

# CALIFORNIA

## HIGHWAYS AND PUBLIC WORKS



*Main Line Railroad Bridge across Los Angeles River  
Wrecked by Flood*

Official Journal of the Department of Public Works

APRIL · 1938

# CALIFORNIA HIGHWAYS AND PUBLIC WORKS

Official Journal of the Division of Highways of the Department of Public Works, State of California

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# Disastrous Winter Floods Caused \$8,000,000 Damage to State Highways and Bridges

**T**HREE separate storms during the period December 11 to March 4, damaged State highways and structures to the extent of \$8,000,000.

December and February storms took their heaviest toll in the northern part of the State, while the March storm concentrated on the southern section. The damage for the entire period, however, was almost equally divided between the two areas.

December and March storms, which caused over 90 per cent of the damage, were of three to five days duration and brought rains of cloudburst proportions to the higher altitudes, while establishing record-breaking hourly and daily precipitation records in the valley and coastal regions.

The March storm, which this article describes, swept in from a low-pressure area over the Pacific which extended from the Aleutian Islands south to a point about 800 miles west of San Francisco. Los Angeles, Orange, Riverside, Ventura, and San Bernardino counties suffered the brunt of its attack.

#### TORRENTIAL RAINS

Heaviest rains centered in the San Bernardino and San Gabriel mountains, northerly of San Bernardino and Pasadena, where a total of 30.49 inches for the storm was recorded at Lake Arrowhead, and 10.89 inches during an 8-hour period at Camp Opids in the upper reaches of the San Gabriel. The city of Los Angeles reported 11.06 inches for the storm, 5.55 inches of which fell within a 24-hour period on March 2.

The rainfall data clearly indicate the increasing precipitation as the storm neared the mountains. For instance, Long Beach reported some 6.99 inches of rain for the storm period; Huntington Park 9.48 inches; Los Angeles 11.06 inches; and Azusa 14.95 inches. Again, Newport Beach reported 5.95 inches; San Bernardino 9.82 inches; Devils Canyon 13.65 inches; Waterman Canyon 22.10 inches; and Lake Arrowhead 30.49 inches. The counties of Santa Barbara and San Luis Obispo to the north of the storm center, as well as San Diego to the south, shared to a lesser degree in the storm damage.

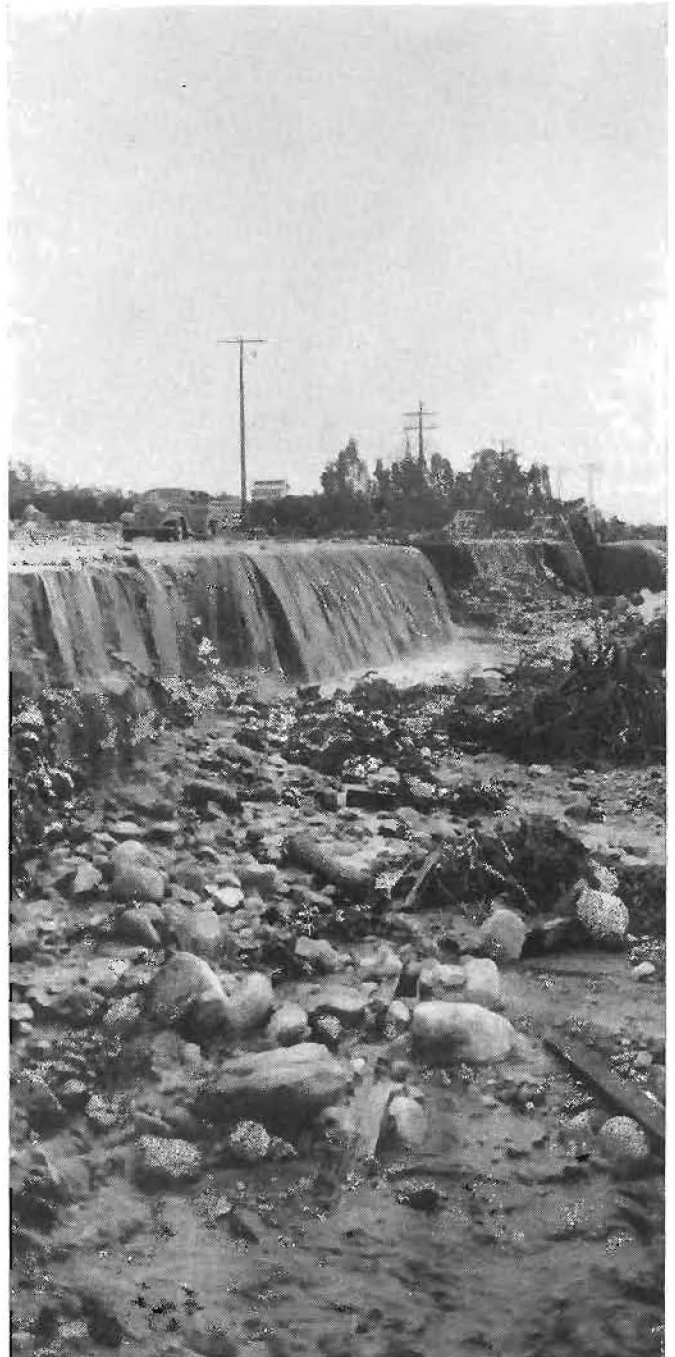
#### RIVERS LEAVE BANKS

The effect of this downpour was immediately evident. The normally dry stream beds on these mountain slopes, tributary to the Santa Clara, San Gabriel, Santa Ana, Mojave and Whitewater rivers, were soon raging torrents. The main rivers, swollen to flood proportions by this sudden influx, overtopped their banks, creating flood conditions unprecedented since 1884. In the resulting chaos, lives were lost, property destroyed and lines of communication and transportation either damaged or disrupted.

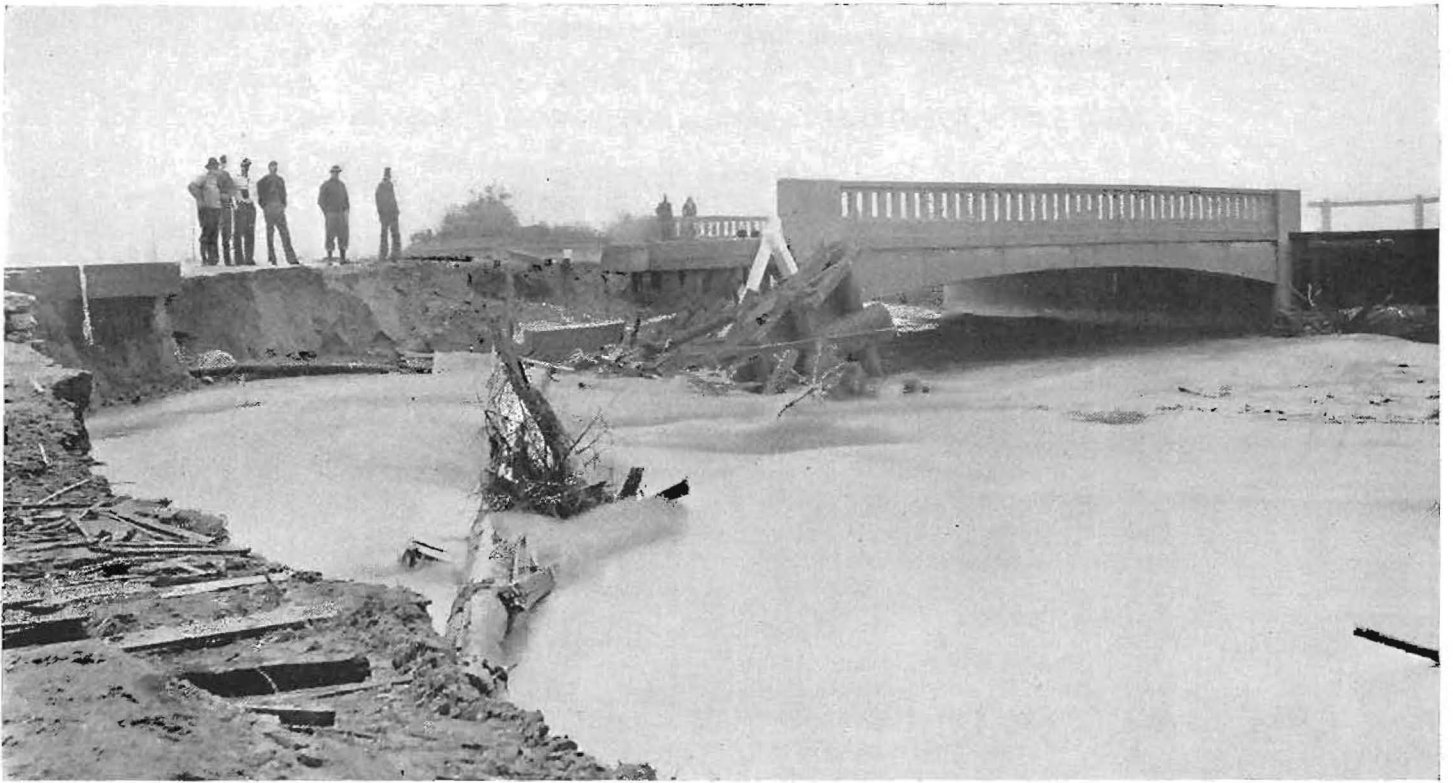
In such a battle no quarter is asked or given. Failures of services under such conditions deserve no censure, as the law of economics must govern man's constructive efforts. There remained, however, the supreme test upon which judgment will always be passed; namely, the ability to recover and function under such punishment.

# March Storms Took Big Toll

By T. H. DENNIS  
Maintenance Engineer



Waterfall on Foothill Boulevard in San Bernardino County caused by flood waters of Cucamonga Creek.



High waters in Barton Wash ripped away timber wing on this bridge on Route 168-C in Los Angeles County.

When it is known that, within two days after the storm, travel was again moving over many of our highways—even though mountains had moved, bridges washed out, and pavements and embankments slipped away—you will acknowledge that the highway forces had justified their ideals of organization and service.

Men and equipment—owned and rented—were worked without stint from the time the storm broke, so that relief might be forthcoming when the danger was past. Had not this been done, the disrupted rail lines, telephone and telegraph service, as well as the broken gas mains, might still be under repair lacking the opportunity of reaching the damaged areas.

Long lines of buses plied the highways transferring railroad passengers around damaged tracks and bridges, to their destination. Trucks loaded with poles and wire were in constant evidence on our roads, speeding out to repair and replace the lines. At one time the telephone, telegraph and teletype communication to coast points was so drastically congested or interrupted that the Federal Communications Commission lifted a certain ban on amateur radio operators

to supply this service. The gas companies at several locations utilized bridge structures to hang temporary gas mains pending their permanent replacement.

#### WHERE DAMAGE OCCURRED

The storm, as previously mentioned, dealt with varying severity throughout the southern counties. In order that its effect and attendant problems may be visualized, a brief account is given of what happened to our highways in each district.

A glance at the maps, in which is indicated in solid dark portions the various kinds of damage, will also prove enlightening. (Pages 7 and 11.)

#### In District VIII

Beginning with District VIII, which includes Riverside and San Bernardino counties, the heaviest damage occurred on the highways leading to the Lake Arrowhead, Big Bear Lake and Barton Flats resort areas; on the Highland, Foothill, Valley and Mission boulevards westerly of San Bernardino; and on the highways in the vicinity of Palm Springs, as well as on the National Old Trails Highway at Cajon Pass and Barstow.

Lytle Creek, joined by the waters of Cajon Creek at the base of the mountains, was responsible for the great damage suffered by San Bernardino and Colton. Overtopping its banks north of Highland Avenue, State Route 190, the water proceeded southerly, tearing out homes and auto courts as well as claiming several lives, until it reached Foothill Boulevard, State Route 9. Here the river poured into one of its old channels, completely covering the highway and isolating San Bernardino from Los Angeles; also, tearing out the steel bridge of the Santa Fe Railroad and the approaches to the bridge of the Pacific Electric Interurban Railroad.

#### SAN BERNARDINO HIT

The flood waters following the main channel continued through the southwest portion of the city of San Bernardino, ripping out bridges and homes, until they reached the vicinity of the famous National Orange Show building, where they destroyed auto courts, covered the highway with silt to a depth of six feet, and washed out some 1800 feet of our embankment on Route 26 at the southerly entrance to San Bernardino. At this point, Lytle and Warm creeks joined in their rush to the Santa Ana River,

forming a half-mile wide channel which completely covered highways and farms.

The waters of Lytle Creek, which broke over into one of its overflow channels, raged through the easterly portion of Colton, closing our Route 26. By this time, Lytle Creek and its tributary side canyons had washed out portions of the Cajon Pass and damaged the Verdemon Subway on Route 31. Here, too, it washed out or buried the Union Pacific and Santa Fe's mainline tracks with sand, rock, and debris. Effecting complete isolation, it also washed out the Pacific Electric and Southern Pacific lines.

#### SANTA ANA RIVER RAMPAGES

The Santa Ana River, originating in the mountains at the easterly end of San Bernardino Valley, picked up new life from large side canyons and reached a peak flood stage at Orange Avenue, State Route 190, north of Redlands.

All road crossings above this point were washed out. Here the river spread northward, inundating one mile of our highway. Further south it breached the southerly approach fill to the highway bridge on Route 26 at the south entrance to San Bernardino, washing it out for a width of 150 feet. There, joined by both Lytle and Warm creeks, it overtopped the fill of the highway on Route 26 connecting the cities of Redlands and Colton. Approximately 600 feet of this fill was carried away, but the three bridges there remained undamaged.

On its way westward, the Santa Ana crossed Highway Routes 43, 19, 193, and 77 in District VIII. Only two of the structures on these routes succumbed to the flood—one at Norco on Route 193, the other at Prado on Route 77. The Norco structure was completely destroyed. This was an obsolete bridge, posted for weight restriction, which was taken into the State System in 1933 by legislative action. The Prado structure, like that at Norco, was county-constructed and

## Praise from South

March 18, 1938

Mr. Earl Lee Kelly, Director  
Department of Public Works,  
Public Works Bldg.,  
Sacramento, California.

Dear Earl:

Yesterday I made the round trip from San Diego to Los Angeles going up via Capistrano through Anaheim and returning in the evening down the Coast Route.

I was absolutely both amazed and surprised at the work which the State Highway Department has done in such a short time, following the storm, returning these highways back to such a splendid condition for traveling. It is certainly a wonderful testimony to you as head of the Department of Public Works, your associates and the maintenance men in the Highway Department for their ability and speed in keeping the highways open and making them passable under such extraordinary conditions. **MORE POWER TO YOU.**

With kind personal regards,  
I am

Yours very truly,

H. E. RHOADES, President,  
The San Diego Club

Below—Views of the Santa Ana River at the State Highway Bridge on the Los Angeles-San Diego route (U. S. 101) near the city of Santa Ana taken before and during the peak of the flood. The bridge was not damaged.

taken into the system by legislative action.

