

STATE OF CALIFORNIA

THE RESOURCES AGENCY

THE RECLAMATION BOARD

C O L U S A W E I R

B Y P A S S

A N D

S E D I M E N T B A S I N

OPERATION AND MAINTENANCE

MANUAL

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COLUSA WEIR BYPASS
OPERATION AND MAINTENANCE

CHAPTER I
INTRODUCTION

1. Purpose

The purpose of this manual is to define the operation and maintenance procedures to be used for the Colusa Weir Bypass. This manual supplements the Corps of Engineers' Standard Operation and Maintenance Manual and the Corps of Engineers' Supplement to Standard Operation and Maintenance Manual, Unit No. 155:

This memorandum covers the general operation and maintenance of the Colusa Weir Bypass. It is to be used by the maintaining agency as a basis for operating procedures and for all maintenance operations of the Colusa Weir Bypass.

2. Project Authority

The Grant Report adopted by the U.S. Congress on May 25, 1928, provided for the construction of the Colusa Weir.

The State Reclamation Board adopted the Modified Plan for the Colusa Weir Bypass on September 15, 1966, by resolution which states:

"WHEREAS, the Colusa Weir as heretofore constructed is an integral part of the plan for controlling flood waters of the Sacramento River and its tributaries for the improvement of navigation and the preservation and reclamation of land susceptible to overflow from that river and its tributaries; and

"WHEREAS, the Legislature of the State of California has granted the Reclamation Board the authority to modify the plan heretofore adopted for the control of the flood waters of the Sacramento River, said authority being contained in Part 4, Chapter 1, Article 2 of the Water Code of the State of California; and

"WHEREAS, the Colusa Weir as designed and as operated has developed a sedimentation problem which threatens to interfere with the efficient execution of the plan for controlling of the flood waters of the Sacramento River; and

"WHEREAS, the Reclamation Board has had the problem created by the excess sedimentation in the Colusa Weir studied by the Department of Water Resources and the said Department has presented its report to the Board, which report sets forth several alternative solutions;

"NOW, THEREFORE, BE IT HEREBY RESOLVED that the State Reclamation Board under the authority granted it by the Legislature of the State of California shall undertake to solve the sedimentation problem in the said Colusa Weir and does hereby adopt a modified plan consisting of the extension of the north training levee, the leveling of the excess sedimentation within the existing training levees and east thereof, clearance of vegetation, the planting of necessary vegetation, and such other construction and modifications as will in the judgment of its General Manager best serve to correct the said sedimentation problem; all subject to necessary appropriations by the Legislature; and

"BE IT FURTHER RESOLVED that the Board does hereby authorize the General Manager of the Reclamation Board to proceed with design in order that the said modification on the Colusa Weir may be initiated as soon as possible."

The authority of the Reclamation Board for such action is contained in Division 5, Part 4, Chapter 1, Article 2 of the Water Code of the State of California.

3. Location

The improvements covered by this manual are located in Colusa County about one mile north of the town of Colusa on the east side of the Sacramento River at Colusa Weir where flood waters from the Sacramento River flow through the weir, bypass and bypass sediment basin into the Butte Sink area, as shown on Plate 1.

4. Description of the Maintenance Area

The maintenance area covered by this manual includes the entire flowage area in the bypass and bypass sediment basin, the bypass sediment basin levees, the area between the bypass sediment basin levees and the property line ditches, and the property line ditches, as shown on Plate 2.

5. Construction Data and Contractor

Colusa Weir and training levees were constructed under Corps of Engineers' Contract No. W-1105-eng-1063 with Fredrickson and Watson Construction Company starting 16 October 1932 and completed 30 January 1933.

Colusa Weir modification was accomplished under four Reclamation Board contracts:

Contract No. E-145-67 with Carl J. Wood for clearing and land leveling for vegetative pad starting 4 October 1967 and completed 1 December 1967.

Contract No. E-162-67 with State Division of Forestry for planting vegetative screen completed in spring of 1968.

Contract No. E-186-67 with H. E. Graf, Inc. and M. Graf, a joint venture, for clearing and levee construction starting 22 May 1968 and completed 6 December 1968.

Contract No. E-197-67 with Robinson Construction Company for rock slope protection starting 9 December 1968 and completed 6 August 1969.

CHAPTER II

EXISTING FLOOD CONTROL IMPROVEMENTS

6. Colusa Weir

The Colusa Weir, on the left bank of the Sacramento River approximately one mile north of the town of Colusa, was constructed in 1933. The weir consists of a 1,650-foot long, 20-foot wide, 1-foot thick reinforced concrete slab set at approximately natural ground elevation (61.8 USCE datum). A two-lane concrete bridge runs the length of the weir and is supported on piers 11.4 feet above the invert slab.

The weir provides an unregulated outlet during high river stages.

7. Colusa Weir Bypass

The bypass channel lies between two training levees that extend easterly from the weir approximately two miles into Butte Basin. The channel is 1,650 feet wide at the weir and gradually widens to about 2,600 feet approximately one mile from the weir at which point the channel widens abruptly to 6,200 feet to form the bypass sediment basin. The width of the channel through the sediment basin is 6,200 feet.

The bypass sediment basin levees average approximately 16 feet in height, have an average crown width

of 20 feet, and have cobblestone revetment on both slopes for the full length of the levees.

Graveled patrol roads run the full length of the bypass levees, with access gates at the weir. There are two gated access ramps from Laux Road to the north levee and one gated access ramp to adjacent ground on the south levee. Turnarounds exist on the easterly ends of the levees.

8. Project Design Flows and Levee Section

The distribution of flows at design flood stage at the Sacramento River and Colusa Weir is as follows:

70,000 c.f.s. through the weir;

65,000 c.f.s. in Sacramento River

downstream from the weir.

Flow over the weir begins when the Sacramento River reaches 27,000 c.f.s.

During the flood stage of 70,000 c.f.s. the maximum design water surface at the weir is elevation 71.2 USCE datum and the maximum design water surface at the outlet of the sediment basin is elevation 69.

CHAPTER III

OPERATION AND MAINTENANCE

9. Operation

The Colusa Weir, bypass, and sediment basin are integral parts of the Sacramento River Flood Control Project and their proper operation is essential to the project.

The weir system is to be operated to assure a design flow capacity of 70,000 cubic feet per second through the weir from the Sacramento River and to assure that at the beginning of each flood season a reserve sediment storage capacity of 1,000,000 cubic yards is available in the bypass sediment basin.

The sediment basin is designed to cause sandy material which is detrimental to agriculture to deposit within the limits of the basin. The fine clays and silts which are non-detrimental to agriculture are carried away from the bypass and deposited in the Butte Sink and Sutter Bypass.

