Mrs. Rothberg

tershed Work Plan

BEARDSLEY WATERSHED

VENTURA COUNTY
CALIFORNIA

DECEMBER 1963

Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd. Congress, 68 Stat. 666) as amended.

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Prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended.

Prepared by

Ventura County Flood Control District
Calleguas Soil Conservation District

With assistance by

U. S. Department of Agriculture, Soil Conservation Service

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Looking southeast from the western boundary of Beardsley watershed north of Highway 101, into the adjacent Revolon watershed following the flood of February 1962. Nyland Acres in the center. Major flood flows had receded when this picture was taken. It indicates the flooding pattern in this portion of the watershed and the interrelationship between the Beardsley and Revolon watersheds.

Looking west from Santa Clara Avenue onto flooded agricultural lands during flood of February 1962.

Flooding at junction of Santa Clara Avenue and Highway 101, adjacent to Nyland Acres, during flood of February 1962.

SUMMARY OF PLAN

The Beardsley watershed is the upper part of the Beardsley Wash - Revolon Slough drainage area, which is located in the south central portion of Ventura County about 60 miles northwest of the City of Los Angeles. This drainage area is tributary to Calleguas Creek just north of Highway 101A bridge, from which point the combined flows of these watersheds discharge through the Naval Air Station property at Point Mugu into the Pacific Ocean. The lower part of this drainage area is included in the Revolon Watershed Project for which a separate work plan has been prepared by the sponsors for concurrent submission.

The works of improvement to be installed in the Beardsley Watershed Project are inter-dependent with those to be installed in the Revolon Watershed Project. Most of the channel improvements on the Beardsley Project should not be installed until the improvement of Revolon Channel has been completed to provide an outlet into Calleguas Creek. The design capacity provided in the improved Revolon Channel includes consideration of the increased peak flows that will occur because of more efficient concentration and control of the flood flows originating in the Beardsley watershed.

The Beardsley watershed contains approximately 20,500 acres. Land use in the area is primarily for the production of citrus fruits and high value truck crops. At the present time urban development has been limited to the Camarillo Hills area, which is almost entirely unsuited for intensive agricultural use, and Nyland Acres. It is anticipated that the expansion of urban and industrial development will continue at an accelerated rate into the watershed especially from the existing urban core developments of the Camarillo and Camarillo Hills areas, Nyland Acres, El Rio and Oxnard. However, the floodplain will remain predominantly agricultural for many years because of the high income received from the production of truck and other specialty crops. It is anticipated that the conversion of land to urban and industrial use will follow a course of orderly development in Ventura County that will result in moderate encroachment onto the floodplain in the vicinity of Nyland Acres and along U. S. Highway 101.

Large areas have been inundated by flooding eight times during the past thirty years. Lesser floods have occurred during other years of this period. From records of precipitation and historical accounts of flood occurrences in the past it seems probable that the floods experienced during this thirty year period are a reasonable indication of the intensity of the flood problem. The flood hazard area includes about 3,200 acres. The 1938 flood is estimated to have been the maximum flood occurrence during the past thirty years. That year about 2,800 acres were inundated.

To solve the flood problem requires control of sediment sources as well as flood flows. There are major sediment sources in the Beardsley watershed. The project includes land treatment measures to control erosion and reduce sediment problems and runoff; and structural measures to stabilize channel grades, control sediment which would make channel improvements less effective, and provide channel realignments and improvements to prevent flooding.

The land treatment measures include conservation farming practices such as cover and green manure crops, use of crop residues in soil management and contour farming; pasture and range seeding and improved management; critical area planting; and stream channel improvement and stabilization structures.

The structural measures will include drop spillways, improved debris basins and the realignment and improvement of about six and one-half miles of channel. These channels will be lined with a rectangular concrete section. All structures will be designed to control a flood of such magnitude that there is only one chance in fifty of it occurring in any given year.

The total capital cost for installing these land treatment and structural measures is $4,753,010, of which $4,038,870, or 85 percent, will be from funds provided under provisions of Public Law 566. The remaining portion of the installation cost, $714,140, and $5,900 annual operation and maintenance costs, will be non-federal. It is anticipated that expenditures for structural measures will be $138,800 during the first year of the project installation period and $77,610, $141,880, $1,521,310 and $2,568,040, respectively, during the subsequent years of a five year period.

The total average annual cost of structural measures, including amortization of capital costs for installation and the annual operation and maintenance costs is $174,700. The average annual benefits are estimated to be $256,300 which provides a benefit cost ratio of 1.47 to 1.

This project is jointly sponsored by the Ventura County Flood Control District and the Calleguas Soil Conservation District. The Flood Control District will be the agency responsible for the installation of structural measures and for their operation and maintenance. It has cooperated in the preparation of the work plan by providing technical assistance for investigations and project formulation and by preparing the work plan document.

Land treatment measures will be installed and maintained by individual farmers and ranchers cooperating with the Calleguas Soil Conservation District.

DESCRIPTION OF THE WATERSHED

PHYSICAL DATA

The Beardsley Wash - Revolon Slough drainage area is the westernmost tributary to Calleguas Creek and joins Calleguas Creek immediately north of Highway 101A from where the combined flows discharge through a short segment of channel on Naval Air Station property at Point Mugu into the Pacific Ocean. It is located in the south central portion of Ventura County approximately 60 miles northwest of the City of Los Angeles.

The Beardsley watershed is the upper part of this drainage area. The northern boundary is South Mountain; the western boundary is a low flat ridge running in a northeasterly direction which separates this drainage area from the Santa Clara River; the eastern boundary is established by the drainage area of Honda Barranca and its tributaries; and the southern boundary is the Camarillo Hills and the boundary of the small area below Highway 101 which will drain directly into Revolon Channel above its junction with the Camarillo Hills Drain.

The area within the Beardsley watershed is about 20,500 acres, or 32.0 square miles. Elevations within the watershed range from about 50 feet to about 2,300 feet.

The headwaters of Beardsley watershed are from the south slopes of South Mountain and the north slopes of the Camarillo Hills. These waters are collected in a network of barrancas which discharge into Beardsley Wash or onto the flood plain area where there are no well defined channels. There is no continuous well defined channel through the watershed. Even minor flood flows spread over considerable areas before they eventually converge into the well defined portion of Revolon Channel outside Beardsley watershed boundaries.

The soils in the Beardsley watershed may be separated into three main groups. Fairly shallow residual soils occur in the upper reaches of South Mountain. The parent rock is encountered at a depth of about three feet and consists of more or less disintegrated shale, sandstone and conglomerate. The surface of this soil is generally steep and dissected with gullies extending well into the parent rock. This area of residual soils is not important agriculturally and is covered with a scant to heavy growth of brush and grasses. The continuing erosion and gullying on these lands provides one source for sediment which causes problems in the lower part of the watershed.

Soils of the old valley-filling and coastal-plain group are intermixed with residual soils but are generally at lower elevations. They include all of the remaining portion of the South Mountain area not included in the residual soils group, the Camarillo Hills and some of the land immediately below these steeper areas. They occur in very hilly or rolling areas, on smooth to eroded stream terraces or on sloping remnants of old alluvial fans that have either been elevated since their deposition or have been left in their present positions by the cutting of deeper stream channels through them. They are undergoing active erosion or are being covered slowly with recent alluvial material. On the steeper slopes these soils are grass and brush covered but generally dissected with gullies. The rolling and stream terrace areas are used for citrus orchards. These soils are the major source of sediment contributing to the problem in the lower part of this watershed and in the Revolon watershed.

The recent-alluvial soils group includes the major portion of the lands within the watershed. These soils are in the Yolo series as the materials for them came originally from sedimentary rocks and old valley-filling deposits. They are usually well drained on the steeper slopes but frequently have a high water table and carry injurious quantities of alkali in the lower areas having less steep slopes. These soils are the most important agriculturally in the watershed. To some extent they are used for citrus orchards but are generally used for truck and other field crops.

About two-thirds of the watershed is used for intensive agricultural production. Urban developments include Nyland Acres and a large part of the Camarillo Hills area. The balance of the watershed is covered with brush and grass and is used for range. It is anticipated that urban developments will extend further into this watershed but it is probable that most of the good agricultural lands will continue in that use for many years to come.

The climate in the watershed is similar to that of other coast regions in Southern California. It is one of the important factors in the high degree of agricultural development attained, as well as in the types of agriculture practiced. The extremes of temperature recorded over a period of 25 years at a United States Weather Bureau Station located at Oxnard, just beyond the southwest boundary of the watershed, are 104°F. and 26°F. The mean monthly temperature over this period was 59°F. Severe frosts are infrequent in this area. The average annual growing season is about 332 days. The winter seasons are cool and wet and the summer seasons are dry and warm. Fogs moderate the aridity. The rainy season occurs within the period November through May with most of the precipitation occurring during the three winter months. The average annual precipitation over a 59 year period at a station within the watershed is 14.70 inches.

ECONOMIC DATA

Agriculture in the Ventura area dates back to about 1782, with the coming of the Mission fathers. Many large Mexican land grants were made at an early date but active farming was not begun until about one hundred years ago. The raising of cattle and sheep occupied the attention of the early settlers. In more recent years the Beardsley watershed area has been used for the production of citrus fruits and field crops. The growing of citrus fruits, especially lemons, is not successful on the flood plain area and areas immediately adjacent to it, because they will not tolerate alkali and require a deep well-drained soil for best development. Citrus fruits are grown extensively in the upper well-drained portion of the watershed. Sugar beets used to be a major crop in the lower portion of the watershed area but have been replaced by truck crops for the fresh and frozen markets, cut flowers and flower seed. The long growing season in this area permits double and triple-cropping of lands not subject to frequent flooding.

Crops from this area supply vital needs of the people throughout the United States and especially the nearby heavily populated Los Angeles area. Since vegetable crops are the main product of the area to be protected against flooding in this watershed, no crops will be added to the surplus problems facing the agricultural economy today.

With the exception of Nyland Acres and the Camarillo Hills area, the entire watershed is used for agricultural production at the present time. About 95 percent of the lands having soils suitable for intensive agriculture are now being used for that purpose.

Ventura County is located within the Southern California Metropolis that has as its core the City of Los Angeles. Within this seven-county region, where nine million people now live, about 24 million residents are expected by 1985.

The population of Ventura County was about 200,000 in 1960 according to the census. The annual population growth rate of Ventura County during the period 1955-60 was estimated as 6.5 percent while that of California was 4.1 percent and of the United States 1.8 percent for the same period. Population projection estimates for Ventura County for the year 1985 range from 600,000 to 1,400,000. For long range County planning purposes a 1985 population

estimate of 800,000 is being used. This phenomenal growth is expected to occur primarily as a consequence of new opportunities in missile, electronic and research activities associated with the role Southern California plays in national defense and space exploration. Secondarily, this growth will be the result of tourism and the improved position the County will assume in the production of goods for West Coast and Pacific rim markets.

In 1960 the population within the Beardsley watershed was less than 3,000, located almost entirely in Nyland Acres and the Camarillo Hills area. No doubt, industrial developments and additional urban developments will continue to encroach upon this watershed area as the County continues to grow. However, it is also probable that the major portion of this excellent agricultural land will continue in agricultural use for many years to come.

Transportation facilities serving this area are excellent. The Southern Pacific Railroad provides rail service with its main coast line running through Ventura, Oxnard and Camarillo and on to Los Angeles. Topography channels a number of major U. S. and State highways into and through the County making it a hub in the south coast highway system. U. S. Route 101, part of the Interstate Highway System, enters the County from the west and branches into two major highways, one running easterly through Camarillo to the San Fernando Valley and Los Angeles and the other extending southerly through Oxnard and along the coast to Santa Monica and Los Angeles. U. S. Route 399 and four State Routes are also included in the County's network of highways. Pacific Airlines provides air transportation for passengers, freight and mail service from the County Airport at Oxnard, with two flights daily to connections with other lines at Los Angeles and San Francisco. The deep water harbor at Port Hueneme, under Navy jurisdiction, will probably be available for less restricted general use in the future, thus giving this watershed area and the County a complete range of transportation types.

Irrigation is necessary for the intensive agriculture practiced in this area. The irrigation water supply is obtained primarily from wells. The water levels in these wells recede during a series of dry years and recover during wet years with a general trend toward recession. There are no practical opportunities to include water conservation measures in the project.

Part of the area has a high water table problem which requires subdrainage systems to prevent alkali accumulations and lower water levels to permit most efficient crop production.

Land use in the watershed is summarized as follows:

Land Use	Acres	Percent
Row and field crops	9,332	45.5
Orchard	4,255	20.8
Pasture	666	3.2
Range	2,200	10.7
Watershed (steep mountains and gullies)	2,566	12.5
Urban (including farmsteads)	720	3.5
Roads and highways	522	2.6
Schools, Industrial, etc.	239	1.2
Total	20,500	100.0

The total area irrigated is 12,180 acres.

Land values in the watershed area, except for the gullied and steep sloped portions of South Mountain, range from $5,000 to $6,500 per acre for lands now in agricultural use. These values are based on lands that have been sold recently and the asking price for other lands. Such prices indicate that lands will not be sold unless a considerable amount of speculative value, based on the probability of future more intensive or changed use, can be obtained. On the basis of current average annual rental rates obtained of about $150 per acre it is estimated that the value of these lands for agricultural purposes is about $3,000 per acre. Undeveloped lands suitable for subdivision developments in the Camarillo Hills area sell for about $7,500 an acre.

There are 131 owners of farm land within the watershed. Farms range in size from 20 acres to one large investment company ownership of about 1,200 acres. Most of the ownerships are between 30 acres and 180 acres. All land within the watershed is non-Federally owned.

WATERSHED PROBLEMS

FLOODWATER DAMAGE

It is estimated that about 3,200 acres in the Beardsley watershed are inundated by floodwaters once every 100 years on a long-term average. Smaller acreages are flooded at more frequent intervals.

Some flooding occurs two years out of every three and the greatest portion of the average annual damages is caused by flooding at an intensity that occurs at least once in ten years. The months during which flooding is most likely to occur are January, February, March and April. The probability of floods occurring during various groupings of months has been estimated as follows:

September, October and November	- 5 percent
December and January	- 38 percent
February, March, April and May	- 52 percent

During the past thirty years more than ten storms have caused serious flooding. Major flooding occurred in 1938, 1941, 1943, 1944, 1946, 1952, 1958 and 1962.

The most recent flood occurred in February 1962. During a period of five days there were about twelve inches of precipitation. About 4,000 acres were inundated in the Beardsley and Revolon watersheds with about 1,300 acres in the Beardsley watershed. Large areas of truck crops, in various stages of development, were badly damaged or destroyed. The flood stages were maintained intermittently over a period of about a week. Homes, farm equipment, roads and bridges were damaged. Many people in Nyland Acres were forced to leave their homes until the floodwaters receded. The flooding of septic tanks in this area not only caused damages but also created a health hazard.