All State-constructed bridges over the Santa Ana River in District VIII, as well as the two county-constructed bridges over Routes 43 and 190, withstood the flood.

#### MOJAVE RIVER OUT OF BED

While the Santa Ana River, Lytle Creek, Warm Creek and their tributaries were wreaking havoc in and around San Bernardino, Colton and Riverside, the Mojave River—which runs through the Mojave Desert to empty into Cronese Valley and Soda Lake at Baker—was doing its share of heavy damage.

At the narrows, southerly of Victorville, the tracks of the Santa Fe and Union Pacific railroads were washed out and all bottom lands inundated. At Barstow the river went completely out of its channel, around historic Buzzard Rock north of the town, destroying some 6000 feet of our highways on State Routes 31 and 59. At Baker on Route 31, the junction with Route 127 to Death Valley, floodwaters doubled the width of the channel and tied up all traffic.

North of San Bernardino, the "Rim of the World Drive"—our Routes 43, 59 and 189—to Lake Arrowhead and Big Bear was severely damaged by slides and slipouts. Saturated to plastic state by some 30 inches of rainfall, high embankments settled and moved down the canyons, while sections in cuts folded together, closing miles of these roads.

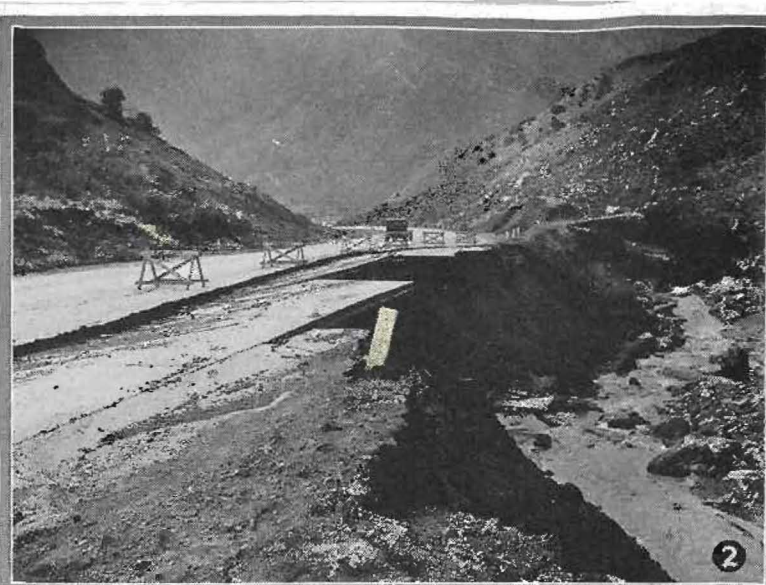
#### TONS OF DEBRIS

Westerly of San Bernardino, Cucamonga Wash and San Antonio Wash tore out sections of Highland Avenue, Foothill Boulevard, Valley Boulevard and Mission Boulevard—our State Routes 190, 9, 26 and 19. These washes, heading back in the mountains, overtopped their banks and deposited thousands of yards of debris and boulders upon the highways, blocking all traffic. Owl Creek Wash, east of Banning, left its banks, carry-





1



2



3



4



5

### Scenes of Highway Damage by March Storm in Southern California

1. Shoulder washed out and pavement undermined on State Highway 26 by flood waters of Santa Ana River near San Bernardino city limits.
2. Canton Creek usually a placid little stream went wild and tore out a large section of embankment and pavement of Ridge Route Alternate near Piru Gorge.
3. A raging flood rushed down from the San Bernardino Mountain range through Cajon Canyon washing out a large section of the National Old Trails Highway (U. S. 66) in Cajon Pass.
4. Normally an insignificant stream, Placerita Creek whirled with mighty force around a bend and scoured out over 10,000 cubic yards of the Newhall-Saugus highway in Los Angeles County.
5. Warm Creek rose out of its banks and cut a new channel that entirely washed away a portion of State Highway No. 26 between Redlands and Colton.
6. Another large section of the Ridge Route Alternate in Los Angeles County was washed out when Piru Creek scoured away paved slopes.
7. San Antonio Wash crossed the Foothill Boulevard near the west San Bernardino County line destroying shoulders and pavement and depositing a mass of large boulders.

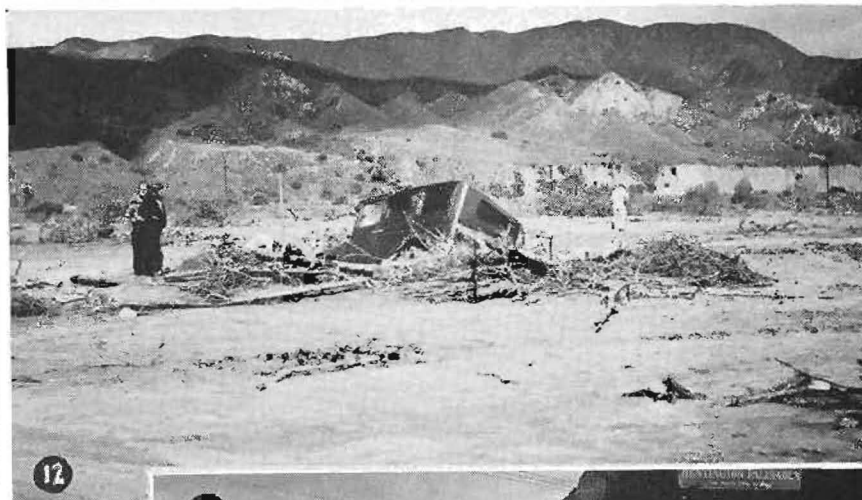
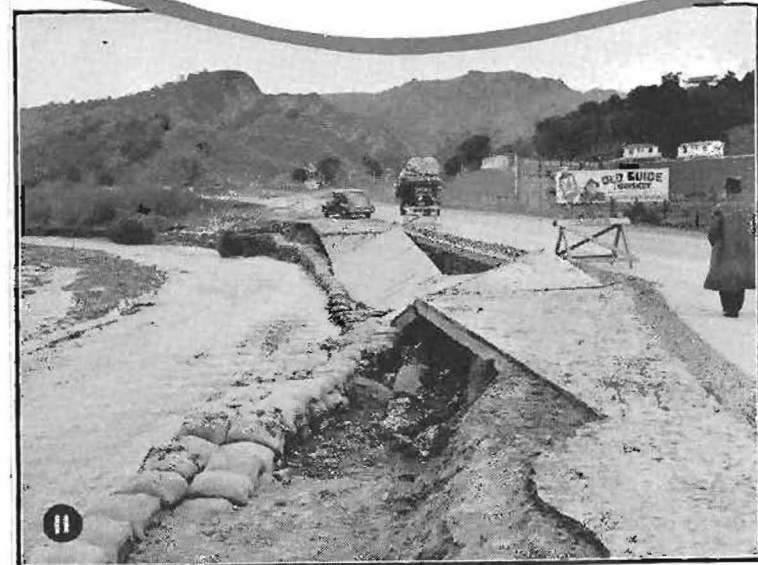


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## Raging Streams Obliterated Many Miles of Roadway and Pavement

8. Lytle Creek inundated areas in vicinity of Colton in San Bernardino County leaving autos stuck in silt on State Highway 26.
9. Rushing through Santa Ana Canyon in Orange County, the Santa Ana River changed its course and washed out State Highway construction that will cost more than \$100,000 to restore.
10. Garapito Creek coursing through Topanga Canyon in Los Angeles County gouged out a large portion of Highway 156.
11. Small streams from the slopes of the Santa Susana Mountains made a wild torrent of Gavin Creek that destroyed part of Route 4 in Weldon Canyon.
12. The Big Tujunga Wash which crosses the route of State Highway 9 near Sunland wreaked destruction on roads and bridges.
13. Embankment was washed out together with half the Newhall-Saugus highway when a creek became a river.
14. The flood roaring down Santa Monica Canyon joined with high-ocean waves to undermine the Coast Highway at the canyon's mouth.



ing away portions of Routes 26 and 187, which lead to Palm Springs and the Coachella and Imperial valleys.

Farther east Whitewater River, after crossing Route 26, left its old channel, destroying a considerable section of the Southern Pacific's main line track to the east. Snow Creek, joined by the Whitewater River, washed out approaches to Snow Creek Bridge on Route 187, as well as long stretches of this highway between there and Palm Springs, virtually isolating the town.

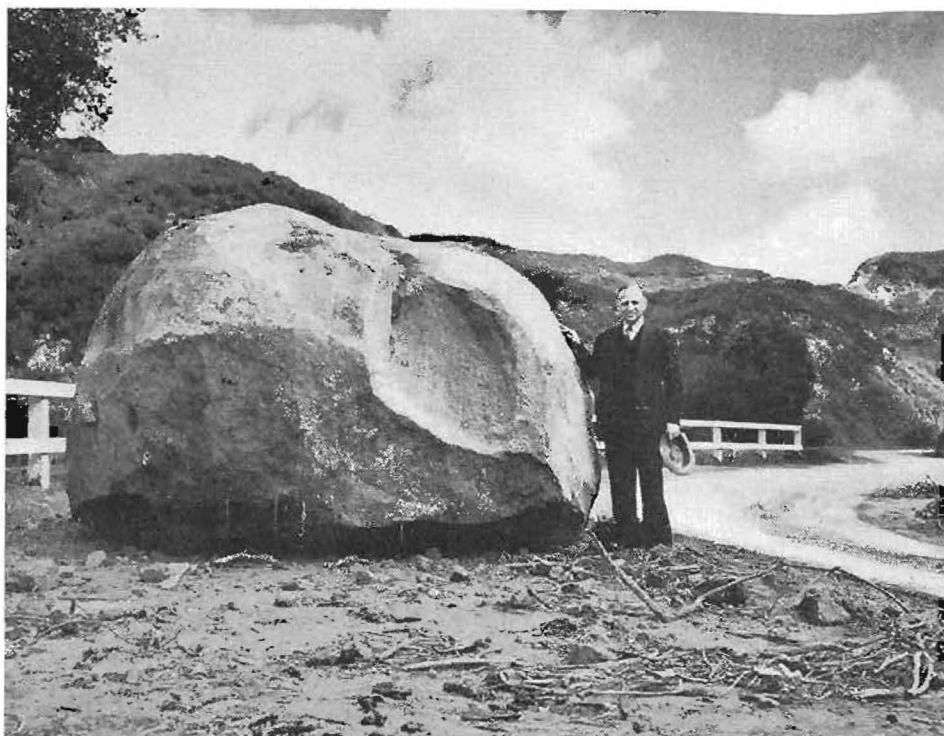
In spite of the heavy damage, traffic was again moving over the greater number of these highways within a few days following the storm. It will require weeks, however, to restore many of those highways in the mountain areas to a safe traversable condition. In this district alone 215 trucks, 44 graders, 48 tractors, 29 power shovels and 1 pile driver, besides hundreds of men, were immediately placed on the restoration of the roads. Of this equipment, 122 of the trucks, 29 of the tractors, 7 of the graders, the power shovels and pile drivers had to be rented. Since competitive bids were required, it may readily be seen how effectively the district was organized.

#### In District VII

District VII, embracing Ventura, Los Angeles and Orange counties, received the first brunt of the storm as it came from the ocean, then its recoil as the floods rushed seaward back from the mountains. The San Juan, Santa Ana, San Gabriel and Santa Clara rivers covered the highways, destroying approaches, undermining the bridges, and in places carrying away large sections of roadbed. Here was a test for the district whose roads served half of the State's population and vehicles. That it was met, and in a remarkably short time, redounds to the District's credit. A brief resume of the extent of this problem now follows:

#### DESTRUCTIVE FLOOD WATERS

The Santa Ana River, fresh from its destruction of the Prado Bridge in District VIII, entered the canyon leading to Olive. On its way it washed out some 3000 feet of heavy roadbed construction and portions of three county-constructed bridges on State Routes 176, 175 and 181. Leav-