Detrimental material is designated as particles of 0.1 millimeter size and larger. A velocity of 1.5 feet per second for 20 minutes or 1.5 feet per second for a distance of 1,800 feet provides sufficient time for the 0.1 millimeter and larger particles to settle.

The required velocity time is provided by assuring that sufficient waterway area is available under conditions of maximum deposition and maximum flow together with a uniform distribution of flow.

The required velocity time is also provided for intermediate flows. A vegetative screen across the basin outlet is of assistance in this regard.

The training levees which define the limits of the sediment basin are designed to operate under maximum ponding water surface in Butte Sink. Both sides of the training levees are stone protected on 3 to 1 slopes to protect against wave wash.

Spoil areas are provided to accommodate sediments removed during maintenance operations. The spoil areas will accommodate 6,500,000 cubic yards at a depth level with the levee crown and an additional 5,800,000 cubic yards at a depth 17 feet higher than the levee crown. Estimated annual average flood flow deposition is 200,000 cubic yards.

10. Maintenance

The maintenance program shall be in accordance with this manual and/or as may be modified by The Reclamation Board.

The maintaining agency shall report the condition of the weir and bypass system as soon as practical at

the end of each flood season. The Reclamation Board thereafter shall determine modifications, if any, for the maintenance program.

10.1 Levees

The sediment basin levees are to be maintained to the same standards as apply to the original bypass training levees. The maintenance requirements are outlined in the U. S. Army Corps of Engineers' "Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project", and "Supplement to Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, Unit No. 155, Colusa Weir and Training Levees, Sacramento River, California".

10.2 Bypass and Sediment Basin

The bypass and sediment basins are to be maintained to effect sheet flow as may be practical.

Sediment and Erosion Channels

At the end of each flood season, observations and/or measurements are to be made of the sediment deposits and erosion channels in the bypass and in the basin. Local sediment buildups of sufficient magnitude to unbalance the flood flow pattern, as viewed in cross section, are to be removed. Erosion channels which are relatively small, numerous,

and form a uniform pattern across the flowage area may be left undisturbed. Major erosion channels which begin to form shall be eradicated.

The Reclamation Board shall determine which of the sediment deposits and which of the erosion channels are beginning to affect the flood flows. The determination shall be made from the annual post-flood season observations and surveys.

Sediments which are removed by the maintenance forces shall be placed in the spoil areas which are indicated on Plate 2. Sediment storage shall begin adjacent to the levees and progressively be built up. Stored sediments shall be rough graded sufficiently to drain away from the levees.

An "operating profile" is indicated on Plate 3. Sediments for which the average grade is above the elevation of the "operating profile" shall be removed. Sediments for which the average grade is below the elevation of the "operating profile" need only be removed sufficiently to maintain uniformity of grade across the line of flow.

Special care and judgment shall be used when removing sediment from the area of the vegetative screen to minimize damage to the screen.

Sediment which may be carried beyond the limits of the property line at the eastern outlet of the basin, is subject to litigation and/or negotiations and is to be managed as directed by The Reclamation Board.

Organic matter need not be separated from spoil material and the spoil area need not be cleared. However, the spoil area is to be left in a presentable condition as to appearance.

Vegetation

Vegetation is to be controlled such that the area in the bypass between the weir and the basin is predominantly weeds or grasses with brush kept to a minimum. Commercial crops are allowable, except within 500 feet of the weir structure, provided they are removed or cut to stubble before flood season.

Brush is allowable in the basin area. When the sediment elevation is well below the "operating profile" grade shown on Plate 3 a 4-5 foot brush height is allowable with "new" growth to higher elevations. Periodically, the brush shall be railed or cut back to prevent the development of heavy woody stems (equivalent alternates are allowable). When the sediment elevation is near

the "operating profile" grade, the brush shall be railed, cut, or otherwise controlled annually.

Grasses, weeds or commercial crops are also allowable in the basin area.

All growth in both the bypass and the basin is to be controlled such that in a north-south direction, across the line of flow, the vegetation is relatively uniform. All maintenance work such as plowing, raiing, planting, etc., is to be performed such that the resultant areas being maintained form strips that extend from the north levee or spoil area to the south levee or spoil area in a north-south direction. A single strip need not be completed in one season, provided the strip is no wider than 300 feet. Vegetation in an east-west direction, along the line of the flow, may vary from strip to strip.

The spoil areas are exempted from the above requirements for vegetative control except vegetation which is determined to be obnoxious by the maintenance forces is to be removed.

Man-Made Installations

All man-made installations are to generally be designed so as to not materially concentrate flows or deflect flows. All man-made installations shall be approved by The Reclamation Board in advance of construction.

10.3 Vegetative Screen

The vegetative screen is comprised of native red or sand bar willow (*salix longiflora*). The screen is to be irrigated, pruned and sprayed as is necessary to develop a vegetative barrier across the outlet of the sediment basin. Maximum density of growth is desirable. There are no limitations on natural growth density except the growth should be thinned when studies indicate the screen is reducing basin flow capacity.

10.4 Area Between Levee and Property Line

Vegetation

Vegetation outside the bypass and basin between the levees and property lines need not be maintained except for removal of plants obnoxious to adjacent farming properties and plants that interfere with access and ditches.

Ditches

The drainage ditch along Laux Road is to be maintained by others. The drainage ditch extending south of Laux Road on the west side of the sediment basin is to be maintained free of weeds and silt. All boundary ditches on the east and south property lines are to be maintained sufficiently free of silt in order that the ditches

may be flooded. Weeds need only be removed at the discretion of the maintenance forces as necessary to maintain good relations with adjacent landowners.

10.5 Access Roads and Gates

Access roads are to be maintained free of growth and shaped as required to maintain original crown or shape. Gravel is to be replaced as needed.

Gates are to be maintained in operational condition.

10.6 Future Spoil Area North of Laux Road

Maintenance of the area north of Laux Road is not required. The area is leased for local farming operations.

Termination of farming leases (through The Reclamation Board) should be sought several years in advance of use of the area for spoil purposes.