The present value of land and improvements in this flood hazard area is about $20,000,000. The major portion of this value is based on selling and asking prices for land and includes some speculative value in anticipation of more intensive or changed use of the land in the future. However, as the developmental growth of the County continues the value of these lands will continue to increase. The flood hazard area includes about 15 percent of the Beardsley watershed and about 22 percent of the land suitable for intensive agriculture.

This watershed includes some of California's most productive agricultural land. Most of the area subject to flooding is farmed intensively for the production of vegetables. Agricultural damages associated with flooding are in two categories. The first category includes the damages caused by the actual flooding of crops. These damages include reductions in crop yields or, in some cases, total crop losses; forced delays in planting due to wet field conditions; required releveling of fields due to scour and deposition; the induction of additional weed growth; and induced plant diseases and rot. The second category is the loss of net income due to certain areas of the flood plain being restricted from use for the growing of winter vegetables because of the flood hazard. These areas are flooded so frequently during the winter months that no attempt is made to grow winter crops on them.

Agricultural damages from the major floods have been very large. The 1938 flood is the largest that has occurred during the past thirty years. It is estimated to have an average frequency of occurrence of about once in twenty years and inundated about 2,800 acres. With the intensity of agricultural land use anticipated in this watershed without flood control improvements during the project evaluation period, it has been determined that about $360,000 in damages would occur to crops and agricultural property from a flood of this size. Similarly, the 1962 flood, with an estimated average frequency of occurrence of once in ten years, inundated about 1,300 acres and would cause about $130,000 in such damages; and the 1958 flood, with an estimated average frequency of occurrence of once in five years, inundated about 700 acres and would cause about $62,000 in agricultural damages. Table 5 shows the average annual equivalent of the direct agricultural floodwater damages in this watershed as amounting to $40,500. In addition, the restrictions on use for the growing of winter crops within the flood plain area are estimated to cause an annual loss of net income amounting to $44,800.

The major area of urban damage is an older tract development known as Nyland Acres. This tract covers an area of 160 acres and currently has 553 dwelling units and nine commercial establishments. The present population is estimated to be 1,740.

Historically, Nyland Acres has had severe flooding about three years in every ten. Minor floods are experienced nearly every year. Frequently this area is flooded several times in the same year. In February 1962 many homes were evacuated for periods of two to three days because of floodwaters. Because of the continuing problem, property values are low and the turnover rate quite high.

The 1938 flood, which was the largest experienced in Nyland Acres, inundated the entire area. In 1952 and 1962, approximately 63 acres were inundated and in 1958 the area flooded included 43 acres. These were the four flood years for which specific information was collected for the economic evaluation of the project.

For residential property the major type of damage is to the house superstructures and their decorations, both interior and exterior. Warping and sagging of floors and dry rot are serious problems. Flood damages to furnishings, including rugs and refrigerator motors, have been a large part of flood losses. The big loss in commercial establishments has been the stocks of merchandise damaged or destroyed.

The floods of 1938, 1962 and 1958 caused damages in Nyland Acres amounting to $430,000, $175,000 and $125,000 respectively. The average annual equivalent value of direct floodwater damages in this urban area is $66,200 as shown in Table 5.

Another serious consideration related to the flooding of Nyland Acres is the potential health hazard. This area does not have a community sanitary sewer system but is dependent on individual home septic tanks. When these septic tanks are flooded this could possibly cause contamination of wells used for domestic water supply and create other health hazards in areas inundated by the floodwaters.

Additional parts of this watershed area, including some of the area now subject to flooding, will eventually be used for urban and industrial developments as the growth of the County continues and the flood hazard has been removed. A large part of the watershed not subject to flooding is restricted from use for urban development until adequate flood channel capacities are provided. Such developments under present conditions would increase the flood problem in the existing flood hazard area and areas immediately adjacent to it.

Additional damages have been caused to public roads, farm buildings, and machinery, and irrigation and drainage systems. Interruption of communication and public utility services and the general disruption of the areal economy are less tangible damages. With the U. S. Air Force Base in the Revolon watershed, and the Naval Air Station at Point Mugu, the effective maintenance at all times of transportation, communication and public utility services throughout this area is important to the national defense.

As stated above the actual physical damages experienced by these floods represent only part of the economic loss caused by the continuance of this flood hazard. The restrictions placed on the use of these lands because of the flood hazard cause considerable agricultural economic loss at the present time and will place a barrier against the full economic development of the County in the future.

SEDIMENT DAMAGE

Damages caused by sediment are not easily separable from those caused by floodwater. Damages to truck crops near maturity are greatly increased by the deposition of sediment which reduces the opportunities for salvaging the crops following a flood. Deposition of sediment on newly planted fields frequently reduces the chances for an adequate stand to emerge. The combination of scour and sedimentation makes necessary the releveling of fields to permit efficient irrigation. Aggradation is a problem in some channels within the watershed. Road damages are largely for cleanup of sediment accumulation on the roads and in the drains and culverts. Table 5 indicates an average annual equivalent value of sediment damage to agricultural property of $2,800. A major portion of sediment damages is included in floodwater damages as they are inseparable.

Sediment damage to urban areas and farm dwellings is of a similar type as that to agricultural areas. Relatively thin deposits of silt are left by the retreating floodwaters on the floors, walls and furniture in homes and on lawns and gardens. The value of these damages is included in the estimates of floodwater damage as they are practically inseparable.

The Beardsley watershed which is directly tributary to the Revolon watershed provides the major source of sediment as well as floodwaters which contribute to these problems in the Revolon watershed.

EROSION DAMAGE

Accelerated erosion and critical sediment source areas occur in the South Mountain and Camarillo Hills areas. The nature of this problem is explained in the description of the soils in this watershed. It is caused by a combination of steep slopes and the soil characteristics. These upper parts of the watershed have been active sediment sources for many years and continuing efforts have been made to control them with land treatment and structural measures. These measures have been installed under one of the Soil Erosion Demonstration Projects, by individuals cooperating with the Calleguas Soil Conservation District and by the Ventura County Flood Control District. These measures have been effective in controlling the erosion in these areas to a large extent but they are still active sediment sources.

Overland flow in the flood plain area where there are no channels at present and in other parts of the watershed when the limited channel capacities are exceeded cause scour and redeposition of the scoured material. This damage is largely reflected in the costs of releveling lands. With the provision of adequate channel capacities this type of erosion will be essentially eliminated.

PROJECTS OF OTHER AGENCIES

The Ventura County Flood Control District has plans to encourage the completion of secondary drains in the Beardsley and Revolon watersheds when the outlet channels that will be provided by these projects have been completed. It is estimated that the secondary drainage channel system that will be required for the ultimate development of the Beardsley watershed will cost at least $8,000,000. A large part of this system will be installed within the next 25 years.

Political subdivisions will probably be formed to finance these tributary channel improvements by local bond issues. These local improvements would not be practical in most instances without the project facilities, as under present conditions there is no adequate channel system to serve as an outlet.

The Calleguas Soil Conservation District has had an effective program operating in this watershed for many years. Land treatment measures, including conservation farming practices, channel and watershed stabilization measures and other conservation treatment and structural measures have been applied to the watershed. Quantities and estimated values of these measures are included in Table 1A.

BASIS FOR PROJECT FORMULATION

As previously stated, flood problems in the Beardsley watershed are closely interrelated with those of the Revolon watershed. Flood flows in the Revolon watershed include those that originate in the Beardsley watershed as the Revolon watershed is the lower part of their combined drainage areas. The sponsoring local organizations have requested concurrent planning for these two watersheds because of this inter-relationship in their flood problems. The Project Map illustrates the interdependence of the two watershed projects.

The major sediment sources affecting the Revolon watershed as well as the Beardsley watershed are in the Beardsley watershed. The stabilization of these sources or control of the sediment produced is important to the effective functioning of the channel improvements to be made on both of these projects.

The objective of the Beardsley Watershed Project is to provide a solution to the existing flood problem including the problems of erosion and sedimentation related to it. The area included in this watershed is a portion of the Beardsley Wash-Revolon Slough drainage area within which this objective can be reached within the limitations placed on the application of the provisions of Public Law 566.

At the present time, with the exception of Nyland Acres, almost the entire area that will be protected is in agricultural use. As the growth of Ventura County will cause continued encroachment onto the watershed area for urban and industrial expansion it is probable that a large part of this area will be in this changed use during the effective life of the project measures. Because of this consideration all structural works of improvement are designed to protect against a flood of such magnitude that it has only one chance in fifty of occurring or being exceeded in any given year. This degree of protection is more than adequate for these lands in their present agricultural

use. However, it is considered adequate for urban and industrial developments. The areas adjacent to the channels have gentle cross slopes and if the channel capacities were somewhat exceeded it is not anticipated that damaging flooding would result under conditions of more intensive development. This degree of protection is consistent with the design standards of the Ventura County Flood Control District for all major flood channels within the County.

Every effort was made to coordinate all structural works of improvement for this project with other existing or proposed projects within or near the project area in order to assure the full development of the soil and water resources. The project measures proposed will not adversely affect and, in most cases, will actually enhance these other projects.

Special care was taken to insure design coordination between the structural works of improvement on this project and those that will be installed on the Revolon Watershed Project. The channel improvements on the Beardsley Watershed Project should not be installed prior to completion of the Revolon Channel improvement. Such installation would concentrate flows and increase flood peaks that would cause accelerated damage in the Revolon watershed. Completion of the Revolon Watershed Project without subsequent completion of the Beardsley Watershed Project would cause a considerable reduction in the benefits that would accrue to the Revolon Project, as the floodwaters from the upper watershed area would not be controlled to discharge into the improved Revolon Channel. For this reason these two watershed projects were evaluated interdependently.

Design capacities for various channel reaches were determined with consideration for probable junction points with secondary channels. Channel dimensions were determined on the basis of the most efficient structural section and the requirement for rights-of-way.

Channel alignment was determined on the basis of various considerations with the objective to obtain the maximum degree of flood protection for the most area at the least cost. The location of diversion channels, such as the Las Posas Estates Drain, the Los Angeles Avenue Drain and the Wright Road Drain are examples of diversion channels into a major channel to reduce the total length of improved channel required. They also release areas below the points of diversion from channel use to more productive uses. The location of the Nyland Drain was determined after consideration of several alternates. The established location required the least costs for right-of-way, relocation of utilities and for the channel construction. The Santa Clara Drain crossing from Santa Clara Avenue to Beardsley Wash was by far the least cost alternate even though costs of right-of-way and severance damages would have been less for other locations considered. In all cases costs were considered without regard to whether they would be Federal or non-Federal.

Considerable areas in the South Mountain and Camarillo Hills portions of the watershed are on steep slopes and are subject to active erosion during storm periods. For many years land treatment measures have been applied and structural measures have been installed to control these sediment sources. They have been quite effective in reducing erosion and controlling sediment but it has been determined as not economically feasible to further control

this problem with major structural measures. Under this watershed project the installed land treatment measures will be maintained and additional measures will be applied, including small structural measures to be installed and maintained by the individual property owners.

Grade stabilization structures have also been installed in past years to stabilize the gullies and barrancas crossing the less steep areas of valuable agricultural land adjacent to and below the steep slopes of South Mountain and the Camarillo Hills. These structures have been very effective and additional similar structures are included in the project to complete the control of these areas.

A large number of debris basins have been installed in the watershed over past years. Several of these larger basins are not provided with emergency spillways and do not have adequate storage capacity to serve effectively during the entire project evaluation period of 50 years. These basins will be enlarged and appropriately revised to meet these needs.

Kinds and amounts of land treatment measures specified herein represent estimates of the need based upon land capabilities and land use, adjusted to the rate of application expected to result from assignment of an optimum technical staff to the Calleguas Soil Conservation District.

WORKS OF IMPROVEMENT TO BE INSTALLED

LAND TREATMENT MEASURES

The land treatment measures included in the work plan are those which will have a measurable effect in reducing runoff or sediment production. They will assist in the further control of erosion and sediment source areas in the South Mountain and Camarillo Hills areas.

They include cover and green manure crops, improvement and proper use of range and pasture areas, contour farming and other conservation farming practices. Land treatment measures such as debris basins, diversions, terraces and channel improvements will provide on-site benefits in reducing erosion and sediment damages to the individual farms as well as off-site benefits in reducing the sediment problems in the watershed, particularly as related to channel maintenance. Improved range and pasture management measures will be applied primarily in the South Mountain and Camarillo Hills areas.

While farm management practices in this watershed conform to a generally high standard and many land treatment measures are being installed at present, the rate of installation will have to be greatly accelerated to maintain proper coordination between the installation of land treatment measures and structural measures. The amounts of land treatment measures to be installed during the project installation period and the estimated costs are shown on Table 1. Cooperative agreements between the Calleguas Soil Conservation District and individual farmers will include the land treatment measures agreed upon with installation scheduled during the project installation period. Planning and installation costs, including $34,400 of Public Law 566 funds for accelerated technical assistance and $270,970 of other funds, amount to $305,370.

STRUCTURAL MEASURES

The plan for structural measures within the watershed includes the construction or improvement of 6.4 miles of channel, the construction of four grade stabilization structures and the revision and upgrading of three existing debris basins. All of these structural measures will be designed to contain or control the two percent frequency of occurrence flood flows. The locations for these improvements are shown on the project map. Drawings numbered 1, 2 and 3 show more detailed location identification along with structural plans for the channel improvements. All of the improved channels will have concrete lined rectangular sections. The estimated costs of structural measures are shown in Table 2 and the channel design characteristics are summarized in Table 3.

The Los Angeles Avenue Drain will divert the runoff from the west end of South Mountain and adjacent lower areas into the improved Santa Clara Drain. Under existing conditions, these flows are conveyed by various small channels and overland flow to a ponding area adjacent to and including Nyland Acres. This channel will be 2,146 lineal feet in length, have a bottom width of 25 feet, a depth of 5'8" and a capacity of 900 cfs. The total estimated cost is $172,370.

The Wright Road Drain will divert flows, now crossing Wright Road and flooding the lands below, into the improved Santa Clara Drain at the intersection of Wright Road and Santa Clara Avenue. This channel will have a length of 433 lineal feet, a bottom width of 10 feet, a depth of 6 feet and a capacity of 950 cfs. The total estimated cost is $21,740.