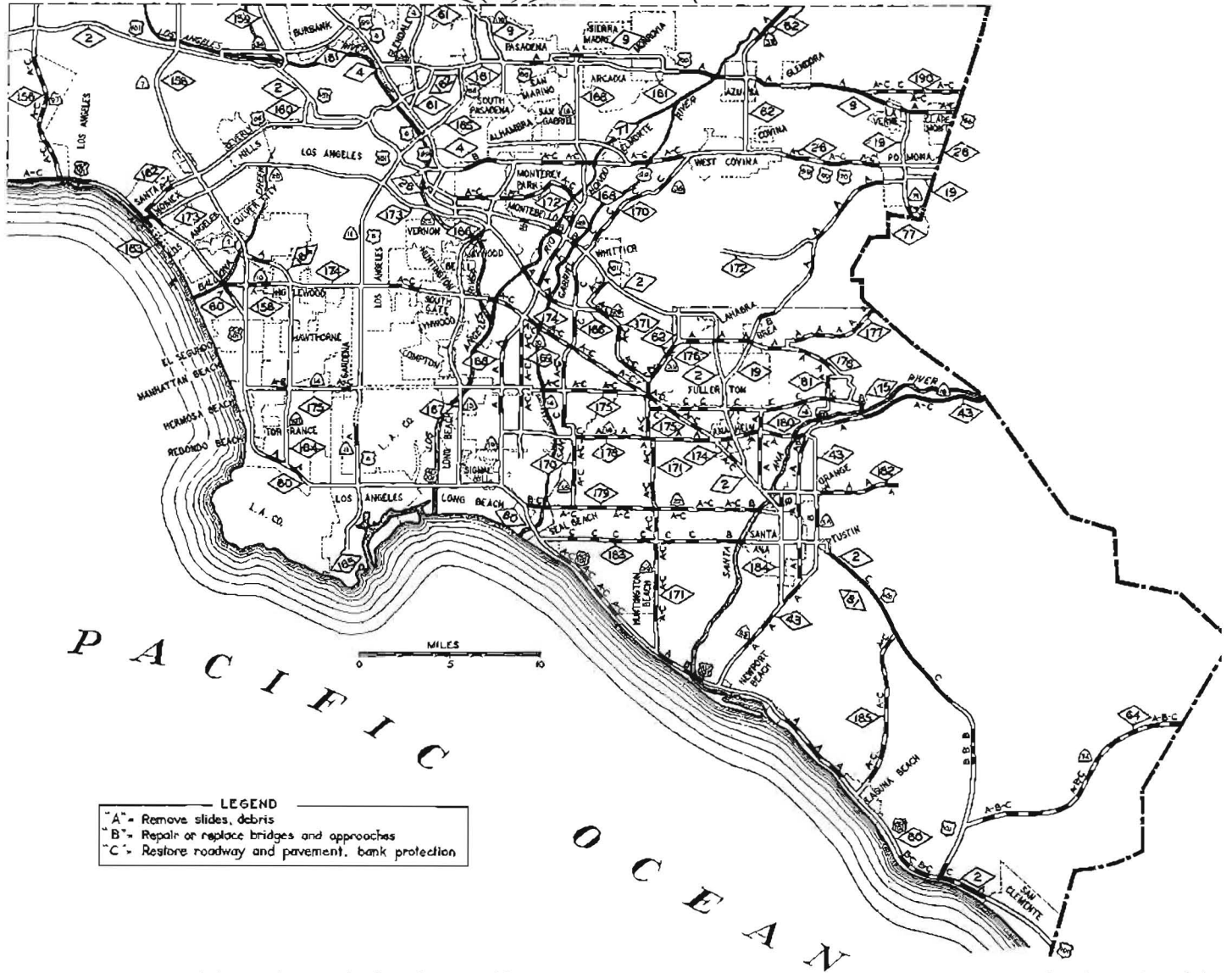
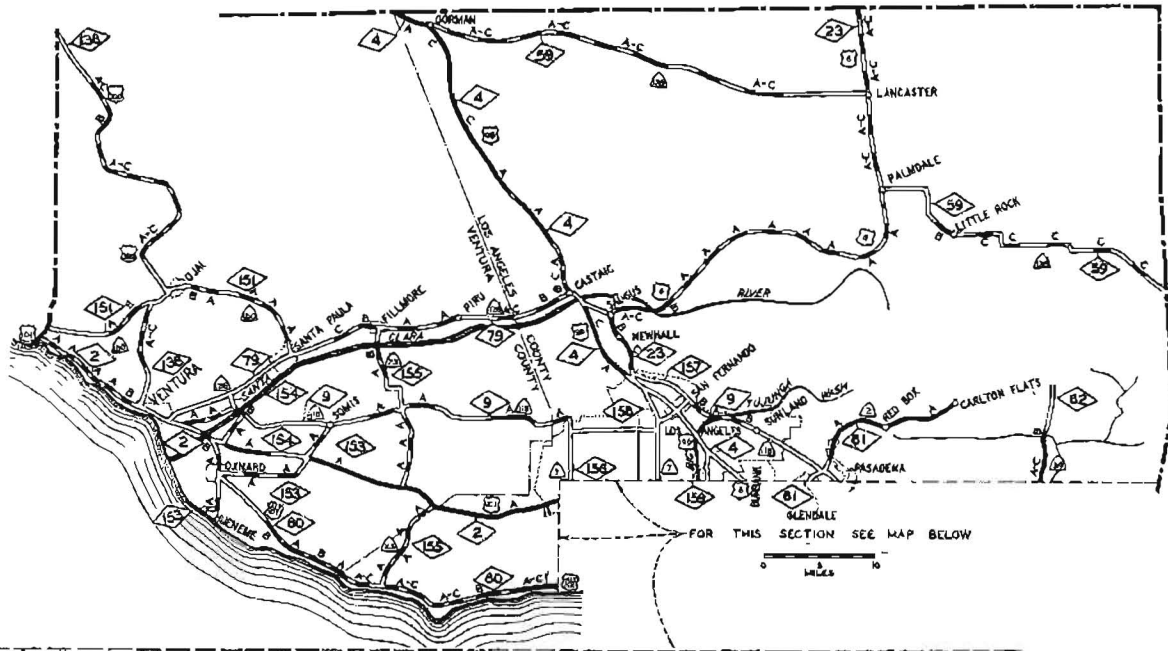
Upper—Huge boulder deposited by flood on Topanga Canyon Road below Wildwood, Los Angeles County. Lower—Mud cleared from highway near east city limits of Colton, San Bernardino County.

ing the canyon, it spread wide over the highways and orchards, damaging everything in its path. Forced back to its channel south of Placentia, it again took its toll of the bridges. First and last on our highways were the Garden Grove structure on Route 179 and that north of Newport Beach

on Route 60. At the former, it took out the westerly approach, making a new channel; and at the latter location it undermined piers, dropped four of the spans, and washed out some 2000 feet of the pavement.

This was the only State-constructed bridge lost on the Santa





Locations of State Highway damage in Los Angeles, Ventura and Orange counties marked by black blocks on roads. Legend explains necessary restoration work.

Ana, though no reflection is intended on those which failed when the river bed was churned to unknown depths by the turbulent flood. Within a week's time travel was again using the canyon, and pile trestles and detours have now closed the gap in the coast route.

SANTA CLARA RIVER CURBED

Once before the Santa Clara pushed its wall of water through the foothill towns of Piru, Fillmore and Santa Paula, leaving a trail of death in its wake. The Saint Francis Dam disaster taught its lesson, and though that former crest was equalled, the material loss this time can fortunately be repaired.

The Santa Clara, on its westward way, crosses Route 4—our Ridge Route—and parallels Route 79, crossing State Routes 155, 9 and 2 where it enters the ocean. On Route 4 it scoured the north approach to the highway structure, undermining the pavement. Proceeding westerly, it carried away 300 feet of the Bardsdale Bridge southerly of Fillmore on Route 155, and 500 feet of the structure on Route 9 at Saticoy.

Nearing the ocean, it swept wide of its banks covering orchards and farm lands and filling the El Rio Subway on Route 60 with sand and debris.

East of Piru, on Route 79, its sharp swing into the bank carried away 3000 feet of the roadway.

BRIDGES RIPPED OUT

While this was taking place, its tributaries—Castaic and Sespe creeks—flowing from the north, carried away 200 feet of the bridge west of Castaic, and 800 feet of the Sespe's overflow structure west of Fillmore, effectively closing Route 79. The Sespe hurled the Southern Pacific structure, parallel and adjacent one on the highway, against the latter with such force that it left its moorings and has not been located since.

All of the structures mentioned as damaged were of early county construction and came into the State System under legislative act. Restoration work was immediately initiated, and traffic has now been restored on Routes 79 and 155, pile trestles and fills replacing the washed out structures and roads.

Early reports from the San Gabriel Mountains told of slide-blocked roads and embankments washed down the canyons on Route 62. Similar word was received from Route 138 high in the Santa Barbara National Forest. Here storm-swollen rivers preempted the canyons, carrying with them much of the roadway. Slides for a

time blocked the Ridge Route, but men and equipment soon restored traffic.

The Coast Route 60 from Santa Monica west was covered with slides and debris from the various washes out of the Santa Monica Mountains. Topanga Canyon Route 156 was badly washed and immense slides closed the road to all through traffic. Malibu Bridge piers were undermined and several spans of the structure collapsed. Within a week's time, trestle bents carried the traffic, and power shovels and trucks were repairing the roadway.

Not one of the district's roads, east of a line between Long Beach and Pasadena, escaped damage. Day and night the district's forces labored, clearing debris-covered pavements, restoring protection work and supporting undermined pavements. Regular forces were augmented by some 700 men, 35 power shovels, 150 trucks, 3 pile drivers and other equipment. Within several days after the storm most of the main roads were open to traffic, though months will elapse before all are repaired.

In District XI

District XI, which includes the counties of San Diego, Riverside and Imperial, lay on the outer edge of the storm path. The damage here was less severe, though some 7.86 inches of rain fell near Descanso on March 3d within a 12-hour period. A 9-inch rain at Escondido forced a heavy runoff from Lake Lodges Dam into San Dieguito Creek, whose storm waters undermined the north approach to the San Dieguito Creek Bridge north of Del Mar on Route 2. Traffic was detoured five days while power shovels repaired the break.

The Puerta La Cruz Crossing on Route 78, and the dips at Pala and Pauma Wash on Route 195, were washed away, closing the roads for a period of three days. High water over Route 197 west of Ramona and on Route 198 north of El Cajon, forced the detouring of traffic for short periods.

In Riverside County, two timber trestles over the Coachella Valley Storm Drain on Route 187 were destroyed by high water. These were obsolete structures, taken into the State System by legislative act, and



This is how flood left E Street in San Bernardino, a thoroughfare leading to famous Orange Show Pavilion, which can be seen on the left of power shovel removing five feet of mud.

plans were already under way for their replacement.

### In District V

District V, embracing Santa Barbara, San Luis Obispo and Monterey counties, was even more fortunate than District XI, as the storm closed but few of its major highways.

Eleven inches of rain on the San Marcos Pass, State Route 80, during the storm period, caused numerous slides on the east slope, as well as damage to the approaches of Santa Aqueda Creek Bridge. Detours were available and traffic was therefore put to no great inconvenience.

The heavy downpour, however, added many thousands of yards of slides on the Carmel-San Simeon road, State Route 56; the Mustang Grade, State Route 10; and the Pinnacles Road, State Route 119. Eight power shovels and thirty-five trucks are now engaged in clearing these roads.

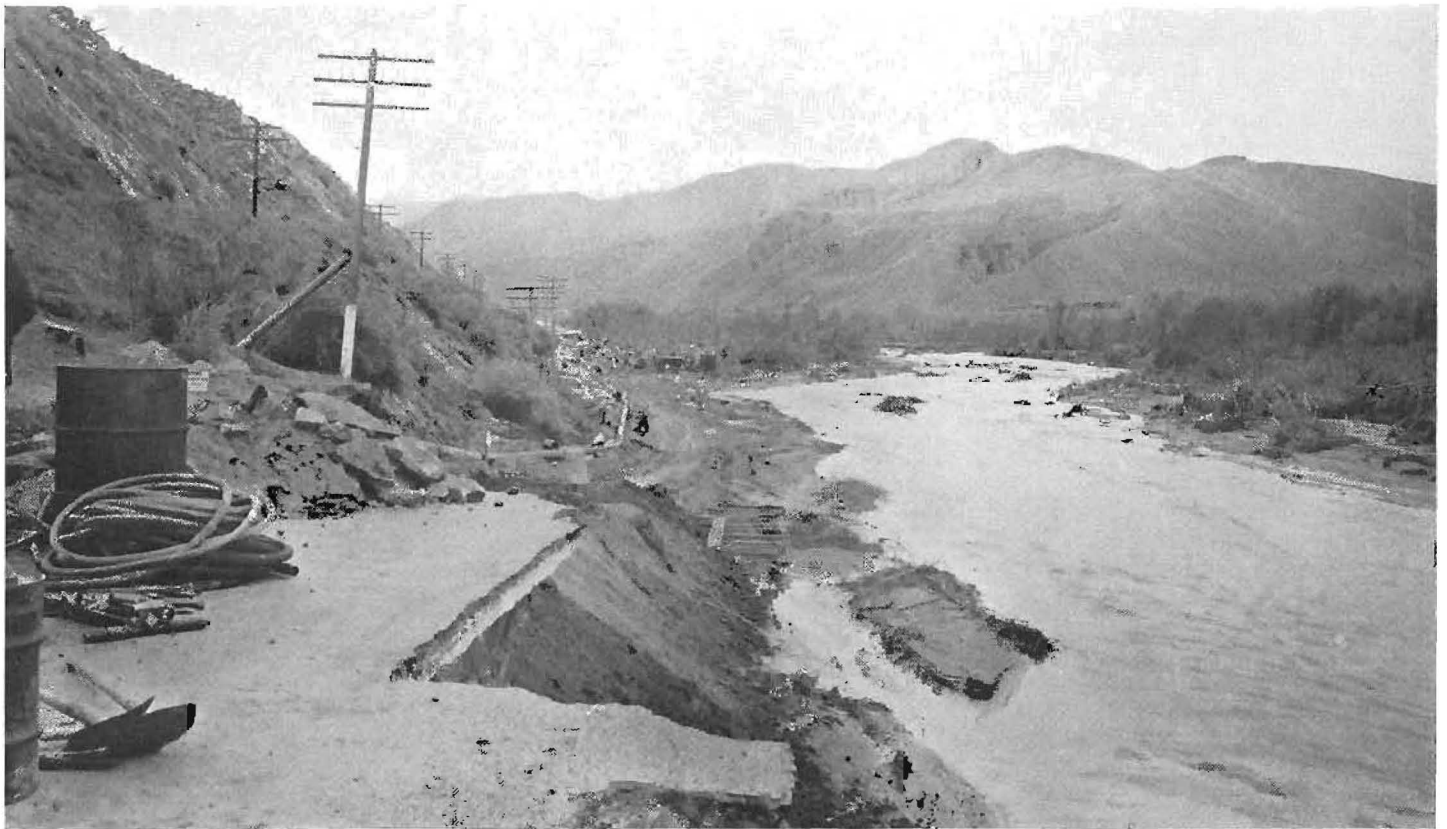
Truck traffic was held up for a few hours when the Santa Maria River swept over the ground level road in



Overflow waters from Coyote Creek left Firestone Boulevard, Los Angeles, looking like this after being cleared of silt.

the old overflow channel, forcing light traffic to use the old trestle. The heaviest damage occurred on the Cu-

yama Road, State Route 58, where a section of pile trestle was carried away by the flood.



This picture vividly reveals damage wrought by Santa Clara River floods on Ventura-Castaic lateral highway between Piru and Los Angeles County line in Ventura County.

(Continued on page 24)

# DAMAGE TO BRIDGES HEAVY

By W. A. DOUGLASS, Associate Bridge Engineer

**I**N DECEMBER 1937, a series of severe storms swept over Northern and Central California, breaking records for concentrated rainfall and leaving widespread damage both to private and public property. Direct and immediate losses to State highway bridges alone exceeded a half million dollars, and the total cost of repairs and replacement on State highways is estimated at nearly three million.

In turn, Southern California was visited, during the first week of March, 1938, by storms leaving behind property damage many times that of the December storm in the north.

The areas most seriously affected were in Los Angeles, Orange, San Bernardino and portions of Ventura and Riverside counties. Effects of the storm, to a lesser extent, were also felt as far north as Monterey and Fresno counties. Rough preliminary estimates indicate a direct loss of State highway bridges in the March storm of over one and one-half million dollars. The total loss to State highways during this storm has been estimated at over five million dollars.

## STREAM CONTROL STUDIES

In addition to the restoration of highways and structures, there will be the cost of new waterway openings and extensive protection work, the need for which became apparent during the recent storm. Extensive studies of the entire area together with the past and probable future behavior of the streams, planned and probable stream control work by other agencies and property owners and a number of other factors must be made before the entire cost may be calculated. The cost of additional bridges, bridge extensions, slope protection and stream control in the immediate vicinity of highway crossings may easily cost a million dollars in addition to the restoration of facilities destroyed by the flood.

