

LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.



IN REPLY REFER TO:

July 19, 1962

Honorable John W. McCormack
Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 21 June 1962, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on a survey of Redwood Creek, Humboldt County, California, authorized by the Flood Control Act, approved 3 September 1954.

In accordance with Section 1 of Public Law 534, 78th Congress, and Public Law 85-624, the views of the State of California and the Department of the Interior are inclosed, together with the replies of the Chief of Engineers thereto. The views of the Departments of Agriculture and Commerce, and the Public Health Service are inclosed also.

The Bureau of the Budget advises that there is no objection to the submission of the proposed report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

A handwritten signature in cursive script that reads "Cyrus Vance".

Cyrus R. Vance
Secretary of the Army

1 Incl
Rept w/accomp
papers & illus

REDWOOD CREEK, HUMBOLDT COUNTY,
CALIFORNIA

LETTER
FROM
THE SECRETARY OF THE ARMY
TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED JUNE 21, 1962, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A SURVEY OF REDWOOD CREEK, HUMBOLDT COUNTY, CALIFORNIA, AUTHORIZED BY THE FLOOD CONTROL ACT, APPROVED SEPTEMBER 3, 1954



AUGUST 1, 1962.—Referred to the Committee on Public Works
and ordered to be printed with two illustrations

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REDWOOD CREEK, HUMBOLDT COUNTY,
CALIFORNIA

LETTER
FROM
THE SECRETARY OF THE ARMY
TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED JUNE 21, 1962, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A SURVEY OF REDWOOD CREEK, HUMBOLDT COUNTY, CALIFORNIA, AUTHORIZED BY THE FLOOD CONTROL ACT, APPROVED SEPTEMBER 3, 1954



AUGUST 1, 1962.—Referred to the Committee on Public Works
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U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1962

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- Plate:
1. Drainage basin map.
 2. Plan of improvement.

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT

BUREAU OF THE BUDGET

WASHINGTON 25, D. C.

July 11, 1962

Honorable Cyrus R. Vance
Secretary of the Army
Washington 25, D. C.

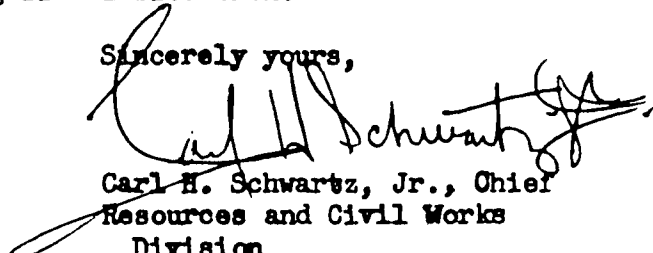
Dear Mr. Secretary:

Assistant Secretary Schaub's letter of June 26, 1962, submitted the report of the Chief of Engineers on Redwood Creek, Humboldt County, California, authorized by section 204 of the Flood Control Act approved September 3, 1954.

The Chief of Engineers recommends, subject to certain conditions of local cooperation, improvement of Redwood Creek for flood control in the vicinity of the municipality of Orick by construction of levees, revetments, channel rectification, a pumping plant, and appurtenant works. The total cost of the improvement is estimated at \$2,850,000, of which \$2,580,000 would be Federal for construction, and \$270,000 non-Federal for land and relocations. The benefit-cost ratio is stated to be 1.8.

I am authorized by the Director of the Bureau of the Budget to advise you that there would be no objection to the submission of the proposed report to the Congress. No commitment, however, can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Sincerely yours,


Carl H. Schwartz, Jr., Chief
Resources and Civil Works
Division

COMMENTS OF THE STATE OF CALIFORNIA

WILLIAM E. WARNE
Director of
Water Resources

EDMUND G. BROWN
GOVERNOR OF
CALIFORNIA



WILLIAM E. WARNE
ADMINISTRATOR
RESOURCES AGENCY

ADDRESS REPLY TO
P. O. Box 388
Sacramento 2, Calif.

JAMES F. WRIGHT
Chief Deputy Director

B. ABBOTT GOLDBERG
Deputy Director—Contracts

REGINALD C. PRICE
Deputy Director—Policy

ALFRED R. GOLZÉ
Chief Engineer

THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

1120 N STREET, SACRAMENTO

April 18, 1962

Lieutenant General Walter King Wilson
Chief of Engineers
Headquarters, Department of the Army
Office of the Chief of Engineers
Washington 25, D. C.

Reference: Your File No. ENOCW-PD

Dear General Wilson:

The proposed report on Redwood Creek, Humboldt County, California, was transmitted on March 2, 1962, to the Director of the Department of Water Resources, State of California, for review and comment in accordance with the provisions of Public Law 534, 78th Congress, and Public Law 85-624. The report of the Department of Water Resources, which incorporates the comments of the Department of Fish and Game and the Division of Highways, is transmitted herewith.

The report recommends that the Redwood Creek Project be authorized for construction as soon as possible, due to the urgent need for flood protection of property rights and human lives, and in view of its favorable benefit cost ratio. It further recommends that, at the design memorandum stage, the recommendations and suggestions of the Department of Fish and Game and U. S. Fish and Wildlife Service should be adhered to in order to minimize damage to fish and wildlife resources.

I concur in the conclusions and recommendations contained in the report, and I request that said report be considered as expressing the views and recommendations of the State of California on the proposed report of the Chief of Engineers. It is further requested that this letter and the report of the department be transmitted to the President of the United States and to the Congress, along with all material that may be so transmitted.

The opportunity to review the Redwood Creek Report is very much appreciated.

Sincerely yours,

A handwritten signature in cursive script, appearing to read "William E. Warne".

Director

REVIEW BY STATE OF CALIFORNIA
OF REPORT OF THE CHIEF OF ENGINEERS
UNITED STATES DEPARTMENT OF THE ARMY
ON
REDWOOD CREEK
HUMBOLDT COUNTY, CALIFORNIA

By letter dated March 2, 1962, the Chief of Engineers, Corps of Engineers, United States Department of the Army, transmitted to the Director of the Department of Water Resources, State of California, his proposed report entitled, "Survey Report for Flood Control and Allied Purposes, Redwood Creek, Humboldt County, California," for review and comment in accordance with the provisions of The Public Law 534, 78th Congress, and Public Law 85-624. Included with the report of the Chief of Engineers were reports of the Board of Engineers for Rivers and Harbors, and the District and Division Engineers. Copies of the report were forwarded by the Chief of the Northern Branch to the Department of Fish and Game and the Department of Public Works, Division of Highways. The comments of these state agencies are included herein.

Authority for state review is contained in Section 12580 of the California Water Code, which declares that "the State should engage in the study and coordination of all water development projects, including flood control projects, undertaken by ... the United States ... in order that such allocations and appropriations as made by the State Legislature ... will be expended upon those projects which are most beneficial to the State" Subsequent sections of the Water Code further outline state authority for review in respect to local and state participation.

The Department of Water Resources has the responsibility of assembling and presenting comments of all interested agencies of the State of California. The following comments, therefore, may be accepted as the

views and recommendations of the State. For the sake of brevity, your report is referred to as the "Redwood Creek Report". Comments are listed under the state agency responsible for each.

Department of Water Resources

The Department of Water Resources has a direct interest in all projects involving the development of water resources within the State, particularly to the extent to which these projects are compatible with the State's comprehensive plan for the orderly development of the water resources of California.

The California Water Plan

The Redwood Creek Project, as outlined in the report, is in consonance with The California Water Plan. This is a master plan to guide and coordinate the activities of all agencies in the planning, construction, and operation of works required for the control, development, protection, conservation, distribution, and utilization of California's water resources for the benefit of all areas of the State and for all beneficial purposes.

Hydrology

The estimated peak of the standard project flood of 77,000 second-feet appears to be reasonable. The standard project flood was obtained by use of the standard project storm and the unit hydrograph developed from analysis of characteristics of known floods.

During the review of the Redwood Creek Report for the district, the department estimated a discharge for the pumping plant higher than that used in the report. Subsequently, the department contacted the district in San Francisco and reviewed their assumptions and calculations for the pumping plant discharge. The pumping plant discharge was obtained by the district,

using a 30-year storm runoff on the tributary area coincident with occurrence on Redwood Creek of the project design flood. Preliminary design for the pumping plant was sized for a 40 second-foot discharge. The district feels that the proposed degree of protection is considered adequate and would allow ponding behind levees without appreciable damage. The department feels these assumptions are reasonable.

With a discharge of 40 second-feet, assuming a 5-foot lift and a combined pump and motor efficiency of 60 percent, a 38 horsepower motor would be required. The cost of this unit would be small in comparison with the total project cost. Therefore, the department is of the opinion that two pumping units should be installed to provide adequate capacity as well as standby capabilities for emergencies. The extra cost would be fully justified for a greater degree of protection.

The department recommends that these units be gasoline-powered instead of electric. During major storms in the North Coastal area, electric power lines may be out due to storm damages.

Right-of-Way and Relocation Estimates

The department has a financial interest in projects involving flood control in accordance with policies set forth in the State Water Resources Law of 1945, and the Flood Control Fund Law of 1946, under which the State is authorized to reimburse local agencies for the cost of lands, easements, and rights-of-way required for channel improvements of federal flood control projects.

The department feels that the rights-of-way and relocation costs are short by approximately \$120,000. With the additional cost of \$120,000 for rights-of-way and relocations, the benefit cost ratio would be 1.6 to 1, in contrast with a value of 1.8 to 1 derived in the survey report.

In order to lower land acquisition and relocation costs, consideration should be given to keeping the flood channel upstream from the Orick Bridge as far to the left as possible. This would avoid any construction in the urbanized area on the right bank.

Design, Construction and Cost Estimates

The department, in its letter to the San Francisco District, stated that it was of the opinion that an item of cost for dredging the sand spit at the mouth should be included in the annual operation and maintenance costs. The district apparently considers that stream velocities would effectively scour and remove the sand spit prior to occurrence of peak flood flows.

Department of Fish and Game

The Department of Fish and Game states that their comments contained in its previous letter report to the District Engineer, Corps of Engineers, dated September 27, 1961, will suffice in regard to the subject report. The department's recommendations are summarized as follows:

1. To permit the passage of salmon and steelhead into Redwood Creek during low flows, the channel at the lower end of the project should be modified to concentrate the flow.
2. To avoid the destruction of salmon spawning areas, gravel should not be moved from areas normally watered by fall and winter flows (excluding peak flows). Borrow should be obtained only from channel sections required to produce needed channel capacity.
3. To assure the upstream passage of anadromous fishes during low flows, certain channel modifications would be required.

These modifications, such as spaced resting pools, would be in addition to the six-by-one-foot fish channel described in the report.

4. Riparian vegetation should be preserved wherever possible.
5. Since the final plans for channel work would be affected by the foregoing recommendations, it is recommended that the Corps of Engineers request the assistance of technical fisheries personnel of the U. S. Fish and Wildlife Service and/or the California Department of Fish and Game. Further, technical personnel of these agencies should be available for review of project operation during construction.

Unfortunately, the report does not indicate the degree our above-submitted recommendations and those of the U. S. Fish and Wildlife Service have been accepted by the Corps of Engineers. Therefore, at this stage we can only resubmit our recommendations and urge that the changes suggested by the U. S. Fish and Wildlife Service in the body of the report as listed in Appendix E, Exhibit A, pages 1-4 be fully implemented.

Division of Highways

The Division of Highways stated that their previous comments still pertain: "It is assumed that the project sponsors will contact the District I office of the Division of Highways in Eureka for permission to perform necessary work within state-owned rights-of-way. It is also assumed that the sponsors will make arrangements for possible grade revision to the highway required by levee construction near station 163+00."

The Division of Highways further stated that they have initiated preliminary studies for conversion of highway U. S. 101 in this vicinity to

a four-lane freeway. The District I office of the Division will keep the San Francisco office of the U. S. Corps of Engineers informed of progress of these studies and any public hearings on highway developments in the area. It would, likewise, be appreciated if the Corps of Engineers would keep the Highway District I office informed of developments in connection with this flood control project.

Conclusions

On the basis of the review of the Redwood Creek Report, it is concluded that:

1. The Redwood Creek, as outlined in the Survey Report, would not conflict with The California Water Plan.
2. The pumping plant for interior drainage should be designed as recommended by the Department of Water Resources.
3. The land acquisition and relocation costs appear low by approximately \$120,000.
4. Using the State's rights-of-way and relocation costs, the benefit cost ratio would be 1.6 to 1 as compared to the ratio of 1.3 to 1 derived in the Survey Report.
5. Insofar as practical and consistent with the basic aims of the project, the following recommendations of the Department of Fish and Game should be followed.
 - (a) The lower end of the project should be channelized in order to permit the passage of salmon and steelhead at low flows.
 - (b) To avoid the destruction of salmon spawning areas, gravel should not be removed from areas normally watered by fall and winter flows (excluding flood peaks). Borrow

should be obtained only from channel sections required to be excavated to produce needed channel capacity.

- (c) To assure the upstream passage of anadromous fishes during low flows, certain channel modifications would be required. These modifications, such as spaced resting pools, would be in addition to the six-by-one-foot fish channel described in the survey report.
 - (d) Riparian vegetation should be preserved whenever possible.
 - (e) Since final plans for channel work would be affected by the foregoing recommendations, it is recommended that the Corps of Engineers request the assistance of technical fisheries personnel of the U. S. Fish and Wildlife Service and/or the California Department of Fish and Game. Further, technical personnel of these agencies should be available for review of project operation during construction.
6. The Corps of Engineers should contact the Division of Highways, District I office, in Eureka in order to coordinate planning problems in connection with state-owned rights-of-way and grade revision of U. S. Highway 101, which is now in the planning stage for conversion to freeway standards.

Recommendations

We recommend that the project be authorized for construction, as soon as possible, due to the urgent need for flood protection of property rights and human lives, and in view of its favorable benefit cost ratio. The County of Humboldt has guaranteed local participation in the project in their Resolution No. 1704, dated March 27, 1962. The recommendations and suggestions of the Department of Fish and Game and U. S. Fish and Wildlife Service should be adhered to in order to minimize damage to fish and wildlife resources.

Submitted by

/s/ John M. Haley

John M. Haley, Chief
Northern Branch

APPROVED:

/s/ Alfred R. Golze'

Chief Engineer

HUMBOLDT COUNTY DEPARTMENT OF FISH AND GAME

LETTER TO THE STATE OF CALIFORNIA



HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO

ENGW-PD

1 May 1962

Mr. William E. Warne
Director, Department of Water Resources
1120 - N - Street
Sacramento 2, California

Dear Mr. Warne:

This is in reply to your letter of 18 April 1962 furnishing the comments of the State of California on the proposed report of the Chief of Engineers on Redwood Creek, Humboldt County, California.