The Santa Clara Drain will contain the combined flows from the western part of the upper watershed and divert them into Beardsley Wash. This channel, in combination with the above tributary channels, will remove a major portion of the present flood hazard to Nyland Acres and adjacent areas. It will have a total length of 9,775 lineal feet, bottom widths varying from 23'6" to 33'6", and depths varying from 6 to 9 feet. Capacities range from 1,700 cfs to 2,600 cfs. The total estimated cost is $1,078,570.

The Nyland Drain will serve as an outlet channel into Beardsley Wash for the remainder of the drainage area contributing to flooding of Nyland Acres and adjacent areas which is not diverted by the Santa Clara Drain. It will have a length of 5,300 lineal feet, a bottom width of 25'6", a depth of 5'9" and a capacity of 1,200 cfs. The total estimated cost is $469,910.

The Las Posas Estates Drain will divert the flood flows originating in the Camarillo Hills from the existing channel at the upper end of the flood plain area into Beardsley Wash. This diversion will eliminate flooding in the flood plain of this channel above and below Highway 101, including the west end of the U. S. Air Force Base in the Revolon watershed. It will have a length of 1,911 lineal feet, a bottom width of 15'6", a depth of 6'9" and a capacity of 950 cfs. The total estimated cost is $144,660.

Beardsley Wash will be improved from the location of an existing grade stabilization structure above its junction with the Las Posas Estates Drain to Highway 101 to contain the combined flows from the channels diverted into it, as indicated above, and from the eastern portion of the upper watershed. These combined flows will be discharged through a revised culvert crossing Highway 101 into that portion of the Revolon Channel included in the Beardsley Project. Beardsley Wash will be improved for a length of 7,812 lineal feet, with bottom widths varying from 21'6" to 54'0" and depths varying from 6'0" to 6'4". Capacities range from 2,400 cfs at the upper end to 4,000 cfs above its junction with the Nyland Drain at Highway 101. The culvert crossing Highway 101 will be revised to provide capacity for 5,000 cfs. The total estimated cost is $1,145,450.

The culvert crossing will include a transition into the Revolon Channel which starts below Highway 101. The Beardsley Project includes the construction of 6,620 lineal feet of the Revolon Channel extending from Highway 101 to its junction with the Camarillo Hills Drain. The combined flows of this segment of the Revolon Channel and the Camarillo Hills Drain are contained in the first segment of the Revolon Channel included in the Revolon Project. The reach of Revolon Channel included in the Beardsley Project will have a bottom width of 27'0", a depth of 13'8" and a capacity of 5,000 cfs. The total estimated cost is $1,113,320.

Three grade stabilization structures will be installed on Milligan Barranca and one on Beardsley Wash. These structures will be drop spillways with a total drop of 20 feet at each structure. Those on Milligan Barranca will provide weir capacities of 650 cfs and the one on Beardsley Wash will have a capacity of 2,400 cfs. They will be designed in accordance with the Soil Conservation Service design criteria for such structures. The total estimated cost for these four structures is $170,410.

Two existing debris basins in the Camarillo Hills subdrainage area above the Las Posas Estates Drain and one on the subdrainage area above the Los Angeles Avenue Drain will be revised and upgraded. These debris basins are functioning effectively at the present time but have only principal spillways without emergency spillways. They will be revised to have adequate capacities to contain the estimated sediment detention required during the 50 year project evaluation period. They will also be provided with concrete lined emergency spillways to eliminate the hazard to the structures in the event that the principal spillways did not function effectively during periods of major flood flows.

The most easterly debris basin in the Camarillo Hills area was constructed to provide a capacity of about 12 acre-feet, of which about 10 acre-feet has been filled by sediment accumulation. Another 15 feet of height will be added to the existing earthfill dam to provide a storage capacity of about 75 acre-feet. The other debris basin in this area has been operated on the basis that sediment accumulation will be removed at intervals as required. An additional 10 feet of height will be added to the existing earthfill dam to provide a storage capacity of about 50 acre-feet. The third debris basin to

be revised, located west of the above two, will be provided with about 15 acre-feet of capacity by adding 10 feet of height to the existing earthfill dam. The total estimated cost to upgrade these three debris basins by providing additional capacities and emergency spillways is $131,210.

These structural works of improvement will alleviate the flood problem in the Beardsley watershed by providing outlet channels with adequate capacities to contain the design flood flows. They will also provide protection against land loss in the remaining unstable reaches in Milligan Barranca and Beardsley Wash and consequently reduce sediment problems. The revised debris basins will insure that the sediment produced by eroding areas that are uneconomical to control will not make the channel improvements ineffective because of sediment deposition. The total estimated installation costs for these structural works of improvement is $4,447,640 (Tables 1 and 2).

EXPLANATION OF INSTALLATION COSTS

LAND TREATMENT MEASURES

Estimated costs to install land treatment measures are summarized on Table 1. These estimates are based on current costs of labor and materials. For those practices involving farm labor and equipment, costs are based on recent studies made by the Soil Conservation Service in the area.

The total estimated cost to install land treatment measures is $305,370. Of this total, $255,870 represents the cost of physically applying these measures. Technical assistance to apply them will be provided by the Soil Conservation Service cooperating with the Calleguas Soil Conservation District. Of the total estimated cost for technical assistance of $49,500, $15,100 will be provided from Soil Conservation Service normal operating funds for the going rate of application and $34,400 will be provided from Public Law 566 funds for accelerating the application rate.

Installation costs of the land treatment measures by years during the project installation period are estimated as follows:

Fiscal Year	P.L. 566 Funds (Dollars)	Other Funds (Dollars)	Total (Dollars)
1	3,400	33,870	37,270
2	4,500	59,400	63,900
3	7,600	63,100	70,700
4	9,800	67,200	77,000
5	9,100	47,400	56,500
Totals	34,400	270,970	305,370

STRUCTURAL MEASURES

The estimated costs to install structural measures, as shown in Tables 1 and 2, include costs for construction, installation services, easements and rights-of-way and administration of contracts.

The construction cost estimates are based on quantities, computed as required to provide structures in accordance with the engineering design, and unit construction costs considered appropriate for this area. The unit construction costs used were determined with consideration of recent bid prices received for similar types of work under comparable conditions. The costs determined by multiplying the estimated quantities by the probable unit construction costs were increased by a 15 percent contingency factor to obtain the estimated project construction costs. As shown in Table 2, it is estimated that total construction costs to install structural measures will amount to $3,269,280.

Installation service costs include engineering costs for surveys and designs, and supervision and inspection during construction; and other costs for administration and general supervision of project structural installations at all administrative levels of the Soil Conservation Service. Engineering costs were estimated as percentages of the construction costs as follows: surveys, 5 percent; design, 6 percent; and supervision and inspection during construction, 6 percent; which provides 17 percent of the construction costs for all engineering services. Other Federal installation service costs are estimated at about 5.5 percent of the construction costs. The total estimated cost for installation services as shown on Table 2 is $735,190. In the schedule of costs by fiscal years during the project period, installation service costs are included on the basis that 11 percent of the construction costs will be required during that year when the planning is estimated to occur and the remainder during that year when construction is estimated to occur.

Federal assistance costs to be provided under provisions of Public Law 566 for the installation of structural measures includes all costs for construction and installation services, amounting to $4,004,470.

Other installation costs for structural measures will be met by non-Federal interests. These include costs to acquire land for rights-of-way; to provide bridges where necessary to maintain access between segments of properties severed by channel construction; to rebuild or revise bridges to maintain traffic routes; to relocate existing utilities such as pipe lines and communication lines; and costs of the local organization for administrative, legal and clerical services incurred in carrying out contracts.

About 51 acres of land will be required to accommodate the channel improvements and allow for the necessary maintenance roads. A portion of this required acreage is now physically dedicated to existing channel and it is assumed can be obtained for project development at small cost. The estimated cost of the remaining "usable" lands required is based on recent sales in this area and asking prices. The total cost of lands required for rights-of-way is estimated as $263,640, including 15 percent of the estimated land costs to cover other costs of acquisition.

The estimated costs to provide new bridges and revise existing bridges are based on recent costs to do this type of construction work in the area. The total estimated cost for bridges and relocation of utilities is $146,850 including 15 percent of the estimated construction costs for engineering and other installation services.

The costs to obtain easements and rights-of-way, including costs for revising and building bridges and relocating utilities, amounting to $410,490, will be the responsibility of the local organization but may be reimbursed in part or all by the State of California.

The cost for administration of contracts by the local organization was estimated on the basis of one percent of the construction costs. This item is estimated to cost $32,680 and will be the responsibility of the local organization.

The installation of structural measures will be accomplished over a five year period in accordance with the following schedule by fiscal years:

FIRST YEAR

Prepare designs and specifications and acquire easements and rights-of-way for the grade stabilization structure in Beardsley Wash and for one in Milligan Barranca; and for revising and upgrading the three debris basins. Receive bids and award contracts for the two grade stabilization structures for which designs and specifications were prepared.

SECOND YEAR

Receive bids and award contracts for revising and upgrading the three debris basins.

THIRD YEAR

Prepare designs and specifications and acquire easements and rights-of-way for the Revolon Channel reach between Highway 101 and its junction with the Camarillo Hills Drain; and for the revised culvert crossing Highway 101 and transition into Revolon Channel.

FOURTH YEAR

Receive bids and award contracts for the Revolon Channel reach between Highway 101 and its junction with the Camarillo Hills Drain; and for the revised culvert crossing Highway 101 and transition into Revolon Channel.

Prepare designs and specifications and acquire easements and rights-of-way for the remaining structural measures to be installed on the Beardsley Project.

FIFTH YEAR

Receive bids and award contracts for the remaining structural measures to be installed on the Beardsley Project.

Estimated total expenditures by years are as follows:

Fiscal Year	P. L. 566 Funds	Other Funds	Total
1	$ 92,110	$ 46,690	$ 138,800
2	76,920	690	77,610
3	105,660	36,220	141,880
4	1,309,600	211,710	1,521,310
5	2,420,180	147,860	2,568,040
TOTALS	$4,004,470	$443,170	$4,447,640

EFFECTS OF WORKS OF IMPROVEMENT

Some flooding occurs in the Beardsley watershed, on an average, two years out of three. The major portion of the floodwater and sediment damage is caused by floods of such size as occur at least once in ten years on the average; that is, the ten percent frequency of occurrence floods and all others which occur more frequently.

It is estimated that 3,200 acres would be inundated in the Beardsley watershed with the one percent frequency of occurrence flood. The 1938 flood inundated about 2,800 acres and the 1962 flood 1,300 acres.

The land treatment and structural measures that will be installed with the project will eliminate all flooding that would result from floods which occur on an average once in fifty years or more frequently. With this protection provided the one percent frequency of occurrence floods will inundate about 500 acres in the watershed as compared to the 3,200 acres under present conditions. On an average annual equivalent basis this amount of very infrequently occurring flooding will be a comparatively minor problem.

Land treatment measures will be effective in reducing floodwater runoff and sediment production. It is estimated that the hydrologic effects of the land treatment measures will reduce flood peaks of the design storm about two percent with increasing reductions for the more frequently occurring storms up to reductions of about six percent. Erosion and sediment production problems in the South Mountain and Camarillo Hills areas will be further controlled by the effects of the land treatment measures, particularly range and pasture improvement, in stabilizing the watershed and reducing runoff.

The structural works of improvement will contain the flood flows in channels and will prevent the inundation of large areas. The system of channel improvements will concentrate the flood flows so that they can be effectively discharged into the improved Revolon Channel. Under existing conditions these flows are so dispersed that by far the major portion of flood flows enter the Revolon watershed from the Beardsley watershed as overland flow.

The grade stabilization structures on Milligan Barranca and Beardsley Wash in combination with those already installed will provide control in all of the gullies and barrancas through the valuable agricultural land below the steep slopes of South Mountain and the Camarillo Hills. The debris basins will assure that the remaining sediment produced in the watershed will not reduce the effectiveness of the flood control channels.

For those lands in the flood hazard area which are in agricultural use at the present time, the project will eliminate flood damages to cropped lands and will encourage more intensive use of about 400 acres by eliminating the dangerof crop damage or destruction by flood waters. With the control of flood flows overland flow causing scour and deposition will be eliminated. The lands can then be leveled to permit more effective irrigation and land management without the danger of having this expensive work made ineffective. The control of flood flows will greatly reduce the problems of weed infestation and the spreading of plant diseases. There are more than fifty farmers in the flood hazard area who will obtain the benefits from this flood protection of agricultural lands.

Flooding of Nyland Acres will be practically eliminated, providing benefits to the 553 property owners and their families in this urban area. Property values will be enhanced and living conditions will be greatly improved.

In addition to practically eliminating flooding in the areas subject to inundation at the present time, the provision of these outlet channels will permit more intensive development of any part of the watershed. The development of a major part of this watershed for urban and industrial development is prohibited at this time because there are no outlet channels for the rapid disposal of runoff waters. This restriction will be removed when the project structural measures have been installed. Consequently, all of the property owners in the watershed will obtain benefits from the project.

With the project measures installed the flood flows will be contained so that damages to roads, bridges and other utilities will be practically eliminated.

PROJECT BENEFITS

Project benefits are composed of direct and indirect damage reductions, benefits from more intensive use of the land for agricultural purposes, benefits that will accrue from changed land use and secondary benefits.

Direct floodwater and sediment damages are caused by physical contact of floodwater and sediment with crops, property, structures, equipment, materials and supplies. Indirect floodwater and sediment damages are those costs or losses that occur because of floodwater and sediment damage, but are not caused by physical contact with floodwater and sediment. Examples of indirect damages are: costs of precautionary flood prevention measures, costs of evacuation and re-entering and loss of business or wages because of floodwaters.

The total average annual equivalent evaluated damage caused by floodwaters and sediment deposition in the Beardsley watershed is $133,300. When the land treatment measures have been installed it is expected that their effects will reduce flood damages by $6,000 annually to leave remaining damages of $127,300. The structural measures will further reduce these damages by $124,900 leaving a remaining average annual equivalent damage of $2,400 with the project installed (Refer to Tables 5 and 6).

With the project measures installed it will be practical to grow winter crops on about 400 acres in the flood hazard area where the danger of crop damage is so great under existing conditions as to preclude such use. As shown on Table 6, the average annual equivalent value of this more intensive use was determined as $44,800.

Under existing conditions some lands in the watershed which would otherwise be used for the orderly development of urban and industrial areas in the County cannot be so used because adequate outlet channels are not available. Appropriate drainage improvement for this changed use would make worse the flood problem in other areas. The project measures will make it possible to proceed with this development and benefits based on this changed use of about 2,060 acres in the Beardsley and Revolon watersheds have been claimed. An average annual equivalent benefit of $65,800 was determined as creditable to the Beardsley Watershed Project, based on the changed use of about 710 acres (Table 6).