The following data will give an idea of the extent and character of the flood damage to State highway

structures. Reports indicate that about forty-five bridges were totally destroyed or seriously damaged. Approach fills were washed out in a number of cases and in three or four locations it appears that extensions to the bridges will be necessary. In at least ten locations entirely new channels were cut across the highway and, in each case it will be necessary either to provide new bridges or return the streams to their former locations.

## BRIDGES WIPED OUT

In western Fresno County, Waltham Creek carried a considerable flow. State Route 10 follows this stream closely, westerly from Coalinga, and a number of temporary crossings as well as a county built concrete bridge were damaged.

A timber bridge over the Cuyama River was washed out near the Santa Barbara-San Luis Obispo county line east of Santa Maria.

The Santa Clara River flooded taking out portions of two bridges, one crossing the river near Fillmore and the other near Saticoy. These were

both old structures on sections of highway recently taken into the system. It is interesting to note that both these bridges withstood the flood caused by the failure of the San Francisquito Dam in 1927, when a portion of the bridge on the coast highway was destroyed. The latter has since been replaced with a modern structure which was not damaged in the March flood while the two older bridges upstream were seriously damaged.

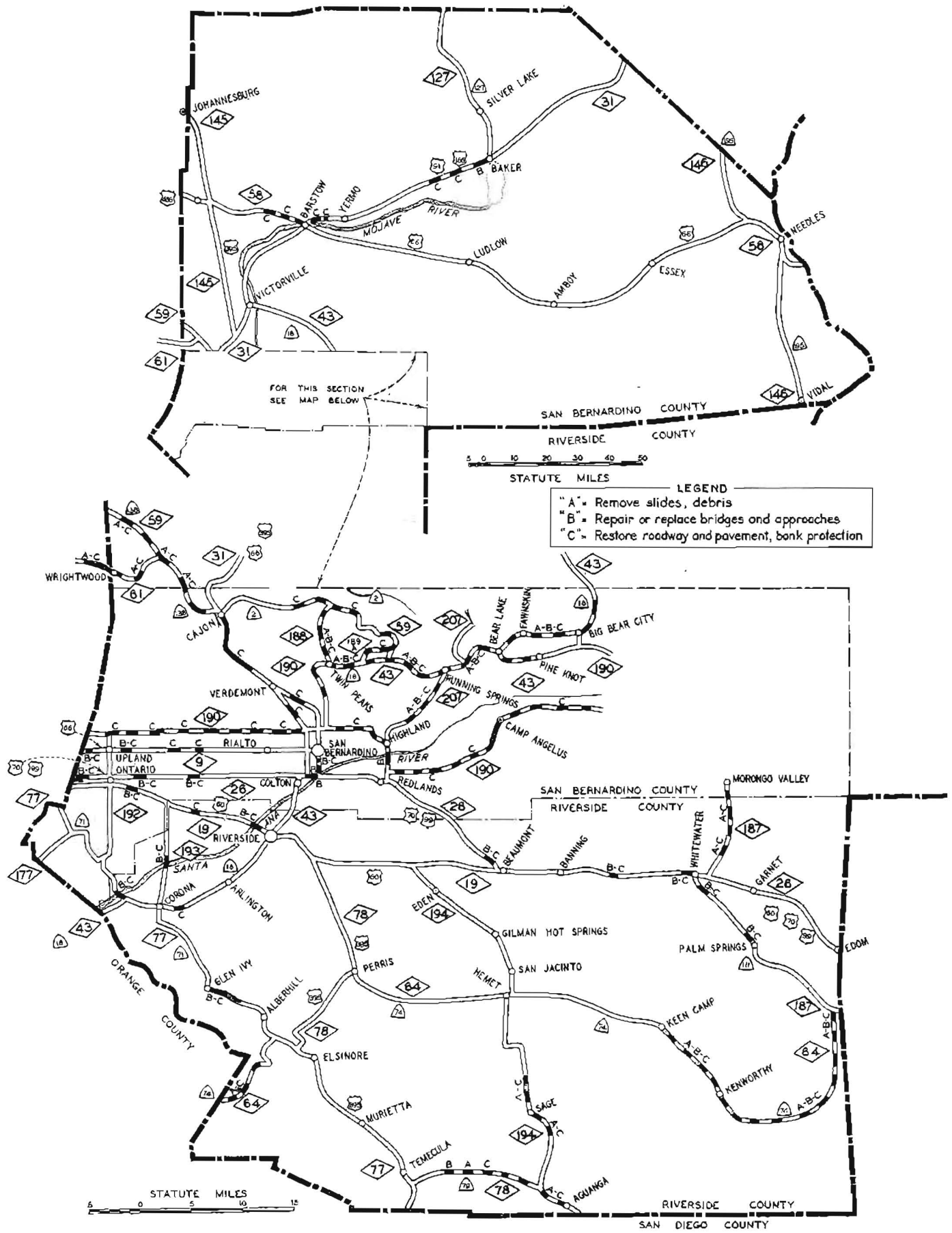
## SANTA CLARA RIVER RAMPAGES

In the valley of the Santa Clara River Highway Route 79 was washed out in spots and two bridges were damaged. An old timber structure over the Sespe Creek Overflow at the westerly edge of Fillmore is practically a total loss. Although it is planned to construct a line change and eventually abandon this particular section of road as a State highway, a bridge will be necessary to accommodate through traffic for about one year and it will continue in use permanently for local traffic.

Three spans of another old timber



Bridge under construction across Big Creek on the San Simeon-Carmel coast highway in Monterey County. Concrete piers withstood flood waters but high winds blew down falsework of one arch.



State Highway damage in San Bernardino and Riverside counties marked by black blocks on roads. Legend explains necessary restoration work.

bridge over Castaic Creek just west of the junction of Route 79 with Route 4 were taken out by the high water. This bridge will probably be replaced with a modern type bridge at a slightly higher grade.

#### SPANS DESTROYED

Three spans of the concrete bridge across Malibu Lagoon, on the Coast Highway above Santa Monica, were lost when heavy scour caused settlement of two piers. This bridge was built by the county about 1923 and later widened to a forty foot roadway by the State.

Further south on the same route, the reinforced concrete bridge near the mouth of the Santa Ana River was damaged in a similar manner. The overflow from this river also washed out a short section of fill a few hundred feet north of the bridge.

Near the junction of Route 60 with Route 2 at Serra, San Juan Creek crosses State Routes 64, 2 and 60. One steel stringer span of a timber and steel bridge on Route 64 was lost. On Route 2 a comparatively new concrete bridge was not injured except that scouring of approach fills resulted in some loss of slope pavement. On Route 60 no damage occurred to the new concrete bridge but additional length of bridge may be advisable to permit more immediate run-off.

Of some fourteen State highway crossings of the Santa Ana River only four are of modern steel or concrete

design and of these four, only one, built about 1925, was damaged. The balance of the Santa Ana bridges were built prior to the inclusion of the routes in the State system. Of the latter group, five bridges were lost or seriously damaged.

In the vicinity of San Bernardino and westerly toward Upland and Pomona, many streams such as the Santa Ana River, Warm Creek, Lytle Creek, Cucamonga Wash and San Antonio Creek, overflowed their banks and in several places established new channels across the highways. Damage by these streams occurred particularly on Routes 9, 26 and 19. New structures, bridge and culvert extensions and extensive protection and control work will be necessary to avoid a repetition of the losses.

It will be noted that this area lies adjacent to the foothills of the San Bernardino Mountains. The sparse forest cover of the mountains permits rapid run-off of rain falling on them with resultant flash floods and high velocities in the canyons. All these conditions are conducive to heavy scour on the steep slopes and the silt and debris is carried to the valleys and plains at the foot of hills where the flatter gradients of the streams permit silting. These silt deposits form debris cones which in this section have built up over a long period of time to sizable proportions and cover areas of many square miles.

The streams ordinarily follow a

course somewhere near the center of the cones and the banks of the channels are usually somewhat higher than the adjacent slopes of the cones. As a result of this condition, the streams at flood stages overflow the banks and spread out over the flat slopes of the cones readily forming new channels in the relatively loose and unstable silt deposit.

#### DEBRIS CONES

Boulders, drift or other obstructions particularly near the upper ends of the cones may easily deflect the flow to one side or the other and change the entire course of the streams. It was these changing conditions and locations of streams which caused so much damage to east and west highway Routes 9, 26 and 19 which cross several such debris cones between Pomona and San Bernardino.

A similar condition occurred in the Big Tujunga Wash. Route 9 crosses this stream between Pasadena and San Fernando. Bridges were provided for both the north and south channels, both of which seemed to be well defined. However, during the March storm, overflow from the south channel spread out and caused considerable damage to the highway between the bridges. The bridges were not seriously damaged but approach fills and protection work were partially destroyed.

Due largely to the heavy flow in the Tujunga, the Los Angeles River



Sespe Creek swollen out of its banks by tributaries in a high mountain area of Ventura County cut a wide swath of damage as it swept across State Highway 79 near Fillmore. A county-built timber and concrete bridge and a paralleling railroad structure were washed away. A large section of highway was obliterated but a detour road shown at right was quickly built and opened.



Before and after views of the bridge across Verdugo Creek on State Highway 61 in Los Angeles County. Fed by small tributary streams in the San Gabriel Mountains the creek became a raging torrent that cut a new channel, swept away the bridge approach and damaged the abutment.

carried an unusually large run-off. The bridge built by the city over that river on Lankershim Boulevard (Highway Route 159) was lost.

In addition to the Los Angeles-San Bernardino and coastal plain area, floods occurred on the Mojave River, damaging the highways near Barstow, probably necessitating a bridge over at least one new channel and taking out bridges at Cronise Valley and Baker. The Owl Wash and San

Gorgonio Wash east of Banning on Route 26 established new channels which will require bridges and protection work. The Whitewater River at two crossings of Highway Route 187 between Indio and Mecca took out portions of two old timber bridges, one of which was included for replacement in the budget for the present biennium. Smaller bridges were lost also on the "Pines to Palms Road" east of Hemet and on various

routes in the San Bernardino Mountains.

A number of the bridges damaged during the flood are located on Federal Aid Routes and are considered qualified for Federal Emergency Relief funds. The balance of the cost will be financed from State Highway Construction and Maintenance Funds.

## STREAMS TEAR OUT HIGHWAYS IN DISTRICT XI

By E. E. WALLACE, District Engineer

The severe rain storm which hit Southern California between February 26 and March 5 did heavy damage to some of the State highways in portions of District XI, which encompasses San Diego, Imperial and the east half of Riverside counties.

On State Route 2, U. S. Highway 101, between San Diego and the northerly county line, there were several incipient failures of bridge approaches due to slumping and erosion of approaches and pot holing around the bridge piers. Protective measures

prevented serious damage or interruption to traffic except at the San Dieguito River Bridge, just north of Del Mar, where 40 feet of the north approach fill slumped out under the footing of the north abutment and between the pilings, due to severe scouring action in front of the abutment.

### SLIDES AND WASHOUTS

On Route 78, at the Puerta La Cruz crossing of the San Luis Rey River north of Warners Hot Springs, the central 100 feet of an overflow dip

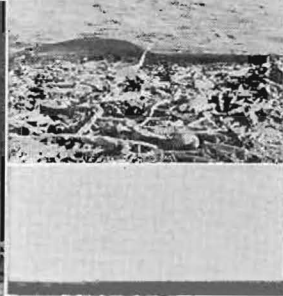
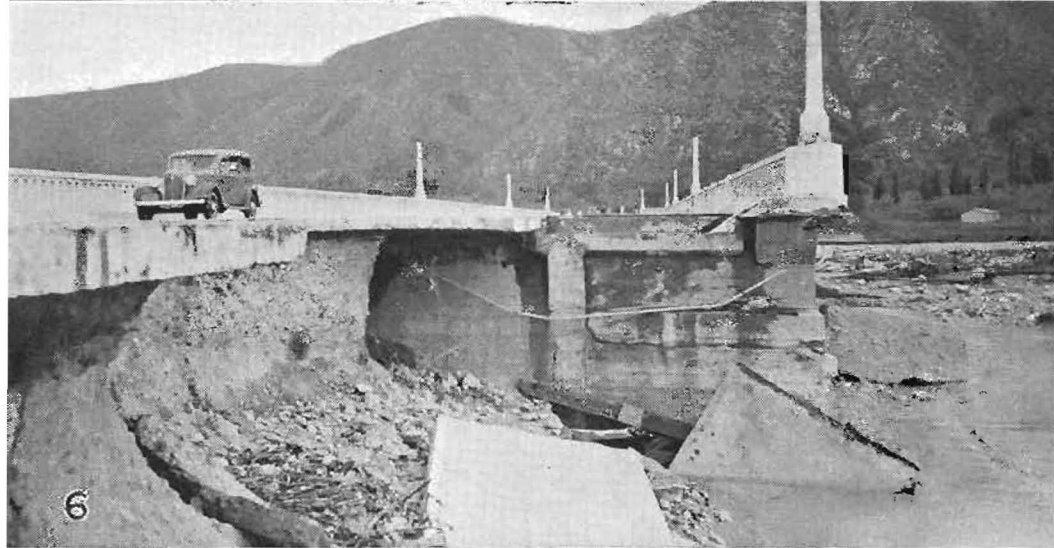
washed out. The dip carried water up to a depth of about five feet, but failed when a peak of more than six feet occurred. Traffic was restored by the construction of a temporary fill after the water subsided sufficiently, three days later.

On Route 195, between Bonsall and Morettis, there were numerous slides and washes, particularly on Cuca Grade, where severe shoulder erosion occurred. At the Pala Dip and Pauna Wash, the shoulders were

(Continued on page 22)

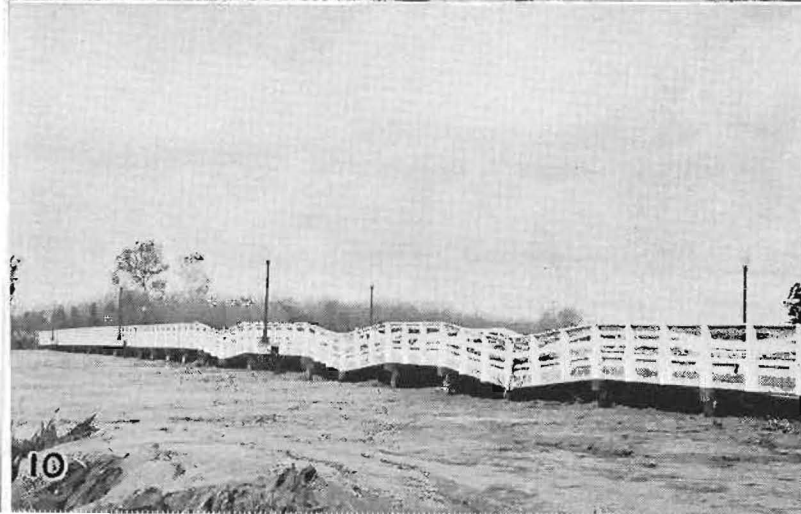


Highway dip washed out by Santa Maria River east of Ramona. Another dip west of Ramona overflowed.