You may be assured that if the project is authorized for construction, full consideration will be given during preparation of detailed plans to the recommendations and suggestions of the Department of Fish and Game and U. S. Fish and Wildlife Service with a view to minimizing damage to fish and wildlife resources.

Copies of your letter and this reply will be included with the report when it is sent to Congress.

Sincerely yours,

(Signed)

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

COMMENTS OF THE DEPARTMENT OF THE INTERIOR



UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON 25, D. C.

May 11, 1962

Lt. General Walter E. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

This will reply to General Cassidy's March 2 letter requesting our comments on reports on Redwood Creek, Humboldt County, California. In order to control floods on Redwood Creek, you recommend construction of levees, revetments, channel rectification, a pumping plant and appurtenant work. Cost of this improvement is estimated at \$2,850,000, of which \$270,000 for land and relocations is non-Federal. Average annual benefits are estimated at \$228,000 as compared to annual charges of \$129,000.

The Bureau of Sport Fisheries and Wildlife reports that the District Engineer has omitted from his report the five measures recommended in the Bureau's letters of March 15, 1960, and September 21, 1961. The agreement of 1954 between the Fish and Wildlife Service and the Corps of Engineers provides that the District Engineer shall incorporate in his report acceptance of the Bureau's recommendations or reasons for considering them unacceptable. The District Engineer's statement that the Bureau's "comments will be given full consideration during definite project studies" connotes neither acceptance nor nonacceptance. We believe that the provisions of the above agreement should be followed, and therefore request that the Chief of Engineer's report include acceptance of the five recommendations made by the Bureau of Sport Fisheries and Wildlife or reasons for considering any of them not acceptable.

We appreciate the opportunity to present our views.

Sincerely yours,

Assistant Secretary of the Interior

RECEIVED MAY 11 1962

LETTER TO THE SECRETARY OF THE INTERIOR



IN REPLY REFER TO

ENG CW-PD

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

15 June 1962

The Honorable Stewart L. Udall

The Secretary of the Interior

Dear Mr. Secretary:

Reference is made to the letter of 11 May 1962 from the Assistant Secretary of the Department of the Interior commenting on the proposed report of the Chief of Engineers on Redwood Creek, Humboldt County, California.

The Bureau of Sport Fisheries and Wildlife reports that the District Engineer has omitted from his report the five measures recommended in the Bureau's letters of 15 March 1960 and 21 September 1961 and that the District Engineer's statement that the Bureau's comments will be given full consideration during definite project studies connotes neither acceptance nor nonacceptance. With the exception of the Bureau's fourth comment concerning public access, I consider that the remaining comments of the Bureau concern matters that should be resolved in the final planning phase and that presentation of further details in the survey report are not warranted.

With regard to the Bureau's comment concerning public access, it should be noted that existing law requires local interests sponsoring local protection projects to furnish lands, easements and rights-of-way for construction and maintenance of the flood control works. Since title to the project lands is vested in the sponsoring agency, public access for fish and wildlife purposes is a local option. However, the Corps of Engineers will cooperate in this matter by forwarding to the sponsoring agency any request for public access which may originate with the Fish and Wildlife Service or the California Department of Fish and Game. Our indorsement would necessarily include adequate safeguards to insure proper functioning of the project for flood control.

You may be assured that full consideration will be given to these matters during the advanced planning stage if the project is authorized

xx

by Congress. Copies of the Assistant Secretary's letter and this reply will be included with the report of the Chief of Engineers when it is submitted to Congress.

Sincerely yours,

(Signed)

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

RECEIVED
ENGINEERING DIVISION
JAN 10 1954



DEPARTMENT OF AGRICULTURE

WASHINGTON 25, D. C.

June 19, 1962

Honorable Elvis J. Stahr, Jr.
Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Acting Chief of Engineers' letter of March 2, 1962, transmitting for our review and comment the proposed survey report of the Chief of Engineers for flood control and allied purposes in Redwood Creek, Humboldt County, California.

The report recommends improvement of the lower four miles of Redwood Creek for flood control by channel rectification, levees, pumping plants and appurtenant works. The report estimates that the improvements would provide protection against the standard project flood, which is approximately 50 percent greater than the maximum flood of record, to the community of Orick and adjacent agricultural lands.

It does not appear that the proposed improvements will adversely affect projects or programs of this Department. There are no National Forest lands which would be affected by the project and it appears that project effects upon non-Federal forest land would be insignificant. According to the report approximately 1,000 acres of agricultural lands would be afforded a measure of flood protection. However, the report does not provide information which would permit us to appraise the estimated increase in returns to agricultural enterprises.

Thank you for providing this report for our review.

Sincerely yours,

A handwritten signature in cursive script, reading "Frank J. Welch".

Frank J. Welch
Assistant Secretary

COMMENTS OF THE DEPARTMENT OF COMMERCE



THE UNDER SECRETARY OF COMMERCE
FOR TRANSPORTATION
WASHINGTON 25

April 24, 1962

Lieutenant General W. K. Wilson, Jr., USA
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

As requested in General Cassidy's letter of March 2, 1962, I am transmitting herein the comments of the interested Department of Commerce agencies on your proposed report on "Redwood Creek, Humboldt County, California."

The Coast and Geodetic Survey advises that vertical geodetic control has been established along U.S. Highway 101 in the immediate vicinity of the project area. Horizontal geodetic control now exists about nine miles southeast of the project area. If additional control should be required or if any of the existing control will be destroyed by the construction of the project, the Coast and Geodetic Survey requests that they be so notified as soon as possible.

The Bureau of Public Roads notes that the construction of this project will necessitate a small amount of highway reconstruction and that this reconstruction has been made a part of the local contribution to the project. It is necessary, therefore, that the local interests be advised that Federal-aid highway funds cannot be used in the financing of this highway work.

Your courtesy in providing a copy of this report for our review is appreciated.

Sincerely yours,

A handwritten signature in cursive script that reads "Frank L. Barton".

Frank L. Barton
Deputy Under Secretary
for Transportation

RECEIVED
MAY 1 1962
U.S. DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

COMMENTS OF THE PUBLIC HEALTH SERVICE



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

WASHINGTON 25, D. C.

BUREAU OF STATE SERVICES

Refer to:

May 31, 1962

Major General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

This is in reply to General Cassidy's letter of March 2, 1962, requesting comments on the U. S. Army Engineers' Report on Redwood Creek, Humboldt County, California.

We have no comments to add to those submitted by our San Francisco Regional Office in September 1961, which are reproduced in Appendix E of the Report.

The opportunity to review the report is appreciated. We stand ready to provide consultation concerning vector control, water supply and pollution control aspects of the project on your request.

Sincerely yours,

Keith S. Krause

Chief, Technical Services Branch
Division of Water Supply and
Pollution Control

REDWOOD CREEK, HUMBOLDT COUNTY, CALIFORNIA

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY



IN REPLY REFER TO

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

ENGCW-PD

21 June 1962

SUBJECT: Redwood Creek, Humboldt County, California


TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on a survey of Redwood Creek, Humboldt County, California, authorized by the Flood Control Act of 3 September 1954. My report includes the reports of the District and Division Engineers and the Board of Engineers for Rivers and Harbors.

2. The District and Division Engineers recommend as the most practicable plan for flood control on Redwood Creek the improvement of the lower 4 miles of the stream in the vicinity of Orick, California, by the construction of levees, revetments, channel rectification, a pumping plant and appurtenant work. Excluding \$50,000 for preauthorization studies, they estimate the cost of the improvement at \$2,850,000. Of this, \$2,580,000 is the Federal cost for construction, and \$270,000 is the non-Federal cost for land and relocations. The annual charges are estimated at \$129,000, including \$19,500 for maintenance and operation by local interests. The average annual benefits are \$228,000 and the benefit-cost ratio is 1.8.

3. The Board of Engineers for Rivers and Harbors concurs in general with the views and recommendations of the reporting officers and recommends the improvement of Redwood Creek in the vicinity of Orick, California, essentially as planned, subject to certain requirements of local cooperation.

4. I concur in the recommendations of the Board.


W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

RECEIVED
JUN 21 1962
ENGINEERING DIVISION

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

ENGBR (Aug 61) 2nd Ind
SUBJECT: Redwood Creek, Humboldt County, California

Board of Engineers for Rivers and Harbors, Washington 25, D. C.
24 January 1962

TO: Chief of Engineers, Department of the Army

1. Redwood Creek is on the western slopes of the Coast Range Mountains in northwestern California. The stream drains about 283 square miles and enters the Pacific Ocean about 50 miles south of the Oregon boundary. About 95 percent of the watershed is wooded hills and mountains with short, steep tributaries leading into the main stream. The cleared and developed area along the lower 4 miles of the alluvial valley is subject to flood damages. The community of Orick, on this reach, has a population of about 900, and serves as a center for the lumber and dairy industries and tourist services. In addition to Orick, the adjacent dairy farms are subject to flood damages. There are no Federal or effective local flood-protection projects, or related water-control projects, on Redwood Creek.

2. The Redwood Creek basin is in a region of high winter rainfall and is subject to frequent flooding. The floods develop rapidly and cause damages in the lower valley in the vicinity of Orick when the flows exceed the bankfull capacity of 17,000 cubic feet per second. There have been eight damaging floods in this reach since 1890. Severe floods in January 1953 and December 1955, each with a peak flow of about 50,000 cubic feet per second, caused damages estimated at \$1,234,000 and \$690,000, respectively, as adjusted to April 1960 price levels and development conditions. The lesser damages of the 1955 flood are attributed to effective evacuation and flood-fighting plans. The standard project flood of 77,000 cubic feet per second would cause about \$1,720,000 damages in the reach. The average annual damages under 1960 stream conditions and expected future development are estimated at \$248,000.

3. In response to the requests of local interests, as expressed at a public hearing, the District Engineer considered flood protection by single- and multiple-purpose upstream storage reservoirs, stream diversion, evacuation and flood-plain zoning, channel rectification, and levees. He finds that the most suitable plan for flood control in the Redwood Creek basin would be a local-protection project for the urban and rural

developments on both banks in the Orick area. The proposed work, consisting of channel rectification, levees, revetments, a pumping plant and appurtenant work extending from near the mouth of Redwood Creek to mile 3.7 would provide protection against the standard project flood which is about 50 percent greater than the maximum of record. The District Engineer estimates the cost of the improvement at \$2,900,000, of which \$2,630,000 is Federal, including \$2,580,000 for construction and \$50,000 for preauthorization studies, and \$270,000 is the cost to local interests for lands and relocations. He estimates the annual charges at \$129,000 including \$19,500 for maintenance and operation by local interests. The annual benefits are estimated at \$222,000 for prevention of flood damages, flood-fighting expenses and erosion losses, and \$6,000 for land enhancement, a total of \$228,000. The benefit-cost ratio is 1.8 based on a 50-year period of analysis. The District Engineer recommends the improvement subject to specified conditions of local cooperation. The Division Engineer concurs.

4. The Division Engineer issued a public notice stating the recommendations of the reporting officers and affording interested parties an opportunity to present additional information to the Board. No communications have been received.

Views and Recommendations of the Board of Engineers for Rivers and Harbors.

5. Views.--The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. The improvements are economically justified and the design levels are adequate to provide a high degree of protection for the area. The requirements of local cooperation are appropriate and local interests have indicated their willingness to comply.

6. Recommendations.--Accordingly, the Board recommends improvement of Redwood Creek, California, for flood control at and near Orick, by the construction of:

A levee about 2.4 miles long with pumping and drainage facilities on the right bank, a levee about 3.0 miles long on the left bank, revetment work, and about 2.8 miles of channel rectification;

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all generally in accordance with the plan of the District Engineer, with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated cost to the United States of \$2,580,000 for construction: Provided that prior to construction local interests give assurances satisfactory to the Secretary of the Army that they will, without cost to the United States:

a. Provide all lands, easements, and rights-of-way, including borrow areas and spoil-disposal areas necessary for the construction of the project;


b. Accomplish all relocations and alterations of buildings, utilities, roads and related facilities necessary for the construction and maintenance of the project;

c. Hold and save the United States free from damages due to the construction works;

d. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army; and

e. Prevent any encroachment on the flood channels and ponding areas which would decrease the effectiveness of the flood-control improvements, and if ponding areas and capacities are impaired, promptly provide substitute storage capacity or equivalent pumping capacity.

FOR THE BOARD:


KEITH R. BARNEY
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

REPORT OF SURVEY FOR FLOOD CONTROL AND ALLIED PURPOSES REDWOOD CREEK, HUMBOLDT COUNTY, CALIFORNIA

August 1961

SYLLABUS

Redwood Creek is situated on the western slopes of the Coast Range Mountains in northwestern California. It drains an area of about 283 square miles and enters the Pacific Ocean about 50 miles south of the Oregon boundary. The stream is not navigable for other than small boats, and enters the ocean by flowing over or through a sandspit. There are no existing storage facilities for beneficial uses of water in the basin. The community of Orick and adjacent dairy-land area lie in a relatively small flood plain along the lower four-mile reach. The north coastal streams of California along the ocean are areas of high rainfall and flooding is almost an annual occurrence. Two floods along Redwood Creek in the last decade have caused heavy damage in the community. The floods of 1953 and 1955 inundated portions of Orick to depths of four feet, and damages from the more severe of the two, that of 1953, are estimated at about \$1,230,000, adjusted to April 1960 price levels and developments.

Studies show that construction of reservoirs for flood control storage is not economically feasible at the present time in either single or multiple-purpose projects. A local flood control project to protect the urban and rural developments in the Orick area is economically justified. The proposed plan of improvement provides for channel rectification, levees and revetment along the lower four miles of Redwood Creek. It would provide protection against a standard project flood which is approximately 50 percent greater than the maximum of record. Total cost of the project is estimated at \$2,850,000 (excluding preauthorization survey costs of \$50,000), of which \$2,580,000 would be Federal, and \$270,000 non-Federal for lands, easements and rights-of-way, and relocations. Average annual benefits are estimated at \$228,000 and average annual charges are \$129,000, including \$19,500 as the non-Federal cost for annual maintenance and operation of the completed works. This results in a favorable benefit-cost ratio of 1.8 to 1.0.

Local cooperation required by Federal flood control laws is assured. Humboldt County has indicated its willingness and ability to furnish assurances of cooperation.

The District Engineer recommends that the proposed project be authorized for construction, subject to the conditions that local interests provide assurances satisfactory to the Secretary of the Army that they will (a) provide without cost to the United States all lands, easements and rights-of-way necessary for construction of the proposed work, (b) hold and save the United States free from damages due to the construction works, (c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army, (d) make all relocations of buildings, utilities, roads, and related facilities necessary for the construction and maintenance of the project, and (e) prevent any encroachment on flood channels, or ponding areas, which will result in decreasing the effectiveness of the flood control improvements.