Secondary benefits are defined as the increase in net incomes or other beneficial effects in activities stemming from or induced by the project. These include benefits from the transporting, processing and marketing of the goods and services that produce the primary project benefits; and the supplying of additional materials and services required to make possible the increased net returns which stem from the installation of the project measures. Increased economic activity in any area raises local purchasing power and hence enhances local as well as national economic growth. Secondary benefits are quite significant but are not subject to rigorous economic evaluation.

Secondary benefits were considered only in relation to the local economy. In this highly developed and intensively used farming area most of the vegetables and citrus fruits are transported, processed and marketed away from the growing area. Much of the produce is transported to Los Angeles and sold, and from there shipped throughout the country. Large numbers of people are employed in harvesting, transporting, processing and marketing this produce. Secondary benefits were estimated on the basis of actual crop losses and the increased production and the increased use of farm supplies and labor that will be induced by the more intensive agricultural use of the

flood hazard area. Their average annual equivalent value was determined as $20,800 (Table 6).

The installation of these projects will cause many other benefits to accrue to the immediate area and the nation which have not been evaluated. The completion of these projects will reduce service interruptions on major communication and transportation facilities as well as other public utilities traversing the area. Interruption of these facilities affects numerous users and, in the case of the highway and railroad lines between San Francisco and Los Angeles, could be of national significance during an emergency. With the U. S. Air Force Base within the Revolon watershed and the Naval Air Station at Point Mugu, as well as other defense installations and production facilities in this general area, this aspect of the project is of importance to the national interest.

As shown on Table 6, structural measures installed in this watershed will provide equivalent average annual benefits of $256,300, composed of floodwater and sediment damage reduction, $124,900; more intensive land use, $44,800; values from changed use of land, agricultural to urban, $65,800; and secondary benefits of $20,800.

COMPARISON OF BENEFITS AND COSTS

The total of equivalent average annual primary benefits from the structural works of improvement is $235,500. The equivalent average annual cost of these measures, including operation and maintenance, is $174,700 (Tables 4 and 6). This relationship between costs and benefits provides a ratio of benefits to costs of 1.35 to 1. With the inclusion of the estimated average annual secondary benefits of $20,800, a ratio of benefits to costs of 1.47 to 1 is obtained.

PROJECT INSTALLATION

The land treatment measures will be installed over a five year period by individual landowners with technical assistance provided by the Soil Conservation Service in cooperation with the Calleguas Soil Conservation District. In order to meet the technical assistance requirements to accelerate the rate of installation of land treatment measures on this watershed during the project installation period, $34,400 of Public Law 566 funds will be used by the Soil Conservation Service, along with $15,100 from their normal operating funds to continue the going program of assistance to the District in this watershed area.

The project structural measures will be installed over a five year period according to the schedule previously described. Most of the channel improvement work on the Beardsley Project should not be done until the Revolon Channel improvement and the outlet channel through Point Mugu, included in the Revolon Project, have been completed. Without the prior completion of Revolon Channel, the construction and improvement of channels included in the Beardsley Project which concentrate the flood flows and reduce their times of concentration would cause greater damage in the Revolon watershed than would otherwise occur. For this reason channel improvement work on the Beardsley Project is not scheduled to commence until the fourth year of the project installation

period when that portion of the Revolon Channel included in the Beardsley Project is scheduled for installation. The installation schedule for the Revolon Project provides that the Revolon Channel reaches included in that project will be completed during the fourth year of the installation period. It is assumed that the installation periods for these two projects will begin during the same fiscal year.

During the first three years of the installation period for the Beardsley Project the installation of grade stabilization structures and the upgrading of existing debris basins is scheduled along with the development of plans and specifications for channel improvements to be made during the fourth year.

During the fourth year the Revolon Channel reach between Highway 101 and its junction with the Camarillo Hills Drain and the revised culvert structure crossing Highway 101 will be installed. The surveys and design work for the balance of the structural measures included in this project along with the preparation of plans and specifications will also be completed during this project year.

The installation of all project structural measures will be completed during the fifth year of the project installation period.

Rights-of-way for structural measures will be procured during the year prior to their scheduled installation except for those measures scheduled for installation during the first year, for which they will be procured during the same year.

It is not probable that there will be any serious difficulties in obtaining rights-of-way for the structural improvements as there is strong support for this work. The Ventura County Flood Control District has legal authority to exercise the power of eminent domain and will use its abilities as necessary to achieve the project purpose. With reimbursement available from the State of California for costs of rights-of-way, sufficient funds will be forthcoming to purchase the required lands.

The Soil Conservation Service will contribute with Public Law 566 funds 100 percent of the construction and installation services costs for these works of improvement, estimated at $4,004,470.

The Ventura County Flood Control District will acquire or purchase all lands required for rights-of-way and will make all the required utility relocations and modifications amounting to an estimated total cost of $410,490 for the structural measures. They may obtain reimbursement for all or part of this from the State of California.

The Ventura County Flood Control District will provide administrative, legal and clerical services as the contracting local organization in carrying out contracts. The cost to meet these responsibilties is estimated at $32,680.

FINANCING PROJECT INSTALLATION

The Ventura County Flood Control District was created by Act 8955 of the California Legislature passed in 1944 and amended in later years. It is divided into four zones, identified by number. The Beardsley watershed is included in Zones 2 and 3.

The powers of the Ventura County Flood Control District are broad when they are related to the purposes of the Act. It has the power of perpetual succession; of eminent domain and entry upon land; to sue and be sued; to acquire, hold and sell property both real and personal; to employ civil engineers; to conduct technical and other investigations; to incur indebtedness; to issue bonds; to tax and assess; to make contracts; and to employ labor.

The Board of Supervisors of Ventura County is empowered to act as the board of supervisors of the Ventura County Flood Control District. It can levy an ad valorem tax or assessment on all property within the District for purposes of common benefit to the whole District, or on all property of a zone for purposes of common benefit to the zone, all property within a zone being considered to be equally benefited. The power to tax or assess in any one year is limited to 40 cents per $100 of assessed valuation in Zones 2 and 3.

The non-Federal share of the cost of the project structural measures is $443,170. As the structural measures are installed the sponsors will request refunds amounting to $410,490 from the State of California, Department of Water Resources. This amount is the estimated cost for rights-of-way associated with the installation of these measures. The Department has been kept informed of the progress in work plan development and is prepared to support the obtaining of this refund subject to its detailed review of the project work plan.

Ventura County Flood Control District recognizes its financial obligations as shown in the installation schedule and is prepared to meet them through local tax funds and reimbursements from the State of California. The sponsoring local organizations are aware that the financial and other assistance to be provided by the Soil Conservation Service is conditioned on the fulfillment of the local obligation presented in this plan and is contingent on Congressional appropriations of the required funds.

While the land treatment measures will be installed on private property by individuals or small groups of landowners, the financial obligation may be met in part through Federal cost sharing in the U. S. Agricultural Conservation Program and through credit provided by the regular loaning facilities of the U. S. Farmers Home Administration.

PROVISIONS FOR OPERATION AND MAINTENANCE

Operation and maintenance of land treatment measures will be the responsibility of the individual landowners on whose properties the measures are installed. The Calleguas Soil Conservation District with assistance from the Soil Conservation Service will provide the technical advice and periodic inspections necessary to assure that the measures remain effective and properly maintained.

The structural improvements to be installed on the Beardsley Project will be operated and maintained by the Ventura County Flood Control District at an estimated average annual cost of $5,900. The District is presently operating and maintaining numerous flood channels within the County by use of tax revenues and is financially able to accept this responsibility for the project structural measures when they have been installed. The estimated cost includes allowances for materials, labor, equipment and administrative costs associated with such channel maintenance work as weed and brush control, rodent control, cleaning out sediment deposition and repair of riprap and concrete structures. Maintenance roads are provided along all improved channels.

Inspection of all completed structural works of improvement will be conducted annually or oftener to determine maintenance needs. The inspection group will consist of representatives of the Ventura County Flood Control District, the Calleguas Soil Conservation District and the Soil Conservation Service and may include representatives of other interested agencies.

Specific maintenance agreements will be executed prior to the issuance of invitations to bid for any construction contract. The Ventura County Flood Control District is fully aware of all its responsibilities with regard to maintenance of the project structural measures.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

BEARDSLEY WATERSHED, CALIFORNIA

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/ P.L. 566 Funds	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Conservation Cropping Syat.	Acre	2,500		2,500	2,500
Contour Farming	Acre	1,800		1,800	1,800
Contour Orchards	Acre	100		300	300
Cover and Green Manure	Acre	2,500		21,250	21,250
Critical Area Planting	Acre	75		3,070	3,070
Crop Residue Use	Acre	5,000		10,000	10,000
Debris Basins	No.	15		36,000	36,000
Diversions	Lin.Ft.	20,000		4,000	4,000
Drainage Field Ditches	Lin.Ft.	100,000		10,000	10,000
Farm Ponds	No.	5		7,500	7,500
Irrigation Land Level	Acre	1,000		80,000	80,000
Outlet Construction	Lin.Ft.	40,000		42,000	42,000
Pasture Planting	Acre	100		1,760	1,760
Pasture Proper Use	Acre	100		190	190
Range Proper Use	Acre	700		1,230	1,230
Range Seeding	Acre	500		5,100	5,100
Streambank Protection	Lin.Ft.	20,000		6,000	6,000
Stream Channel Improvement	Lin.Ft.	15,000		7,500	7,500
Structure for Water Control	No.	35		7,000	7,000
Subsoiling	Acre	300		3,000	3,000
Terrace Gradient	Lin.Ft.	40,500		5,670	5,670
Technical Assistance	Dollar	---	34,400	15,100	49,500
TOTAL LAND TREATMENT			34,400	270,970	305,370
STRUCTURAL MEASURES					
Soil Conservation Service					
Stream Channel Improvement	Mile	6.4	3,062,280		3,062,280
Grade Stabilization Structs.	No.	4	138,000		138,000
Debris Basins - Revise	No.	3	69,000		69,000
Sub-total - Construction			3,269,280		3,269,280
INSTALLATION SERVICES					
Soil Conservation Service					
Engineering Services			555,790		555,790
Other			179,400		179,400
Sub-total - Installation Services			735,190		735,190
OTHER COSTS					
Land, Easements & R/W				410,490	410,490
Administration of Contracts				32,680	32,680
Sub-total - Other Costs				443,170	443,170
TOTAL STRUCTURAL MEASURES			4,004,470	443,170	4,447,640
TOTAL PROJECT			4,038,870	714,140	4,753,010
SUMMARY					
Sub-total - Soil Conservation Service			4,038,870	714,140	4,753,010
TOTAL PROJECT			4,038,870	714,140	4,753,010

1/ Price Base 1962

Note: No Federal land in watershed

June 1963

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

BEARDSLEY WATERSHED, CALIFORNIA

Measures	Unit	Applied to Date	Total Cost 1/ (Dollars)
LAND TREATMENT			
Conservation Crop System	Acre	2,797	2,800
Contour Farming	Acre	1,586	1,590
Contour Orchards	Acre	706	2,120
Cover and Green Manure	Acre	2,331	19,810
Critical Area Planting	Acre	65	2,660
Crop Residue Use	Acre	3,772	7,540
Debris Basins	No.	25	60,000
Diversions	Lin.Ft.	79,380	15,880
Drainage Field Ditches	Lin.Ft.	5,000	500
Farm Ponds	No.	2	3,000
Irrigation Land Level	Acre	5,363	429,040
Minimum Tillage	Acre	300	---
Outlet Construction	Lin.Ft.	80,754	84,790
Pasture Planting	Acre	300	5,280
Pasture Proper Use	Acre	253	480
Range Proper Use	Acre	853	1,490
Range Seeding	Acre	302	3,080
Streambank Protection	Lin.Ft.	43,500	13,050
Stream Channel Improvement	Lin.Ft.	22,800	11,400
Structure for Water (Control)	No.	37	7,400
Subsoiling	Acre	250	2,500
Terrace Gradient	Lin.Ft.	35,140	4,920
TOTAL			679,330

1/ Price Base 1962 June 1963

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

BEARDSLEY WATERSHED, CALIFORNIA

(Dollars) 1/

Structure Identification	Installation Cost-P.L. 566 Funds				Instal. Cost - Other Funds			Total Instal. Cost
	Constr.	Instal. Engineering	Services Other	Total P. L. 566	Admin.of Contracts	Easements & R/W	Total Other	
Channel Improvement								
Los Angeles Ave. Drain	124,730	21,200	6,850	152,780	1,250	18,340	19,590	172,370
Santa Clara Drain	772,760	131,370	42,400	946,530	7,730	124,310	132,040	1,078,570
Wright Road Drain	11,090	1,880	610	13,580	110	8,050	8,160	21,740
Nyland Drain	318,980	54,230	17,500	390,710	3,190	76,010	79,200	469,910
Beardsley Wash	880,920	149,760	48,340	1,079,020	8,810	57,620	66,430	1,145,450
Las Posas Estates Drain	98,330	16,720	5,400	120,450	980	23,230	24,210	144,660
Revolon Channel Hwy. 101 to Jct.Cam.Hills Dr.	855,470	145,430	46,940	1,047,840	8,550	56,930	65,480	1,113,320
Grade Stabilization Structures								
Milligan Barranca (3)	103,500	17,600	5,680	126,780	1,030	----	1,030	127,810
Beardsley Wash (1)	34,500	5,870	1,890	42,260	340	----	340	42,600
Debris Basins (Revise 3)	69,000	11,730	3,790	84,520	690	46,000	46,690	131,210
GRAND TOTALS	3,269,280	555,790	179,400	4,004,470	32,680	410,490	443,170	4,447,640

1/ Price Base 1962 June 1963

TABLE 3 - STRUCTURE DATA

CHANNELS

BEARDSLEY WATERSHED, CALIFORNIA

Channel Designation Station to Station	Dwg. No.	Water-shed Area (Sq.Mi.)	Planned Channel Capac. (cfs)	Bottom Width (Feet)	Side Slopes (Horiz. to Vert.)	Average Depth of Flow (Feet)	Channel Gradient (Ft/Ft)	Average Velocity (Ft/Sec.)	Volume of Excavation (1000Cu.Yds)
Los Angeles Ave. Drain									
0+00 to 21+46	3	2.6	900	25	Vert.	5.	.0010	7.4	16.7
Santa Clara Drain									
L.A. to Jct.Wright Rd. Drain									
156+98 to 136+73	3	5.2	1,700	23.5	Vert.	5.	.0040	14.6	17.5
Jct.Wright Rd.Dr. to Dep.S.C.Ave.									
136+73 to 121+73	3	8.2	2,600	26.5	Vert.	6.	.0040	16.2	11.6
Dep.S.C.Ave. to Transition									
121+73=0+00 to 35+00	3	8.2	2,600	26.5	Vert.	6.	.0040	16.2	38.9
Transition to Jct.Beardsley Wash									
35+00 to 62+50	3	8.2	2,600	33.5	Vert.	8.	.0010	9.7	47.5
Wright Road Drain									
0+00 to 4+33	3	2.5	950	10	Vert.	5.	.010	18.4	1.3
Nyland Drain									
0+00 to 53+00	2	4.8	1,200	25.5	Vert.	5.	.0016	9.4	50.8
Beardsley Wash									
Hwy. 101 to Jct. Santa Clara Dr.									
0+00 to 37+57=0+00)	2	25.0	4,000	54	Vert.	5.	.003275	14.9	113.3
0+00 to 11+90)									
Jct.S.C.Dr. to Jct.L.P.E. Dr.									
11+90 to 32+22	2	16.3	2,600	31	Vert.	5.	.00475	16.6	57.7
Jct.L.P.E. Dr. to End Ch. Imp.									
32+22 to 40+55	2	13.7	2,400	21.5	Vert.	5.	.0098	22.3	7.1
Las Posas Estates Drain									
0+00 to 19+11	2	2.1	950	15.5	Vert.	6.	.0020	10.1	17.4
Revolon Channel									
Hwy. 101 to Jct.Cam.Hills Dr.									
435+13.8 to 368+93.35	1	31.2	5,000	27	Vert.	12.	.00208	15.7	137.6

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TABLE 4 - ANNUAL COST

BEARDSLEY WATERSHED, CALIFORNIA

(Dollars) 1/

Evaluation Unit	2/ Amortization of Installation Cost	Operation and Maintenance Cost	Total
Beardsley Watershed	168,800	5,900	174,700
Total	168,800	5,900	174,700

1/ Price Base 1962 for capital investment costs; long term for operation and maintenance costs.

