant on North Fork.
- (5) The license for the project, if granted, be held open with respect to the problem of screening the intakes of diversions from Rock Creek and Cresta Dams. The justification for screens cannot be adequately determined until the project is in operation.
- (6) The entire project area be open to free public access for fishing and other recreational uses, except such portions as may be reserved by the Pacific Gas and Electric Company in the interest of safety, efficient operation, and protection of property.

ACKNOWLEDGEMENT

1. The California Division of Fish and Game assisted in field work and supplied data pertinent to this report.
2. Officials of the U. S. Forest Service supplied certain data and information and concurred in the recommendations made herein.
3. The Federal Power Commission furnished engineering data, maps, and other information.

GENERAL DESCRIPTION OF THE PROJECT

4. Feather River rises near the crest of the Cascade Range and its channel approximates the boundary between that range and the Sierra Nevada. It flows in a general southwesterly direction joining the main stem of Sacramento River about 15 miles northwest of Sacramento, California. The project stream, North Fork, regarded as a continuation of the main stream, rises on the southern slope of Lassen Peak (elevation 10,437 feet) and for the greater length of its course, flows through a deep, narrow canyon joining Middle Fork at elevation 250 feet. Its drainage area is approximately 2,230 square miles. Flow is regulated by Lake Almanor and by the operation of Caribou, Buck's Creek, and Big Bend power plants, existing units of the Pacific Gas and Electric Company.

5. The present application of the power company proposes the development of two units (Rock Creek and Cresta) of a comprehensive plan that will fully utilize the flow and gradient of North Fork for the production of hydro-electric power. Completion of all units of the plan (see map) will place the flow of North Fork in tunnels and conduits, except for diversion dam forebays, from Lake Almanor to Middle Fork.

6. In the Rock Creek Unit, the applicant proposes construction of a concrete dam 115 feet high and 550 feet long to be located on North Fork immediately below the confluence of Opopee in the NW $\frac{1}{4}$ of NW $\frac{1}{4}$ of Section 35, Township 25 North, Range 6 East, Mount Diablo Base and Meridian. A 315-foot, overflow-type spillway 315 feet long with a capacity of 120,000 second-feet controlled by 3 drum gates, 105 feet by 22 feet, would be provided. Two sluice gates, 7x7 feet, located at almost stream level, would also be provided.

7. Water would be diverted from the northwest end of the dam and carried 34,500 feet by means of a 26-foot diameter tunnel having a capacity of 3,000 second-feet (average 1,560 second-feet) to the head of the penstock. The penstock would consist of 800 feet of 20-foot diameter tunnel and 800 feet of 162 to 192-inch diameter pipe leading to the power house. Power plant would consist of a steel reinforced concrete building, 54 x 166 feet, having an abutting switchhouse, 30 x 146 feet. This plant would be equipped with 2 vertical, Francis turbines, each directly connected with a 3-phase, 60-cycle, 13,800 volt, 0.9 factor, 63,000 kva generator. The power plant would be located about 7.5 miles below the dam.

8. The forebay would have a capacity of 2,300 acre-feet and the surface area at normal operating pool level would be 122 acres inundating 2.8 miles of stream.

9. For the Cresta unit, the applicant proposes construction of a concrete dam 113 feet high having a crest length of 360 feet. An overflow, 124,000-second-foot capacity spillway 132 feet long would be provided and controlled by 2 wheel gates, 50 x 50 feet, and 2 drum gates, 16 x 50 feet. Three sluice gates, 7 x 7 feet, located at about stream level would be provided. The dam would be located a short distance downstream from Swamp Creek in the NE $\frac{1}{4}$ of SW $\frac{1}{4}$ of Section 1, Township 23 North, Range 5 East, Mount Diablo Base and Meridian.

10. Water would be diverted from the south end of the dam and carried through a 27-foot diameter, 3,500-second-foot (average 1,880 second-feet) capacity tunnel and through a penstock consisting of 700 feet of 20-foot diameter tunnel and 700 feet of 174 to 198-inch diameter pipe to the powerhouse. The power plant would be located about 4.8 miles below the dam in Section 27, Township 23 North, Range 5 East, Mount Diablo Base and Meridian. Building would be of identical size and similar construction as the Rock Creek plant, but would be provided with two 46,500 horsepower, vertical, Francis turbines, each directly connected to a 3-phase, 60-cycle, 13,800-volt, 0.9 power factor, 37,500 kva generator.

11. Cresta forebay would have a capacity of 2,000 acre-feet and a surface area of 97 acres at normal operating pool level and would inundate 1.75 miles of North Fork.