STATE OF CALIFORNIA

The Resources Agency

THE RECLAMATION BOARD

DESIGN MEMORANDUM NO. 1

COLUSA WEIR BYPASS MODIFICATION PROJECT Colusa County, California

LEVEE CONSTRUCTION AND BYPASS IMPROVEMENT GENERAL DESIGN

N. B. LIVERMORE, Jr.
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STATE OF CALIFORNIA
THE RESOURCES AGENCY
THE RECLAMATION BOARD

Design Memorandum No. 1

COLUSA WEIR BYPASS
MODIFICATION PROJECT
Colusa County, California

GENERAL DESIGN

FEBRUARY 1968

N. B. Livermore Jr.
Administrator
The Resources Agency

Ronald Reagan
Governor
State of California

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The Reclamation Board

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THE RESOURCES AGENCY
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DESIGN MEMORANDUM NO. 1
COLUSA WEIR-BYPASS MODIFICATION PROJECT
COLUSA COUNTY, CALIFORNIA

GENERAL DESIGN

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DESIGN MEMORANDUM NO. 1

COLUSA WEIR-BYPASS MODIFICATION PROJECT

CHAPTER I

INTRODUCTION

1. Purpose and Scope

This memorandum covers the general design of the levee construction and flood plane area improvement for the Colusa Weir-Bypass Modification Project. It is to be used as a basis for the detail design and for the preparation of contract plans and specifications. Preproject conditions are defined and analyzed. The design criteria for levee cross sections, new structures, modification of existing structures, grading of bypass within project area and other features are established. The memorandum also recommends a logical and practical sequence of construction for this project.

2. Project Authorization

The Grant Report adopted by U. S. Congress on May 25, 1928 provided for the construction of the Colusa Weir.

The Colusa Weir was constructed and accepted as complete on January 30, 1933.

The State Reclamation Board adopted the Modified Plan for the Colusa Weir Bypass on September 15, 1966 by resolution which states:

"WHEREAS, the Colusa Weir as heretofore constructed is an integral part of the plan for controlling flood waters of the Sacramento River and its

tributaries for the improvement of navigation and the preservation and reclamation of land susceptible to overflow from that river and its tributaries; and

"WHEREAS, the Legislature of the State of California has granted the Reclamation Board the authority to modify the plan heretofore adopted for the control of the flood waters of the Sacramento River, said authority being contained in Part 4, Chapter 1, Article 2 of the Water Code of the State of California; and

"WHEREAS, the Colusa Weir as designed and as operated has developed a sedimentation problem which threatens to interfere with the efficient execution of the plan for controlling of the flood waters of the Sacramento River; and

"WHEREAS, the Reclamation Board has had the problem created by the excess sedimentation in the Colusa Weir studied by the Department of Water Resources and the said Department has presented its report to the Board, which report sets forth several alternative solutions;

"NOW, THEREFORE, BE IT HEREBY RESOLVED that the State Reclamation Board under the authority granted it by the Legislature of the State of California shall undertake to solve the sedimentation problem in the said Colusa Weir and does hereby adopt a modified plan consisting of the extension of the north training levee, the leveling of the excess sedimentation within the existing training levees and east thereof, clearance of vegetation, the planting of necessary vegetation, and such other construction and modifications as will in the judgment of its General Manager best serve to correct the said sedimentation problem; all subject to necessary appropriations by the Legislature; and

"BE IT FURTHER RESOLVED that the Board does hereby authorize the General Manager of the Reclamation Board to proceed with design in order that the said modification on the Colusa Weir may be initiated as soon as possible."

Progressive sedimentation at the bypass outlet, due to operation of the weir, started in 1933 and amounted to 6,050,000 cubic yards when surveyed in 1958. On August 19, 1959, a lawsuit for sediment damage due to the operation of

the Colusa Weir was initiated against the State of California. On March 22, 1965 the City Council of the City of Colusa requested that the State Reclamation Board remove the sediments at the mouth of the bypass to allow the Colusa Weir to function properly in order to protect the health, welfare and safety of the people of the City of Colusa. The Reclamation Board authorized studies of Colusa Weir in 1960, 1961 and 1965. The studies indicated the sedimentation to be a continuing and increasingly serious problem and recommended corrective measures. The authority of the Reclamation Board for such action is contained in Division 5, Part 4, Chapter 1, Article 2 of the Water Code of the State of California.

3. Description of the Project

The Modified Plan for Colusa Weir Bypass is a project to control and instigate a maintenance program for the sedimentation which is being deposited in a delta at the outlet of the existing bypass. The project extends the existing bypass training levees to form an enlarged detention basin within which the flood flows are sufficiently controlled to cause coarser sediments to deposit within the project limits.

Land Requirements

Due to previous legal actions, a portion of the area required for the project is existing State fee-owned property. The fee-owned property is comprised of an 80-acre parcel, a 320-acre parcel and a 120-acre parcel. Additional property required for the project is an 80-acre parcel south of the

existing 320-acre fee-owned land. A 320-acre parcel, west of the existing 320-acre fee-owned land, is also required for the project. There is an existing State easement on this 320-acre parcel.

In addition, a 1.82 acre, 30-foot wide parcel is required along the south side of Laux Road for a drainage ditch which is to be part of the project work. (See Plate 2)

Construction

The general construction includes construction of extensions to the existing training levees of the bypass, the clearing and levelling of the area in the existing bypass and the area between the extended training levees, planting a vegetative screen, construction of drainage ditches, and construction of boundary ditches.

The details of construction are covered in Chapter VII in this report.

Maintenance

It is necessary to maintain the channel surface and control and remove sediments in the flowage area and to control the vegetative growth to insure proper operation. The maintenance of the project will be performed by the Department of Water Resources. The required maintenance is outlined in Chapter IV.

4. Description of Project Area

The project is located in Colusa County about one mile north of the town of Colusa where flood water from the Sacramento

River flows through the Colusa Weir and Bypass into Butte Sink and thence into the Sutter Bypass.

The project covers the area between the existing bypass levees and approximately one and one-quarter square miles adjacent and easterly of the existing bypass, as shown on Plate No. 2.

CHAPTER II

EXISTING FLOOD CONTROL IMPROVEMENTS

5. Colusa Weir

The Colusa Weir, on the left bank of the Sacramento River approximately one mile north of the town of Colusa was constructed in 1933. The weir consists of a 1,600-foot long, 20-foot wide, 1-foot thick reinforced concrete slab set at approximately natural ground elevation (61.8 USGE datum). A two-lane concrete bridge runs the length of the weir and is supported on piers 11½ feet above the invert slab.

The weir provides an unregulated outlet during high river stages.

Borrow operations downstream from the weir, in the bypass channel, have in the past caused erosion of the channel at the edge of the weir. The channel was stabilized in this area by rock revetment across the whole width of the weir.

The area upstream from the weir to the Sacramento River has been cleared and leveled to remove sediments which were impeding the functioning of the weir.

6. Colusa Weir Bypass Channel

The bypass channel lies between two training levees that extend easterly from the weir one mile into Butte Basin. The channel is 1,600 feet wide at the weir and gradually widens to about 2,600 feet at the easterly end of the training levees.

At the present time, the channel is used for grazing cattle, and is mostly flat or gently rolling grassland except

for areas of brush, a few scattered groves of oak trees, and a number of deeply scoured channel sections. Sediments have deposited in areas downstream from the oak groves causing those areas to be generally higher than adjacent ground.