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
180 New Montgomery Street
San Francisco, California

SPNGP

August 1961

SUBJECT: Report of Survey on Redwood Creek, Humboldt County,
for Flood Control and Allied purposes

THRU: Division Engineer
U.S. Army Engineer Division, South Pacific
San Francisco, California

TO: Chief of Engineers
Department of the Army
Washington, D. C.

AUTHORITY

1. AUTHORIZATION OF INVESTIGATION

This report is presented pursuant to Section 204 of the Flood Control Act of 1954 (P.L. 780, 83rd Congress, 2d Session), approved 3 September 1954, which reads in part as follows:

"Section 204. The Secretary of the Army is hereby authorized and directed to cause preliminary examinations and surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to winds or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its Territorial possessions, which includes the following named localities: *** Redwood Creek, Humboldt County, California."

EXTENT OF INVESTIGATIONS

2. SUMMARY OF STUDIES

Investigations and studies were made of the need and the feasibility of providing flood control by reservoir storage and by levees and channel improvements. Investigations were also made of the need for additional water for consumptive use, and

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of the need for and feasibility of developing hydroelectric power in connection with multiple-purpose reservoirs. Preliminary analyses of benefits and costs indicate conclusively the lack of economic justification for flood control or water conservation by reservoir storage or for the development of hydroelectric power at this time. Detailed studies were limited, therefore, to levees and channel improvements to protect the developed area in the town of Orick and vicinity, the only significant urban development in the basin. Aerial photographs, flown in July 1957, were taken of the greater part of the Redwood Creek basin. These were supplemented by investigations of a proposed damsite and by instrumental surveys on the developed area at Orick and the data thus obtained were combined with the aerial photographs to develop suitable maps. These maps were used to delineate the area subject to flood damage and to present the proposed plan of improvement. Information concerning a Public Hearing in 1955 is given in subsequent discussions of this report.

3. ECONOMIC INVESTIGATIONS

The value of property in the flood plain was estimated by field inspection and appraisal, supplemented by reference to tax records, reports of sale of real property, and reports of earnings by business establishments. Estimates of damages by past floods were used as a basis for determining the average annual damage from future uncontrolled floods. A study was made also of development trends during past decades and this study was the basis for predicting future development and property values. Opinions of local interests were considered in these analyses.

4. GEOLOGICAL INVESTIGATIONS

A detailed surface examination was made of proposed damsites to establish a basis for determining the most suitable type of structure. Also, a field examination was made of the existing channel and adjacent valley in the vicinity of Orick, and available information concerning subsurface conditions was collected. Information thus obtained was supplemented by subsurface investigations and laboratory analysis of materials to determine the design requirements for levees and channel improvements. A field inspection was also made of a developed source of riprap.

5. EXAMINATION BY THE DISTRICT ENGINEER

The District Engineer made a reconnaissance of the basin including a detailed inspection of the Orick area.

6. REPORTS BY CORPS OF ENGINEERS

The only previous report by the Corps of Engineers was the preliminary examination completed in May 1956, in response to the congressional authority quoted in paragraph 1. The report concluded that prospective benefits appeared to be of such magnitude that a justified flood control project might be developed.

7. REPORTS BY OTHERS

General information concerning the Redwood Creek drainage basin is contained in report of the State of California, Department of Water Resources, Bulletin No. 3, the California Water Plan, dated May 1957. A preliminary report by the U.S. Department of the Interior also has general information on resource development in the Redwood Creek basin. That report is dated 1956 and the final report is scheduled for publication in 1961.

DESCRIPTION

8. LOCATION AND EXTENT

Redwood Creek discharges into the Pacific Ocean approximately 50 miles south of the Oregon-California border. The basin is an elongated area of approximately 283 square miles. It extends about 56 miles from northwest to southeast and has a maximum width of about seven miles. The upstream or south end of the basin is approximately 25 miles east of Eureka, California. The basin's only urban-type community is Orick located about 2-1/2 miles above the mouth.

9. STREAMS

The largest tributary to Redwood Creek is Prairie Creek which drains the northern part of the watershed and joins the main stream about 3-1/2 miles above its mouth. Prairie Creek drains an area of about 40 square miles, extending approximately 12 miles north of the junction of the two streams. Other tributaries are short, steep-gradient creeks which enter the main stream from each side throughout its length.

10. TOPOGRAPHY

The predominant topographic feature of the basin is its rugged, timber-covered hills and mountains which cover about 95 percent of the area and are cut by narrow, steep stream channels. The crest of the mountains which marks the drainage divide attain an elevation of

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5,000 feet above mean sea level. The only significant area of level land is the alluvial valley along the lower four miles of the main stream, and along the lower three miles of Prairie Creek. The flood plain of Redwood Creek in that four-mile reach varies from 2,000 feet wide at the upstream end to greater than 4,000 feet.

11. GEOLOGY

Redwood Creek flows north northwesterly for 50 miles through a narrow, V-shaped canyon and the channel is cut more or less along the fault contact between hard, blocky schist at the west and softer, Franciscan Group sediments at the east. The creek then flows westerly through its alluviated valley in its last four-mile reach to its mouth at the ocean. The alluvium throughout this lower reach is deeper than any of the subsurface explorations which reached a maximum depth of 25 feet.

12. SOILS

The portion of Redwood Creek drainage basin above Orick, which consists of about 95 percent of the basin area, is covered with a relatively deep mantle of soil developed from the weathering of the shale, schist, and metamorphic rock which form the base of the entire area. There is extensive intermingling of the harder more resistant pieces of the base rock in the fully developed loam. The combination of less pervious base material which underlies the soil mantle and of the heavy rainfall and dense vegetation creates a tendency for landslides on steep slopes. Soils in the valley in the vicinity of Orick are waterborne deposits brought down from the upstream areas and consist of a gravel sub-strata of unknown depth covered by a mantle of fine sand and silt several feet thick. This soil is very fertile.

13. STREAM SLOPES

The channel slope of Redwood Creek from the mouth of Prairie Creek downstream ranges from about ten feet per mile to 2-1/2 feet per mile near the mouth. The present thalweg increases in elevation from ten to approximately 18 feet above mean sea level in the short distance from the Orick bridge to the confluence of Prairie and Redwood Creeks. For approximately three miles above the mouth of Prairie Creek, the average slope of the Redwood Creek channel is about 12 feet per mile. Above this point the slope increases progressively to over 100 feet per mile. Average slope of Prairie Creek is about 60 feet per mile.

14. CHANNEL DIMENSIONS AND CAPACITIES

The channel of Redwood Creek through the lower four-mile alluvial valley ranges from about 200 feet to over 500 feet in width and from 12 to about 20 feet in depth. It is obstructed in many places by growths of willows and other vegetation along the bank and on the gravel bars between the banks. The bankfull capacity at Orick is about 17,000 cubic feet per second. Extensive flooding takes place when the flow is above 35,000 cubic feet per second. A large lagoon located near the mouth of Redwood Creek is separated from the Pacific Ocean by a bar and low beach lands. The bar is scoured out during high flows of the stream but silts up by tidal action during low flow discharges.

15. VEGETATION

The mountainous portion of the Redwood Creek basin is covered with dense growth of forest timber consisting primarily of first and second growth redwood. Vegetation in the alluvial valleys consists of native grass with some brush and willows along the banks of the stream. The main valley in the vicinity of Orick and along the lower reach of Prairie Creek has been cleared and developed for agricultural use. Hay is the principal harvested crop. The area is also used extensively for pasturing dairy cattle.

ECONOMIC DEVELOPMENT

16. POPULATION

The principal community in the Redwood Creek basin, the town of Orick, has a resident population estimated at 900. Orick is also a stopping point for sportsmen and tourists and is the base of operations for a considerable number of people employed in the lumber industry. The Humboldt County Chamber of Commerce estimates that about 1,000 people are employed in the lumber industry in the basin.

17. OCCUPATIONS AND INDUSTRIES

The major industry of the Redwood Creek basin centers around lumber. There are four large mills in the vicinity of Orick and several smaller mills along the lower reaches of Redwood Creek and along Prairie Creek. California redwood is the most important timber although there are also significant stands of Douglas Fir. It is estimated that there are about five-billion board feet of lumber in the basin. Most of the timber lands are being operated on a sustained yield basis which alleviates the threat of timber depletion and assures the economic future of the area. The town of Orick contains several general stores, motels, service stations, and other establishments catering to the local residents and summer tourists. Large numbers of livestock are grazed in the upland areas, and the alluvial valley in the vicinity of Orick is highly developed for dairy production.

18. LAND USE AND DEVELOPMENTS

Urban developments at Orick cover about 120 acres on the valley floor and some residential development on the hills to the north. This latter development may be the result of the flood threat on the valley floor. The upland area is excellent for growing timber suitable for commercial use. Change in use of land in this upland area is not anticipated.

19. NATURAL RESOURCES

The chief natural resource of the Redwood Creek Basin is commercial timber. The gravels in the stream channel in the vicinity of and upstream from Orick are an excellent source of aggregates for concrete and surfacing material for highway construction. Redwood Creek and many of its tributaries are good spawning grounds for anadromous fish. Deer and other game animals are found in considerable numbers throughout the basin.

20. TRANSPORTATION AND COMMUNICATIONS

Highways and roads provide the only means of ground transportation. The nearest airport is at Eureka-Arcata, about 30 miles to the south. There are no railroads or shipping ports. The main source of transportation is Highway U.S. 101, the principal arterial highway along the west coast of California. The upstream portion of the basin is crossed by Highway U.S. 299, the transmountain highway from the Pacific Coast to the Sacramento Valley. An improved county road traverses the ridge that marks the northeast boundary of the basin. It extends from the mouth of Prairie Creek to the northwest corner of the Hoopa Valley Indian Reservation. Bus lines provide passenger service and trucks provide for the movement of freight, chiefly lumber. Telephone and telegraph service is available in Orick.

21. DEVELOPMENT TRENDS

Although the town of Orick has sustained severe damage from floods on two occasions during the past decade, developments here and throughout the basin follow the general development trend of California. There is an urgent demand for additional housing to accommodate both permanent and transient people. Also, a need exists for additional business establishments to serve the growing lumber industry and to cater to the needs of tourists. The county road extending along the northeasterly boundary of the basin has recently been improved to provide better access to timber lands. A large modern sawmill, designed primarily to process redwood timber, was completed during the summer of 1959 near the intersection of this county road and U.S. Highway 101. Electricity from the lines of the Pacific Gas and Electric Company is available.

22. CLIMATE

The climate of the Redwood Creek basin is influenced by its nearness to the Pacific Ocean and is characterized by mild summers and local diurnal fog, and mild wet winters. Fogs are prevalent in the lower part of the basin; less summer fog and a greater diurnal temperature variation exists in the inland portion of the basin. The entire basin is characterized by a rainfall season extending from October through April, during which about 90 percent of the average annual precipitation occurs.

23. TEMPERATURES

The mean annual temperature in the basin is about 51 degrees Fahrenheit. Both diurnal and seasonal variations increase progressively from the alluvial valley at Orick to the headwaters. Extreme temperatures of record in the vicinity of Orick range from a high of 95 degrees to a low of 19 degrees, whereas, near the headwaters, this range is from 105 degrees to -2 degrees. Near the coast, the daily range of temperature is usually very small, often not more than two or three degrees. The warmest months are July and August and the coldest is January, the estimated average of which is 67 degrees and 35 degrees respectively.

24. PRECIPITATION

The average annual precipitation is estimated at about 80 inches and ranges from 70 inches in the lower portions to over 84 inches on the high ridges. December is the wettest month, with 16.7 percent, and August the driest, with 0.4 percent of the mean annual precipitation. Snowfall is insignificant near the coast, but moderate at high elevations; however, low temperatures are seldom of sufficient duration to allow the accumulation of any great depth of snow. Ten inches of rainfall from a single storm of about three days duration is not uncommon.

25. STORM RECORDS

Storms that produced damaging floods occurred in December 1937, January 1950, January 1953, and December 1955. Storms which produced floods of considerable magnitude are also reported to have occurred in 1880, 1889, 1903, 1904, and 1920.

RUNOFF AND STREAMFLOW DATA

26. RECORDS

Significant streamflow measurements have been made at three locations in the Redwood Creek Basin. Recording gages have been maintained

and operated by the U.S. Geological Survey since 1953 at Orick, and near the Highway U.S. 299 crossing of Redwood Creek. The streamflow was also measured from 1911 through 1913 on Redwood Creek at Orick and at one location in the headwaters. A Corps of Engineers staff gage, installed at Orick in 1949, was used for observations of the 1950 flood stage. Stream gaging stations and recorded extreme flows in Redwood Creek are summarized as follows:

STREAM-GAGING STATION DATA

Item	Location on Redwood Creek		
	<u>At Orick</u>	<u>Near Korbelt</u>	<u>Near Blue Lake</u>
a. Period of record	1911-13, Oct 1953-present	1911-13	1953-58
b. Drainage area in square miles	278.0	82.8	67.5
c. Maximum flow:			
Date	22 Dec 1955	17 Feb 1912	21 Dec 1955
Stage in feet	24.0	12.6	13.6
Magnitude in c.f.s.	50,000 ^{1/}	7,410	12,100
Five-day flood run- off, in acre-feet	164,000	27,800	44,900
d. Minimum flow in cubic feet per second	10	2	5
<u>1/</u> Also occurred in January 1953. Information from staff gage reading			

27. RUNOFF CHARACTERISTICS

Average annual runoff for the basin above the Orick gage during seven years of record is 854,700 acre-feet. The average annual runoff from Redwood Creek during a long representative period is estimated to be about 750,000 acre-feet, representing an average depth of 50 inches over the basin. Appendix A, Hydrology, contains further hydrologic details.

28. ADEQUACY OF RECORDS

Runoff and streamflow data from the Redwood Creek Basin alone would be inadequate for reliable determination of flood-frequency

relationships, yields of water for conservation purposes and other related water resources features. It was possible to extend the date, however, by correlation with adjacent areas, with similar topography, climatic conditions, and having longer periods of record to obtain values which are considered satisfactory for purposes of this report.

FLOODS OF RECORD

29. FLOOD CHARACTERISTICS

Floods are the result of rainfall, and they develop rapidly, with the peak being reached about a half a day after occurrence of flood-producing rainfall. During the 1955 flood, one of the two largest of record, the flow at Orick increased from 10,000 cubic feet per second to the peak of 50,000 cubic feet per second in approximately 14 hours, and was above 17,000 cubic feet per second (bankfull capacity) for about 32 hours. The volume of runoff was 164,000 acre-feet, or 11 inches over the basin, during the five-day period 21-25 December. During occurrence of the standard project flood, it is estimated that flows in excess of 17,000 cubic feet per second would continue for approximately 60 hours. Detailed information concerning the characteristics of the floods in Redwood Creek drainage basin is presented in Appendix A - HYDROLOGY.