2/ Amortized over 50-year period at 2 7/8 percent interest.

June 1963

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

BEARDSLEY WATERSHED, CALIFORNIA

(Dollars) 1/

Item	Estimated Average Annual Damage Without Project	With Project	Damage Reduction Benefit
Floodwater			
Crops	31,700	400	31,300
Agricultural Property	8,800	100	8,700
Non-Agricultural Property			
Residential	61,500	1,500	60,000
Commercial	4,700	100	4,600
Other Property	8,100	100	8,000
Sub-total	114,800	2,200	112,600
Sediment			
Agricultural Property	2,800	100	2,700
Sub-total	2,800	100	2,700
Indirect	15,700	100	15,600
Total	133,300	2,400	130,900

1/ Long Term Price Level

June 1963

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

BEARDSLEY WATERSHED, CALIFORNIA

(Dollars) 1/

Evaluation Unit	Average Annual Benefits Flood Prevention 2/ Damage Reduction	More Intense Land Use	Changed Land Use to Urban	Secondary Benefits	Total	Average Annual Cost	Benefit Cost Ratio
Beardsley Watershed	124,900	44,800	65,800	20,800	256,300		
Grand Total	124,900	44,800	65,800	20,800	256,300	174,700	1.47

1/ Price Base - Long Term

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $6,000 annually.

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INVESTIGATIONS AND ANALYSES

PROJECT FORMULATION

The Beardsley Wash-Revolon Slough drainage area has had a very damaging flood problem over a period of many years. The solution to this problem has been complicated by uncontrolled sediment source areas and the commingling of Revolon Slough and Calleguas Creek floodwaters in the lower portion of this area. For about the past thirty years, beginning with a Soil Erosion Service demonstration project in the early 1930s, and in more recent years through the Calleguas Soil Conservation District, land treatment measures and grade stabilization structures have been installed to control sediment sources. Ventura County has installed a number of debris basins in the area to reduce the remaining sediment loads so that channel improvement can be effective. The lower end of Calleguas Creek which borders the eastern boundary of the Revolon watershed has been improved under a Pilot Watershed Project and the Calleguas Creek floodwaters do not combine with Revolon Slough waters in causing the flood problem in the lower area.

In preparing this work plan the local people have been consulted in determining the extent of the problems and considered solutions have been discussed with them to assure that the project will meet their objectives for flood control. The objectives of the local people are to establish a program of land treatment and structural measures that will maintain and protect the watershed and prevent flooding.

LAND TREATMENT MEASURES

The estimated needs for the land treatment measures to be installed during the project installation period were developed by technicians of the Soil Conservation Service and are based on technical standards which they have developed from years of experience in this area. The data used as a basis for estimating these needs included a detailed tabulation of the lands within the watershed according to land capability classes and use. From this was developed an inventory of the land treatment measures considered necessary to provide the total conservation needs for these lands. An inventory of land treatment measures that have been installed in the watershed was also prepared (see Table 1A). With this information the total remaining needs for land treatment measures was determined. This list of remaining needs was then reduced so as to include only those measures that would have a measurable effect upon the production of floodwater and sediment. From this list was selected the amounts of measures most needed and that could be installed during the project installation period with the optimum technical staff. The selected measures, quantities and costs are shown in Table 1.

In the determination of land treatment needs within the watershed, particular attention was given to the need for improved watershed stabilization in the South Mountain and Camarillo Hills areas. Improved range and pasture management measures included in the work plan are primarily for these areas.

The accelerated program for the installation of land treatment measures during the project period requires more technical assistance from the Soil Conservation Service than the present staff can provide during the installation period. Costs to provide additional technical assistance to meet these additional requirements will be met from Public Law 566 funds.

STRUCTURAL MEASURES

Principles

The primary basis for determining the structural works of improvement to be included in this work plan was to provide the maximum level of flood protection to the watershed within the limits of sound economic and engineering practice. Costs of various alternates were considered without regard to their being Federal or non-Federal. The project measures were selected on the basis that they would provide the maximum net benefits to the area with consideration of probable future needs in the watershed as well as current needs. The project measures to be installed have the strong support of the sponsoring organizations as well as the local people in general.

In formulating the project consideration was given to alternate channel locations, types of channel section and control, types of materials and levels of protection. A major consideration was to provide an adequate level of protection which would not preclude a more intensive development of the area or cause the installed measures to become obsolete before the end of their otherwise useful life.

Scope of the Project

Flood flows and sediment produced in the Beardsley watershed contribute largely to flood problems in the Revolon watershed. Also, the system of channel improvements to be installed with the Beardsley Project are required to concentrate flood flows in the improved Beardsley Wash for discharge into the Revolon Channel. Otherwise, overland flow would continue from the flooded areas in the Beardsley watershed into the Revolon watershed.

Consideration was given to developing a single project including the total Beardsley Wash-Revolon Slough drainage area. However, it was determined that the criteria and limitations of Public Law 566 could be applied most effectively to solving the flood problem in this area by preparing two work plans, one for the Beardsley watershed and another for the Revolon watershed. The works of improvement included in these two work plans are interdependent. It would be very undesirable to construct the Beardsley Project prior to or without constructing the Revolon Project as these improvements would cause more damage in the Revolon watershed than occur at present. Constructing the Revolon Project without subsequent construction of the Beardsley Project would reduce the benefits accruing to the Revolon works of improvement. They would not be used to their full potential because floodwaters originating in the Beardsley watershed would not be satisfactorily diverted into the Revolon Channel.

The Beardsley Project channel improvements will divert and concentrate flood flows, reduce times of concentration and prevent inundation of large areas. These improvements will increase peak flows under flood conditions over those that would occur without the project. Revolon Channel improvement has been planned to contain these increased peak flood flows.

The Beardsley Project includes the development or improvement of about 6.4 miles of channel to contain the design flood flows from the Beardsley watershed area. It also includes the construction of four grade stabilization structures and the revision of three existing debris basins to reduce sediment production and control the sediment produced from areas that can not be economically stabilized.

Structural measures are prescribed on the basis of investigations made in sufficient detail to establish locations and feasibility. After work plan approval, further investigations and studies will be made for the development of detailed designs and the preparation of construction plans and specifications. These additional data may dictate variations within the indicated scope of the project in accordance with technical standards of the Soil Conservation Service and the desires of the sponsoring organizations.

Alternate Kinds of Measures

There are no opportunities to control floods in this watershed by floodwater retarding structures. It is necessary to provide flood control channels of adequate capacity to contain the peak flood flows required to obtain the level of protection desired. Alternate types of channel improvement considered were: unlined channels with riprapped side slopes and grade stabilization structures; and concrete lined channels with trapezoidal section or rectangular section.

It was determined that a rectangular section concrete lined channel would be most satisfactory for all channel improvements included in the project. The use of a trapezoidal concrete lined section was considered and discarded in favor of a rectangular section because of the following factors: (1) construction problems related to the unstable nature of the soil and the water problems that would be encountered in this area, (2) reduced areas would be required for rights-of-way with the rectangular section, (3) better hydraulic characteristics would be obtained in the rectangular section, and (4) the cost of bridges would be less with the rectangular section. This last consideration will become progressively more important as the watershed area becomes more intensively used. The use of an unlined earth section with riprapped side slopes and grade stabilization structures was also considered for some of the channels. Increased costs for operation and maintenance, rights-of-way and bridges along with the general incompatibility of this type of improvement with the eventual use of this area were reasons for discarding further consideration of this type of channel improvement. Basically, the rectangular concrete lined section was selected as the type of improvement that was most compatible with the use of these watershed lands during the useful life of these structural measures and the best investment based on the above considerations.

Consideration was given to all possibilities for additional grade stabilization structures to control gully erosion. It was determined that the only remaining opportunities to install grade stabilization structures that could be economically justified were on Milligan Barranca and Beardsley Wash. With the additional three on Milligan Barranca and one on Beardsley Wash that will be installed under the project, along with those that have been installed in the past, erosion in all gullies below the South Mountain and Camarillo Hills areas will be effectively controlled. Because of the steep gradients in these areas it was determined as impractical to construct additional grade stabilization structures.

With the remaining sediment production in the South Mountain and Camarillo Hills areas which is impractical to control, there will be a continuing need for debris storage basins to prevent this sediment from reducing the effectiveness of the flood control channels. The grade stabilization structures, particularly the one on Beardsley Wash, will provide considerable capacities for debris storage. Three existing debris basins in the watershed will be upgraded to provide additional capacities. This combination of debris storage facilities will assure the control of sediment so that the functioning of the flood control channels will not be impaired.

Alternate Structure Locations

The existing location of the Beardsley Wash channel remains essentially the same for the improved channel. There were no practical alternate locations to consider. For all of the other channels various alternates were considered. The selected locations were determined on the basis of the least cost improvement to provide the flood protection needed.

One general alternate that has been considered was to divert the upper Beardsley Wash drainage area, along with the remainder of the upper western drainage area, into the Santa Clara River. With the sediment loads that may be produced during major storms this concentration of flows was considered hazardous to control by this alternate. Failure of such a diversion channel would cause great damage. Also, this alternate would not preclude the need for a similar channel system as is provided by the project. It would only reduce the capacity requirements. This alternate was discarded because of both functional and economic considerations.

The locations of the Wright Road Drain, the Los Angeles Avenue Drain, and the Las Posas Estates Drain were determined as the least cost channels that could be provided to divert the runoff from these drainage areas into the major flood control channels. Consideration was also given to degree of protection provided, right-of-way problems and severance damages as they would affect the benefit-cost relationship.

Several alternates were considered affecting the Santa Clara and Nyland Drains. One possibility was to continue the Santa Clara Drain along Santa Clara Avenue to its junction with Nyland Drain and carry the combined flows through this drain into Beardsley Wash. Another was to continue Santa Clara Drain along Santa Clara Avenue to Central Avenue, then along Central Avenue to Beardsley Wash. These alternates would have reduced severance damages but their total costs far exceeded that of the alternate selected.

An alternate location considered for the Nyland Drain was to divert these flows across Highway 101 at Santa Clara Avenue, then continue on an alignment parallel and adjacent to the highway right-of-way to a junction with Revolon Channel. This alternate was considered on the basis of reduced severance damages but the total cost was excessive as compared to the cost for the alternate selected.

The alignment for the reach of Revolon Channel included in the Beardsley Project was selected with consideration of ownership boundaries, utility and other improvements and the least cost improvement to join with the continuation of this channel through the Revolon watershed.

The four grade stabilization structures included in the project will be located to complete the stabilization of Milligan Barranca and Beardsley Wash above the end of that portion of Beardsley Wash that will be concrete lined.

Alternate Levels of Protection

The eventual use of this watershed area, and the use during the useful life of the channel improvements, will be urban and industrial to a large extent. The design standards of the Ventura County Flood Control District require that all major flood control channels in the County be designed to contain the two percent frequency of occurrence flood flows in anticipation of more intensive developments in the County. The present agricultural use of this watershed area would not justify providing protection against the two percent frequency of occurrence flood flows. However, on the basis of projected development in this watershed area during the project evaluation period as indicated in the General Plan Report of the Ventura County Planning Commission sufficiently large areas of the watershed will be in more intensive uses than agriculture to justify this higher degree of protection. In addition, later more intensive use of larger areas during the useful life of the structural measures, and beyond the evaluation period, makes the higher degree of protection more appropriate. With the gentle slopes in the flood hazard area, even the less frequently occurring flood flows will exceed channel design capacities so slightly as to cause little damage even under more intensive use. On the basis of these considerations channels are designed to contain the two percent frequency of occurrence flood flow.

HYDROLOGIC INVESTIGATION

WATERSHED HYDROLOGY

About 90 percent of the historical floods in the watershed have occurred during the six month period December-May. January, February and March are the major flood hazard months. Precipitation within the watershed has averaged about 15 inches over a period of 60 years. Major flooding within the watershed is almost exclusively associated with cyclonic storms that move in from the Pacific and generally exceed 24 hours' duration. A study of major storms of record indicates that these storms are characteristically three to four days in duration with maximum flooding occurring during the second or third day of the storm sequence. It is also indicated that the duration of continuous rainfall which causes flood peaks does not exceed 24 hours.

Very limited runoff records are available which can be considered directly applicable to the Beardsley and Revolon watersheds for specific storms. The records available are for portions of the upper Beardsley watershed ranging in size from two to twelve square miles.

Because of the limited runoff records the design capacities to be provided in the various channel reaches were computed by the general simplified method described in SCS National Engineering Handbook, Section 4, Supplement A, page 3.21-11, using the family of semi-dimensionless hydrographs developed by W. J. Owens. The curve numbers estimated by evaluating soil-cover complexes were checked against the available runoff records with consideration of antecedent moisture conditions to assure reasonable consistency.