Sediment deposition at the mouth of the bypass at the east end of the training levees has raised the channel grade to a maximum of 62.0 feet in elevation. The sediment generally spreads out easterly in a fan-shaped delta laced with deeply scoured channels. The sediment delta reaches as far north as Laux Road, easterly for approximately one mile and south one-quarter mile.

7. Bypass Training Levees

Material obtained from landside cuts was used to construct the training levees. These levees were completed at the same time as the weir and show no evidence of any failure. There has been minor erosion of the levees and scoured areas exist around the easterly ends of the training levees.

The levees are approximately 16 feet in height, have an average crown width of 20 feet and a crown elevation of approximately 72⁵ (U.S.C.E. Datum) at the easterly ends. Cobblestone revetment is provided on the inside for the full length of the levees and on the outside for the easterly 2/3 of the length.

Graveled patrol roads run the full length of both levees, with access gates at each end of the weir.

The map was based on aerial photography and field work performed in the spring of 1967. The Reclamation Board staff did supplemental work which consisted of taking soundings to determine ground elevations in all areas which were flooded at the time when the aerial photography was taken. Miscellaneous surveying was also done by the staff.

10. Foundation and Construction Materials

A soils and foundation report, dated August 1967, was prepared by Clair Hill and Associates for the Reclamation Board. The geology of the area was studied and an engineering analysis made. The structural stability, foundation settlement, seepage and borrow sources were determined.

11. Project Design Flows and Levee Section

The distribution of flows at design flood stage at the Sacramento River and Colusa Weir is as follows:

60,000 c.f.s. through the weir;

48,000 c.f.s. in Sacramento River downstream
from the weir.

Flow over the weir begins when the Sacramento River reaches 27,000 c.f.s.

During the flood stage of 60,000 c.f.s. the water surface in the bypass will be at elevation $70\frac{4}{16}$ at the weir and as high as elevation 69 beyond the end of the existing levees. The height of the extended levees should be constructed at Elevation 72.5 feet which will provide a freeboard of 3.5 feet.

CHAPTER III
BASIS OF DESIGN

8. Reports and Studies

Colusa Weir Investigation, February 1967

This investigation is an Office Report for the Reclamation Board. It is a report by the Department of Water Resources summarizing the operational problems of the Colusa Weir and recommending corrective measures.

United States Corps of Engineers' Letter, March 24, 1967

This letter to the Reclamation Board presents the views of the U. S. Corps of Engineers on action to be taken in correcting operational problems of Colusa Weir. The U. S. Corps of Engineers agreed with the recommendations of the "Office Reports" listed above and stressed a need for a rigid annual maintenance program.

United States Corps of Engineers Office Memorandum,
May 15, 1951

This memorandum entitled "Reclamation of Butte Basin" presents historical flood data of Butte Basin and hydrological and hydraulic studies of the area. Colusa Weir, being an overflow inlet for flood waters into the basin, was included in the study. Recorded flood flows and water elevations for Colusa Weir are contained in the memorandum.

9. Surveys

Topographical Map

A topographical map of the project area, scale 1" = 100', was prepared by Clair Hill & Associates for the Reclamation Board.

The levee crown width is to be 20 feet, with side slopes of 3 to 1. The levee section conforms to the requirements for project levees on the Sacramento River adopted by the Corps of Engineers. The landside slope of the levee has been flattened to conform to the waterside slope requirements due to anticipated ponded waters landside. The average levee height will be 16 feet.

An inspection trench is to be constructed in specified areas. The inspection trench will reduce seepage through the levee base due to differential hydraulic heads. The levee, with inspection trench, will also conform to project standards as may be required for future modifications or work.

A patrol road will be constructed on the levee crown and will be 12 feet wide and consist of 4 inches of gravel surface in conformance with Corps of Engineers' standards. The levee embankment is to be obtained from local sources with 90% compaction required, said compaction based on using AASHO Test Designation T-180-57.

12. Hydraulic Design

Hydraulic analysis and flood records were used for developing the general requirements for the design of the bypass basin.

A detention time of twenty minutes at 1.5 feet per second velocity is required to allow particles 0.1 millimeter in diameter and larger to settle within the basin limits.

A uniform sheet flow was determined to be necessary for flood flows through the project. A 1,000,000 cubic yard sediment

storage capacity was determined to be the minimum storage necessary for annual operation to accommodate anticipated maximum flood flows.

Hydraulic designs to determine maximum limiting elevations for sediment deposits in the bypass which do not decrease the 60,000 c.f.s. design flood flows through the weir and which allow a basin detention time of 20 minutes at 1.5 feet per second are to use a recommended Manning's "n" of .030. It is anticipated the initial "n" value in the bypass will be .025 due to a high degree of maintenance, and that scouring and channeling of the deposited sediments under flood flows will cause this value to increase.

For intermediate and lower flows, velocity is a prime consideration. The recommended Manning's "n" values to be used are .025 from weir to approximate end of existing bypass levees, .027 over areas of shallow flow, .030 over remaining area to vegetative screen, and .035 through vegetative screen. Under flow conditions, scour in the area of deposition, together with debris in the channel area, will increase the foregoing "n" values somewhat. The "n" value through the vegetative screen will increase as the screen matures, and also its effect on deeper flows will increase. The design "n" values, however, are to give the maximum anticipated velocities which are desirable for a conservative design.

Manning's "n" values may vary for successive flowage reaches, but the value within each reach must be uniform over

the entire width of the reach. Variation of roughness over significant portions of width will cause a non-uniform distribution of velocity and flow capacity; hence, will cause an uneven deposition of sediments. Such a condition, under continuing flood flows, will progressively decrease the operating effectiveness of the sediment basin.

13. Levee Slope Protection

The velocity of water in the bypass flowage area is relatively low and levee slope erosion due to such velocity is anticipated only at the mouth of the existing bypass levees where the flow will be expanding and at the ends of the extended levees. Stone bank protection will be provided in these areas.

Wave wash could occur on either side slope of the levee extensions. The side slopes are to be seeded and a grass cover developed to minimize such wave wash as may occur. Such wave wash as occurs is to be controlled as a maintenance feature.

14. Structural Design

Structural design is based on standards of the U. S. Corps of Engineers, the State Reclamation Board and the Department of Public Works of the State of California.

15. Drainage

Sediments from the Colusa Weir Bypass have raised the ground elevation between the bypass outlet and Laux Road hindering drainage easterly along Laux Road. Landleveling in conjunction with farming operations lying south of Laux Road and west of the project work and landleveling in conjunction with farming

operations north of Laux Road and north of the project work have also changed ground elevation and hindered drainage from west to east. Some of the landleveling includes areas with prior sediment deposits.