30. HISTORICAL FLOODS

The only major floods which occurred since installation of the recorder gage are those of 1953 and 1955, each of which produced a peak discharge of 50,000 cubic feet per second at the gage on Highway U.S. 101 bridge at Orick. Based on field observations of the staff gage at Orick, it was estimated that the January 1950 flood attained a peak flow of 37,000 cubic feet per second. During a public hearing in Orick, residents of the area mentioned that floods occurred also in 1889 or 1890, 1921, 1927, 1935 and 1937. Significant data on heights reached, or damages caused by these earlier floods are not available.

31. FLOOD FREQUENCIES

Flood frequency curves have been developed for purposes of economic evaluations. The curves are based on streamflow records in the Redwood Creek basin correlated with recorded stream flows in other nearby streams such as Klamath-Trinity Rivers, Mad River and Eel River. The resulting curves indicate that bankfull stages of 17,000 cubic feet per second in Redwood Creek would have a chance of occurrence of once in two years. The 1953 and 1955 floods with peak discharges of 50,000 cubic feet per second would occur about once in 15 or 20 years. Derivation of frequency curves and the graph thereof are given in Appendix A.

32. DEFINITION

A standard project flood is a hypothetical flood approximating that which would result if the most critical storm of record in the region should occur over the drainage area under consideration when conditions were reasonably favorable for flood runoff. It is quantitatively estimated to determine the upper limit of flood protection which might be sought.

33. DERIVATION

Only general type storms are critical over basins of the size of the Redwood Creek basin in this coastal area. The general storm of 21-24 December 1955, which centered in the Dos Rios-Laytonville area, was transposed to derive the standard project storm. The transposed storm has a duration of 72 hours and results in 17.8 inches of precipitation over the 278 square mile drainage area above Orick.

34. STANDARD PROJECT FLOOD FLOW

The estimated peak of the standard project flood at the highway bridge in Orick is 77,000 cubic feet per second, and was obtained by use of the standard project storm and the unit hydrograph developed from analysis of characteristics of known floods. Derivation of the standard project flood is given in Appendix A, "Hydrology." The standard project flood was approved by the Chief of Engineers prior to completion of this part of the report.

EXTENT AND CHARACTER OF FLOODED AREA

35. LOCATION AND EXTENT

The flooding extends from about stream mile 4 downstream to the mouth. The flood plain area within the limits of the proposed project is estimated at about 1,950 acres, including the waterway area of Redwood Creek. Due to the steepness of the hills at the edge of the flood plain in Orick Valley, the flood plain of the standard project flood would be only slightly larger than that shown on Plate 1 for the 1953 and 1955 floods.

36. TYPE AND VALUE OF IMPROVEMENTS IN FLOOD PLAIN

Improvements subject to inundation and flood damage consist of homes and business establishments in Orick, Highway U.S. 101, county roads, local streets and roads, and improved farm lands. There are approximately 360 houses and 38 business establishments in Orick.

A relatively large shopping center on the right bank near the Orick bridge opened for business in July 1960. Business establishments include stores, restaurants, motels, hotels, service stations, and house-trailer parks. There is also a school valued at \$500,000, a post office, a telephone office, and an electric power sub-station. Several lumber companies also have mills and other installations on the flood plain in the vicinity of Orick. The estimated gross value of land and improvements in the flood plain is given in the following tabulation:

Residential	\$ 4,375,000
Schools and churches	725,000
Commercial	2,000,000
Industrial	2,100,000
Agricultural	<u>1,300,000</u>
TOTAL	\$10,500,000

37. PHYSICAL AND ECONOMIC FACTORS

Past floods have inundated industrial, commercial, residential and farm-land areas to depths of four feet. This causes considerable damage to lumber stock; commodities and stock in business establishments; residential property and home furnishings, farm houses, and related developments; and loss of crops, damage to pasture, and deposition of debris. There is record of the loss of one life in the 1953 flood and there are possibilities of other such losses, since any warning system involved may not function adequately or at opportune times. Flooding causes periodic and costly delays in transportation facilities and business activities in proportion to the severity and duration of flood stages. Local people find it difficult to obtain loans for the construction of improvements in the flood plains. However, the trend for development is upward, and damages from future flooding will be increased thereby.

FLOOD DAMAGES

38. TYPES OF DAMAGE

Floods in the valley near Orick cause damage by inundation, erosion, and deposition of silt and debris. The Redwood Creek drainage basin is a heavily forested area and the stream carries a large amount of brush, large trees, and other debris. This debris is deposited on the overbank areas, resulting in high cleanup costs. Floating debris may also strike, or be lodged against buildings and other structures, thereby causing structural damage and increasing the difficulties of

post-flood cleanup. There is also some tendency for the stream to meander at flood stages and a considerable amount of valuable land is lost by erosion.

39. DAMAGES FROM PAST FLOODS

Data on damages were obtained for the floods of January 1950, January 1953 and December 1955. The latter two of these floods which were the highest of record, inundated most of Orick to maximum depths of four feet and caused extensive damage to buildings and contents, including general merchandise. Although these two floods were of the same magnitude, 50,000 cubic feet per second, the damages from the 1953 flood within the project limits were \$941,000 as compared with \$568,000 for the 1955 flood. The principal reason for this difference can be ascribed to the fact that local interests had prepared evacuation plans, in the interim, which proved effective in reducing damages in 1955. It is considered that local interests were fully alert to the flood damage potential when the December 1955 flood occurred. It can be expected, however, that the tendency will be toward increased laxity in effecting evacuation plans as more time elapses between occurrence of large floods. For evaluation purposes, the average damage of the two floods has been adopted. The estimated damages within the project limits for the January 1950, January 1953, December 1955, and the standard project floods, adjusted to April 1960 price levels and developments, are summarized in the following tabulation:

FLOOD DAMAGES (April 1960 Price Levels and Developments)

Type	Damages sustained within limits of Proposed Project				Standard Project Flood
	1950	1953	1955	Average 1953-55	
Residential	\$ 24,000	\$ 245,000	\$ 81,000	\$ 163,000	\$ 344,000
Public Facilities	32,000	315,000	56,000	186,000	447,000
Commercial	41,000	403,000	266,000	335,000	568,000
Industrial	1,000	156,000	231,000	193,000	206,000
Agricultural	82,000	115,000	56,000	85,000	155,000
TOTAL	\$180,000	\$1,234,000	\$ 690,000	\$ 962,000	\$1,720,000

40. AVERAGE ANNUAL DAMAGES

Average annual damages have been computed by standard analysis from the relationships between damage, discharge, and frequency of flood occurrence. The value thus obtained was then adjusted to reflect the expected future growth in the flood plain in the absence of a flood

control project. The resulting average annual flood damages under 1960 stream conditions and with future development are estimated at \$248,000. More detailed information on derivation of this figure is given in Appendix D.

EXISTING CORPS OF ENGINEERS' FLOOD-CONTROL PROJECTS

41. GENERAL

No Corps of Engineers flood control projects have ever been authorized by Congress for the Redwood Creek basin. Emergency bank protective works, however, were constructed along two reaches of the left bank in and near Orick in 1953 and 1956 under authority of Section 14 of the Flood Control Act of 24 July 1946. The Federal cost for these works was approximately \$83,000. This work consisted of bank stabilization along about 1,500 lineal feet near stream mile 1.9 and about 2,000 lineal feet upstream from the Orick bridge.

IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

42. FEDERAL

Other Federal agencies have not constructed improvements for flood control or water utilization in the Redwood Creek basin.

43. NON-FEDERAL

There are no storage facilities for flood control or related water utilization by non-Federal governmental agencies in the Redwood Creek basin. Corporations, governmental agencies, and individuals owning land adjacent to the creek have constructed bank-protection works and earth levees at a few isolated locations. About 1,800 lineal feet of low earth levee is on the right bank near river mile 2.1 and 2.4. About 400 feet of dumped stone protects the highway on the right bank downstream from and near the mouth of Prairie Creek. A short reach of dumped stone has been placed at an eroding right bank near river mile 1. Willows have been planted along the bank at numerous reaches to reduce velocities and prevent bank erosion. This work is rather piecemeal in nature and provides little protection against major floods.

IMPROVEMENTS DESIRED

44. PUBLIC HEARINGS AND INTERVIEWS

A public hearing held in Orick on 1 November 1955 was attended by approximately 70 persons. In attendance were the members of Congress from that district, the State Senator, the State Assemblyman, representatives from the U.S. Bureau of Reclamation, the U.S. Forestry Service,

and the U.S. Weather Bureau. Also in attendance were representatives of the California State Department of Water Resources, the California State Division of Highways, the Humboldt County Board of Supervisors, the Humboldt County Chamber of Commerce and other civic organizations; and, interested residents of the area.

45. IMPROVEMENTS DESIRED

Local interests did not present any specific plan for flood control or related water utilization. However, they expressed the desire that the Corps of Engineers study the problem and develop an effective plan of improvement. Local spokesmen requested consideration of multiple-purpose reservoirs for flood control and hydroelectric power. It was suggested, also, that a channel be excavated to divert a portion of Redwood Creek flows to the ocean through the valley drained by Skunk Cabbage Creek, which joins Prairie Creek from the west about one mile above its mouth.

46. JUSTIFICATION FOR IMPROVEMENTS DESIRED

Local interests expressed the opinion that channel improvements would be justified by the prevention of inundation and erosion damages to the town of Orick and the adjacent agricultural property. They also expressed the opinion that any works which made the town secure from flood damage would restore land values in the flood plain and result in some increased residential developments. Meetings have been held with local interests, subsequent to the public hearing, at which the progress of the investigations was discussed, the general features of the plan of improvement were described, and the requirements of local cooperation were presented. Acceptance of the plans and the requirements of local cooperation were favorably considered at these meetings.

FLOOD PROBLEMS AND SOLUTIONS CONSIDERED

47. GENERAL

Due to the narrow, timbered canyon of Redwood Creek and the limited area of economic development, the flood problem generally is confined to the town of Orick and vicinity. Two major floods in the last 10 years have severely damaged the community and the adjoining farm lands throughout the lower 4 miles of the stream. Bank erosion is a factor contributing to heavy losses. Consideration has been given to flood protection by upstream storage reservoirs, and by various types of channel improvements. The diversion of Redwood Creek flows to water deficient areas of the State is so far in the future that studies of such a possibility are precluded from consideration at this time.

48. EVACUATION AND FLOOD PLAIN ZONING

Evacuation of people from the flooded area has been accomplished during past major floods. However, the degree of economic development in the community and the cost involved in complete abandonment of the flood plain is not considered practicable or feasible. The small valley with limited area for development and production is an important factor to the local lumber industry and to the economics of a large adjoining land area lying between Eureka and Crescent City. Flood-plain zoning under the proposed plan of improvement would be unnecessary.

49. UPSTREAM STORAGE

Consideration was given to control of storm runoff by upstream storage. Preliminary studies were made for two dams, one near the upstream crossing of U.S. 299 and one near river mile 7 on the main stream. The upstream site, about 35 miles from the mouth, would control an insufficient area to adequately reduce flood stages in the lower reaches and is economically infeasible. Storage for flood control is not economically justified under present conditions in either single or multiple-purpose reservoirs. The other site investigated is upstream from the mouth of McArthur Creek near river mile 7. A dam at this location would control the major portion of the drainage basin but costs would far exceed the prospective benefits.

50. CHANNEL IMPROVEMENTS

The limited economic development in the lower valley precludes the use of any type channel improvements other than channel rectification, levees and partial revetment. Consideration was given to a relatively narrow, trapezoidal channel type and to a wider, offset levee type system. The proximity of costly local improvements to the banks of the river throughout the town of Orick showed the need for use of a minimum-width, trapezoidal-type channel through the well developed portion of the town. Consideration was given to diversion of Prairie Creek waters through Skunk Cabbage Creek. The cost for such a plan was found to be excessive in comparison with expected benefits. Lengthy excavated cuts (some of which would be in excess of 50 feet in depth) would be required through a coastal ridge.

FLOOD CONTROL PLANS

51. GENERAL

The plan found to be most feasible for resolving the flood problem on Redwood Creek provides for channel improvements along

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the lower four miles of the stream. The improvements would consist of channel enlargement, earth levees with service roadways on both sides of the channel, dumped stone revetment along most of the levee and riverbank length, and other features pertinent to a channel improvement project. The works would extend from above the mouth of Prairie Creek (on the left bank) almost to the ocean. Details of specific phases of work are given in the paragraphs which follow. Local geologic and soil conditions and availability of construction materials are favorable for the type work proposed herein. Details pertinent to the drainage basin, plan, profile and typical sections are shown on Plates 1 and 2.

52. PROJECT FORMULATION

The degree of protection and type of facility recommended is established in accordance with the basic principles of project formulation and evaluation giving full consideration to the engineering and economic factors involved. Business and residential developments, existing and foreseen, in and near Orick warrant urban-type flood protection. Therefore, project formulation envisions protection against the standard project flood, if economically justified. Types of solutions studied included flood protection by reservoirs, channel improvement, levees, and by a combination of levees and channel improvements. A discussion of flood control by means of reservoirs is contained in paragraph 49 of this report. As indicated therein flood control by use of reservoir storage is not economically justified at this time. Flood control by means of channel improvements alone would be more costly than the proposed plan. A combination of channel improvements and levees is considered to be the most economical solution to provide flood protection to the Orick area. On the left bank, the upstream levee tie-in could be made to high ground southeasterly from near the south abutment of the Orick bridge. However, the relatively small additional cost of extending the levee to protect level ground on the left bank is considered justified by prevention of flood damage to existing development, by probable future development in the area, and by the inability to convince local interests that damages on the left bank would not be increased by confining flows with the required right bank levee. The right bank levee was extended upstream to high ground for protection of a residential area and a portion of Highway U.S. 101. Downstream limits of the project were selected to provide adequate flood protection for the area at minimum cost. It is believed that backwater flooding will be minor with levees as proposed.

53. HYDRAULIC DESIGN

The design discharge for the standard project flood is 77,000 c.f.s. Water surface profiles under proposed channel conditions were computed by standard methods and are shown on Plate 2. Mean computed velocities of 12 feet per second would predominate

although velocities of 19 feet per second would occur under drawdown of floodwaters to natural channel level at the downstream end of the levees. A freeboard of 3 feet has been used to allow for variations from computed water surface, wave action, and irregularities of channel bottom under bedload movement. Drainage culverts would be provided to pass local runoff through the levee system. A pumping plant would remove excess local runoff from the tributaries when interior drainage would not have gravity flow to the main stream.