## BRIDGES HARD

- 1—San Antonio Creek Bridge, Ventura County, California
- 2—Santa Clara River Bridge near Santa Ana
- 3—Wreckage of bridge across Santa Ana River
- 4—Santa Ana River Bridge east of Santa Ana
- 5—Sespe Creek Bridge east of Fillmore
- 6—Big Tujunga Bridge, Los Angeles
- 7—Cujama Bridge, 20 miles east of Los Angeles
- 8—Santa Clara River Bridge, Ventura County
- 9—Bridge across Santa Ana River near Santa Ana
- 10—Bridge across Santa Ana River near Santa Ana
- 11—Santa Ana River Bridge in Santa Ana
- 12—Castaic Creek Bridge, Los Angeles
- 13—Santa Ana River Bridge near Santa Ana







# HIT BY FLOODS

Ventura County.

near Fillmore.

Santa Ana River, Orange County.

near Colton.

Fillmore.

Los Angeles County.

near Santa Maria.

Ventura County.

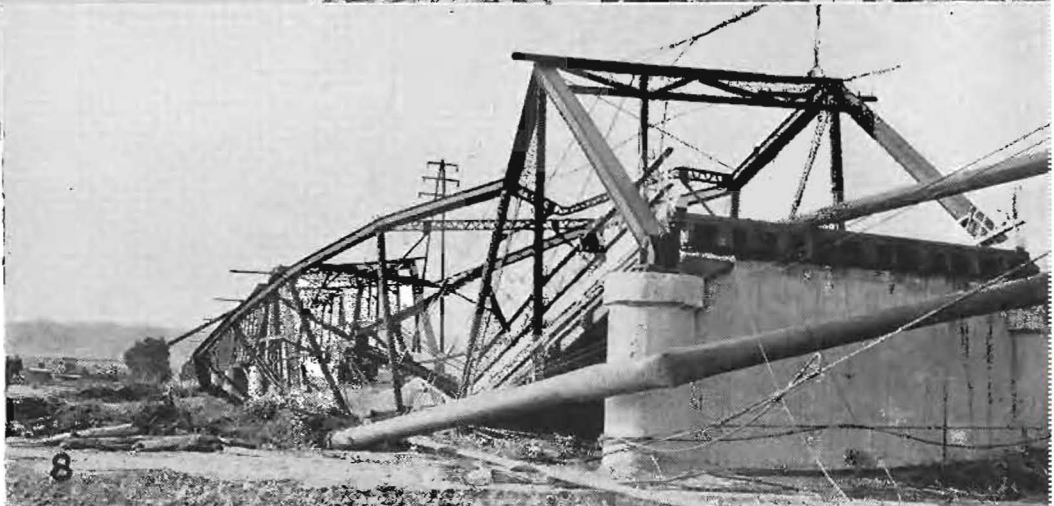
near Newport.

Santa Ana River in Santa Ana

Canyon.

Los Angeles County.

near Olive, Orange County.



# Snow Removal to Date Totals 100,000,000 Cubic Yards

By W. A. SMITH, Assistant Maintenance Engineer

THE 1937-38 winter season in northern California started in a normal manner with the first snowfall on October 3. The first real storm extended from November 11 to 18.

Typical of the storm periods and the rate of snowfall is the record obtained by District III from the United States Weather Bureau station located three miles west of Donner Summit at Soda Springs on U. S. 40.

Storm Periods 1937	Snowfall During Storm in Inches	Depth of Snow Pack in Inches
October 3-----	3	---
November 11 to 18-----	53	31
December 10 to 11-----	(10.8 inches rainfall)	---
December 22 to 25-----	24	28
1938		
January 15 to 20-----	48	53
January 31 to		
February 15-----	256	202
March 1 to 3-----	31	138
March 15 to 23-----	63	170

The total snowfall at Norden near the Donner Summit as reported to date of April 1 was 587 inches.

#### IN OTHER AREAS

The record of snowfall on a few other routes, typical of various areas is as follows:

	Inches
Sign Route 24—East of Quincy-----	208
U.S. 99—Vicinity of Weed-----	132
Sign Route 89—Cayton Valley-----	207
U.S. 299—Fall River-----	195
U.S. 97—Weed to State line-----	207
Sign Route 36—Deer Creek Meadows to Susanville-----	507
Sign Route 36—Paynes Creek to Deer Creek Meadows... 551	
Sign Route 8—At Antelope Springs east of Jackson... 106	
Sign Route 4—At Camp Connell east of Big Trees... 218	
Sign Route 108—At Pinecrest east of Sonora ..... 261	

The last three points are at the limit of winter maintenance.

The Redding district estimates that some forty million cubic yards of snow was moved by their forces. On the same basis for the other dis-

## Snow Removal Crews Lauded

Tahoe, California  
Feb. 23, 1938

Mr. C. H. Weeks,  
Division of Highways,  
Truckee, Calif.

Dear Mr. Weeks:

We do want you to know how very much we appreciate the untiring efforts of yourself and your crew in getting the road open to Tahoe, and feel that this is the sentiment of all in this region. During a storm, many people become panicky, and perhaps you were unduly harassed, but we know that you did all that was humanly possible.

We hope the time will come, and before too long, when a plow can be kept for use in the Lake Tahoe region. The railroad parallels the road over the summit, and can be used in emergency, while we are dependent upon the road being kept open between Truckee and Tahoe. We who have lived here for many years have an emergency supply, but many people nowadays just live from one day to the next, and think they are suffering unless they can have everything a city market affords.

We would like to write a letter, commending the efforts of yourself and your crew, to the higher-ups. To whom should it be addressed to do the most good?

Yours very truly,

(Signed)

Mr. and Mrs. George R. Bliss

tricts, in excess of one hundred million cubic yards of snow has been removed from the highways during the season.

#### 156 PLOWS PROVIDED

In preparation for the work, the Division had purchased nine auger type rotary plows, making a total of twenty-six plows of this type ready for service. In addition to the rotary plows, some one hundred and thirty push plows of various types were made ready for service.

In order to reduce drifting in certain well defined areas, eleven miles of new snow fence was erected, and the fence erected in previous years was repaired or reinstalled at locations where it had been taken down at the end of the 1936-37 winter season.

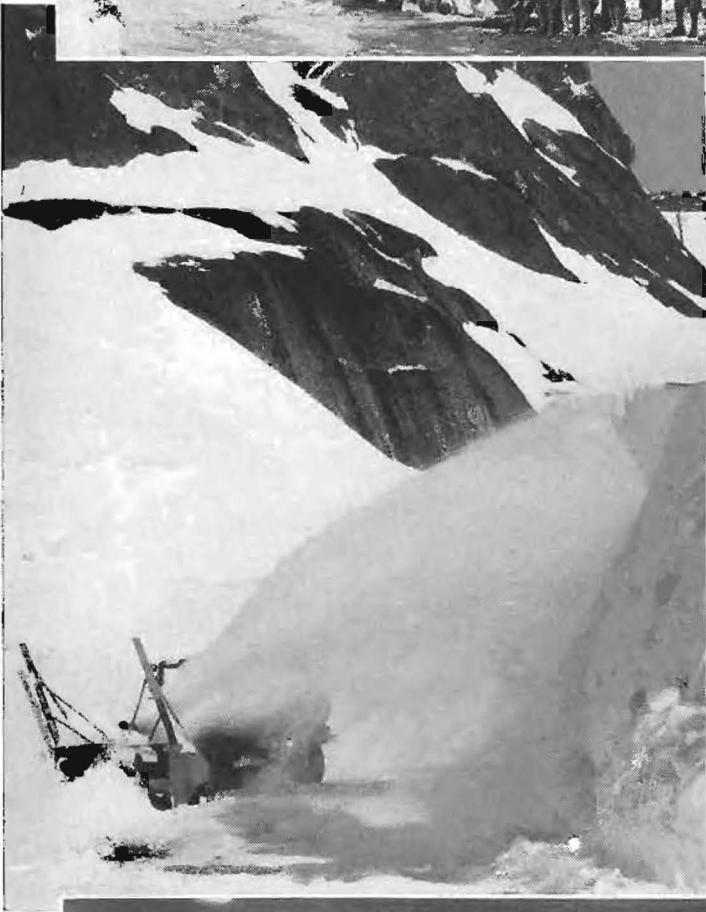
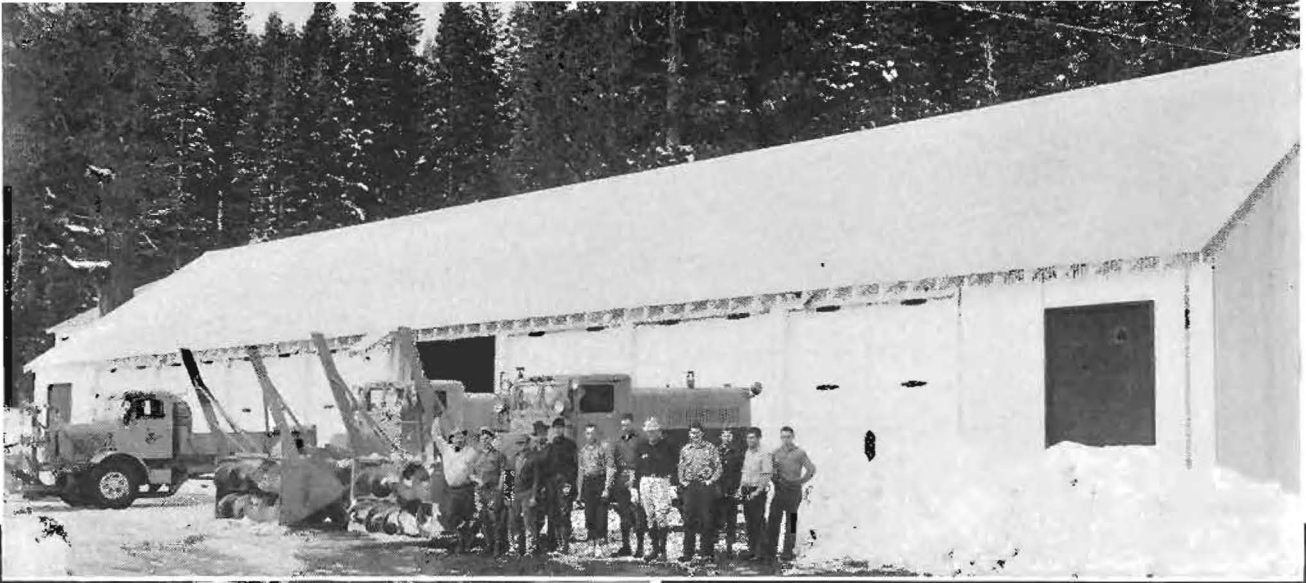
When the season advanced toward the end of January, the department began to feel that this was to be one of those exceptional years. Certain roads, such as U. S. 50 over Echo Summit and many miles of other mountain routes, were still open to travel, a condition that had not existed in any season since snow removal was undertaken.

#### MANY FALLEN TREES

With the start of the storm on January 31, however, this optimism was quickly dispelled. The snow was heavy but still drifted badly. In certain areas the snow removal was seriously handicapped by the large number of trees that fell into the traveled way. At such times the plows were tied up until a path could be cut and in the meantime the road was becoming filled with drift.

The normal plan in snow removal work in the heavy fall areas is to start the push plows as soon as there is enough snow on the pavement to form a windrow. The rotaries then come along and move this windrow clear of the roadway. Under the conditions encountered, the crews found

(Continued on page 22)



Snow removal crews and equipment. Upper—Maintenance Station Building and crew at Yuba Pass on Donner Summit Highway. Center left and right—Snow plows operating day and night on Donner Summit. Lower—Interior of Donner Summit Maintenance Station showing men and equipment.

# El Camino Real Project In San Diego Dedicated by Governor

**A**S THE setting sun cast a roseate glow over the waters of the Pacific on the evening of Saturday, March 26, Governor Frank F. Merriam stood on the Coast Highway at the San Diego County line north of Oceanside and formally opened and dedicated the \$1,225,000 final link of a multi-lane highway extending for 235 miles from the Mexican border to Santa Barbara on U. S. Route 101.

The ceremonial climaxed a day of fiesta celebration under auspices of the Oceanside and San Clemente chambers of commerce that began with a large official luncheon at the California-Carlsbad Hotel in Carlsbad, which was followed by a radio dramatization of the Romance of El Camino Real at Oceanside Beach stadium and concluded with a coronation ball at San Clemente Casino where Miss Norma Ellis, of Oceanside, queen of San Diego County highways, and Miss Dorothy Walker of San Clemente, queen of Orange



Governor Merriam and Leo Carrillo.

separate opposing streams of traffic and make headon collisions virtually impossible.

Governor Merriam told of the efforts of the early road boosters and builders, of the \$73,000,000 succes-

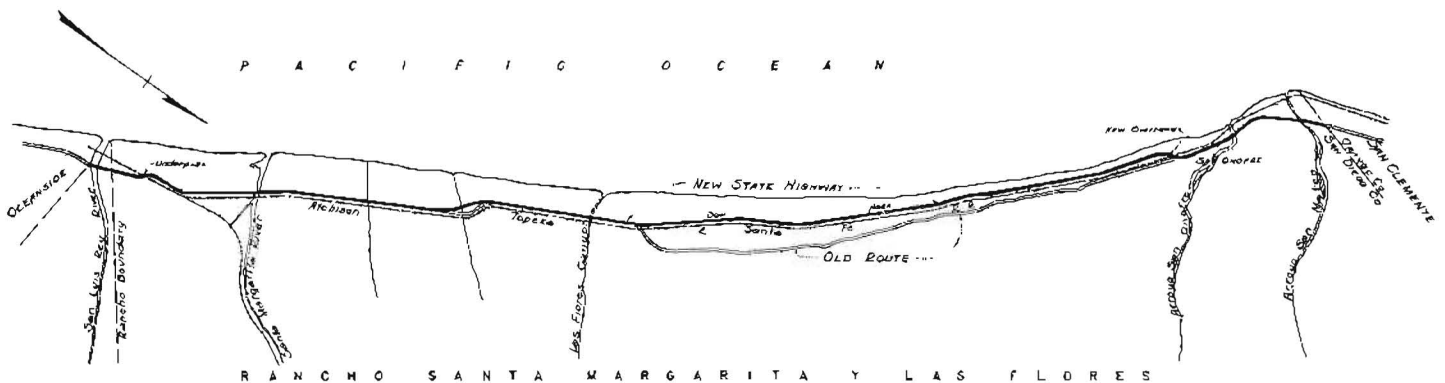
and youth of California both materially and spiritually."