Ditches are to be constructed as part of the project to restore the efficiency of drainage along Laux Road and to drain the area westerly of the project north of the existing bypass.

16. Water Rights

A portion of the project work which lies within the East 1/2 of Section 21 and the West 1/2 of Section 22, Township 16 North, Range 1 West is within the irrigable service area of Reclamation District 1004 under State Water Rights Board License No. 3165. A portion of the project work which lies within the East 1/2 of Section 9 and the West 1/2 of Section 10, Township 16 North, Range 1 West is within the irrigable service area included under State Water Rights Board License No. 1407. Unrecorded riparian or other appropriative water rights may have been established prior to December 1914.

The values as may be attributed to such parcels of land by virtue of being within such License Areas or by virtue of such unrecorded rights, is considered in the property acquisition price.

CHAPTER IV
PROJECT PLAN

17. General

The project generally follows the recommended corrective measures as presented in the "Colusa Weir Investigation" office report for The Reclamation Board, State of California, prepared by the Department of Water Resources and submitted in February, 1967; said report is referred to in this memorandum under Chapter III.

The project includes extending the existing bypass levees to form an enlarged bypass basin east of the existing bypass. The enlarged basin is approximately 5,000 feet in length and approximately 6,200 feet wide. The enlarged basin provides an area within which the Colusa Weir flood flows are sufficiently controlled to cause suspended sediments 0.1 millimeter and larger to settle out of the flood waters. The storage capacity of the basin is to provide for a minimum of 1,000,000 cubic yards of deposited sediments during a single flood season.

The proposed plan of improvement includes the following:

a. Use of 120 acres north of and adjacent to Laux Road upon which sandy sediments are encroaching and which area will be a secondary spoil site; use of 80 acres adjacent and along the southerly boundary of the State's 320 acre fee parcel, which 80 acres will be within the project basin area; use of 320 acres of property within the project basin area which lies between the end of the State fee-owned Colusa Bypass and the

320 acres of State fee property to the east of the bypass. The above parcels are shown on Plate 2.

b. Extending the north bypass levee a total of approximately 7,100 feet; approximately 2,400 feet is in a northerly direction and approximately 4,700 feet is in an easterly direction. Extending the south bypass levee a total of approximately 6,100 feet; approximately 1,300 feet is in a southerly direction and approximately 4,800 feet is in an easterly direction. See Plate 2.

c. Clearing and leveling the basin area and the area between the existing bypass levees to develop sheet flow in the bypass area.

d. Planting a vegetative screen across the easterly end of the bypass basin area to retard flood flows.

e. Providing drainage for land adjacent to the levee extensions and westerly along Laux Road.

f. Constructing ramps to provide access to the project area between the extended levees.

g. Raising the P.G.&E. power distribution line across the extended levees to provide overhead clearance. The portion of power line in the basin area will be undisturbed.

h. Developing a storage capacity in the flowage area for 1,000,000 cubic yards of sediments.

i. Developing a sediment removal program for an average annual capacity of 200,000 cubic yards of sediments.

18. Bypass Channel Improvement

All existing trees, brush and vegetation are to be cleared. Grubbing will not be required.

All existing irrigation, drainage ditches, and eroded channels within the bypass are to be backfilled.

The entire area is to be landleveled as necessary to produce a uniform sheet flow for flood flows passing through the bypass. Such landleveling is to be the minimum necessary to balance required cuts and fills. The grading tolerance will be plus or minus (+) six inches or as directed by the Engineer.

19. Roads

One east-west county road (Laux Road) lies parallel and northerly of the north levee extension. Laux Road is to remain as it is now. The material deposited along the south side of Laux Road is to be removed as part of the project.

20. Levee Extensions

The north bypass levee will be extended approximately 7,100 feet and the south bypass levee approximately 6,100 feet. The levee will have a crown width of 20 feet, side slopes of 3 to 1 (3:1), and a 12-foot wide x 4-inch deep graveled patrol road on the crown. An inspection trench will be required as indicated by the foundation report. Area prepared for levee construction shall be cleared and grubbed and all organic vegetative matter removed. Soil unsuitable for levee construction shall be removed.

21. Stone Bank Protection

Stone bank protection is to be cobblestone or quarry rock. Such stone is to be 12-inch maximum size and in accordance with Corps of Engineers' specifications for cobbles or quarry rock, whichever is applicable.

The top of the stone protection is to be at the highest anticipated flood plane (elevation 69) and the toe is to be below scour elevation. The Corps of Engineers' standard of extending stone protection 5 feet below grade is considered to provide an ample safety factor and is to be used for construction of stone protection.

The length of area stone protected is to be along the full length of curves diverging away from the line of flow, including the ends of the levee extensions, plus adjacent areas of turbulence against the levee slope.

The salvaged derrick stone is to be stored along the toe of the nearest reach of stone protection.

22. Drainage Ditches

Drainage to the west of the north levee extension will be provided for by means of drainage ditches. A drainage ditch is to be constructed parallel and immediately south of Laux Road from approximately one half mile westerly of the levee extension to existing drainage near the easterly end of the levee extension. A lateral north-south ditch is to be constructed parallel and west of the north-south portion of the north levee extension.

23. Irrigation Facilities

A pipe structure may be constructed through the north levee extension. See Plate 2.

24. Utilities

The power and telephone facilities adjacent and parallel to Laux Road are not to be disturbed.

The power line adjacent to the easterly line of the Laux property is to be raised to provide proper clearance over the levees.

25. Property

All property and/or property rights are to be acquired in advance of construction or such acquisition is to be at a sufficiently advanced stage to allow construction.

All property and/or property rights are to be perpetual and are to be sufficient for the following:

Construction of the project and/or any part thereof.

Construction of all revisions or modifications.

Maintenance and operation of the project.

Access and control of access.

Flow of all flood waters and all future waters
due to changed conditions.

Deposition of all materials.

Storage of all materials.

Control of all surface use.

Control of all subsurface use as may affect the project.

26. Maintenance and Operation

Maintenance is to be in accordance with standards adopted by The Reclamation Board, State of California.

Sediment removal in the project area is to be an annual operation by the maintenance forces. A 1,000,000 cubic yard storage capacity is to be available annually in the flowage area. The area allowed for storage is not to decrease the 60,000 cubic feet per second design capacity of the Colusa Weir and is not to decrease the 20 minute detention time at 1.5 feet per second except under extreme conditions.

Accordingly, sediments in the bypass will be maintained at or below grades as determined by The Reclamation Board through hydraulic analysis of the flood flows and anticipated rate of sedimentation. Removed sediments are to be spoiled in the area as designated on Plate 2.