54. CHANNELS AND LEVEES

The subsurface soils are predominantly fine silty sand and sandy silt with some clays overlying sands and gravels. The fine grained materials vary from 5 to more than 25 feet in depth. The depth of underlying sands and gravels was not determined. The constricted nature of the channel due to brush, tree growth and gravel bars has created a condition that requires correction to improve hydraulic characteristics of the stream. Stream deposits and natural banks near Orick Bridge would be removed to provide a uniform channel through the town portion of the project. A large channel change near the mouth would provide for more direct and effective flow into the Pacific Ocean. The existing sandbar at the mouth would not be removed as a part of the construction since it is anticipated that stream velocities would effectively scour this bar out prior to occurrence of peak flood flows, even though it would be filled in each year during low flows. Additional waterway area would be provided by bank shaping excavation which would provide materials for levee embankment. The improved channel would have a minimum bottom width of 250 feet.

55. Levees would be constructed continuously along both banks of the river almost to the Pacific Ocean. The central portion of the levee would be constructed of the fine-grained material contained in the relatively impervious soils of the channel embankment. The upstream ends would tie-in to high ground to prevent flanking of the improvements. The tie-back on the right bank would cross Highway U.S. 101 and would involve raising of the highway. Downstream ends of the levees would have short flares and then dead-end at locations sufficiently far downstream to minimize effects of backwater. The plan provides for toe drains along a portion of the left and right banks downstream from and adjacent to the town. The levees would be constructed with a 12-foot top width, and slopes of one vertical on 3 horizontal on the riverside and one on 2-1/2 on the landside. Dumped stone riprap would be placed in critical sections where stream velocities require protection. The quarry stone riprap would vary from 12 to 24 inches thick and would extend from top of levee to a minimum of 5 feet below improved or natural channel bottom, or to natural ground after stripping along offset levees. Fine-grained bank slopes would be covered with a 6-inch layer of river-run gravels

before placement of riprap. Riprap and filter gravel thickness would be increased by 50 percent where materials are placed under water. See Plate 2 for channel alignment, and levee and revetment details, and Appendix C, Bases for Design and Cost Estimates for supporting data.

56. DRAINAGE FACILITIES

Facilities for removal of local runoff from behind the levee system would be required only at a single location. These facilities would consist of a battery of gated culverts through the levee to prevent flood flow onto protected areas during high flood stages of Redwood Creek. A pumping plant would be installed near this drainage facility to remove floodwaters which would collect behind the levee with the flapgates closed due to high water in the stream. Culvert and pumping plant locations are shown on Plate 2.

57. RELOCATIONS

The proposed works would require a number of relocations of buildings and utilities, which would be a responsibility of local interests. Buildings would have to be moved; roads and streets reconstructed; and utility poles, fences, sewer and water lines would require relocation. A short reach of Highway U.S. 101 road grade would need to be raised to the grade of the right bank levee at the upstream end. Additional details of this phase of work are shown in Appendix C.

58. CONSTRUCTION MATERIALS

Quarry stone for riprap would be secured from the Trinidad site located about 20 miles south of the project (see Plate 1 for location). Materials for levee embankment would be secured from channel excavation. Additional details on sources of materials are contained in Appendix B.

ESTIMATES OF COSTS

59. GENERAL

Unit prices used for the cost estimates in this report are based upon price levels of July 1960. An adequate allowance has been included for contingencies, engineering, supervision and administration. The total cost of the project is estimated at \$2,900,000 and the works could be completed within a two-year period. As explained later in this report and in Appendix C, local interests would provide all lands easements and rights-of-way; relocate roads, bridges and utilities; and maintain and operate the project after completion. Distribution of first costs between the Federal government and non-Federal interests is given in the following tabulation:

SUMMARY COST ESTIMATE

Federal cost

Channel and levees	\$ 2,580,000	
Preauthorization studies	<u>50,000</u>	
TOTAL FEDERAL FIRST COST	\$ 2,630,000	
Less preauthorization studies	<u>-50,000</u>	
Required Federal appropriation		\$ 2,580,000

Non-Federal cost

Lands	\$ 160,000	
Relocations	<u>110,000</u>	
TOTAL NON-FEDERAL FIRST COST		\$ 270,000
TOTAL PROJECT FIRST COST (less preauthorization studies costs)		\$ 2,850,000
Preauthorization studies		<u>50,000</u>
TOTAL PROJECT COST		\$ 2,900,000

60. ANNUAL CHARGES

Average annual charges are based on a 50-year project life and include interest on, and amortization of, the initial investment at current rates of interest; and an estimated amount for annual maintenance and operation of the project after construction. An interest rate of 2-5/8 percent is used for Federal costs and 4 percent for non-Federal costs. An adjustment was made, also, to reflect the loss of return on the portion of lands required for the project which would be taken out of production. Since the project would be constructed in less than two years and benefits would accrue as construction is performed, interest

during the construction period has not been included. Total average annual charges are estimated at \$129,000 of which \$19,500 is the estimated amount for replacements and annual maintenance and operation which are a responsibility of local interests. Summary of annual charges is as follows:

Federal		\$ 95,000
Non-Federal		
Interest and amortization	\$ 13,000	
Adjustment for loss of productivity	1,500	
Maintenance and operation	<u>19,500</u>	<u>34,000</u>
TOTAL AVERAGE ANNUAL COST		\$ 129,000

ESTIMATE OF BENEFITS

61. GENERAL

Flood control benefits are the difference in average annual flood damages without the proposed project and with the project constructed. Benefits creditable to the flood protective works are (a) flood control for prevention of future flood damages and (b) land enhancement due to increased land-use after flood protection is realized. Appendix D presents details and analysis of flood damages and flood control benefits.

62. FLOOD CONTROL BENEFITS

Benefits creditable to the flood control improvements are (a) prevention of flood damages due to inundation and bank erosion; (b) elimination of costs for flood fight, relief and evacuation, and debris clean-up; and (c) reduction of intangible damages including possible loss of life. Total average annual damages are estimated at \$248,000. Residual damages of \$26,000 annually are expected to continue to occur, which results in net average annual flood control benefits to the proposed project of \$222,000.

63. INCREASED UTILIZATION BENEFITS

Benefits attributable to higher utilization of lands, made possible by providing flood protection, are the increase in earning power of the 50 acres in Orick due to the elimination of the flood hazard. The net increased earning power is determined from reduced amounts due to the additional investment that must be made in order to realize the increased use of those lands. These benefits are evaluated on the basis of probable future use and are estimated

to be \$6,000, as derived in in Appendix D.

64. OTHER COLLATERAL BENEFITS

Collateral benefits attributable to purposes other than flood control, such as sanitation, pollution abatement and protection against epidemics, are insignificant. Recreation facilities would be improved in that facilities within the protected area would not suffer flood damages and the area would be more inviting to tourists, fishermen and hunters. Intangible benefits such as prevention of loss of life, impairment of health and living conditions, loss of wages, or profit because of interruption of business activities and related matters have not been evaluated.

65. ADVERSE PROJECT EFFECTS

It is recognized that the confining nature of the proposed channel and levee project will create certain conditions which have the potential for adverse effects. Floodflows which previously spread over the flood plain will now be restricted to a relatively narrow channel. The upstream funnel-shaped entrance levees would tend to create somewhat higher backwater conditions. However, this increase would be insignificant and would only affect a short reach of unimproved, narrow canyon along Redwood Creek. The downstream open-ended levees with a controlled direction of released flows may cause erosion and flood stages dissimilar to those which would occur naturally. However, the overall beneficial effects from more efficient floodflow into the ocean and reduced flood stages in the waste-land areas far exceed the adverse effects. An allowance has been included in costs for lands and easements to adequately cover the minor detrimental effects of modified erosion or land inundation.

66. TOTAL BENEFITS

The total average annual benefits are estimated at \$228,000. These consist of \$222,000 flood control benefits and \$6,000 land enhancement benefits.

ECONOMIC JUSTIFICATION

67. BASIC PRINCIPLES

The proposed plan of improvement is developed on the basis of providing the most practicable and economically feasible method of alleviating the flood problem in the lower reaches of Redwood Creek.

The degree of protection the project would provide, that of the standard project flood magnitude, is consistent with sound engineering concepts for protection of urban areas by means of channel enlargement and levees.

68. ECONOMIC JUSTIFICATION

Evaluated average annual benefits attributable to the proposed project are estimated at \$228,000. Average annual costs are estimated at \$129,000. The resulting benefit-to-cost ratio is 1.8 to 1.0 and the proposed improvements are considered to be economically justified.

PROPOSED LOCAL COOPERATION

69. GENERAL POLICY

In accordance with existing legislation and policies, local interests will be required to furnish assurances of cooperation satisfactory to the Secretary of the Army that they will: (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project; (b) hold and save the United States free from damages due to the construction works; (c) maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of the Army; (d) provide without cost to the United States all relocations of buildings, roads, public utilities, and related facilities; and (e) provide assurances that encroachment on improved channels or ponding areas will not be permitted.

70. LOCAL SPONSORSHIP

Local individuals and representatives of a local improvement association have expressed interest in securing a project for flood damage presentation. Officials of Humboldt County are familiar with conditions and past floods, and have indicated their willingness to sponsor the project. The plans, cost estimates and requirements of local sponsorship were reviewed with local interests on 10 October 1960. Officials of Humboldt County and the town of Orick, townspeople, and adjacent landowners were present at this meeting.

71. A letter of intent to furnish the assurances of local cooperation has been received from Humboldt County and is included in Appendix E, Exhibit D.

72. GENERAL

Phases of the survey studies have been coordinated with Federal, State and local governmental agencies. Coordination with Federal and State agencies has been accomplished to insure that objectives, responsibilities and plans of other agencies have been considered. Comments of other agencies are contained in Appendix E.

73. FEDERAL AGENCIES

The U.S. Fish and Wildlife Service indicate that project effects on wildlife would be temporary and minor. Possible adverse effects on fish habitat could be minimized by adopting certain construction precautions. Representatives of the U.S. Bureau of Reclamation offered no adverse comments, following a review of the general plan of improvement.

74. STATE AND LOCAL AGENCIES

The California State Department of Water Resources has been informed of the studies. The California Division of Highways was advised of the proposed project and an offer was extended to cooperate as necessary in the future. Officials of Humboldt County and local people in the Orick area have reviewed the plans, costs and requirements of sponsorship for a Federal flood control project.

DISCUSSION

75. GENERAL

The only economically important area of developed lands in the Redwood Creek drainage basin is the alluvial valley along the lower four miles of the main stream. This area contains the town of Orick, the principal business center in the 90-mile reach from Arcata to Crescent City, California. Orick has a population of about 900 and is the center of a rich dairy farming area of about 1,000 acres lying within the flood plain. The town contains several general stores, motels, service stations, lumber mills, a school, post office and other establishments which serve the town and recreation and tourist trade. The agricultural area is an important link in the local economy due to the great distance to other business centers. The town of Orick and its adjacent

rural area sustained damages amounting to \$1,234,000 from the flood of January 1953 and of more than \$600,000 from the flood of December 1955. Peak discharges from these floods approximated 50,000 cubic feet per second and caused inundation to depths of four feet in the business and residential areas of the town and adjacent farming areas. Damaging floods may be expected to occur on an average of once every five years. Floods equal to the 1953 and 1955 floods are expected to occur on an average of once in 15 to 20 years.

76. PLAN OF IMPROVEMENT

Studies show that flood control by means of storage in either single or multiple-purpose reservoirs is not economically justified at this time. A system of channel improvements consisting of channel rectification, levees and partial revetment would provide solution of the local flood problem. The proposed project would give protection against the standard project flood discharge of 77,000 cubic feet per second. The total first cost of the project is estimated at \$2,900,000. The Federal cost would be \$2,580,000, exclusive of preauthorization studies costs of \$50,000. Non-Federal costs would total \$270,000 for lands, easements and rights-of-way, and for relocations. Average annual costs to non-Federal interests for maintenance and operation of the project are estimated at \$19,500. Average annual charges amount to \$129,000 and average annual benefits are estimated at \$228,000. The resulting benefit-to-cost ratio is 1.8 and the project is economically justified.

77. LOCAL COOPERATION

The Board of Supervisors of Humboldt County has indicated its willingness and ability to furnish the assurances of local cooperation. Local interests recognize the urgent need for flood control and are in favor of the project.

78. SENATE RESOLUTION 148

Additional information on recommended and alternative projects called for by Senate Resolution 148, 85th Congress, adopted 28 January 1958, is contained in Attachment I to this report.

CONCLUSIONS

79. These studies show that:

- a. Flood control by reservoir storage is not economically justified at this time.
- b. Practically all of the flood damage in Redwood Creek Basin is in the lower alluvial valley in and near Orick.
- c. Urban development in Orick warrants a high degree of protection corresponding to the standard project flood magnitude.
- d. The proposed project would provide flood protection for the community against floods equal to the standard project flood discharge. Total cost of the project is \$2,900,000. Average annual costs are estimated at \$129,000 and average annual benefits are estimated at \$228,000. The project is economically justified by a benefit-to-cost ratio of 1.8 to 1.0.

RECOMMENDATIONS

80. The District Engineer recommends that:

a. The United States adopt the proposed project for flood control on Redwood Creek, Humboldt County, California, consisting of channel improvements and levees in the lower four miles of the stream, as a means of providing protection to the town of Orick and vicinity, at an estimated Federal cost of \$2,800,000 exclusive of preauthorization studies costs.

b. That construction of the project be subject to such reasonable modifications as, in the opinion of the Chief of Engineers, may be deemed advisable at the time of construction, and subject, also, to the condition that local interests give assurances satisfactory to the Secretary of the Army that they will:

(1) Provide without cost to the United States all lands, easements and rights-of-way necessary for construction of the project.

(2) Hold and save the United States free from damages due to the construction works.

(3) Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army.

(4) Make all relocations of buildings, utilities, roads, and related facilities necessary for the construction and maintenance of the project.

(5) Prevent any encroachment on flood channels, or ponding areas, which will result in decreasing the effectiveness of the flood control improvements.

JOHN A. MORRISON
Colonel, Corps of Engineers
District Engineer

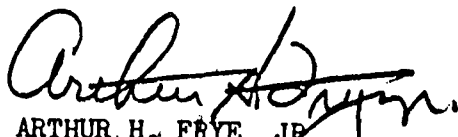
SPDGP (Aug 61).

SUBJECT: Report of Survey on Redwood Creek, Humboldt County, for Flood Control and Allied Purposes

U S Army Engr Div, South Pacific, San Francisco, Calif 26 September 1961

TO: Chief of Engineers, DA, Washington, D. C.

I concur in the conclusions and recommendation of the District Engineer.