## WEDDING OF COUNTIES

Other speakers were State Highway Commissioners William T. Hart and Phillip A. Stanton, Hamilton Cotton, Mayor Albert P. Waibel of Oceanside and Mayor Dan Mulherron of San Clemente. General Chairman E. E. Hyde announced that the theme of the occasion was the "wedding" of Orange and San Diego counties and called upon Assistant Director of Public Works Harry A. Hopkins to perform the nuptial ceremonies.

On the San Diego County side of the boundary line were Mayor Waibel; Supervisor B. A. Sweet; Commissioner Hart, representing the State, and Queen Norma Ellis. On the Orange County side were Mayor Mulherron; Hamilton Cotton, substituting for a county supervisor, Commissioner Stanton and Queen Dorothy Walker.

Assistant Director Hopkins para-



County highways, reigned over the festivities.

In his brief dedication address Governor Merriam said the latest ideas in modern road building had been incorporated in the newly completed 18-mile stretch between San Onofre and Oceanside. The State Highway engineers, he pointed out, had provided two and one-half miles of four-lane divided highway with ample division strips arranged to

sive bond issues that were expected "to build all the roads California would ever need" and the progress that began and has continued under the gas tax.

"Under the gasoline tax we have been moving fast," he said, "building better, stronger, wider highways and incorporating more safety features, but this is not the end. There are greater things ahead, greater developments for the men and women

phrased a wedding service with the others joining hands and responding "I do" to the "marital" obligations.

## CARLSBAD LUNCHEON

Governor Merriam then tied the white ribbons together symbolical of the "wedding" of the counties, and dedicated the new highway "to the use, pleasure and convenience of the people of the counties, the State, the Nation and visitors who come to



The ample separation strip on the four-lane section of new realignment between San Onofre and Oceanside renders head-on collisions practically impossible.

California from nearly all countries in the world."

The official luncheon at Carlsbad was attended by several hundred citizens, city, county and State officials, contractors and chamber of commerce representatives. Leo Carrillo, motion picture star, was master of ceremonies and the "kidding" and sallies of wit and repartee that passed between him and the Governor added much merriment to the occasion.

In his speech Governor Merriam told of the efforts of farsighted men and women of San Diego and Los Angeles who late in the last century talked and dreamed about a highway that would follow the trail of the Franciscan friars all the way north to Sonoma.

Reviewing the difficulties that had to be surmounted through the period of the inadequate bond issues to the

coming of the gas tax financing plan and the progress that has been made since then Governor Merriam said:

"As you know, our highways are built and maintained by gasoline and motor vehicle tax funds. Without the gasoline tax we could not have our vast highway system and without it we could not be dedicating this completed road today. Our gasoline tax moneys must never be diverted to purposes other than highway construction.

"You can safeguard these funds for all time by a constitutional provision making their misuse impossible. You will have an opportunity to do this at the general election in November."

State Director of Public Works Earl Lee Kelly told the assemblage that the people were to be congratulated

in having a Governor who cooperated so zealously in keeping the gas tax funds for roads.

"Since Governor Merriam has been in office more money has been spent on the development of this road than in any other period. It has been developed from a 15-foot road to a highway with three and four 12-foot lanes. The contention that the gas tax fund is so large that a portion of it can be used for other purposes is erroneous. Our traffic has increased from 77,000 vehicles to more than 2,500,000 automobiles, outranking every other State in the Nation. We are now ten years behind in our highway construction program necessary to satisfy present traffic needs."

State Highway Commissioner Hart introduced other dignitaries present and brief talks were made by Assistant Director Hopkins, Commissioner



View of four-lane divided highway section on new realignment of Coast Route (U. S. 101) between Oceanside and San Onofre.



"Wedding of the Counties" was the symbolic theme of the ribbon ceremony at the dedication of the newly completed Oceanside-San Onofre link of Coast Highway as Governor Merriam tied the ribbon joining San Diego and Orange Counties. At left, Mayor A. P. Waibel of Oceanside, State Highway Commissioner W. T. Hart, Supervisor B. A. Sweet and Queen Norma Ellis representing San Diego County. At right, Queen Dorothy Walker and Highway Commissioner P. A. Stanton, representing Orange County.

Stanton, District Engineer E. E. Wallace and H. Matthias, representing the contractors.

Some 3000 people attended the El Camino Real dramatization based on historical facts and incidents that followed the luncheon in which Governor Merriam, Mr. Kelly and Leo Carrillo participated.

#### CONTRACTS COVERED 18.5 MILES

The progressive improvement in San Diego County to the main State highway connecting San Diego and Los Angeles has been one of the larger programs of the Division of Highways for modernization of arterial routes in Southern California. As important units in such reconstruction several contracts involving work on the 18.5 miles between Oceanside and the Orange County line through the great Santa Margarita Ranch in northern San Diego County have been completed at a total cost of approximately \$1,225,000.

These contracts included improvement to modern standards of alignment and grade with multiple lane pavements providing better facilities for movement of the ever increasing volume of traffic on this important

State route. In the last year or two travel along this portion of El Camino Real reached a volume for which two lanes were inadequate, the daily average ranging from 6,500 to 8,500 vehicles, with many days totaling 10,000 and more cars. In design of the improvements, an ultimate 4-lane divided pavement was adopted as the desired standard and both reconstruction and new construction adapted to fit into such a plan.

#### WIDENED TO 3-LANE

The first of the contracts for the present improvement to the highway north of Oceanside covered a distance of 7.9 miles, from Eighth Street in Oceanside to the Las Flores Underpass. The work performed under this contract consisted in widening the pavement to provide a 3-lane highway on existing alignment for the southerly 5.4 miles and constructing new 2-lane pavement to serve for southbound traffic only, thus providing a 4-lane divided highway over the remaining portion. The existing pavement, separated from the new pavement was left intact to serve for northbound travel.

The contract also included paving

the approaches to the bridge across Santa Margarita River, which was built under a separate contract concurrently with the road reconstruction; the construction of a bridge across Aliso Creek; and the widening of the bridge across Las Flores Creek. The bridges and their approaches were constructed to 4-lane widths to conform to plans for ultimate standards.

#### ULTIMATE 4-LANE PLAN

Widening the pavement to three lanes was accomplished by placing a lane of asphalt concrete along one side of the existing Portland cement concrete pavement. Under this method, the plan for future widening will be to place two additional concrete lanes beyond the asphalt so that a divided 4-lane roadway may be obtained by tearing up the center strip of asphalt.

Work on the contracts for the portion of the route from Oceanside to the Las Flores subway was performed by the contracting firm of Wood and Bevanda of Stockton, with the exception of the bridge across the Santa Margarita River, which was erected by Clyde C. Wood, and the approach

fills constructed by Basich Brothers. The largest contract in the improvement north of Oceanside consisted of construction on new alignment of 8.0 miles from the Las Flores underpass to one mile south of San Onofre. On this portion of the route the new highway was placed parallel to and westerly of the tracks of The Atchison, Topeka and Santa Fe Railway, instead of passing under the railroad through the Las Flores Subway on the old alignment and following the base of the hills easterly of the tracks. At the time this revision in highway line was planned, a realignment of a portion of the railroad's line was undertaken to the benefit of both the State and the railway location.

The pavement placed on the new location consisted for the most part of a 3-lane width made of a central lane of plant-mixed asphaltic surface with a lane of Portland cement concrete on each side. Future widening of this section will require only the placing of one additional concrete lane on each edge of the present three lanes which, with the breaking up of the central lane of treated rock surfacing, will provide a 4-lane divided highway.

#### OLD ROAD ELIMINATED

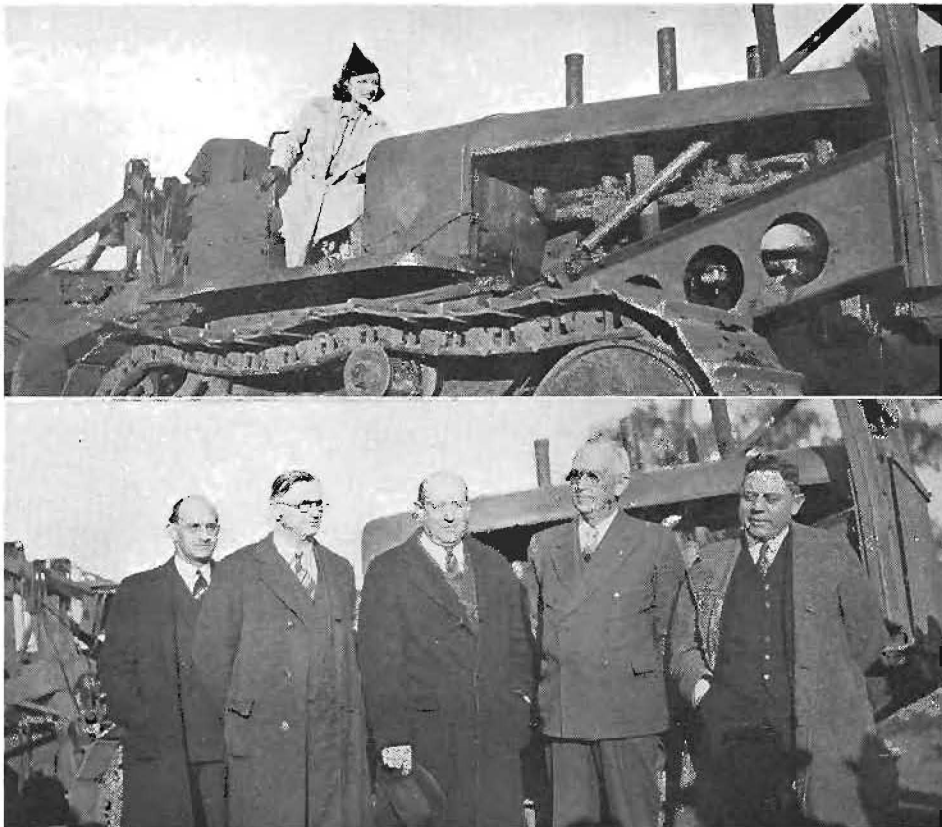
The construction of this eight mile section on new location has eliminated from the State route the substandard portion of the old road which was built at the foot of the hills on a rolling grade.

David H. Ryan was the contractor on this important contract.

At the San Onofre end of the new location the State constructed an overhead grade crossing over the railroad to connect with the existing 3-lane pavement near San Mateo Creek. To effect this location a new bridge across San Onofre Creek was required. Both of these structures were built to a 4-lane standard but the roadway improvement was held to a 3-lane standard on the 2.6 miles from the overhead crossing to the county line, with the exception of necessary transitions at structure approaches.

There were three contracts for construction at this northerly end of the improvement: one for the overhead crossing, one for the bridge over San Onofre Creek and one for the road work. B. G. Carroll of San Diego was the contractor to whom each of these contracts were awarded.

## CEREMONIES LAUNCH WORK ON ARROYO SECO HIGHWAY



Scenes at groundbreaking on Arroyo Seco Highway. Upper—Miss Cheryl Walker moves first earth with huge tractor. Lower—Left to right: John C. Jacobs, mayor of South Pasadena; Arthur Kennedy, president Los Angeles City Planning Commission; Roger W. Jessup, chairman Los Angeles Board of Supervisors; E. O. Nay, president Board of City Commissioners, Pasadena; Harry A. Hopkins, Assistant State Director of Public Works.

**H**OPES and plans of civic leaders of Los Angeles, Pasadena and South Pasadena, sustained and carried to fruition over a period of twenty years, were realized on March 22 when ground breaking ceremonies signaling the start of work on the \$1,327,000 Arroyo Seco Parkway between Los Angeles and Pasadena were held at South Arroyo Boulevard and Sterling Street in South Pasadena.

State and county officials participated in the celebration. Ground breaking ceremonies included brief addresses by Edward S. Graham, President of the Arroyo Seco Parkway Association, who presided; Carl Hinshaw, chairman of the executive committee of the association; Harry A. Hopkins, Assistant State Director of Public Works; Roger Jessup,

chairman of the Los Angeles board of supervisors; A. W. Kennedy, Los Angeles city planning commission; Mayor John C. Jacobs, of South Pasadena; and E. O. Nay, chairman of the board of trustees of the city of Pasadena. Among others on the speakers platform were William J. Fox, county regional engineer, and S. V. Cortelyou, District Highway Engineer.

Actual breaking of ground on the project became a reality when Miss Cheryl Walker, Queen of the 1938 Tournament of Roses, pulled the lever on a giant tractor which moved the first earth on the roadway site.

Following the ceremonies, a breakfast was served at the Pasadena Athletic Club, presided over by Donald C. McCoy, vice president of the Pasadena Chamber and Civic Association.

(Continued on page 27)

# Snow Removal Totals 100,000,000 Yards

(Continued from page 16)

that the push plows shortly were of little use.

On February 8, rain fell up to the 6,000 foot elevation, and the packed snow on the pavement turned to heavy slush, making it necessary to concentrate the equipment to combat this condition, as traffic and even the snow removal equipment could make little headway in such going. As the storm continued the rotary equipment began to show the strain, as it was operated continuously except for servicing periods, and breakdowns began to occur.

## HANDICAPPED BY BREAKDOWNS

Naturally this further complicated the situation, as breakdowns occur in the heaviest going. This requires moving equipment from another section where it is badly needed, in order to rescue the cripple. In locations where normally one plow only is required, a breakdown for a few hours allows the road to close and may more than double the work of opening the road.

The comparatively high temperatures with occasional rain in the upper elevations caused the snow to pack solidly, although there was little ice next the pavement. Opening the roads, such as the Tahoe-Ukiah route between the Washington Road and junction with U.S. 40, and between Truckee and Tahoe City, was unusually difficult.

In the latter case, twelve hours of continuous operation was necessary to open a section three hundred feet long at Deer Park, where a snow slide had occurred.

## COST OVER MILLION

The snow removal work for the 1937-38 season will not be completed for some time, as considerable fall may be expected during April, and opening the closed routes will probably extend well into June in a few cases.