Grading and shaping in the project area is to be an annual maintenance operation. Erosion channels are to be minimized and areas of excessive deposition removed or spread out. The purpose of the grading and shaping is to maintain the area so as to cause flood waters to flow as sheet flows.

Clearing in the project area is to be an annual maintenance operation. Isolated areas of vegetative growth are to be removed. Vegetative growth is to be maintained essentially uniform from bank to bank when measured at right angles to the direction of flow; however, the growth, as measured along the line of flow, may vary, as determined by the Reclamation Board. The

purpose of the clearing is to control the hydraulic roughness as necessary to control flow velocities and to assure that the flow is essentially uniform across any section of channel.

The vegetative screen is to be maintained as an annual operation. The vegetative screen is to be irrigated during the dry summer season. Insect and disease sprays are to be applied as required. The purpose of the vegetative screen is to increase hydraulic friction across the mouth of the basin area to control velocity.

The levees are to be maintained annually in accordance with standard levee maintenance procedures adopted by the Reclamation Board.

Ditches are to be cleaned and vegetative growth removed as annual maintenance.

Use of the project area that interferes with maintenance or operation is to be prohibited. Use of the project area that does not interfere with maintenance or operation may be allowed. The purpose of controlling the use of the area is to: (1) assure proper control of clearing which is necessary to control the hydraulic roughness in the project area; and (2) assure proper sediment control, removal, and storage.

CHAPTER V
COST ESTIMATES

27. Project Cost

Costs of lands and rights of way were estimated by The Reclamation Board staff right-of-way appraisers.

Construction costs and cost of utility relocations were estimated by The Reclamation Board staff engineers.

Summary of Estimate of Cost

<u>Feature</u>	<u>Amount</u>
Land	\$ 164,000
Land Clearing	50,000
Land Leveling	307,000
Levee Embankment	329,250
Drainage Ditches	26,000
Drainage Structures	1,000
Rock Revetment	46,200
Planting Vegetative Screen	1,700
Patrol Roads	15,300
Utility Relocation	3,000
Sediment Settling Area*	<u>500,000</u>
Project Cost	\$1,443,450

*The cost estimate for the Sediment Settling Area is based on maximum construction requirements. The actual construction of a sediment settling area is to be deferred to allow field observations of sediment management under scheduled maintenance.

28. Maintenance Cost

Levee maintenance costs are based on standard maintenance for the levee extensions, plus additional costs to repair anticipated wave wash.

Sediment removal and grading costs are based on removing an average 200,000 cubic yards of sediments annually from the entire bypass flowage area, plus grading and shaping to minimize scour channels.

Clearing costs are based on clearing as necessary to control vegetative growth within the entire bypass flowage area.

Vegetative screen maintenance costs are based on irrigating, spraying, and replacing screen growth as required.

	<u>Annual Cost</u>
Levee maintenance	\$ 4,500
Sediment removal and grading	53,000
Clearing	6,000
Vegetative screen	<u>400</u>
	\$ 63,900
15% Administrative and Overhead	<u>9,585</u>
Total	\$ 73,485

CHAPTER VI

BENEFITS

29. Flood and Sediment Damages

Since the construction of Colusa Weir, flood flows have been transporting sediments which have been depositing in a delta at the mouth of the bypass and on adjacent farmlands. The fine silts transported and deposited have been beneficial to farming as it is excellent soil for farm crops. The sediment depositions, however, have altered drainage patterns in the area to the point where orchards north of the bypass are being threatened. Landowners have notified The Reclamation Board that slow and improper drainage of ponded flood waters, which remain when flood flows recede, is a continuing and increasingly serious problem. Orchards in the area have developed "sour-sap" damage to the extent that the land is becoming marginal for orchard crops.

In more recent years for the past decade or so, flood flows have been transporting an increasing amount of coarse sediments consisting of sand and fine sand. The coarse sediments, unlike the fine silts, are detrimental to farming. The coarse sediments are depositing on the delta at the mouth of the bypass and on adjacent farmlands. The increasing damage to the farmlands has resulted in court actions for damages being filed against the State of California. As a result, in 1964, 400 acres of farmland were purchased by the State of California for \$205,000 and, in 1967, 120 acres of farmland were purchased by the State of California for

\$80,000. The steady and increasing nature of the sand encroachment on the adjacent farmlands indicate continuous future damages and hence continuous future lawsuits for damages.

The total depth of sediments in the delta at the mouth of the bypass has steadily increased to the point where design flood flows are being effected. The city of Colusa has notified The Reclamation Board by a resolution expressing its concern for the safety of the Sacramento River Flood Control Project downstream from Colusa Weir and hence concern for the safety of the city of Colusa. State maintenance agencies have also expressed concern over the steady build-up of sediments and the proper operation of the Colusa Weir.

When the sediments build up to an elevation where the backwater effect impairs flood flows over Colusa Weir, the downstream flood flows in the Sacramento River will be increased with corresponding decrease in the safety of the Sacramento River Flood Control Project.

30. Benefits

Restoration of drainage to approximately 400 acres of orchard lands north and west of Colusa Weir Bypass.

Protection for an estimated 800 acres of adjacent farmlands from encroaching damaging sediments.

Protection for the Sacramento River Flood Control Project from Colusa Weir downstream to the Fremont Weir at the head of Yolo Bypass. The area protected by this portion of the Sacramento River Flood Control Project is approximately 35 miles in length (or 60 river miles) by 10 miles in width and is comprised of highly developed

agricultural lands and includes the townsites of Colusa, Meridian, Grimes, Robbins, and Knights Landing.

CHAPTER VII

CONSTRUCTION PROGRAM

31. General

The project will be completed in consecutive construction contracts, with the first construction beginning in the fall of 1967.

32. First Contract (September 1967)

The first contract will be for the construction of a level pad, upon which a vegetative screen will be planted at a later date. The planting is to be in early spring after flood flows recede. It is therefore necessary to prepare the planting area in advance prior to the flood flows.

The pad will be constructed across the area which is to be the east end of the proposed bypass basin. The pad will begin near Laux Road and extend southerly approximately one and one-quarter miles then westerly one-half mile. (See Plate 2)

A boundary ditch will also be constructed on the southerly and easterly property line of an 80-acre parcel to be acquired from Butte Creek Farms.

33. Second Contract

The second contract will provide for the cutting and planting of willows to form the desired dense vegetative screen along the easterly limit of the deposition area. The screen will be planted in the level pad constructed under the first contract. The planting will be accomplished under contract by the State Division of Forestry.

34. Third Contract (May 1968)

The third contract will be for the extension of the existing bypass training levees, clearing and leveling the existing bypass, clearing and leveling the area between the levee extensions, and constructing drainage ditches.