FISHERY SECTION

A. Preproject evaluation.

12. The project, as proposed by the sponsor, makes no provision for minimum flows for the maintenance of fish life in sections of North Fork below Rock Creek and Cresta dams amounting to a total of 12.3 miles of stream. In addition, forebays of these dams will inundate 4.55 miles of stream, making a total of 16.85 miles that will be affected by the project. This large section of stream supports a sport fishery of considerable magnitude and includes the most picturesque section of North Fork. On the basis of estimates made by the California Division of Fish and Game in 1946, the annual angler effort on these sections would be approximately 31,500 angler days. Rainbow and brown trout are the principal species of game fish in the affected section of stream although smallmouth black bass and occasionally chinook salmon are taken in sections of North Fork below the project area. The Division estimates that a minimum of 108,000 trout were caught by anglers in 1946 in North Fork.

13. The California State Chamber of Commerce ("California" Vol. XXXV, No. 2, Feb. 1945) estimates the average annual expenditure of a California angler at \$120. Estimates based on catch records made by the Division of Fish and Game indicate that anglers average 10-12 fishing days per year or about \$10 per day.

14. On the basis of the above estimates, anglers spent approximately \$315,000 in pursuit of fishing on North Fork of Feather River in 1946.

15. The preproject annual value of the fishery resources of these sections is, therefore, concluded to be \$315,000. The 16.85 miles of stream involved in the project plan are readily accessible to anglers and support the bulk of the existing recreational facilities. The greater part of the total angler effort on North Fork is expended in this section.

B. Postproject evaluation.

16. The mean minimum flow of North Fork through the project area is approximately 1,500 second-feet, although flows of less than 600 second-feet have been recorded at the Big Bar gaging station. With the project in operation as planned by the sponsor, the only flow below Rock Creek and Cresta dams would be that resulting from leakage, flood spill, and inflow of tributaries. Minimum tributary inflow to the 7.5-mile section between Rock Creek dam and Cresta forebay is 17 second-feet and in the 4.8-mile section between Cresta dam and powerhouse 14.5 second-feet. The extent that leakage would supplement these flows is unknown, but quite obviously the total minimum flow from these sources would be inadequate to maintain more than a vestige of the present fishery.

17. On the basis of these flows as compared to those prevailing at the preproject level, it is estimated that fishery values would be reduced about 89 per cent and would amount to approximately \$35,000 annually including a fishery value of \$2,450 for the forebays of Rock Creek and Cresta Dams. Annual losses to the fishery resources would be about \$280,000.

18. The irreducible minimum flow recommended for the maintenance of fish life and fishing in the 12.3 miles of stream that will be affected by the project is 200 second-feet as measured at the point of release from Rock Creek and Cresta dams. Flows greater than this would enhance fishery values, and careful study indicates that the fishery resources might be maintained at or near their present levels of abundance with a minimum flow of about 400 second-feet.

19. Because the present application concerns only two units of a total of ten ultimately planned, three of which - exclusive of Lake Almanor - have already been constructed and are in operation, it seems appropriate to call attention to certain phases of operation of existing units that should be corrected for the protection of fish life.

- a. Releases from Lake Almanor to North Fork are quite erratic and affect about 10 miles of stream between the dam and Caribou powerhouse. According to 1943 flow records, the mean discharge from Lake Almanor was 283 second-feet. However, releases of less than 20 second-feet were made during the months of May, June, July, August, and September, with a minimum release of 4.4 second-feet being made in September. These are the months of the year during which the water demands of trout are greatest. Under present operation schedules, flows are obviously lowest during these months. In order to correct this situation in the interest of fishery maintenance, it is recommended that a minimum flow of not less than 100 second-feet, as measured at a point 0.5 mile above Caribou powerhouse be maintained in North Fork.
- b. The operation of Caribou power plant seriously affects about 7 miles of North Fork from the powerhouse to the confluence of East Branch and to a lesser degree additional miles of stream below that point. The plant apparently operates on a demand basis which results in extreme fluctuations in discharge. During the course of a one-hour observation on April 10, 1947, discharges from the plant varied between 20 and 850 second-feet. Vertical changes in stream level below the plant varied between 6 inches and 3 feet depending on the character of the stream channel. In the interest of conservation and maintenance of fish life in North Fork, this condition should be and can be corrected by construction of an afterbay dam to smooth flow irregularities.

20. If recommendations for minimum flows as made herein are followed below Rock Creek Dam, it is estimated that fishery values in the project area could be maintained at about 50 per cent of the preproject level and would amount to about \$160,000 annually. The fishery resources would sustain annual losses amounting to at least \$155,000. If releases are made from

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Lake Almanor to provide flows of 100 second-feet at Caribou, and this increased flow is carried unimpeded downstream, an additional annual fishery value of \$85,000 would be provided for the stretch from Lake Almanor to Rock Creek Dam. The net annual loss to the North Fork would be reduced to \$70,000. This total value precludes the improvement of stream fluctuations below Caribou powerhouse.