Under the existing program all established communities are provided an outlet, although the more remote places may be snowbound for the duration of a severe storm and even the main roads closed to part or all traffic because of the hazard. In

Mr. C. M. Weeks,  
Division of Highways,  
Truckee, Calif.

Dear Mr. Weeks:

Perhaps the worst of your work is over for a bit so you can take a moment off to read a few words of commendation I should like to say for the splendid work of your maintenance crews on Highway 40 which you control.

On the night of February 2-3, I had the tremendously interesting experience of spending some 12 hours in the Yuba Pass district, most of it with three of your young snow plow drivers. A broken skid chain stalled me just past Emigrant Gap, and after sending Mrs. Howard and children to Baxters, I stayed with the car. Darn near frozen and blinded in the storm, I was rescued by Driver Wallace and passed on successively to Peters and Lowry. Riding with them I had firsthand opportunity to judge of the work they are called upon to do and to note the skill, the loyalty, and untiring energy they put into their tasks. I won't forget that night. Through the courtesy of these men and of Mr. Hawks, I escaped pneumonia, had my chain fixed, and finally got on my way. Was stalled by other vehicles next morning but hauled out by the Snogo and reached Baxters after lunch on the 3rd.

I'd like to say a word for Wallace, Peters, and Lowry, particularly the former. Men who work 15 hours as cheerfully and competently as these men show that their superiors are the right sort. You have their respect and you have built up a fine organization.

Sincerely yours,

(Signed) I. C. HOWARD

Berkeley, Calif.

view of the need of funds for other purposes and the fact that six cents of every dollar provided for maintenance purposes during the past two years has been expended for snow removal, it seems wise and reasonable to delay expansion of the program into strictly recreational areas.

The hazards may be poor visibility, narrowed roadway, snow slides and blockading of the road catching some unwary traveler in an isolated position. It is to the credit of the field organization that no serious mishap has been recorded this season, although a number of travelers have been blockaded for several hours at different times.

## District XI Damage

(Continued from page 13)

washed out due to the high water, and traffic was halted three days until the waters subsided.

On Route 197, west of Ramona, a concrete overflow dip with paved slopes across the Santa Maria River was badly undermined, leaving only the dip shell remaining.

On Route 198, north of El Cajon, the San Vicente Creek overflowed the road, washing out shoulders and short pieces of pavement.

On Mussey Grade, a frame house floated downstream and blocked a 10 by 10 foot culvert, causing a 25-foot section of fill to wash out. Two miles east of Ramona, 80 feet of a concrete overflow dip across the Santa Maria River was washed out.

In Riverside County, two timber trestles across the Coachella Valley Storm Drain were washed out on Route 187. The drain also broke at one place north of Route 204 and the flood waters passed over Routes 203 and 204, depositing thick layers of mud and debris on the pavement and washed shoulders.

In all cases where traffic was interrupted, it was restored either by temporary repairs or by detours over adjacent roads within three days after the damage occurred, and in all cases except two, within a few hours.



# Bay Bridge Is Provided With Air Analyzer

SACRAMENTO laboratories of the Division of Highways have devised an air analyzer for use on the San Francisco-Oakland Bay Bridge, the first ever used on a bridge, it is believed.

The instrument has been placed at the crux of the giant steel cross-beams just below the lower deck at Tower W-2. It works like this: a four-blade scoop-like fan operates a pump which sucks the air into a bottle of distilled water. Thirty revolutions of the fan make one revolution of the pump, scooping up 75 cubic centimeters of air. When the counter on the pump shows up to 99,999 revolutions, the bottle is removed, sealed, and sent to the Division of Highways' laboratories in Sacramento for analysis; 7,500,000 cc. of air can be drawn through the apparatus with accuracy.

First experimental tests, according to Carl Hamilton, Maintenance Engineer of the Bay Bridge, show that the big span breathes an atmosphere consisting, among other things, of sulphates, salt, coffee chaff, and soot.



This instrument is an "air analyzer" used on the San Francisco-Oakland Bay Bridge. Carl Hamilton, Maintenance Engineer of the span, demonstrates its use.

Object of the apparatus is to analyze the air for components destructive to paint.

The air analyzer is being used in conjunction with "washing" tests. So far 120 "spots" on the bridge, of 2½-square feet proportions, have been "washed" by clean cheese cloth

dipped in distilled water. The cloth is wrung dry after the process into a bottle and the water sent to Sacramento laboratories for analysis. From 9 ounces of distilled water approximately 8 ounces are recovered after the washing, according to Mr. Hamilton.

## Railway Facilities on Bay Span Nearing Completion

With practically all ties laid east of the Center Anchorage and rails placed east of Pier E-6, work on the construction of electric railway facilities for the San Francisco-Oakland Bay Bridge is progressing rapidly, it is announced by Chief Engineer C. H. Purcell.

Approximately 105,000 California Redwood ties, equivalent to 7,000,000 board feet, will be used on the railway facilities and 15,910,000 gross pounds of track rail. On the bridge proper and the viaduct connecting with the Terminal Building 400,000 spikes will be used, approximating a weight of 320,000 pounds.

He: "I'm almost fast asleep."  
She: "That's good, because you're plenty slow when awake."

## Bay Bridge Traffic Up Slightly

A SLIGHT increase in traffic over February was announced by State Highway Engineer C. H. Purcell in a March report on the San Francisco-Oakland Bay Bridge filed with State Director of Public Works Earl Lee Kelly.

There was a total of 669,431 vehicles crossing the span last month compared to 694,378 in the preceding period. Daily average was 21,696, up 387 vehicles per day over February. Total vehicles using the bridge to date number 12,380,000.

Three additional days in March over February accounted in part for the increase, Mr. Purcell said, with seventeen rainy days recorded last month.

March traffic totals, however, showed a decrease by 96,884 vehicles from the corresponding period last year. An optimistic note was the increase in freight using the span in March. There were 68,607,331 freight pounds recorded, the largest total since the span opened, except for October, when there were 69,243,169 pounds. The March revenues were \$348,235.23 as compared with \$313,306.17 for February. Comparative totals follow:

	Total March	Total Feb.	Total since Opening
Passenger Autos .....	617,244	558,239	11,737,626
Auto Trailers .....	595	513	19,273
Motorcycles .....	1,895	1,497	41,826
Tricars .....	1,061	845	11,806
Trucks .....	35,173	22,983	409,500
Truck Trailers .....	1,172	878	25,390
Buses .....	10,586	9,423	133,726
Total Vehicles .....	669,431	594,378	12,380,851
Extra Passengers .....	166,045	146,941	2,709,504
Freight Lbs. ....	68,607,331	54,078,501	926,722,350

# \$8,000,000 Damage to Highways

(Continued from page 9)

The district forces are now busily engaged in clearing the various roads for spring traffic.

## NORTH SUFFERS AGAIN

The March storm brought added work to the northern districts, still laboring to extricate their roads from the slides and slipouts of the December and January-February storms. To District IV, it brought some 200,000 yards of additional slides, scattered over the Coast Route 56; the Hecker Pass, Route 32; the Bay Shore, Route 68; the Skyline, Route 55; and Routes 42, 44, and 116 leading into the California State Redwood Park near Santa Cruz.

Some eleven additional power shovels and twenty-five trucks were rented and put to work on the repair of these roads. Traffic was delayed for short intervals, and now all of these routes are traversable.

## In District X

In District X high water over various roads required the employment of some 125 additional flagmen

to warn traffic. Sections of overflowed pavements on Route 4, north and south of Merced, necessitated the detouring of traffic, as did similar conditions on Routes 122, 123 and the Pacheco Pass road, our Route 32.

Men worked day and night marking the edges of overtopped pavements with lanterns, and holding equipment in readiness to tow the unlucky who might stall their cars in the flood. The same forces and equipment were used in restoring the washed out shoulders and undermined pavement as soon as the waters subsided.

## In District VI

In District VI, the counties of Kern, Fresno and Kings took the brunt of the storm as it crossed east of the mountains. Pavements were overtopped and undermined by the flood waters on Route 4, south of Madera; the General Grant Road, Route 41; the Huntington Lake Road, Route 76; and Route 10, west of Coalinga.

South of Madera, on Route 4, Cot-

tonwood Creek overflowed its banks and backed up for more than a mile behind the Southern Pacific Railroad embankment, adjacent the highway. The embankment finally gave way, flooding the highway and forcing the detouring of traffic.

On Route 41, the Kings River again carried away the approach to the structure at Minkler, making the third time this winter that this particular approach has washed out. Route 76, the road to Huntington Lake, was closed by slides and washouts.

On Route 10, west of Coalinga, Waltham Creek washed out three spans of a concrete bridge in the canyon, closing the route. All the routes were again open for traffic in a short time, some 4 power shovels, 55 trucks, 26 tractors, and 31 graders being used in the repair work.

## RECORD SNOW FALL

While the districts mentioned were contending with slides and floods, Districts II, III and IX were busily engaged in handling the heaviest snowfalls of the year. During the early weeks of March, some 7 to 20 feet of snow fell in their respective territories. Late reports from District III indicate some 574 inches of snow for this season, 434 inches of which has fallen since February. Again in District IX, some 260 inches came down in the same period with a record of 300 inches for the season.

The response of the Maintenance organization to the March challenge has been a source of pride to the Division of Highways. This storm, which within a few days time damaged State highways to the extent of \$4,000,000, was the heaviest within our experience.

While practically all of these routes are now open, months will be required for their final repair. It is hoped that the public will not be too critical of road conditions pending the completion of this work.

Visitor: "How do you manage to live during this depression?"

Farmer: "Well, last year we lived by faith, this year we live in hope, and next year we plan to live on charity."



House washed onto highway on E Street near city limits of San Bernardino.

# Elevating Grader Cuts Down Road Excavation Costs

By H. B. MILNER  
Resident Engineer

**T**HE constant improvement of earth moving equipment is one of the reasons for increased efficiency in highway grading operations and for lower unit prices for excavation.

The development of the elevating grader has kept pace with the improvement of other earth moving equipment and today, in its own special field, it is still considered supreme as an economical method of excavating.

The modern machine differs but little from the older types in basic design, but improvements and modifications have increased its efficiency. Powerful tractors are now used as motive power, replacing the horses and mules of the old era, and the belt is operated by an independent motor.

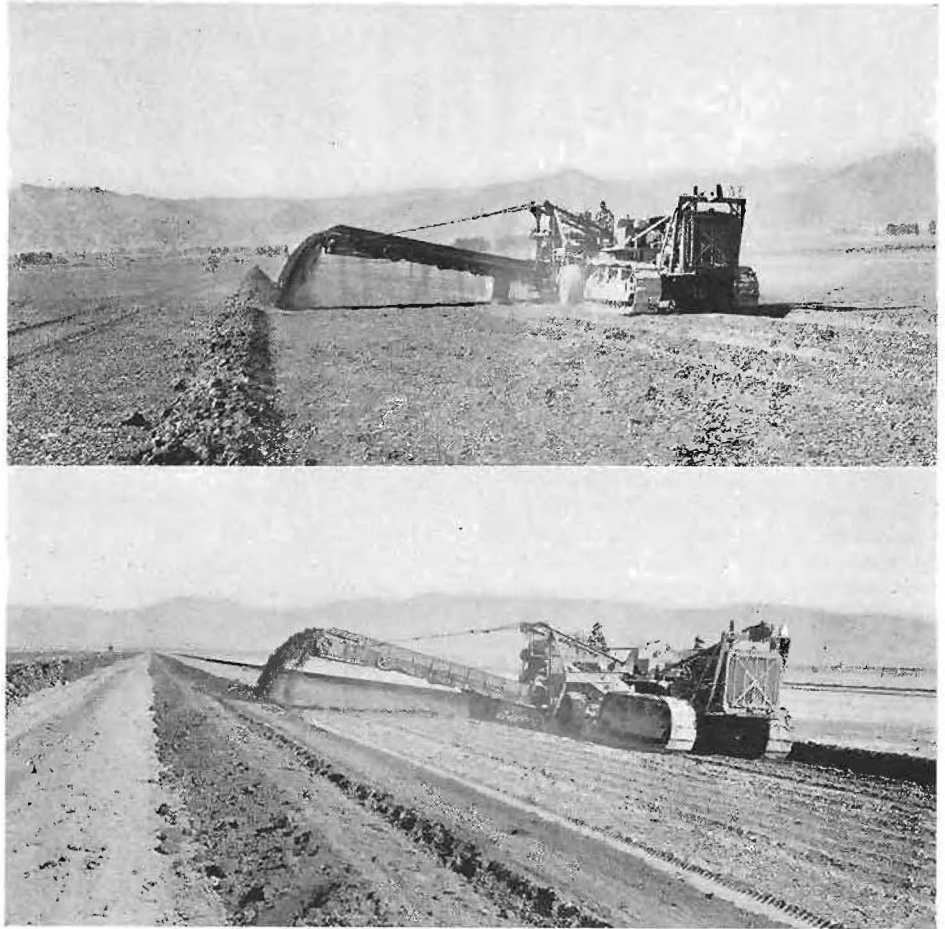
## MODOC HIGHWAY WIDENED

The ideal set-up for this type of machine was furnished on the contract completed by Poulos & McEwen, contractors, for widening the roadbed and constructing protective dykes across the dry bed of Middle Lake near Cedarville, in Modoc County, about 1.4 miles in length.

The original roadbed was confined by vertical rock walls averaging three feet in height and was dangerous to traffic, particularly in winter when snow and poor visibility increased the hazard.

The improvement eliminated this condition by widening the roadbed three feet on each side and providing gentle slopes to the fills. During occasional wet seasons the lakebed is covered with a foot to eighteen inches of water and the high winds sweeping up and down the valley drive the water from one end of the lake to the other and cause considerable wave action.

To prevent erosion of the newly constructed fills, protective dykes were thrown up on each side of the roadway about 160 feet from the cen-



1—Elevating grader constructing protective dyke across head of Middle Lake in Modoc. 2—Grader delivering roadside material for widening roadway across bed of Middle Lake. Rock wall bordering present road shown at left.

ter line extending entirely across the lake-bottom. Several gaps 50 feet long were left in these levees and short levees were built opposite these gaps. This permits the passage of water from one side of the road to another, through culverts under the road, and still protects the shoulders of the road against waves.

An elevating grader, with an auxiliary motor for operating the 48-inch by 35-foot belt, and drawn by a 75-horsepower tractor, was used on the work. A heavy motor grader with a 12-foot blade spread and compacted the windrows placed by the grader.

## LOW EXCAVATION COST

The machine excavated at an average rate of 500 cubic yards per hour, actual working time, although the contractors claim to have considerably exceeded this output on previous jobs. Nearly 38,000 cubic yards of material were placed at a contract price of ten cents per yard.