ARTHUR H. FRYE, JR.
Colonel, Corps of Engineers
Division Engineer

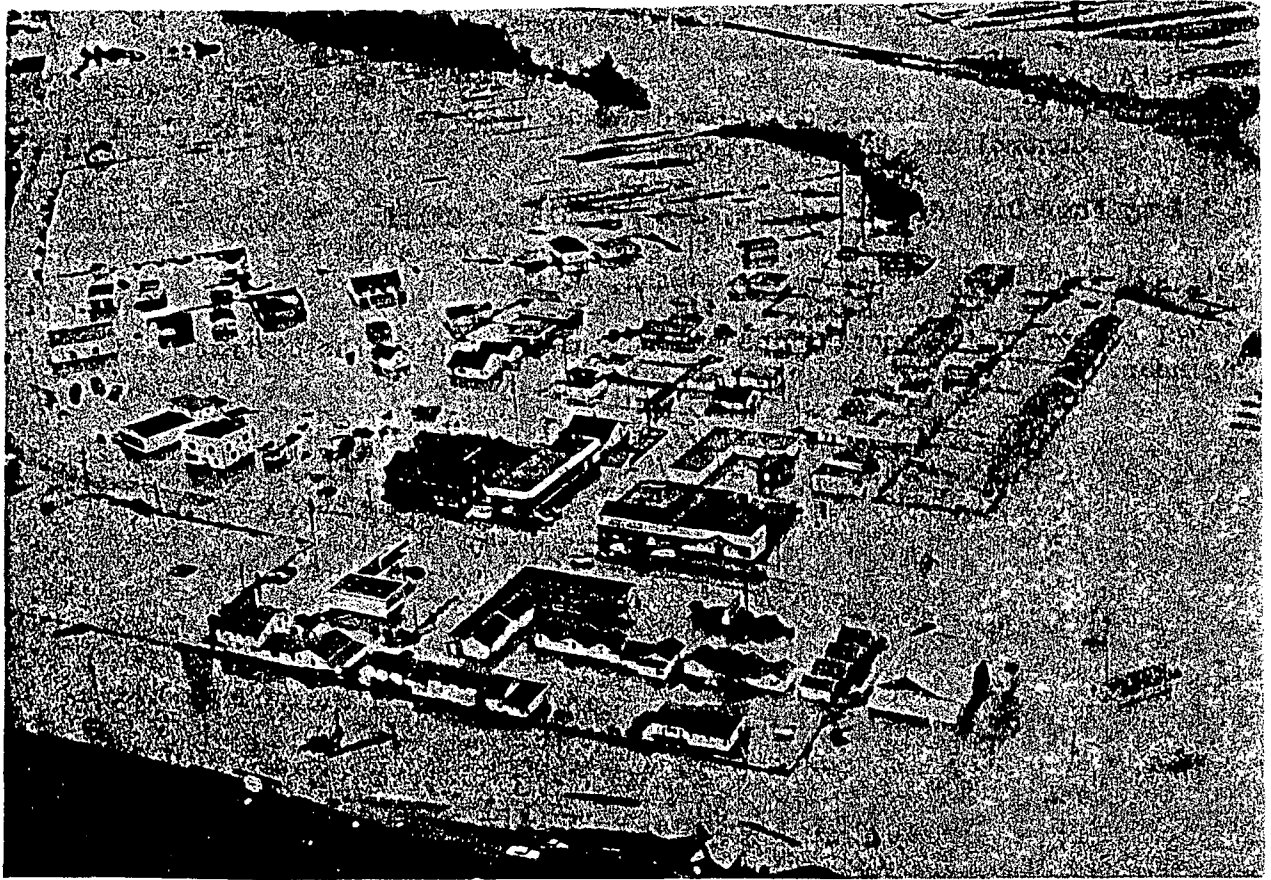


Figure 1: Aerial view of December 1955 flood at Orick. Peak flood stages covered the flood plain with a 4-foot depth of water. Highway U.S. 101 is at the extreme left and passes through the left bank business district near middle of picture. Redwood Creek flows from right to left and a peak discharge of 50,000 c. f. s. was recorded.

FIGURE 1:

APPENDIX E
COMMENTS OF OTHER AGENCIES

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COMMENTS OF OTHER AGENCIES

SECTION I - GENERAL

E-1. SCOPE.

In accordance with departmental and interagency policy, coordination with Federal and non-Federal agencies has continued during investigation of Redwood Creek for flood control and allied purposes. This appendix presents the comments of these agencies relative to the recommended plan of improvement which proposes channel improvements in the lower reaches of the stream. Discussion of the comments is also included.

SECTION II - FEDERAL AGENCIES

E-2. U. S. FISH AND WILDLIFE SERVICE.

Exhibit A of this appendix presents the comments of the U. S. Fish and Wildlife Service. Five recommendations are made which the Service states will minimize the adverse effects the project would have on fish and wildlife resources. The comments will be given full consideration during definite project studies.

E-3. BUREAU OF PUBLIC ROADS.

The Bureau of Public Roads finds that Highway US-101, Federal-aid Primary Route No. 1, will require raising at one location. Inasmuch as the design has been coordinated with the California Division of Highways, the local agency directly responsible for the affected Federal-aid highway, the Bureau's interests appear satisfied, as stated in Exhibit B.

E-4. BUREAU OF RECLAMATION.

Exhibit C of this appendix presents the comments of the Bureau of Reclamation. The Bureau finds that the recommended improvements do not conflict with any of its existing projects or plans.

E-5. U. S. SOIL CONSERVATION SERVICE.

The comments of the U. S. Soil Conservation Service are presented in Exhibit D. The Service is not as active in this area as in most parts of California but has an interest in the project since agricultural lands are being protected from flood damage.

E-6. PUBLIC HEALTH SERVICE

The recommendations of the Public Health Service are contained in their report included herein as Exhibit E. As is the case with the U. S. Fish and Wildlife Service, the recommendations of Public Health Service are concerned with construction aspects of the project which will be fully considered during advanced planning stages.

SECTION III - STATE AGENCIES

E-7. STATE OF CALIFORNIA

The Department of Water Resources has consolidated the comments of interested State agencies and these are presented as Exhibit F in this appendix.

a. Department of Water Resources. The Department of Water Resources finds that the proposed plan of improvement would have no apparent conflict with the California Water Plan. The estimated land acquisition and relocation costs are questioned by the Department as is the decision not to remove the sand spit at the mouth of the stream. Land costs have been reviewed and those presented in the report are considered adequate for this stage of project formulation. It is anticipated that stream velocities would effectively scour and remove the sand spit prior to occurrence of peak flood flows.

b. Department of Fish and Game. The recommendations of the Department of Fish and Game are similar to those of the U. S. Fish and Wildlife Service and will be fully considered during the advanced planning stage of the project.

c. Division of Highways. The Division of Highways assumes that it will be contacted by the project sponsors for permission to perform necessary work within state-owned rights-of-way during construction of the project.

SECTION IV - RESOLUTIONS

E-8. SPONSORING AGENCY

The Board of Supervisors of Humboldt County, by letter dated 24 January 1961, gave assurances of required local cooperation. The letter is presented as Exhibit G. The cash contribution noted in item (6) of the letter will not be required under current policies of the Corps of Engineers.



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

PACIFIC REGION
(REGION 1)
CALIFORNIA
IDAHO
MONTANA
NEVADA
OREGON
WASHINGTON

ADDRESS ONLY THE
REGIONAL DIRECTOR

1001 N. E. LLOYD BLVD.
P. O. BOX 3737
PORTLAND 8, OREGON

(1-RB)

March 15, 1960

Colonel John S. Harnett, District Engineer
San Francisco District, Corps of Engineers
Box 3050, Rincon Annex
San Francisco 19, California

My dear Colonel Harnett:

We have reviewed your plan of improvement for Redwood Creek, Humboldt County, California. Our analysis of the effects the proposals would have on fish and wildlife is based upon data obtained from you prior to December 1959. This is our report prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

Redwood Creek would be confined to the existing channel by installation of rip-rap and construction of levees along both sides of the stream for about one mile in the vicinity of Orick, California. There would be no significant change in channel alignment although the levees would result in some constricting of the channel. Woody vegetation would be removed along the banks. Changes in the channel bed would be limited to some clean-up work between the existing banks above the existing channel grade. Snags, boulders, and flow-retarding materials would be removed. Levee material would not be obtained from the channel, but the channel bottom would be affected by construction activity.

Reservoirs on Redwood Creek for single purpose flood control and for dual purpose flood control and fishery enhancement have been investigated but were not found to be economically feasible.

Redwood Creek flows in a northwesterly direction through heavily forested hilly terrain in Humboldt County and enters the Pacific Ocean about 11 miles south of Klamath River. Streamside vegetation in the project area is composed largely of willow thickets with some alder and cottonwood trees. The understory includes blackberry vines and forbes.

EXHIBIT A

Prairie Creek, the principal tributary, joins Redwood Creek at the head of the project area about 4 miles upstream from the ocean. Lesser upstream tributaries are short and precipitous.

Streamflow is highly variable, ranging from a minimum of 10 second-feet to a flood peak of 50,000 second-feet at Orick. Mean streamflow for the period 1896 through 1947, as indicated by synthetic records developed by the California Department of Water Resources, was about 1,100 second-feet at Orick. Usually at this point in late summer and in early fall prior to the fall rains, streamflow is about 20 second-feet. (Based upon 6 years of record 1911-13 and 1953-56.)

It is estimated that Redwood Creek presently receives average annual runs of 5,000 chinook salmon, 2,000 silver salmon, and 10,000 steelhead trout. These spawning runs ascend the stream for a distance of at least 48 miles. The lower section of the stream and Prairie Creek support good populations of sea-run cutthroat trout. Chinook salmon and silver salmon utilize Prairie Creek and reaches of Redwood Creek for spawning. A moderate amount of chinook salmon spawning occurs in the project area. The stream section that would be affected by the project is a valuable rearing area for young steelhead and salmon. Steelhead spawn in accessible headwater areas. Fishing pressure on Prairie Creek and lower Redwood Creek is moderate.

Wildlife in the project area is varied and includes nearly all species common to northwestern California. However, only a small number of any species exist in the immediate area to be affected. Ducks, geese, and various shore birds utilize the lower stream reaches during migrations. There are moderate numbers of fur animals in the watershed. Hunting pressure on big game, waterfowl, and upland game in this drainage is light.

Levee construction and channel modification could adversely affect fish habitat unless precautions are taken during the construction period. Construction specifications should include provisions to preserve all pools and the low flow channel. Should portions of the low water channel be unavoidably destroyed or disrupted these sections should be restored by means of a training channel.

Small numbers of California quail and brush rabbits would be adversely affected by the removal of bank vegetation and clearing proposals. There would be minor losses of mallard and wood duck nesting habitat. Beaver, mink, raccoon, and skunk habitat would be disturbed during the construction period, but losses to these species would be temporary and minor.

To minimize the adverse affects the project would have on fish and wildlife resources, it is recommended that:

1. Insofar as possible construction activity be limited to the period July 1 - October 31.

2. Construction specifications provide for preservation of the existing low flow channel and pool, and that a training channel not less than 1 foot deep and 6 to 10 feet wide be installed in sections of the existing low water channel unavoidably destroyed or disrupted.

3. Clearing specifications provide for preservation of riparian vegetation.

During the development of detailed plans and specifications and during the construction period, Bureau of Sport Fisheries and Wildlife working in cooperation with California Department of Fish and Game will be pleased to provide general advice on fish and wildlife matters related to Redwood Creek project.

Sincerely yours,

J. J. Lamaly
Acting Regional Director



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE (1-RB)
BUREAU OF SPORT FISHERIES AND WILDLIFE

1001 N. E. LLOYD BLVD.
P. O. BOX 3737
PORTLAND 8, OREGON

PACIFIC REGION
(REGION 1)
CALIFORNIA
IDAHO
MONTANA
NEVADA
OREGON
WASHINGTON

ADDRESS ONLY THE
REGIONAL DIRECTOR

September 21, 1961

AIR MAIL

Colonel John A. Morrison, District Engineer
San Francisco District, Corps of Engineers
P. O. Box 3050, Rincon Annex
San Francisco 19, California

Dear Colonel Morrison:

This responds to your August 30, 1961, request for our comments on your report on Redwood Creek, Humboldt County, California.

Our letter report, dated March 15, 1960, based on data received from your office in December 1959, is still to a large extent applicable to your present plan and should be included in your Appendix E together with this letter.

The plan recommended in your report is considerably more comprehensive than that considered in our March 1960 letter report. It would intensively channelize and confine by levees about 3 miles of Redwood Creek between Prairie Creek and Pacific Ocean rather than 1 mile. It would be more damaging to fish and wildlife. Recommendations and conclusions of our report are only briefly mentioned in your report. We consider your discussion of the impact of the work on fish and wildlife to be inadequate.

The following specific comments refer to paragraphs and pages of your report draft, dated August 1961, and its appendices:

1. Paragraph 2, p. 1, and paragraph 49, p. 15, made no mention of the fact that fishery enhancement was among the purposes for which upstream reservoir construction was considered.

EXHIBIT 'A'

2. Paragraph 19, p. 6, mentions fish and wildlife but unfortunately states, "The gravels in the stream channel in the vicinity and upstream from Orick are an excellent source of aggregates." (italics ours). This was stated despite our March 1960 recommendation number (2) which recommends in part, "Construction specifications provide for preservation of the existing, low flow channel"
3. Paragraphs 45 and 50, pp. 14 and 15, mention potential diversion to Skunk Cabbage Creek. Although your report rejects this proposal, we desire to emphasize that construction of such a diversion would destroy substantial amounts of wildlife habitat and would have potential for damage to migrating fish which would be stranded in the dry channel of the lower reaches of Redwood Creek following a flood.
4. The discussion of paragraphs 52, 54, and 55, pp. 16-18, gives no evidence of consideration of the fish and wildlife effects outlined in our report of March 1960.
5. Paragraph 64, p. 21, is unduly optimistic about benefits to fish and wildlife. Your present plan calls for complete channelization with loss of existing pools, and essentially complete removal of vegetation along 3 miles of the creek near Orick. Both fish habitat and wildlife habitat will be destroyed with resultant losses to these resources as discussed in our March 1960 report. Our recommendations numbered (2) and (3) specifically requested avoidance of this type of damaging construction, yet no comment on this fact is contained in your report. Your paragraph 65, p. 21, makes no mention of these losses among the adverse project effects.
6. Paragraph 73, p. 23, does not accurately reflect our March 1960 report, nor does it adequately treat the subject of fish and wildlife effects. Each of our specific recommendations should have been discussed. If our recommendations were rejected, as appears to be the case, then an explanation should have been given.
7. Paragraph B-11b., p. B-6 (Appendix B), mentions the gravel bars near the confluence of Prairie and Redwood Creeks as a source for sand and gravel. These bars are used by salmon for spawning. None of the gravel bars within the channel normally watered by the fall and winter flows (excluding flood peaks) should be disturbed unless absolutely essential to the planned channelization. Borrow should be obtained entirely from channel sections

where excavation is required to produce the needed channel capacity, or outside the normal channels as recommended in our March 1960 report (recommendation 2). Both the low-flow channel and the pools should be preserved insofar as possible in the channelized section. Gravels of the stream bottom should not be removed unnecessarily, especially in the area upstream from Orick.