The Soil Survey of Ventura Area by the U. S. Department of Agriculture, Bureau of Soils, 1917 was used as the basic soils information from which the hydrologic classifications were determined. Cover types were based on Ventura County Planning Commission Future Land Use Map for the year 2000. Antecedent moisture condition II was assumed in curve number estimation.

The precipitation records of a standard rain gage station having a period of record of about 60 years was used as the basis for determining intensities of rainfall for various durations. The maximum annual 24 hour precipitation amounts for this gage were plotted by the 1945 Gumbel Method to estimate the intensities of the 24 hour duration storms for various frequencies of occurrence. To determine intensities of other storm durations the constants tabulated in Table 3.21-2 of SCS National Engineering Handbook, Section 4, Supplement A, were used. Some recording rain gage records were available for use in analysing the more recent storms.

The Type C storm pattern was assumed in these analyses as flood producing storms in this area have generally conformed to this precipitation pattern or a period of high intensity rainfall has occurred under conditions of high antecedent moisture.

Times of concentration for the eleven subwatersheds used in the hydrologic analysis were determined by estimating on the basis of the Kirpich procedure (figure 3.15-3, SCS-NEH, Sect. 4, Sup. A) with the limitation of a maximum average velocity of six feet per second in natural channels.

The hydrographs determined for the subwatersheds in accordance with the above procedures were combined and routed by the Wilson Method. The travel time for each reach of channel was computed by Manning's formula for channel conditions as they would exist with the project installed.

Listed below are the computed two percent frequency of occurrence peak flood flows for channel improvements included in the Beardsley Project.

Channel Improvement	Area Sq.Mi.	CFS
Los Angeles Avenue Drain	2.6	900
Santa Clara Drain		
L. A. Ave. to Jct. Wright Rd. Drain	5.2	1700
Jct. Wright Rd. Drain to Jct. Beardsley Wash	8.2	2600
Wright Road Drain	2.5	950
Nyland Drain	4.8	1200
Beardsley Wash		
Hwy. 101 to Jct. Santa Clara Drain	25.0	4000
Jct. Santa Clara Drain to Jct. L.P.E. Drain	16.3	2600
Jct. L.P.E. Drain to End Channel Imp.	13.7	2400
Las Posas Estates Drain	2.1	950
Revolon Channel		
Hwy. 101 to Jct. Camarillo Hills Drain	31.2	5000

HYDROLOGY FOR ECONOMIC STUDIES

The floodwater and sediment damage estimates used in project evaluation were based on the damages experienced with the floods which occurred in 1938, 1958 and 1962.

Historical data were obtained for these three floods in the Beardsley and Revolon watersheds from photographs and by accounts provided by residents in the watershed. The information obtained for the 1938 flood had to be adjusted in consideration that Calleguas Creek floodwaters commingled with Revolon floodwaters during that flood. Calleguas Creek improvements made in recent years have separated these flood flows so that flooding of areas during the 1958 and 1962 floods was caused by Revolon floodwaters only.

There were some records of gaged runoff from sub-drainage areas within these watersheds for each of these floods used in the economic evaluation. By using this limited runoff information along with precipitation data from standard and recording rain gages in and adjacent to these watersheds, and with consideration of the antecedent moisture conditions, peak flood flows for the total drainage area were estimated for these storms. This was accomplished by determining the curve numbers that applied to the gaged drainage areas and adjusting soil-cover complex determined curve numbers for the subwatersheds used in hydrologic analysis in the two watersheds accordingly; and using the general simplified method referred to above to determine peak flows. This determination of peak flows for each of these floods was then considered in relation to the estimated two percent frequency of occurrence flood peak, and the historical evidence obtained, to arrive at an estimated frequency of occurrence for these floods.

The frequencies of occurrence estimated for these floods and used in the economic evaluation were: 1938, 5 percent; 1958, 20 percent; and 1962, 10 percent.

HYDROLOGIC EVALUATION OF LAND TREATMENT MEASURES

The effects of the installation of project land treatment measures were estimated by computing their effects on composite curve numbers according to material in Section 3.4 of the NEH, Sect. 4, Sup. A.

The effects of these changes in curve numbers in reducing runoff volumes were computed. Peak flows were assumed to be proportionately reduced. For economic evaluation these peak flow reductions were translated into area-inundated reductions by relating the reduced peak flows to areas inundated on the area-inundated versus frequency of occurrence curves developed for project economic evaluation.

GEOLOGIC INVESTIGATION

AREAL GEOLOGY

Most of the agricultural land in the Beardsley watershed has recent-alluvial soils derived from sediments that have not undergone material changes or internal modification since their deposition, and which are still in process of formation. This alluvium is composed of sand, gravel and clay. It is generally underlain in turn with variable depths of the San Pedro and Santa Barbara formations of sand, gravel, silt and clay. At greater depths formations of sandstone, conglomerate, shale and associated volcanics occur. In the Camarillo Hills area the San Pedro and Santa Barbara formations appear at ground surface along with sandstone, conglomerate and shale. The geology of the upper part of the Beardsley watershed is similar to that in the Camarillo Hills area with some residual soils in small areas.

SEDIMENTATION

Sediment continues to be an important part of the flood control problem in the Beardsley and Revolon watersheds even though considerable progress has been made in the control of this problem over the past thirty years. The major sediment sources are in the Beardsley watershed as the south slopes of the Camarillo Hills are the only significant sediment sources in the Revolon watershed.

In the upper, South Mountain portion of the Beardsley watershed, above La Loma Avenue and Berylwood Road, extensive raw vertical banks in each of the three major barrancas, Milligan, Arroyo Colorado and Hondo, attest to the probability that large volumes of sediment are produced during major storms. This sediment source has been partially controlled by stabilization structures constructed with CCC and WPA labor about twenty five years ago but the total problem does not appear to be susceptible to a feasible solution because of the steep slopes and geologic conditions peculiar to this area. These barrancas on the flatter grades below the above-described area are largely controlled by existing stabilization structures. Other areas in the South Mountain portion of the Beardsley watershed have similar sediment producing characteristics.

In order to determine the size distribution of the coarser sediments that the channel sections will be required to carry, samples of sediment deposits from various locations in the watershed were obtained and mechanical analyses of these samples were made. In theory the design velocities in the project channel improvements are such as will carry these sediments through all sections. However, during receding flood flows and the lesser floods some deposition in the lower earth section in the Revolon watershed can be expected. Once deposited, re-entrainment is doubtful and maintenance excavation will be required. The amount will vary widely from none in some years to as much as 200,000 cubic yards after events of very infrequent occurrence.

Sediment yield in the Beardsley-Revolon watersheds has varied widely, from as much as 160 acre feet in the 1938 flood to none in dry years. Existing stabilization measures have had a very beneficial effect and the stabilization measures that will be installed with the Beardsley Project will provide additional controls, but the rate will remain substantial because of barranca and slide erosion that would not be economically feasible to control.

EROSION

Erosion in the Beardsley and Revolon watersheds may be placed in three classifications. Erosion of the steep slopes of South Mountain and the Camarillo Hills is the major source of sediment in these watersheds. The on-site damages of erosion in the South Mountain area are comparatively unimportant economically as most of this area has very little value for agriculture or other uses except watershed. Erosion in the Camarillo Hills area is of considerably greater economic concern as continued gullying often destroys or threatens valuable urban improvements in the highly developed portions of this area.

Sheet and gully erosion on the lower agricultural lands has been caused by overland flow and scouring because of the absence or inadequacy of flood control channels. This damage has been reflected mostly in the costs of releveling and in the maintenance of transportation facilities. This category of erosion damage will be largely eliminated with the installation of the project measures.

Erosion of channels through the bottom lands has been a serious problem in the past but grade stabilization structures have been installed which have largely controlled this category of erosion. The remaining problem will be solved with the installation of the project measures. The erosion of channels has caused land loss and contributes to the sediment damage problem.

CHANNEL INVESTIGATION

A soil investigation along the alignment of the Revolon Channel was made by Dames and Moore, consultants in applied earth sciences, for the Ventura County Flood Control District. Their report presents the results of this investigation and recommendations related to the soil engineering features of the Revolon Channel improvement.

This investigation was undertaken to:

1. Determine the soil conditions along the channel route.
2. Determine ground water elevations along the channel route.
3. Provide recommendations regarding the side slopes for the channel.
4. Provide recommendations regarding underdrainage systems for relieving uplift water pressures on channel linings.
5. Provide recommendations regarding concrete linings for the channel.
6. Provide recommendations regarding riprap revetments and bedding blankets for channel slopes.
7. Provide recommendations for the construction of compacted earth fill embankments.

To develop the required information, 50 borings were drilled and laboratory tests were performed on undisturbed samples obtained from the borings. This information applies specifically to the reach of Revolon Channel included in the Beardsley Project and provides some guidance in considering channel improvements having similar soil conditions in other parts of the project area.

ECONOMIC INVESTIGATION

GENERAL

In that the structural works of improvement to be installed on the Beardsley and Revolon watersheds are interdependent, the economic evaluation was developed for the combined drainage area and a single benefit-cost ratio was derived.

Flood damages were evaluated as a basis for determining benefits to be obtained by the completion of these projects. Investigations were made in order to translate the relationships among such elements of flooding as depth, area, duration, season of occurrence, sediment content, location and frequency, as developed in the hydrologic investigation, into dollar damage values. This translation required determining how land use on the flood plain area will change during the 50-year evaluation period and evaluating damages expected under these uses. The potential for other benefits in these watersheds, based on additional opportunities for more intensive or changed use made possible by the provision of an adequate outlet channel for flood flows, was also evaluated.

With consideration of the residual damages that would occur with the projects installed, the total estimated benefits that would be obtained with the two projects installed was computed. Residential and commercial property damages and benefits were assigned to the Beardsley project, inasmuch as they occur in the Nyland Acres segment of the drainage area. All other damages and benefits were then adjusted so the total benefits were allocated to the two projects in proportion to their average annual equivalent costs. On this basis the Beardsley watershed project was credited with 43.1 percent of the total benefits that will accrue to the combination of the two projects.

EVALUATION AREAS

For the economic evaluation, the combined flood plains and other areas to be benefited were divided into four evaluation areas. One of these evaluation areas includes almost all of the Beardsley watershed and the other three are almost entirely in the Revolon watershed. These evaluation areas are not

hydrologically independent but were established on the basis of homogeneity of their evaluation problems.

LAND USE EVALUATION

Basic data used in ascertaining present land use patterns within these watersheds were obtained by field observations and aerial photographs. With the exception of Nyland Acres in the Beardsley watershed and the western end of the U. S. Air Force Base, in the Revolon watershed, the entire flood plain area of these two watersheds is in agricultural use.

The projected use of land within the flood plain area and adjacent areas which are dependent upon the provision of an outlet channel before they can be used for urban and industrial developments was based on plans that have been completed or are being developed within the County. The projected use for watershed lands in the economic evaluation was considered to the year 1985.

A general land use plan prepared by the Oxnard City Planning Department and Victor Gruen Associates indicates easterly expansion of the City of Oxnard generally limited by the flooding problem and surface drainage outlet deficiencies on the Revolon watershed. The completion of these project works of improvement will eliminate this physical restriction to easterly expansion.

The Ventura County Planning Commission and Wilsey, Ham and Blair, as planning consultants, are preparing a County General Plan which is designed to guide the growth of developmental features in the County during the period ending in the year 1985. This plan anticipates growth of population in the County from the 200,000 residents in 1960 to 800,000 in 1985. The growth rate of the County in recent years appears to justify this projection. This plan envisages intensive urban development of the Camarillo Hills area and a general expansion from the present Camarillo urban and industrial core. A major portion of this development is anticipated to occur in the Revolon watershed with a minor portion projected onto the flood plain area. This intensive development with its attendant drainage improvements would tend to make worse the flood problems in the Revolon watershed without Revolon Channel improvement to serve as an outlet.

The County plan also anticipates urban expansion from the present El Rio urban and industrial core to include all of the area west of Santa Clara Avenue and south of Los Angeles Avenue in the Beardsley watershed. Such development in this area of 2,495 acres would not be permitted without prior installation of the flood control works of improvement included in the Beardsley and Revolon Projects. A benefit based on urban use of an equivalent area of 2,060 acres within these two watersheds is included in the economic evaluation of these projects.

DETERMINATION OF DAMAGES

Types of Damage

Total damage values developed include both direct and indirect damages. Direct damages are caused by direct contact with floodwater and sediment and

were evaluated as described below. Indirect damages include such items as loss of trade during and after a flood; loss of productive time in replacing or renovating damaged property; loss suffered by users of utilities and communication facilities made ineffective by a flood; and costs incurred in routing traffic, evacuating people and providing emergency flood protection works during the period of flooding. Indirect damages were estimated to be 10 percent of direct agricultural damage, 15 percent of direct urban damage and 20 percent of direct damage to commercial enterprises.

Agricultural Damages

Agricultural damages were considered in two main categories: crop damage and property damage. Crop damage was considered to include damages that occur on these lands when used to the intensity that is practical with the existing flood hazard. Agricultural property damage includes damage to farm buildings, equipment and other farm improvements and accessories.

In the determination of crop damage use was made of the composite crop acre. This acre represents a composite of all the various crops grown in the area during particular months of the year, weighted in proportion to the percentages of the area used for each of the crops.

Representative crop yields and adjusted long-term prices were estimated for each of these crops on the basis of farmer interviews, interviews with Extension Service personnel and use of publications. The publications included the Ventura County Annual Report and Crop Statistics, 1961; California Prices Received by Farmers for Farm Commodities, Monthly and Seasonal Average Prices 1908-1960 by California Crop and Livestock Reporting Service; and the project feasibility report of the Pleasant Valley Project which was the basis for obtaining Federal assistance in the improvement of irrigation water service for an area which includes part of the Revolon watershed.

Budgets and tables relating net crop income to various yield levels were developed for each crop from the above information and additional information obtained by interviews with farmers, the County Farm Advisor and others acquainted with local conditions. This information provided the basis for developing estimates of damage to the composite crop acre for various degrees of flood damage occurring during various months.

Direct crop damages for the flood occurrences of 1938, 1958 and 1962 were then estimated on the basis of areas inundated, the degree of damage to various parts of these areas and the time of year when the flood occurred. Information relative to areas inundated and the degree of damage experienced during each of these floods was obtained from photographs, records of county agencies and interviews with residents of the area.

Agricultural property damage was included as part of the information obtained by interviewing local residents. These damages include floodwater and sediment damages to tile lines; costs due to increased weed infestation and plant disease; extra land leveling and farm ditch repair costs; and costs to pump flood waters from fields.

With the estimated frequency of occurrence for these floods and the damages obtained as indicated above, damage-frequency curves were developed from which the average annual equivalent damages were measured. As shown on Table 5, the average annual equivalent floodwater damage to crops was determined as $31,700, and to agricultural property, $8,800. The average annual equivalent sediment damage to agricultural property was determined as $2,800.