The north training levee will be extended northward approximately 2,400 feet to the southside of Laux Road, then east parallel to Laux Road approximately 4,700 feet. The south training levee extends southerly approximately 1,300 feet and then easterly 4,800 feet.

The area between the existing bypass levees and the extended bypass levees will be cleared of trees, logs, brush and all other vegetation. Grubbing will not be required in this area. In areas of levee construction, clearing, stripping and grubbing will be required. In areas of ditch construction clearing will be required.

The land leveling shall include the backfilling of all irrigation and drainage ditches within the project overflow area.

A drainage ditch will be constructed adjacent to the north training levee parallel to Laux Road. A drainage ditch will be constructed westerly of and parallel to the north-south leg of the north training levee.

Ramps will be constructed to provide access to the area between the extended training levees.

35. Fourth Contract

The fourth contract, for the construction of a sediment basin, with a 1,000,000 cubic yard capacity, is to be held in

abeyance until significant observations can be made of flood flows under the new project conditions. Scour patterns and sediment patterns are to be observed and the sediment collection area adjusted accordingly.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

36. Conclusions

Based on the facts and studies contained in this design memorandum, it is concluded that:

a. The adopted proposed Modification Plan is economically justified on the basis of primary benefits to the safety of the Sacramento River Flood Control Project; and

b. The adopted proposed Modification Plan will provide the desired operation of Colusa Weir.

37. Recommendations

Pursuant to the information contained in this design memorandum, it is recommended that:

a. The Reclamation Board proceed with the preparation of contract plans and specifications for the project; and

b. The Reclamation Board contract for the construction of the project.

TABLE I

DETAILED ESTIMATE OF COST

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT
LANDS	80 320	acre acre	\$ 600.00 362.50	\$ 48,000 116,000 <u>164,000</u>
LEVEES	553,500 21,000	Cu. Yd. M. Gallons	\$ 0.50 2.50	\$ 276,750 52,500
LAND CLEARING	1 Job	L. S.		50,000
LAND LEVELING	1,535,000	Cu. Yd.	0.20	307,000
DRAINAGE DITCHES	7,693 4,820	Lin. Ft. Lin. Ft.	1.50 3.00	11,540 14,460
DRAINAGE STRUCTURES	1 Job	L. S.	1,000.00	1,000
ROCK REVETMENT	5,200 1 Job	Ton L. S.	6.00	31,200 15,000
PLANT VEGETATIVE SCREEN	1 Job	L. S.	1,700.00	1,700
PATROL ROADS	4,800 1 Job	Ton L. S.	3.00 900.00	14,400 900
UTILITY RELOCATION	1 Job	L. S.	3,000.00	3,000
SEDIMENT SETTLING AREA	1 Job	L. S.	500,000.00 (other than lands)	\$ 500,000 <u>\$1,279,450</u>

TABLE II

ESTIMATE OF COST BY CONTRACT

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT
LANDS				
Butte Creek Farms Parcel	80	acre	\$ 600.00	\$ 48,000
Laux Parcel	320	acre	362.50	116,000
			Total lands	<u>164,000</u>
<u>Contract #1</u>				
LAND CLEARING	1 Job	L. S.		\$ 5,000
LAND LEVELING	85,000	Cu. Yd.	\$ 0.20	17,000
DITCHES	3,040	Lin Ft.	\$ 1.50	4,565
			<u>Contract #1 Total</u>	<u>26,565</u>
<u>Contract #2</u>				
PLANT VEGETATIVE SCREEN (includes cutting & planting)	1 Job	L. S.		\$ 1,700
			<u>Contract #2 Total</u>	<u>1,700</u>
<u>Contract #3</u>				
LEVEES				
Embankment	553,500	Cu. Yd.	0.50	\$ 276,750
Water	21,000	M. Gallons	2.50	52,500
LAND CLEARING	1 Job	L. S.		\$ 45,000
LAND LEVELING	1,450,000	Cu. Yd.	0.20	\$ 290,000
DRAINAGE DITCHES				
Type "A"	4,650	Lin. Ft.	1.50	\$ 6,975
Type "B"	4,820	Lin. Ft.	3.00	14,460
DRAINAGE STRUCTURES	1 Job	L. S.		\$ 1,000