8. Paragraph B-11c., p. B-6, again notes that materials can be obtained from streambed deposits. In all cases, only the deposits required to be excavated for channel rectification should be removed as borrow or construction materials.
9. Paragraph C-2c., p. C-3 (Appendix C), mentions the training channel recommended (recommendation 2) in our March 1960 report. However, our Recommendations numbered (1) and (3) do not appear to have been considered among the bases for design as outlined in Appendix C.

We reemphasize the applicability of our March 1960 report to your present plan and strongly urge that our previously stated three recommendations be given full and careful consideration in your planning and report discussion. In addition, we request consideration of the following.

In addition to the three recommendations of our March 1960 report, it is recommended that:

- 4) The Corps of Engineers encourage local agencies to provide to the public foot access to the river within the project area for purposes of fishing and, where not restricted for safety reasons, for hunting.
- 5) The Corps of Engineers place limitations upon the project contractors to prevent destruction of fish and wildlife habitat. Of particular concern are spawning gravels and riparian vegetation. Silt and other debris should be prevented from entering the river, gravel of the streambed should not be removed except to achieve required lowering of the channel grade, and riparian vegetation should be preserved wherever possible.

This letter has been reviewed by Bureau of Commercial Fisheries and they concur in its content. Our comments have been discussed with California Department of Fish and Game, and that Department is in general agreement.

This opportunity to comment on your report is appreciated. The two advance copies of your report are attached and being returned as you requested.

Sincerely yours,

James S. Roberts

Regional Supervisor
River Basin Studies

Attachments 2.

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

REGION SEVEN

California Division
07-04

P. O. Box 1915
SACRAMENTO 9, CALIFORNIA

September 12, 1961

District Engineer
Corps of Engineers
180 New Montgomery Street
San Francisco, California

Dear Sir:

By letter dated August 30, 1961, you submitted for our review and comments an advance copy of your survey report for flood control and allied purposes on Redwood Creek, Humboldt County, California.

We note that Highway US-101, Federal-aid Primary Route No. 1, will require raising at one location. Federal funds participated in the construction of this highway under Project FA 16B, north of Orick and FA 16(4) south of Orick.

As it is understood that your office is in contact with the California Division of Highways, the local agency directly responsible for the affected Federal-aid highway, Public Roads' interests are satisfied.

In compliance with your request the advance copy of the report and appendices are returned herewith.

Very truly yours,



For D. J. STEELE
Division Engineer

Enclosure

EXHIBIT B



ADDRESS ALL
COMMUNICATIONS TO
THE REGIONAL DIRECTOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGIONAL OFFICE, REGION 2
P. O. BOX 2511
SACRAMENTO, CALIFORNIA
(TOWN AND COUNTRY AREA)

IN REPLY
REFER TO: 2-730

September 15, 1961

District Engineer
U. S. Army Engineer District, San Francisco
Corps of Engineers
San Francisco 5, California.

Dear Sir:

This is in response to your letter of August 30 (file SPNGP), requesting our review and comment on your survey report and appendices on Redwood Creek, Humboldt County, California.

We have reviewed your report and appendices, and the plans presented do not conflict with any existing projects or plans of the Bureau of Reclamation.

We are returning the report as you requested; thank you for the opportunity to review it.

Sincerely yours,

E. F. Sullivan
Acting Regional Director

Enclosures 2

EXHIBIT C

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

2020 Milvia Street
Berkeley 4, California

September 19, 1961

Colonel John A. Morrison, District Engineer
U. S. Army Engineer District, San Francisco
Corps of Engineers
180 New Montgomery Street
San Francisco, California

Dear Colonel Morrison:

We have received a copy of Survey Report for Flood Control and Allied Purposes, Redwood Creek, Humboldt County, California, with Appendices, which we are returning herewith. We have no adverse comments.

While the Soil Conservation Service is not as active in the area as in most parts of California, we have an interest in the fact that agricultural land and agricultural flood damage are involved in the project. As a general principle, protection of agricultural land from flooding facilitates the application of beneficial land treatment measures.

We would appreciate your placing this office and that of our Area Conservationist on the list for information pertinent to the project. The Area Conservationist is:


Jack E. Woods
Soil Conservation Service
226 South Main Street
Sebastopol, California

Thank you for the opportunity to review the report.

Sincerely,

John S. Barnes
State Conservationist

By


C. H. Buell, Acting

cc: Kirk M. Sandals, SCS, Berkeley
E. J. Core, SCS, Portland, Oregon

EXHIBIT D

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

PUBLIC HEALTH SERVICE
447 Federal Office Building
San Francisco 2, California

September 22, 1961

Col. John A. Morrison
District Engineer, Corps of Engineers
U. S. Army Engineer District
180 New Montgomery Street
San Francisco, California

Dear Col. Morrison

As requested in your August 30, 1961 letter, enclosed please find our report on the Public Health Aspects of the Survey for Flood Control and Allied Purposes of Redwood Creek, Humboldt County, California, together with four copies of your report (Nos. 32, 34, 35, & 36) and appendices. We shall return the remaining copy (No. 33) and appendices as soon as we receive the set from the California Department of Public Health.

It is our feeling that the 20 days allotted for this report distribution and review were not enough. It would be appreciated, therefore, if your office would allow a minimum of 45 days for the review and submittal of Public Health comments, when submitting future reports.

Sincerely yours,

Dale I. Byason

For William B. Schreeder
Sr. Sanitary Engineer
Division of Water Supply &
Pollution Control
Region IX

Enclosures

EXHIBIT E

REPORT
on
THE PUBLIC HEALTH ASPECTS
of the
SURVEY FOR FLOOD CONTROL AND ALLIED PURPOSES
of
REDWOOD CREEK, HUMBOLDT COUNTY, CALIFORNIA
for
THE U. S. ARMY CORPS OF ENGINEERS

prepared by
THE U. S. PUBLIC HEALTH SERVICE

DEPT. OF HEALTH, EDUCATION, & WELFARE
REGION IX - SAN FRANCISCO, CALIFORNIA

September 1961

EXHIBIT E

PUBLIC HEALTH ASPECTS
of the
SURVEY REPORT FOR FLOOD CONTROL AND ALLIED PURPOSES
REDWOOD CREEK HUMBOLDT COUNTY, CALIFORNIA

INTRODUCTION

In accordance with the policies and procedures of the Federal Inter-Agency Committee on Water Resources, this office has reviewed the Survey Report for Flood Control and Allied Purposes, Redwood Creek, Humboldt County, California, as requested by the San Francisco District of the Corps of Engineers. In preparing this report the Public Health Service has requested the comments of the California State Department of Public Health.

PROJECT DATA

Location & Description
of Project Area

Redwood Creek is situated on the western slopes of the Coast Range Mountains in northwestern California. It drains an area of approximately 283 square miles located entirely in Humboldt County. The drainage basin is roughly rectangular in shape extending 56 miles along a northwest-southeast axis and having a maximum width of about seven miles. With the exception of the lower five miles, the stream flows through a narrow deep canyon. The stream is not navigable for other than small boats. The flat valley area contains approximately 1,000 acres of agricultural lands, practically all of which are devoted to dairy farming and production of forage crops. Elevations of the drainage basin vary from sea level at the Pacific Ocean, about 50 miles south of the Oregon boundary, to 5,000 feet mean sea level at the southeastern extremity of the basin. The largest tributary is Prairie Creek which drains the northern part of the basin and joins Redwood Creek just upstream from the town of Orick. The terrain is mountainous and heavily wooded. Level land is found in small areas along the streams. The only significant area of level land is along the lower four miles of the stream, where the town of Orick is located. Practically all the areas suitable for agriculture in the Redwood Creek basin are located within the proposed project limits. The problem area is the flood plain and channel of the lower four miles of Redwood Creek, starting approximately from the confluence with Prairie Creek downstream. Agricultural activities are devoted mainly to the dairy industry. Much of the commercial and industrial activities are dependent upon the lumber industry. Developments in the area include the town of Orick, about five

sawmills, one large logging pond, and about 1,000 acres of relatively flat agricultural lands.

Problems of the Area

The north-coastal streams of California along the ocean are in areas of high rainfall and flooding is almost an annual occurrence. Due to the long, narrow shape of Redwood Creek basin and the limited area of economic development, the flood problem generally is confined to the town of Orick and vicinity. In the last 10 years, two major floods along Redwood Creek have severely damaged the community and adjoining farm lands throughout the lower four miles of the stream. The floods of 1953 and 1955 inundated portions of Orick to depths of four feet, and damages from the more severe of the two, that of 1953, are estimated at about \$1,230,000, adjusted to April 1960 price levels and developments. The small valley, with limited area for development and production, is an important factor to the local lumber industry. The degree of economic development in the community and the cost involved in complete abandonment of the flood plain is not considered practicable or feasible.

Proposed Plan of Improvement

The plan of improvement considered most feasible for resolving the flood problem of Redwood Creek includes construction of earth levees and channel improvements along the lower four miles of the stream. The work would consist of channel rectification, levees, and partial revetment. A trapezoidal-type channel would be used through the urban and downstream rural areas and a system of setback levees with an improved channel upstream from the mouth of Prairie Creek.

In order to assure adequate interior drainage of local runoff from behind the levee system, a battery of gated culverts through the levee would be provided to prevent flow onto protected areas during high flood stage. A pumping plant would be installed near this drainage facility to remove floodwaters which collect behind the levee when the flapgates are closed due to high water in the stream.

SANITARY ENGINEERING

Water Supply

This plan for watershed protection does not contemplate diverting water for beneficial use. To our knowledge, the proposed plan in no way conflicts with measures in the State of California Water Plan or with existing potable water supplies.

Water Pollution Control

Provisions for debris retention in the flood water retention structures

and concrete lining of the drainage channels will be of general benefit in protecting sewage disposal facilities and subsequently the spread of polluted flood waters.

General Sanitation

Measures should be incorporated in the work plan to protect the channels from being used as trash dumps and open sewers. All construction camps and temporary facilities should be in accordance with local health regulations regarding water supplies and sewage disposal facilities. Inspection of the works of improvement is desirable in the fall and spring, in addition to after each major flood, in order to determine what maintenance activities are required.

VECTOR PROBLEMS

Public Health and Socio-Economic Importance

Mosquitoes are the principal vectors which might be affected by the project. Several species of mosquitoes of public health importance may be produced in large numbers in the area when suitable aquatic habitats are present. Encephalitis, commonly known as sleeping sickness or brain fever, is now the most important mosquito-borne disease in the United States and this area. Mosquitoes transmit the encephalitis viruses among birds and from them to horses and humans. There are no effective chemotherapeutic measures for preventing or treating human cases, and some individuals, particularly children, who recover from encephalitis, often suffer permanent mental disability.

Records of the U. S. Department of Agriculture show that equine encephalitis cases occurred in Humboldt County during 8 years of the 17-year period, 1939 through 1955, for which records are available. These records of equine encephalitis cases indicate that the viruses of the disease occur in the area. Culex tarsalis, the encephalitis mosquito, is common to the area of the proposed project. It is produced in a wide range of aquatic habitats, such as roadside ditches, seepage pools, flooded depressions, and other semipermanent and permanent bodies of water which contain emergent vegetation.

Several species of vicious-biting Aedes mosquitoes, including A. dorsalis, A. nigromaculis, and A. increpitus are prevalent in the area. Large numbers of these biting mosquitoes may create public health problems aside from the transmission of specific diseases. These insects may interfere with the healthful outdoor activities of both children and adults during the summer months. Individuals, particularly children, frequently require medical attention and sometimes hospitalization for treatment of secondary infections and allergic reactions resulting from mosquito bites. Overflow pools along streams provide favorable larval

habitat for several species of the highly pestiferous Aedes mosquitoes.

In addition to their public health importance, large numbers of biting mosquitoes also cause severe economic losses by lowering meat and milk production, by reducing the efficiency of agricultural and industrial workers, by interfering with recreational enterprises, and by lowering the value of real estate.

Anticipated Effects of the Project on Vector Problems

The project is expected to result in reduced flood damages sustained by the town of Orick, several lumber mills, and most of 1000 acres of agricultural area. The over-all effects of the project should therefore be beneficial from a mosquito control standpoint. Mosquito production may occur in the channel and behind levees if any of the gated culverts and other drainage facilities become clogged and water is ponded for periods of 5 days or longer. The aquatic stages of mosquitoes generally occur in shallow water with abundant vegetation and flottage and where they are protected from wave action and water currents; they do not occur in the deep open waters of streams, ponds, and lakes.

Mosquito production can be prevented or minimized if adequate preventive and control measures are planned and built into the project and continued as a part of the regular operation.

RECOMMENDATIONS

Responsibility for Vector Control

Responsibility for vector prevention and control is normally associated with land ownership or operating rights. The agency, group, or individuals responsible for various aspects of the proposed project should therefore be prepared to accept full responsibility for the prevention and control of mosquitoes and other vector problems resulting from the design, construction, operation, or maintenance of the project.

Prevention and Control Measures

In order to minimize public health hazards, every possible effort should be made to avoid creating manmade conditions which will increase populations of mosquitoes and other aquatic arthropods of public health importance. It is recommended that the following principles and practices be adhered to in the design, construction, operation, and maintenance of the proposed project:

1. Lateral drainage should be built and maintained for all potential ponding areas resulting from channel improvements and construction of levees.
2. Culverts, inlets, underdrains, etc., should be placed on grade to insure complete drainage.
3. If permanent ponding areas are anticipated, steep side slopes should be provided for these ponds and emergent vegetation should be controlled periodically by mechanical, chemical, or biological measures.
4. By-passed natural drainageways should be filled in and graded to insure complete lateral drainage into the new channel.
5. Borrow areas should be left in a self-draining condition.
6. Water should be pumped or otherwise removed from ponding areas behind levees as rapidly as possible, preferably within 5 to 7 days.
7. Provisions should be made for periodic removal of debris, silt, and vegetation from drains and channels to insure free flows.

Supplemental Chemical Control Measures

In situations where adequate control of mosquitoes is not obtained through the prevention and source reduction measures outlined above, provision should be made for supplementary use of insecticides to achieve the desired level of control.

Technical Assistance

In the event that vector controls are encountered in the proposed project technical assistance may be obtained from the California State Department of Public Health and the U. S. Public Health Service.

Accident Prevention

Generally, the reduced flood danger should lead to a safer environment. However, the following additions to the planned facilities are recommended:

1. Channels should be fenced through residential areas and should be so designed as to prevent public access, insofar as feasible.

2. Warning signs should be placed at all dangerous facilities and at suitable points on canals to advertise to the public the danger of flash floods.