Urban Damages

The major urban area in the flood plain area is a tract development known as Nyland Acres. Damage records for residences and commercial establishments were obtained and the validity of the data obtained was checked against the curves developed by Stanford Research Institute in 1960 for California flooding. The estimated average annual equivalent urban damage is $66,200 as shown on Table 5.

Other Non-Agricultural Property Damage

This category includes damages to utilities, increased channel maintenance costs to the County and other organized groups, increased road maintenance costs to the County, State or Federal governments, and other damages to isolated commercial establishments in the watersheds. The basic data used for the determination of these damages were damage records obtained by contacting all businesses, special districts and governmental agencies located on the flood plain. Average annual equivalent damages of $8,100 were estimated from these data considered on a damage-frequency basis.

DETERMINATION OF BENEFITS

Benefits Attributed to Land Treatment Measures

Off-site benefits attributed to land treatment measures were estimated on the basis of reduced areas of inundation caused by the effects of land treatment measures translated into monetary values through an approximate method that assumes damages are directly proportional to flooded area. The reductions in inundated areas were estimated on the basis of changes in the weighted curve number for the watershed that would be caused by the effective installation of the land treatment measures. This procedure indicated that land treatment measures will provide flood damage reduction benefits of $6,000 annually in this watershed.

Benefits Attributed to Structural Measures

Floodwater and Sediment Damage Reduction

A small amount of residual flooding will occur from very infrequently occurring floods with all of the works of improvement installed to protect against the two percent frequency of occurrence flood flows. The average annual residual damage with the project measures installed is estimated at $2,400. The total average annual equivalent benefits credited to the structural measures for the reduction of these damages is $124,900.

a degree of protection which is adequate for the present agricultural use of the land. To provide the degree of protection appropriate for urban or industrial use would require supplementary pumping during the more infrequently occurring flood flows. Also, the outlet channel through Point Mugu requires dikes to contain the major flood flows.

All concrete lined channels have rectangular sections. The channel width to depth ratio used was such as to obtain approximately the least cost section to construct. A gravel filter with a thickness of 12 inches and extending over the full perimeter of the concrete lined section to within two feet of ground surface is provided. Lateral drain tiles, 6 inches in diameter will be installed on each side of the channel section at the bottom elevation with inlets into the channel spaced about 25 feet.

The minimum slab thickness for reinforced concrete lined sections was determined in accordance with the structural design criteria for channels included in SCS Engineering Design Standards, Far West States, Figure 1.10. Side thicknesses at the base of the wall were determined on the basis of maximum bending moment using a surcharge of two feet and a fluid pressure of 30 lbs. per foot. Thicknesses at the top of the sides are 6 inches minimum, with 8 inches when two rows of reinforcing steel are required.

Freeboard requirements and other design characteristics of the channel section related to hydraulic considerations were determined on the basis of design criteria included in Section VI, SCS Engineering Design Standards, Far West States. A value of n = .015 was used for concrete lined channels.

Unlined earth channel sections have side slopes of 2:1 (horizontal to vertical). Riprap protection is provided on both sides, except for the outlet channel through Point Mugu Naval Air Station, to the design water surface plus the appropriate freeboard, and to a depth of 5 feet below invert grade line. An average thickness of two feet is provided. A value of n = .025 was used for these wide channel sections with riprapped side slopes.

Channel design characteristics were influenced by information included in a report by Dames and Moore, consultants in applied earth sciences, on a soil investigation which they made in this area for the Ventura County Flood Control District. The scope of this investigation is included under "Geologic Investigation".

Maintenance roadways are provided on the basis of a road on one side for channels less than 20 feet in width and a road on each side for channels wider than 20 feet. Maintenance roadways will be 15 feet in width.

COST ESTIMATION

LAND TREATMENT MEASURES

The unit costs for installation of land treatment measures were based on current costs of materials and construction in this area. For those practices involving farm labor and equipment estimated costs were based on recent studies made by the Soil Conservation Service in the area.

the primary project benefits, and (2) the supplying of additional materials and services required to make possible the increased net returns which stem from the installation of the project measures.

All of the vegetables and citrus fruits produced in this intensively farmed area must be transported, processed and marketed away from the growing area. This produce may be hauled to Los Angeles and sold, then shipped throughout the country. Large numbers of people are employed in the harvesting and throughout the farmer to market route. The determination of this secondary benefit is not subject to rigorous evaluation and was considered to be equal to 10 percent of the value of the actual crop losses, $31,700, or an average annual equivalent benefit of $3,170.

When flood protection is provided, land that now lies idle during the flood season will be cropped. When this occurs the farmers will need more farm machinery, fertilizer, seeds and pesticides. Increased net income will allow farm families to spend more for consumer goods. Additional secondary benefits of $17,630 annually were estimated as 10 percent of the increased production costs on these more intensively used lands.

The total benefits attributable to the structural measures include damage reductions, benefits from more intensive and changed land use and secondary benefits. The total benefits for the structural measures that will be installed are estimated at $256,300 on an average annual basis.

SURVEYS

Field surveys for cross-sections along the Revolon Channel alignment have been made. Sections are spaced at a minimum of 50 feet and cover a width of 600 feet. Map manuscripts have been prepared which include the topography of the existing land surface and indicate the alignment of the channel improvement. These surveys have been adapted to a right-of-way map which shows channel alignment, width of right-of-way required and ownership of property from which right-of-way must be obtained.

Survey data for the Los Angeles Avenue Drain, Wright Road Drain, Las Posas Estates Drain, Beardsley Wash and the portion of the Santa Clara Drain bordering Santa Clara Avenue were available from surveys that were made by Ventura County in recent years. These data include profile elevations at channel center lines and adjacent ground elevations.

For the remaining portion of the Santa Clara Drain and for the Nyland Drain control elevations were available for channel inverts at each end and ground surface elevations were obtained for intermediate points.

Available survey data on gully profiles were used to determine the number of additional grade stabilization structures required to complete the control on Milligan Barranca and Beardsley Wash.

Information available on the existing debris basins was used for estimating the costs for upgrading to meet the project requirements.

DESIGN OF STRUCTURES

The basic concept used in the design of all channel improvements was to keep the full channel section, including freeboard, below ground surface level, where possible. This will permit the effective diversion of local runoff during design storm conditions into the channels.

All channel improvements have rectangular concrete lined sections. A gravel filter with a thickness of 12 inches and extending over the full perimeter of the concrete lined section to within two feet of ground surface is provided. Lateral drain tiles, 6 inches in diameter will be installed on each side of the channel section at the bottom elevation with inlets into the channel spaced about 25 feet.

The minimum slab thickness for reinforced concrete lined sections was determined in accordance with the structural design criteria for channels included in SCS Engineering Design Standards, Far West States, Figure 1.10. Side thicknesses at the base of the wall were determined on the basis of maximum bending moment using a surcharge of two feet and a fluid pressure of 30 lbs. per foot. Thicknesses at the top of the sides are 6 inches minimum, with 8 inches when two rows of reinforcing steel are required.

Freeboard requirements and other design characteristics of the channel section related to hydraulic considerations were determined on the basis of design criteria included in Section VI, SCS Engineering Design Standards, Far West States. A value of n = .015 was used for concrete lined channels.

Channel design characteristics were influenced by information included in a report by Dames and Moore, consultants in applied earth sciences, on a soil investigation which they made in this area for the Ventura County Flood Control District. The scope of this investigation is included under "Geologic Investigation".

Maintenance roadways are provided on the basis of a road on one side for channels less than 20 feet in width and a road on each side for channels wider than 20 feet. Maintenance roadways will be 15 feet in width.

Grade stabilization structures will be installed in accordance with plans and specifications which have been used for similar structures installed in these gullies. These plans were prepared in compliance with the design criteria included in the Soil Conservation Service Engineering Handbook, Section 11, Drop Spillways.

The existing debris basins will be upgraded by raising the earth embankments to provide additional storage capacities and installing concrete lined emergency spillways.

COST ESTIMATION

LAND TREATMENT MEASURES

The unit costs for installation of land treatment measures were based on current costs of materials and construction in this area. For those practices involving farm labor and equipment estimated costs were based on recent studies made by the Soil Conservation Service in the area.

The cost of technical assistance for the installation of land treatment measures was based upon an analysis of Soil Conservation Service expenditures and accomplishments for the past several years in the Calleguas Soil Conservation District.

STRUCTURAL MEASURES

Construction Costs

Estimated costs to construct the project structural works of improvement are based on quantities calculated for the structural measures as designed and estimated unit costs of the individual items. Unit costs are based on actual bid prices for similar works under comparable conditions in Southern California. The contract costs, estimated on the basis of quantities and unit costs, as indicated above, were increased by 15 percent for contingencies to obtain the estimated construction cost.

Unit costs are as follows:

Channel improvement:

Concrete - structural	$100.00 per cu. yd.
Concrete - channel lining	50.00 " " "
Excavation - common	0.55 " " "
Filter material	3.25 " " "
Drain tile - 6" dia.	1.00 " lin. ft.

Installation Services

The total installation services cost was estimated as about 22.5 percent of the construction cost. This includes engineering and Federal administrative functions on project, state and national levels. Engineering consists of performing final construction surveys, 5 percent; final design of structural measures and preparation of plans and specifications, 6 percent; and supervision and inspection of construction, 6 percent. Technical reviews and administrative services account for the other 5.5 percent.

Right-of-Way Costs

Estimated costs of land required for rights-of-way are based on recent sales of land and asking prices for other land in the watershed. In some channel reaches a part of the land required for right-of-way is now physically dedicated to the existing channel. This portion of the required right-of-way is estimated to cost $200 per acre, even though it may be donated. The remainder of the land required for right-of-way is estimated to cost from $5,000 to $6,000 per acre. All costs are based on fee title acquisition of the required lands even though actual construction may be completed on the basis of easements in some instances. The costs computed on the above basis were increased 15 percent to cover acquisition costs.

Utility relocations include replacement or modification of existing bridges to accomodate the improved channel; provision of farm bridges to reduce severance damages; and relocation of utilities such as irrigation lines and subdrainage system outlets. Highway bridges were estimated to cost $15 per square foot and farm bridges $12 per square foot. The costs for other utility relocations were based on experience with similar work on other projects in the area.

Administration of Contracts

An allowance of 1 percent of the total construction cost was included for the local administration of contracts. This cost includes all local costs for administrative, legal and clerical services incurred by the contracting local organization in carrying out contracts.

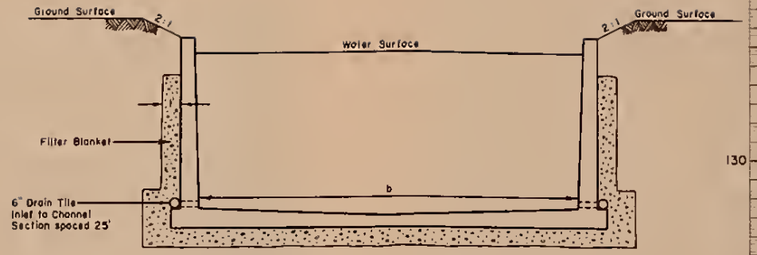
Operation and Maintenance

The estimated average annual cost for the operation and maintenance of structural measures is $5,900. This cost was estimated on the basis of percentages of construction cost for the channel improvement and other structural measures based on general experience: rectangular section concrete lined channel, 0.2 percent; concrete drop structures, 0.1 percent; and debris basin revisions, 0.5 percent. The annual cost computed by the use of these percentages was adjusted to long-term price levels.

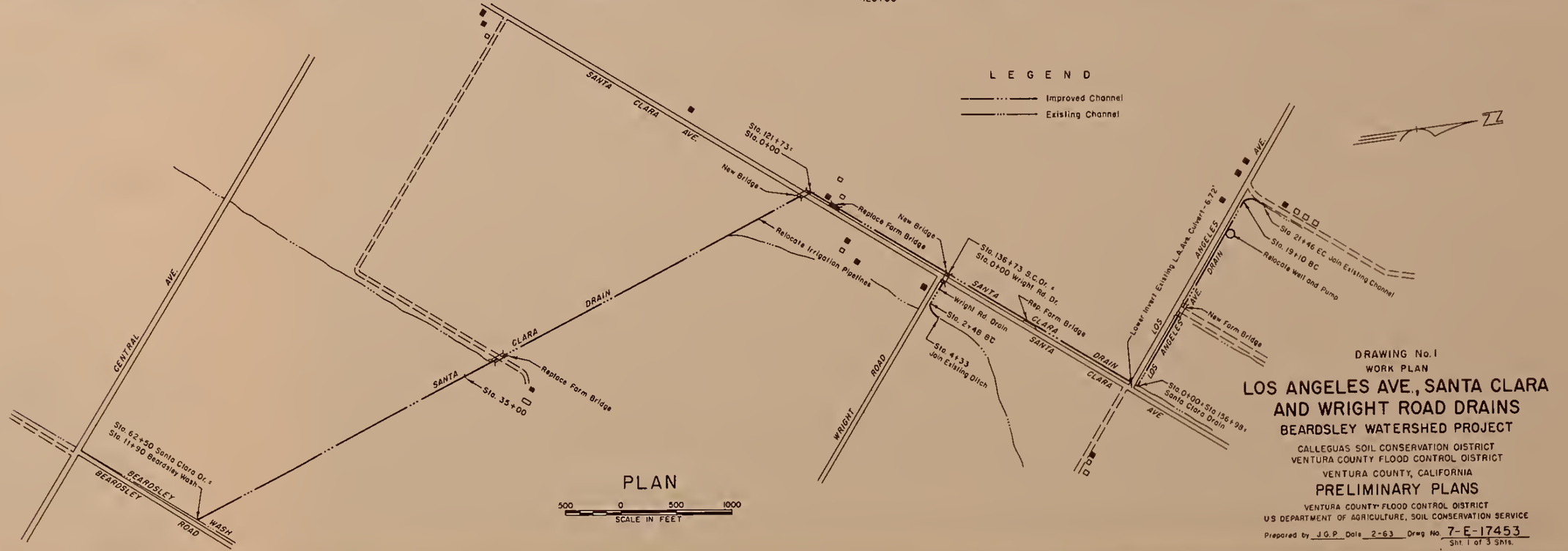
Average Annual Equivalent Cost

The total average annual equivalent cost for the structural measures is composed of the total installation cost amortized over 50 years at 2-7/8 percent interest plus annual operation and maintenance costs.

The benefit-cost ratio is the ratio obtained by dividing the average annual equivalent benefits by the average annual equivalent costs.