21. Rock Creek and Cresta dams would be constructed solely to create head for the diversion of water. Forebay waters would be rapidly exchanged since storage capacities are low in relation to inflow and discharge. Thus, these waters would retain some stream characteristics while assuming certain reservoir characteristics as depth and increased placid surface area. Their value to the fishery resources of North Fork lies somewhere between typical stream and typical reservoir conditions. However, after careful study, it seems proper to evaluate them on an area basis rather than in terms of volume of flow and limit the per-acre value to one-half of the regular reservoir value for storage impoundments of the same area.

22. The Rock Creek forebay would have an effective area of 122 acres and the Cresta forebay, 97 acres for a total of 219 acres. These forebays would have an annual fishery value of about \$2,450.

23. Fishways would not be required for the dams since migratory fishes are not involved. Consideration should be given the problem of screening diversion intakes to prevent possible loss of fish. However, it is recognized that the screening of the diversions from Rock Creek and Cresta dams might not be economically justified nor physically possible to accomplish.

24. Schedule of Minimum Flows

Stream Section	Minimum Flows in Second-feet			
	Miles	Preproject	Sponsor's Plan	Recommended
Lake Almanor to Caribou Powerhouse	10.00	10	10	100
Caribou Powerhouse to East Branch	7.00	60	60	150
East Branch to head of Rock Creek Reservoir	2.00	182	182	272
Head of Reservoir to Rock Creek Dam	2.80	202	Inundated by reservoir	
Rock Creek Dam to Bucks Creek Powerhouse	6.00	220	17	217
Bucks Creek Powerhouse to head of Cresta Reservoir	1.50	520	317	517
Head of Reservoir to Cresta Dam	1.75	532	Inundated by reservoir	
Cresta Dam to Cresta Powerhouse	4.80	547	14.5	214.5

25. Summary of Fishery Values in the Project Area

Preproject	Postproject		Loss	
	Sponsor	Service	Sponsor	Service
\$315,000	\$35,000	\$160,000	\$280,000	\$155,000*

* Excluding recommended flow below Lake Almanor.

WILDLIFE SECTION

26. The project will not appreciably affect existing wildlife resources of the area. In general, the precipitous, rocky canyon of North Fork provides very little suitable habitat for upland game birds and animals. Deer are found in the highlands and to some extent in the canyon. Quail are the only upland game birds found in the area, but they are few in number and their habitat is limited to stream margins.

27. Occasional waterfowl frequent the area in flight between Lake Almanor and Central Valley and might possibly use the forebays of Rock Creek and Cresta Dams as resting areas. But because of the Rocky nature of the terrain that they would inundate, these forebays would not develop feeding areas.

28. A few mink, skunk, and coyotes are known to occur in North Fork canyon, but it is doubtful that any are resident in the areas that would be affected by the proposed impoundments because of the lack of suitable habitat for them.

/s/ Rudolph Dieffenbach,
Coordinator, River Basin Studies,
March 1948.

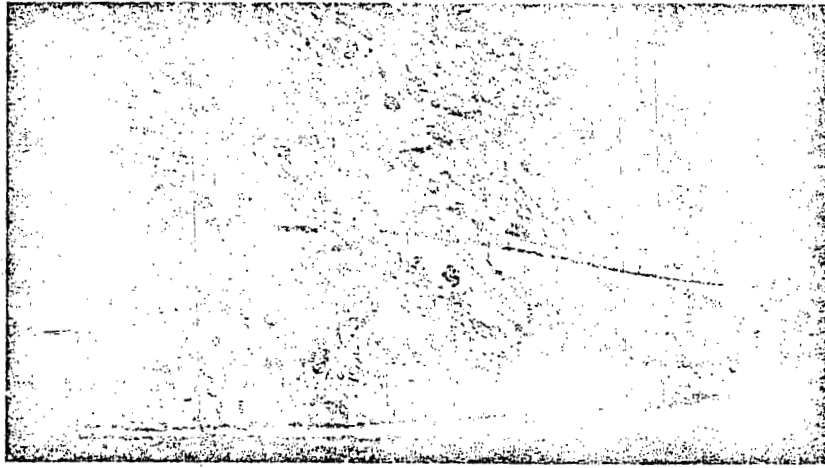


Figure 1. Rock Creek Dam site East bank. Line indicates approximate crest level of dam.



Figure 2. Rock Creek Dam site West bank looking downstream.

1. Mark at crest level of dam.
2. Center line marker of tunnel.



Figure 3. Rock Creek Dam site looking downstream from northwest corner of axis of spillway.



Figure 4. Cresta Dam site (approximate). View looking upstream.