General

It is further recommended that the California State Department of Public Health and the U. S. Public Health Service be kept currently informed regarding any changes in plans, so that guidance and consultation may be provided with regard to health problems associated with the project.



STATE OF CALIFORNIA
Department of Water Resources

SACRAMENTO

September 27, 1961

Colonel John A. Morrison
District Engineer
U. S. Army Engineer District
Corps of Engineers
San Francisco 15, California

Subject: Your File No. SPKGP

Dear Colonel Morrison:

This is in reply to your letter of August 30, 1961, which transmitted copies of your "Survey Report of Flood Control and Allied Purposes, Redwood Creek, Humboldt County, California", dated August 1961, for review and comment by interested state agencies.

The following comments of state agencies concerned are submitted for your consideration. For the sake of brevity, your survey report will be referred to as the "Redwood Creek Report".

DEPARTMENT OF WATER RESOURCES

The Department of Water Resources has a direct interest in all projects involving the development of water resources within the State. Of particular interest is the extent to which these projects are compatible with the State's comprehensive plan for the development of the water resources of California.

With regard to projects involving flood control, the department has a financial interest in accordance with policies set forth in the State Water Resources Law of 1945 and the Flood Control Fund Law of 1946, under which the State is authorized to reimburse local agencies for the cost of lands, easements, and rights of way required for channel improvements of federal flood control projects.

Plan of Improvement

The Redwood Creek Report presents a plan of flood control for the lower reaches of Redwood Creek, in and about the community of Orick,

EXHIBIT F

in Humboldt County, California. The plan proposes channel rectification, levees and revetment along the lower four miles of Redwood Creek. Interior drainage would be provided by a battery of gated culverts through the levee, and a pumping plant installed near this drainage facility to remove collected flood waters when the flapgates were closed.

The project would produce average annual benefits of \$228,000. Annual cost of the project is listed as \$129,000, and the ratio of benefits to cost is 1.77 to 1.00. Total first cost of the project would be \$2,850,000. The annual non-federal cost for operation and maintenance would be \$19,500, which would be borne by local interests.

Design discharge for the standard project flood is 77,000 second-feet. The improved channel would vary in dimension, but would have a minimum bottom width of 250 feet.

The California Water Plan

The proposed plan of development would have no apparent conflict with The California Water Plan.

Hydrology

The standard project flood of 77,000 second-feet appears to be reasonable. However, using the same flood frequency of one in 30-years, computations by the department indicate that the pumping plant for interior drainage should be redesigned to accommodate 338 second-feet in contrast to a design capacity of 143 second-feet as outlined in the report.

Right of Way and Relocation Estimates

Upon review of the rights of way costs as outlined in the Redwood Creek Report, the following is concluded:

1. The land acquisition and relocation costs as outlined in the report appear to be low by approximately \$120,000. Adjustment of the benefit-cost ratio to accommodate this increase of expected expenses results in a ratio of 1.56 to 1, in contrast with a value of 1.77 to 1 derived in the survey report.
2. In order to lower land acquisition and relocation costs mentioned above, consideration should be given to keeping the flood channel upstream from the Orick Bridge as far to the left as possible, thus avoiding any construction in the urbanized area on the right bank.

Design, Construction and Cost Estimates

The survey report leaves some doubt as to whether the mouth of Redwood Creek would remain open should a sand spit form there as at present. If the mouth tended to fill in, there should be an adequate item for dredging in the annual operation and maintenance costs. The

possibility also exists that the spoiling of waste excavation in the abandoned channel would fill in portions of the channel, thus creating new land. No benefit was claimed for this land, and no mention was made of its disposal.

DEPARTMENT OF FISH AND GAME

The Department of Fish and Game recommends that the following be adhered to in order to keep damage to fish and wildlife resources within acceptable limits:

1. To permit the passage of salmon and steelhead into Redwood Creek during low flows, the channel at the lower end of the project should be modified to concentrate the flow.
2. To avoid the destruction of salmon spawning areas, gravel should not be removed from areas normally watered by fall and winter flows (excluding peak flows). Borrow should be obtained only from channel sections required to produce needed channel capacity.
3. To assure the upstream passage of anadromous fishes during low flows, certain channel modifications would be required. These modifications, such as spaced resting pools, would be in addition to the six by one foot fish channel described in the report.
4. Riparian vegetation should be preserved wherever possible.
5. Since the final plans for channel work would be affected by the foregoing recommendations, it is recommended that the Corps of Engineers request the assistance of technical fisheries personnel of the U. S. Fish and Wildlife Service and/or the California Department of Fish and Game. Further, technical personnel of these agencies should be available for review of project operation during construction.

DEPARTMENT OF NATURAL RESOURCES

The Department of Natural Resources reviewed the survey report but had no comments.

DIVISION OF HIGHWAYS

It is noted by the Division of Highways that the proposed levees cross U. S Highway 101 at the Orick Bridge in the vicinity of levee station 163 + 00. It is assumed that the project sponsors will contact the District I office of the Division of Highways in Eureka for permission to perform necessary work within state-owned rights of way. It is also assumed that the sponsors will make arrangements for possible grade revision to the highway required by levee construction near station 163 + 00.

CONCLUSIONS

On the basis of the review of the Redwood Creek Report, it is concluded that:

1. The Redwood Creek Project, as outlined in the Survey Report, would not conflict with The California Water Plan.
2. The pumping plant for interior drainage should be redesigned to accommodate 338 second-feet, in contrast to a design capacity of 143 second-feet as outlined in the report.
3. The estimates of flood control benefits appear reasonable.
4. The land acquisition and relocation costs appear low by approximately \$120,000 and should be reviewed.
5. Insofar as practical and consistent with the basic aims of the project, the following recommendations of the Department of Fish and Game should be followed:
 - (a) The lower end of the project should be channelized in order to permit the passage of salmon and steelhead at low flows.
 - (b) To avoid the destruction of salmon spawning areas, gravel should not be removed from areas normally watered by fall and winter flows (excluding flood peaks). Borrow should be obtained only from channel sections required to be excavated to produce needed channel capacity.
 - (c) To assure the upstream passage of anadromous fishes during low flows, certain channel modifications would be required. These modifications, such as spaced resting pools, would be in addition to the six by one foot fish channel described in the survey report.
 - (d) Riparian vegetation should be preserved whenever possible.
 - (e) Since final plans for channel work would be affected by the foregoing recommendations, it is recommended that the Corps of Engineers request the assistance of technical fisheries personnel of the U. S. Fish and Wildlife Service

and/or the California Department of Fish and Game. Further, technical personnel of these agencies should be available for review of project operation during construction.

6. The Corps of Engineers should contact the Division of Highways, District I Office, in Eureka in order to coordinate planning problems in connection with state-owned rights of way and grade revision of U. S. Highway 101.

The foregoing comments are subject to such revision as may be considered advisable upon official receipt by the State of California of the report of the Chief of Engineers. The opportunity to review the report is very much appreciated.

Sincerely yours,


Director

SAM B. MERRYMAN, JR., 5TH DIST.
CHAIRMAN
PHONE ORCHARD 7-0074
ROUTE 1, BOX 20, GRANNELL

STATE OF CALIFORNIA
COUNTY OF HUMBOLDT

BOARD OF SUPERVISORS

VETERANS' MEMORIAL BUILDING

P. O. BOX 1014 EUREKA, CALIFORNIA

PHONE HILLSIDE 3-0811
AREA CODE 415

JANUARY 24, 1961

ELWYN L. LINDLEY, 1ST DIST.
PHONE FERNDALE 253
425 - 5TH ST., FERNDALE

MELVIN J. BAREILLES, 2ND DIST.
PHONE ROCKWELL 4-5741
P. O. BOX 464, RIO DELL

NORMAN R. ROBERTSON, 3RD DIST.
PHONE HILLSIDE 2-2016
5349 BRADWAY, EUREKA

E. M. PETERSEN, 4TH DIST.
PHONE HILLSIDE 2-0125
2301 FAIRFIELD ST., EUREKA
CHAIRMAN

FRED J. MOORE, JR.
CLERK
PHONE HILLSIDE 3-0811
P. O. BOX 1014, EUREKA

DISTRICT ENGINEER
U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
Box 3050, RINCON ANNEX
SAN FRANCISCO 19, CALIFORNIA

DEAR SIR:

REFERENCE IS MADE TO YOUR LETTER OF 19 OCTOBER 1960 CONCERNING A PROPOSED FLOOD CONTROL PROJECT ON REDWOOD CREEK IN THE COMMUNITY OF ORICK. AT THE PUBLIC HEARINGS HELD 10 OCTOBER 1960, THE COMMUNITY OF ORICK MOST UNANIMOUSLY EXPRESSED ITS APPROVAL OF THE PROJECT. THE BOARD OF SUPERVISORS HAS DISCUSSED THE MATTER AND HAS AUTHORIZED ME AS THE CHAIRMAN OF THE BOARD OF SUPERVISORS TO COMMUNICATE TO THE CORPS OF ENGINEERS THE COUNTY'S WILLINGNESS TO INSURE THE LOCAL COOPERATION REQUIRED BY THE CORPS OF ENGINEERS, NAMELY:

(1) TO PROVIDE WITHOUT COST TO THE UNITED STATES ALL LANDS, EASEMENTS, AND RIGHTS OF WAY FOR THE CONSTRUCTION OF WORKS.

(2) TO HOLD AND SAVE THE UNITED STATES FREE FROM DAMAGES DUE TO THE CONSTRUCTION WORKS.

(3) TO MAINTAIN AND OPERATE ALL THE WORKS AFTER COMPLETION IN ACCORDANCE WITH REGULATIONS PRESCRIBED BY THE SECRETARY OF THE ARMY.

(4) TO PROVIDE WITHOUT COST TO THE UNITED STATES ALL RELOCATIONS OF BUILDINGS, ROADS, AND UTILITIES REQUIRED BY THE PROJECT.

(5) PROVIDE ASSURANCE THAT ENCROACHMENT ON IMPROVED CHANNELS, OR ON PONDING AREAS, WILL NOT BE PERMITTED.

(6) PROVIDE A CASH CONTRIBUTION IN VIEW OF SPECIAL BENEFITS.

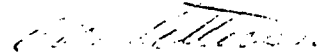
Exhibit G

IT IS UNDERSTOOD THAT AS PRESENTLY INVISIONED THE LOCAL CASH CONTRIBUTION WILL BE APPROXIMATELY 1.3 PERCENT OF THE TOTAL PROJECT.

IT IS REGRETTEED THAT SO MUCH TIME HAS PASSED SINCE YOUR ORIGINAL REQUEST FOR THE ABOVE ASSURANCE BY THE BOARD, BUT IT WAS FELT NECESSARY TO EXPLORE THE AVENUES AVAILABLE TO THE COUNTY FOR FINANCING THE RIGHTS OF WAY, RELOCATIONS AND THE CASH CONTRIBUTION.

IT IS PRESENTLY FELT THAT THESE MATTERS HAVE BEEN SATISFACTORILY RESOLVED AND IT IS OUR HOPE THAT THE CORPS OF ENGINEERS WILL BE ABLE TO PROCEED WITH THIS PROJECT IN ALL HASTE.

VERY TRULY YOURS,



E. M. PETERSEN
CHAIRMAN, BOARD OF SUPERVISORS

CHS:MS

REDWOOD CREEK
HUMBOLDT COUNTY, CALIFORNIA

ATTACHMENT I

Information called for by
Senate Resolution 148, 85th Congress
Adopted 28 January 1958

1. PROJECT FEATURES

Flood control improvements proposed along the lower four miles of Redwood Creek near Crick would consist of channel rectification, levees, bank revetment and other pertinent facilities. The project is analyzed on the basis of a 50-year economic life and with normal maintenance and operation should be functionally operable at the end of that period. Total cost of the project, based on unit prices prevailing in July 1960, is estimated at \$2,900,000, of which \$2,630,000 is a Federal cost and \$270,000 is a local interest cost. Included in the estimates are allowances for contingencies, engineering and design, supervision and administration, and costs of preauthorization studies. Average annual charges include interest and amortization of first costs, adjustment for loss of land productivity, and an average amount of maintenance and operation of the project after construction. Federal and non-Federal costs have been computed by using 2-5/8 percent and four percent interest rates, respectively. The project has been analyzed on the basis of a 100-year economic life and on the assumption that the original first cost and average annual maintenance and operation charges would be the same as for a 50-year economic project life. The following is a summary of the project costs as presented in the Survey Report dated August 1961 based on a 50-year project life, and alternative studies for 100-year life.

Summary of Project Costs

Economic life (years)	First costs			Annual Charges
	Federal	Non-Federal	Total	
50	\$2,630,000	\$270,000	\$ 2,900,000	\$ 129,000
100	2,630,000	270,000	2,900,000	108,000

2. Benefits creditable to the proposed improvements would result from (1) prevention of inundation and erosion damages, and (2) land enhancement to a portion of the left bank flood plain within the community

limits of Orick. The benefits and costs of the project based on both a 50- and 100-year project life are as follows:

Summary of Benefits and Costs

	Project Life	
	<u>50-year</u>	<u>100-year</u>
Average annual benefits	\$ 228,000	\$ 259,000
Average annual costs	129,000	108,000
Benefit-cost ratio	1.8	2.4

3. The benefits presented in the report do not include intangible benefits. However, there has been one loss of life directly connected with flooding within the last 10 years and future floods of major magnitude are a potential for such to occur again.

4. Preliminary studies showed that construction of storage facilities for flood control or other water uses in the Redwood Creek Basin is economically infeasible at the present time. Preliminary studies for a dam and reservoir at the most favorable site near stream mile 7 showed that storage of 1,000,000 acre-feet would cost over \$50,000,000, and would provide a benefit-to-cost ratio of about 0.5 to 1.0. However, the potential for flood control benefits under present development would be less than 15 percent of such a project and the present and near future power demand is minor. The high degree of protection provided by the proposed channel improvements precludes the necessity for consideration of any further flood control needs in the near future. The proposed works have a single purpose; therefore, allocation of costs for other than flood control are not necessary.

5. NON-FEDERAL RELATIONSHIPS TO THE PROJECT

Local interests have expressed their desires for flood control improvements at a public hearing in Orick in 1955, and informally at other times. They have indicated a preference for control by upstream storage but were satisfied with the proposed channel improvement works when plans, costs and sponsorship requirements were presented at a public meeting in Orick on 10 October 1960. Officials of Humboldt County are interested in flood control improvements and have indicated a favorable attitude toward the proposed project. The State of California has assisted in certain phases of other flood control

projects, and is authorized to consider participation in the Redwood Creek project. There is no need for a repayment schedule for any portion of the project improvements. A substantial portion of project benefits are based on protection of a section of Highway U.S. 101 within the flood plain limits and the State of California would benefit thereby.