TYPICAL SECTION
CONCRETE LINED CHANNEL



DRAWING No. 1
WORK PLAN

LOS ANGELES AVE., SANTA CLARA AND WRIGHT ROAD DRAINS

BEARDSLEY WATERSHED PROJECT

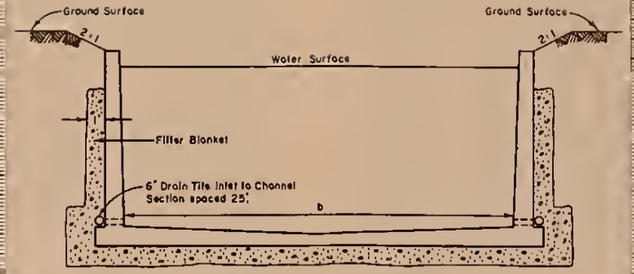
CALLEGUAS SOIL CONSERVATION DISTRICT
VENTURA COUNTY FLOOD CONTROL DISTRICT
VENTURA COUNTY, CALIFORNIA

PRELIMINARY PLANS

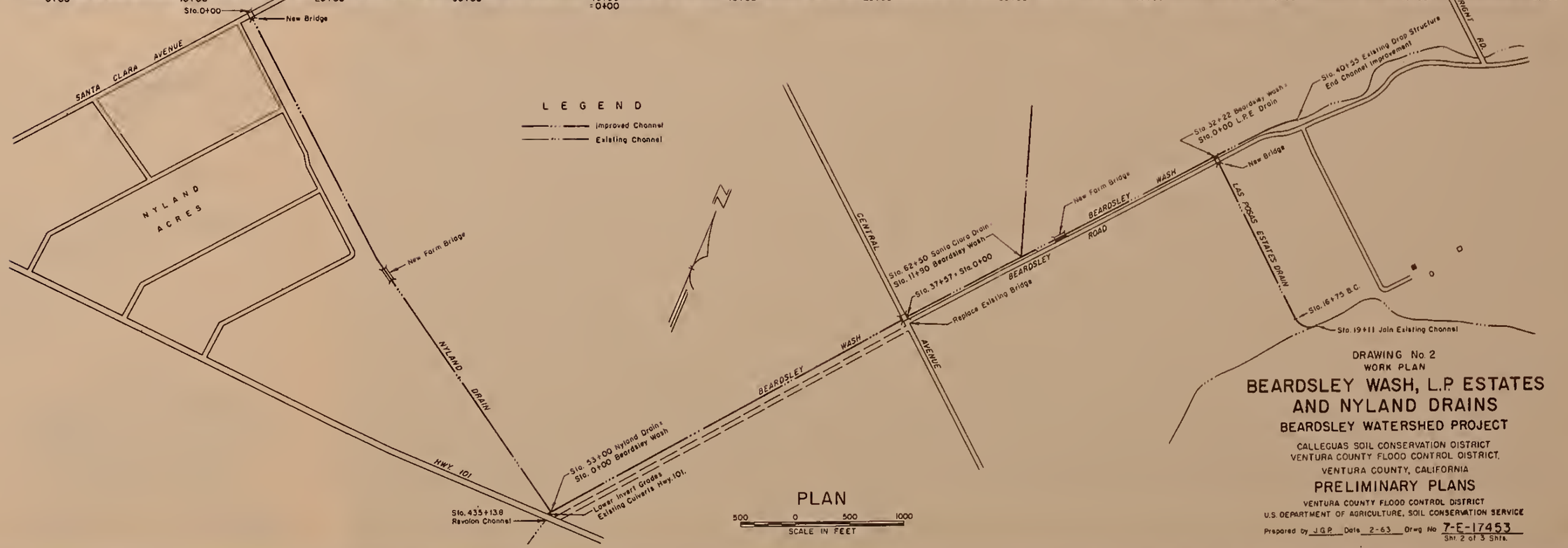
VENTURA COUNTY FLOOD CONTROL DISTRICT
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by J.G.P. Date 2-63 Drwg No. 7-E-17453
Sht. 1 of 3 Shts.

M-3872



TYPICAL SECTION
CONCRETE LINED CHANNEL



DRAWING No 2
WORK PLAN

BEARDSLEY WASH, L.P. ESTATES AND NYLAND DRAINS

BEARDSLEY WATERSHED PROJECT

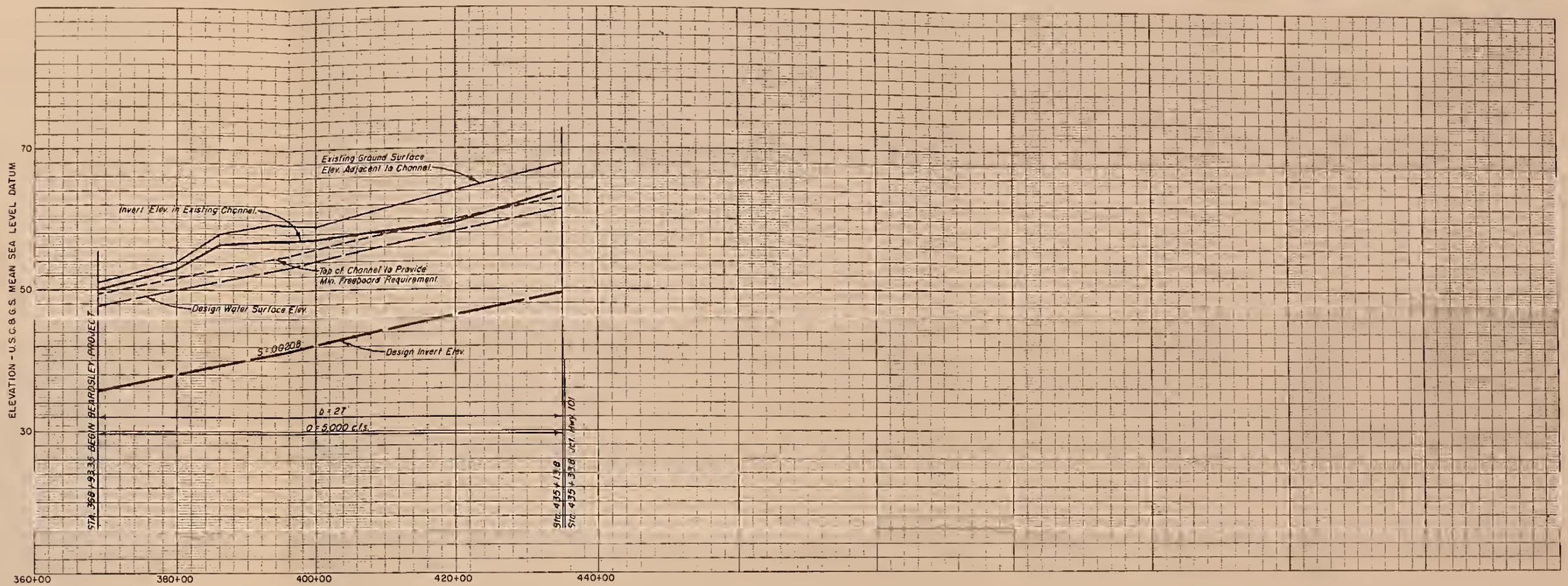
CALLEGUAS SOIL CONSERVATION DISTRICT
VENTURA COUNTY FLOOD CONTROL DISTRICT.
VENTURA COUNTY, CALIFORNIA

PRELIMINARY PLANS

VENTURA COUNTY FLOOD CONTROL DISTRICT
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by J.G.P. Date 2-63 Drwg No 7-E-17453
Sht. 2 of 3 Shts.

M-3872



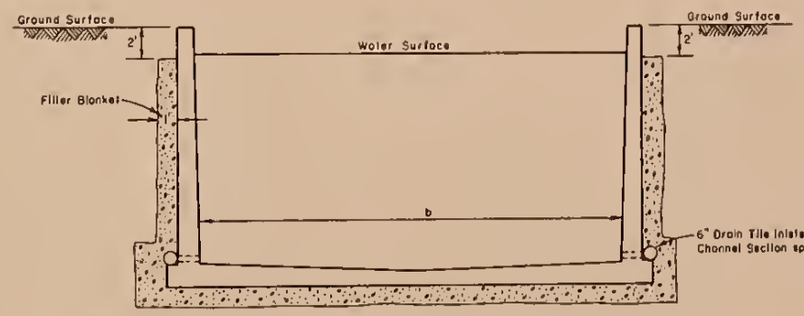
PLAN

CONCRETE LINED CHANNEL

500 0 500 1000

SCALE IN FEET

NOTE: Channel widths not to scale.



TYPICAL SECTION

CONCRETE LINED CHANNEL

DRAWING No. 3

WORK PLAN

REVOLON CHANNEL

BEARDSLEY WATERSHED PROJECT

CALLEGUAS SOIL CONSERVATION DISTRICT

VENTURA COUNTY FLOOD CONTROL DISTRICT

VENTURA COUNTY, CALIFORNIA

PRELIMINARY PLANS

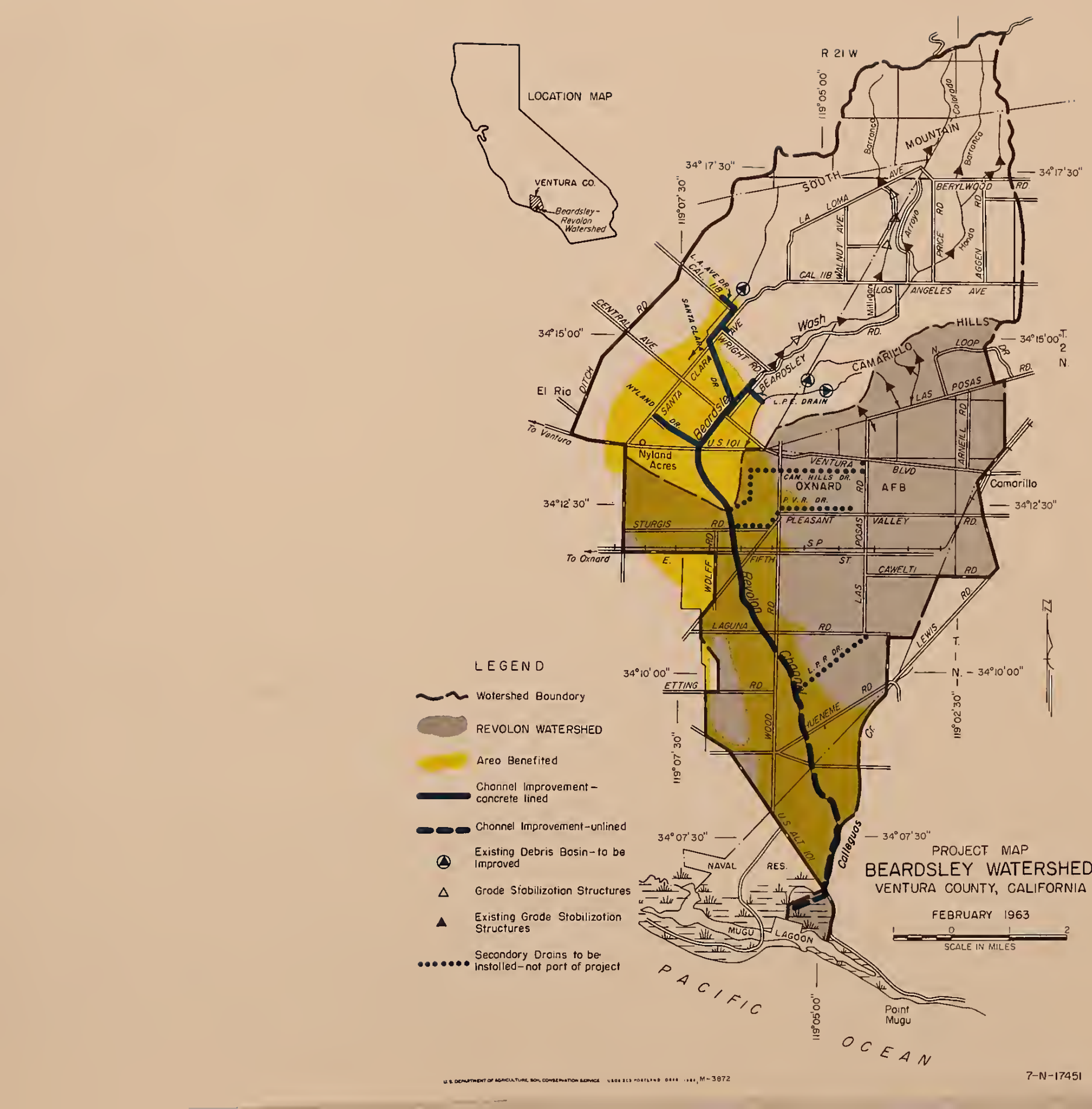
VENTURA COUNTY FLOOD CONTROL DISTRICT

U.S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by J.G.P. Date 2-63 Drwg. No 7-E-17453

Sht. 3 of 3 Shts.

M-3873


LOCATION MAP
VENTURA CO.
Beardsley-Revolon Watershed
R 21 W
T. 2 N.
119°05'00"
119°07'30"
119°02'30"
34°17'30"
34°15'00"
34°12'30"
34°10'00"
34°07'30"
MOUNTAIN
SOUTH
BERYLWOOD RD.
LA LOMA
WALNUT AVE.
CAL 118
LOS ANGELES AVE
CENTRAL AVE
SANTA CLARA
WRIGHT RD.
Wash
HILLS
CAMARILLO
N. LOOP DR.
POSAS
El Rio
DITCH
NYLAND
SANTA CLARA DR.
Beardsley
L.P.E. DRAIN
To Ventura
U.S. 101
Nyland Acres
VENTURA BLVD
CAM. HILLS DR.
OXNARD AFB
P.V.R. DR.
Camarillo
ARNEILL RD.
PLEASANT VALLEY RD.
STURGIS RD.
To Oxnard
S P
FIFTH ST.
CAWELTI RD.
WOLFF RD.
Revolon
LAGUNA RD.
LEWIS RD.
L.R.R. DR.
Channel
ETTING RD.
HUENEME RD.
WOOD Cr.
U.S. ALT 101
Calleguas
NAVAL RES.
MUGU LAGOON
Point Mugu
PACIFIC OCEAN
LEGEND
Watershed Boundary
REVOLON WATERSHED
Area Benefited
Channel Improvement – concrete lined
Channel Improvement – unlined
Existing Debris Basin – to be Improved
Grade Stabilization Structures
Existing Grade Stabilization Structures
Secondary Drains to be Installed – not part of project
PROJECT MAP
BEARDSLEY WATERSHED
VENTURA COUNTY, CALIFORNIA
FEBRUARY 1963
0
2
SCALE IN MILES
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
M-3872
7-N-17451