TABLE II

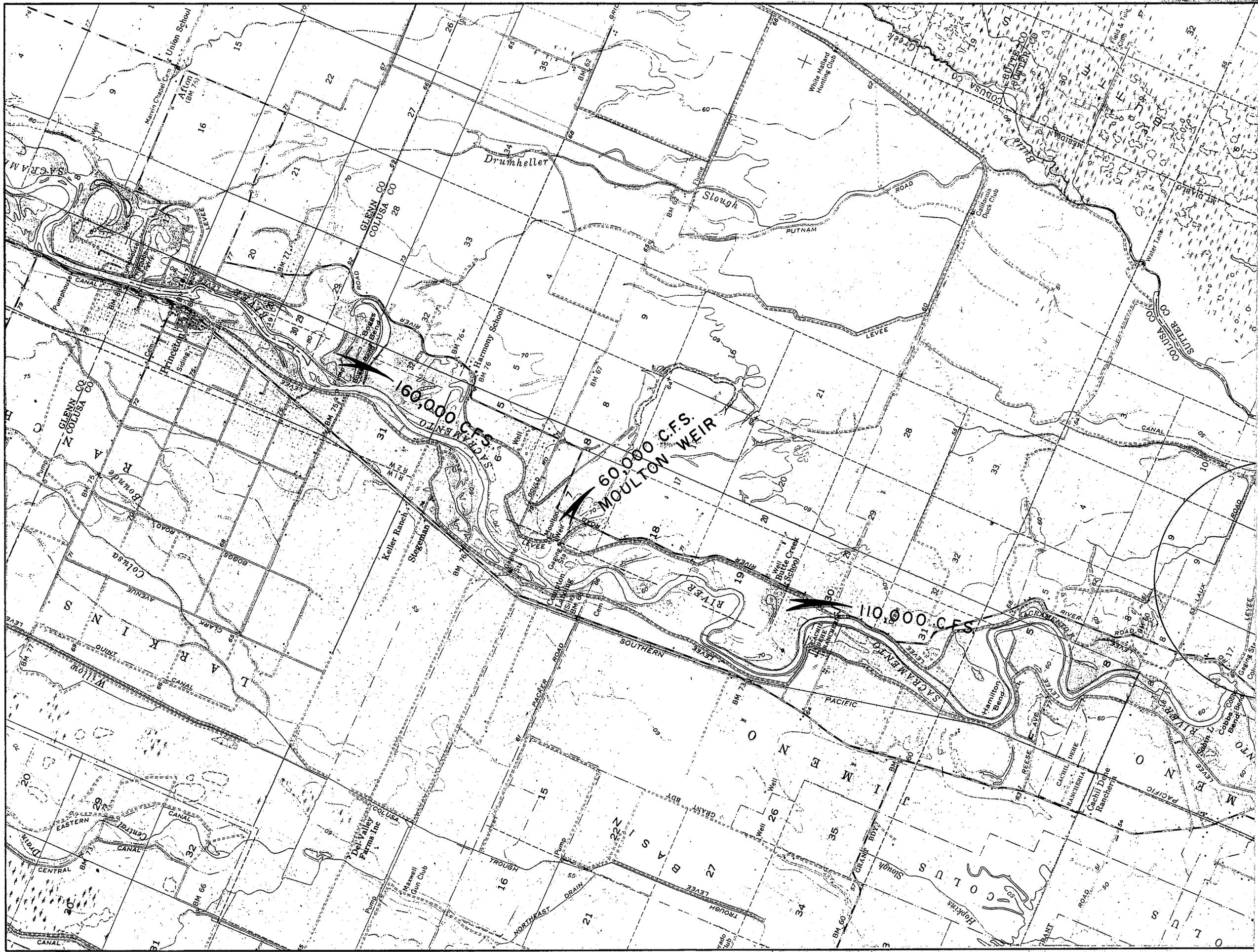
ESTIMATE OF COST BY CONTRACT CONTINUED

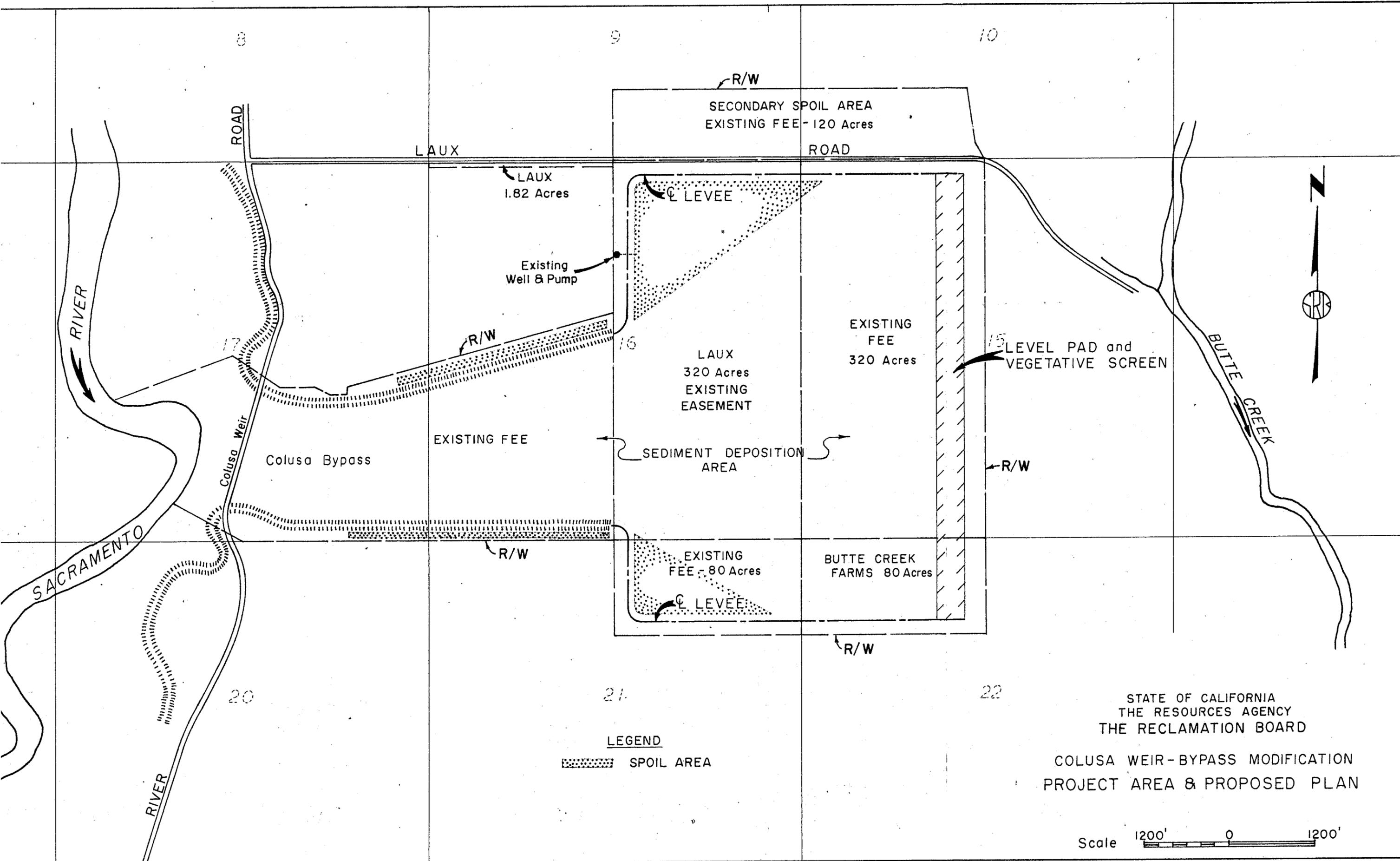
ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT
<u>Contract #3 Continued</u>				
ROCK REVETMENT				
Rock Slope Protection	5,200	Ton	\$ 6.00	\$ 31,200
Remove and Reuse Existing Riprap	1 Job	L. S.		15,000
PATROL ROADS				
Mineral Aggregate	4,800	Ton	\$ 3.00	\$ 14,400
Cable Gates	1 Job	L. S.		900
UTILITY RELOCATION				
	1 Job	L. S.		3,000
<u>Contract #4</u>				<u>\$ 751,185</u>
SEDIMENT SETTLING AREA				
	1 Job	L. S.		\$ 500,000
				<u>\$ 500,000</u>

TABLE III

CUMULATIVE ESTIMATE OF COST

ITEM	COST	CUMULATIVE TOTAL
LANDS	\$ 164,000	\$ 164,000
CONTRACT #1	26,565	190,565
CONTRACT #2	1,700	192,265
CONTRACT #3	751,185	943,450
CONTRACT #4	500,000	\$ 1,443,450





STATE OF CALIFORNIA
 THE RESOURCES AGENCY
 THE RECLAMATION BOARD
 COLUSA WEIR-BYPASS MODIFICATION
 PROJECT AREA & PROPOSED PLAN

Scale 1200' 0 1200'

LEGEND
 SPOIL AREA