Elevating graders function best

when excavating along the roadside and delivering to the fill by means of a belt, usually about 35 feet long. In flat borrow pits they are the most economical equipment for loading excavated material into trucks. Although their field of operation for the elevating grader is limited, their usefulness and efficiency on projects such as this are quite pronounced.

On another highway contract in Siskiyou County similar equipment moved material into the fill at the rate of over 5000 cubic yards per 8-hour day.

An old ducky visited a doctor and was given definite instruction as to what he should do. Shaking his head he was about to leave when the doctor said, "Here, Rastus, you forgot to pay me."

"Pay you for what, boss?"

"For my advice," replied the doctor.

"No, suh! I ain't gwine to take it," and Rastus shuffled out.

Salesman: "How would you like some nice horseradish today?"

Lady Customer: "No thank you. We have a car."



# DIVISION OF WATER RESOURCES

OFFICIAL REPORT  
FOR THE MONTH OF  
**March, 1938**

EDWARD HYATT, State Engineer

**T**HE Division of Water Resources representing the Water Project Authority of the State of California, has continued engineering studies and negotiations in connection with the construction of the Central Valley Project under a cooperative work agreement with the U. S. Bureau of Reclamation. Under this agreement negotiations have been carried on with the owners of lands in the San Joaquin Valley for the acquisition of such lands and water rights as are needed for the project.

Construction work by the Bureau of Reclamation on the project was somewhat delayed by weather conditions. However, work was continued and considerable progress made on the construction of the Contra Costa Canal and the government camp for the Shasta Dam.

## IRRIGATION DISTRICTS

The recent severe storms producing heavy runoff and causing considerable damage to agricultural interests in the valleys from floods, will prove beneficial in many respects to areas dependent upon summer irrigation for maturity of crops. Most of the large storage reservoirs are nearing or have already reached the spilling stage and the abundant snow pack in the mountains insures ample summer flow for those districts dependent upon direct diversion for their water supply.

## CALIFORNINA COOPERATIVE SNOW SURVEYS

The storm period that began late in January, with storm after storm arriving in quick succession from the Gulf of Alaska, did not come to an end until the middle of February. After the deep accumulations of new snow had had time to settle sufficiently to allow of travel, men on skis and webbed snow shoes were sent out from different parts of the State to measure at various locations the increase in the snow pack due to the extended storms.

Further routine progress snow surveys were made at key snow courses during the last few days of February and the early days of March, by employees of the Divi-

sion of Water Resources and those other organizations and parties participating in the field work of the California Cooperative Snow Surveys.

The results show that at the end of February, in every watershed of the Sierra the snow pack was in excess of the normal quantity to be expected by that date, while in those watersheds north of the American River, the snow pack was even then ahead of the normal snow pack to be expected by the first of April.

## SUPERVISION OF DAMS

Our records disclose that all dams came through the severe floods without failure in major degree.

Work is progressing at a very rapid rate on the construction of the Copper Basin Dam of the Metropolitan Water District, Los Angeles, located in Copper Basin, tributary to Colorado River, in San Bernardino County.

With the opening up of the season in the Mono Basin, work will be resumed on the Long Valley and Grant Lake dams owned by the city of Los Angeles.

## WATER RIGHTS

*Supervision of Appropriation of Water.*

Twenty applications to appropriate water were received during February, of which two of considerable importance were those of the Oakdale Irrigation District to appropriate 93,000 acre-feet per annum by storage at Beardsley Flat Reservoir site on Middle Fork of the Stanislaus River for irrigation and power purposes at an estimated cost of \$2,900,000. During the month 13 applications were denied and 13 permits were issued. During the same period 9 permits were revoked and the rights under 7 were confirmed by the issuance of license.

## SACRAMENTO-SAN JOAQUIN WATER SUPERVISION

During the past month activities have been wholly in the office assembling the field data gathered during the summer months in order to compile a mimeographed report showing the diversions, acreage irrigated, stream and return flows in the Sacramento and San Joaquin valleys.

The sampling of water in the delta for salinity is being carried on at all regular stations to record the retreat of salinity.

## FLOOD CONTROL AND RECLAMATION

*Maintenance of Sacramento Flood Control Project.*

During this period extremely high stages were reached in the flood channels of the upper Sacramento Valley, and it was necessary to maintain full patrol day and night from March 18th to March 28th.

*Relief Labor Work.*

During this period about 70 relief laborers were employed in patrolling levees and in miscellaneous emergency work and, in addition, for about five days a crew of 50 men was stationed at Colusa for emergency work. It was not possible to continue with channel clearing work on the Feather River during this period, on account of high water.

*Sacramento Flood Control Project.*

The work of removing the levees in the Feather River overflow channel south of Marysville in District 784 was completed during this period at a cost of approximately \$18,000. A small amount of work remains to be done, which will be deferred until the weather is favorable. Construction of the timber bridges in the Dry Creek project near Wheatland has continued and all will be completed within about ten days.

*Emergency Levee Repairs.*

Under Executive Order No. E 177 work is continuing in making repairs to levees in Glenn, Shasta, Butte and Tehama counties, and at this date approximately \$60,000 has been expended out of the total of \$150,000. The work is now proceeding rapidly due to the favorable weather, and it is expected that all work will be completed by April 20th.

With the money provided by the State emergency fund, this office has undertaken the protection and patrol of the levee on the west bank of the Sacramento River from Colusa to Butte City. A number of breaks were prevented during the extremely high water commencing on March 18th.

Levee protection work along the San Joaquin River south of Stockton was commenced on March 16th under an emergency allotment of \$20,000, and is still under way. During this period a number of levee breaks were averted with the assistance of State forces, on Roberts Island, the Stewart tract, Reclamation District No. 17, the Pink tract, and on the levee between Paradise cut and the Banta-Carboua irrigation intake.

# R. M. Gillis Wins Promotion to Post of Construction Engineer

**M**R. R. M. GILLIS, for the past five years District Engineer of the Division of Highways at Fresno, has been promoted to the position of Construction Engineer, the position left vacant by the death of Mr. C. S. Pope.

Mr. Gillis is a graduate of the Massachusetts Institute of Technology and has had long experience in engineering work with an outstanding record in highway engineering, particularly in Washington and California.

He was first employed in California on April, 1929, as Assistant District Engineer, District X, and on November, 1929, he was promoted to the position of Assistant Construction Engineer at Headquarters; in 1935, he was promoted to District Engineer at Fresno.

He brings with him to the new position a thorough knowledge of both the District and Central Office problems, a wide acquaintance among the highway personnel and a proven ability in highway construction.

Mr. Earl T. Scott, who for the past three years has been District Maintenance Engineer in District VII, has been promoted to the position of District Engineer at Fresno.

Mr. Scott is a graduate of Stanford University with approximately 22



R. M. GILLIS

years of experience in highway engineering. He has been with the Division of Highways since 1914 with the exception of 19 months during the World War when he was in the service and approximately nine months beginning in July, 1921, when he accepted employment with the U. S. Bureau of Public Roads. He has had experience in all phases of highway engineering.

nineteen-foot spans and grading approaches and applying road-mix surface treatment thereto. District IV, Route 56, Section D. Peter J. McHugh, San Francisco, \$17,942; Franzini and Fredenburg, San Rafael, \$18,372; A. Soda and Son, Oakland, \$20,508; Palo Alto Road Materials Co., Palo Alto, \$20,564; Parish Bros., Los Angeles, \$20,735; Chas. L. Harney, San Francisco, \$20,743; Lee J. Immel, Berkeley, \$21,057; B. A. Hawkins and Co., San Francisco, \$21,705; C. C. W. & H. H. Haun, San Francisco, \$21,785; E. T. Lesure, Oakland, \$23,769; E. A. Forde, San Anselmo, \$19,055; Valley Construction Co., San Jose, \$19,559; Pacific States Construction Co., San Francisco, \$19,931; Clausen and Corfield, Berkeley, \$20,842; F. J. Maurer and Son, Inc., Eureka, \$20,930; Claude C. Wood, Stockton, \$21,680. Contract awarded to Albert H. Siemer and J. Carcano, San Anselmo, \$17,220.50.

**MONTEREY COUNTY**—Between five miles and 5.9 miles west of Greenfield, about 0.9 mile to be graded. District V, Feeder road. Young and Son Co., Ltd., Berkeley, \$16,802; Mountain Construction Co., Sacramento, \$17,435; M. J. Ruddy, Modesto, \$17,640; Bodenhamer Construction Co., Oakland, \$24,609; Guerin Bros., San Francisco,

## Arroyo Seco Highway

(Continued from page 21)

The Arroyo Seco Highway will follow down the Arroyo Seco, from Pasadena, through Victory Park, skirt the back edge of Sycamore Grove, and connect with San Fernando Road and North Figueroa Street leading to the center of metropolitan Los Angeles. When completed, the highway will be one of the most modern in the nation. There will be no grade crossings throughout its entire length.

A total of \$1,112,000 has been allocated for the Arroyo Seco project. The contract now under way calls for the expenditure of \$118,000 and includes the construction of three bridges and two blocks of grading.

\$24,549; John Jurkovich, Fresno, \$22,724; Chas. L. Harney, San Francisco, \$20,694; Valley Construction Co., San Jose, \$21,750; George K. Thompson and Co., Los Angeles, \$20,640; L. C. Karstedt, Watsonville, \$17,493; Claude C. Wood, Stockton, \$23,156; George J. Bock Company, Los Angeles, \$24,294; Martin Bros. Trucking Co., Long Beach, \$31,045; Triangle Rock and Gravel Co., San Bernardino, \$28,676; N. M. Ball Sons, Berkeley, \$21,757; Granfield, Farrar and Carlin, San Francisco, \$19,623; Harms Bros., Sacramento, \$17,963; Minnis & Moody, Los Angeles, \$18,997. Contract awarded to J. L. Conner and Sons, Monterey, \$15,317.16.

**NAPA COUNTY**—Three bridges, one across Dry Creek, one across Bale Slough Overflow and one across Bale Slough, between 6 and 15 miles north of Napa to be widened. District IV, Route 49, Sections B, C. M. J. Lynch, San Francisco, \$20,359; C. W. Calletti and Co., San Rafael, \$23,360; Claude C. Wood, Stockton, \$21,012; Carl N. Swenson Co., San Jose, \$21,950; Brown and Lambretti, Mill Valley, \$21,998; Peter J. McHugh, San Francisco, \$24,059; Pacific States Construction Co., San Francisco, \$24,339; Rock and Gravel Trucking Co., Oakland, \$24,402; C. C. W. & H. H. Haun, San Francisco, \$26,412. Contract awarded to Palo Alto Road Materials Co., Palo Alto, \$19,947.98.

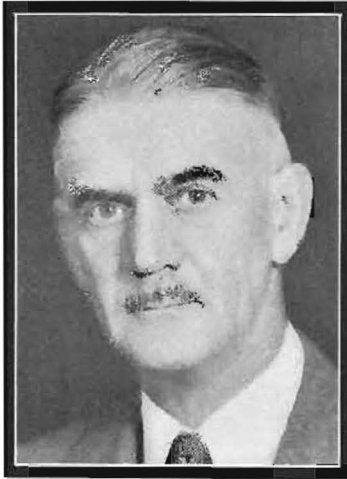
**SAN BENITO, MONTEREY, SAN LUIS OBISPO, SANTA BARBARA COUNTIES**—At various locations, diesel oil to be applied to roadside vegetation for a distance of about 242.6 roadside miles. District V. Pacific Truck Service, Inc., San Jose, \$8,418; Lee J. Immel, Berkeley, \$7,797; Western Motors Transfer Co., Santa Barbara, \$10,660; Oilfields Trucking Co., Bakersfield, \$7,624; L. A. Brisco, Arroyo Grande, \$9,970; Bradley Truck Co., Inc., Santa Maria, \$9,125. Contract awarded to Bert Hale, Pismo Beach, \$6,658.50.

**TULARE COUNTY**—Between Morton Street in Porterville and Mulberry Street, about 0.9 mile to be graded and surfaced with plant-mixed surfacing on crusher run base and road-mix surface treatment to be applied to the shoulders. District VI, Route 129, Section P. C. Oilfields Trucking Co., Bakersfield, \$40,819; Griffith Co., Los Angeles, \$34,698; Piazza and Huntley, San Jose, \$36,223; Union Paving Co., San Francisco, \$41,217. Contract awarded to N. M. Ball Sons, Berkeley, \$33,235.60.

## Highway Bids and Awards for March, 1938

**LOS ANGELES COUNTY**—Two bridges, an equestrian and pedestrian subway with approaches to be constructed on Arroyo Seco Parkway between Arroyo and Grand Avenue. District VII, Route 205, Section S. Pas. C. O. Sparks and Mundo Engineering Co., Los Angeles, \$117,158; John Strona, Pomona, \$123,883; Oscar Oberg, Los Angeles, \$110,848; Griffith Co., Los Angeles, \$113,251; Claude Fisher Co., Ltd., Los Angeles, \$112,886; George J. Bock Co., Los Angeles, \$120,930; Byerts & Dunn, Los Angeles, \$112,629; Oswald Bros., Los Angeles, \$130,892; W. E. Hall Co., Alhambra, \$116,959; Minnis & Moody & Werner & Webb, Los Angeles, \$119,968; Carlo Bougiovanni, Los Angeles, \$118,049; United Concrete Pipe Corporation, Los Angeles, \$114,211; Fred E. Potts Co., Los Angeles, \$121,718. Contract awarded to J. E. Haddock, Ltd., Pasadena, \$109,837.40.

**MARIN COUNTY**—A timber bridge with concrete deck across Stemple Creek, about one mile north of Tomales consisting of 11



Charles Stockton Pope

## In Memoriam



Samuel Alexander Hart

Charles Stockton Pope, Construction Engineer of the Division of Highways since 1923, passed away on March 16, 1938, at Riverside, while on an inspection trip of recent storm damage to highways in southern California.

Mr. Pope was born August 10, 1874, at Fort Stockton, Texas, the son of Dr. Benjamin F. Pope, a distinguished surgeon in the U. S. Army. He received his early education at army schools, private and public schools, graduating from Stanford University with an A.B. in C.E. in 1897. While at Stanford, he was a member of the Chi Psi fraternity, varsity track team in 1896 and 1897, and was elected perpetual class president in his senior year.

Mr. Pope began his professional career in 1898, on land and irrigation surveys in Kern County. In 1900 and 1901 he was assistant engineer on power projects for the Standard Electric Co., continuing similar work in 1902 and 1903 for the North Shore Railroad and Stanislaus Water and Power Co. During 1904 to 1906 he was engaged as surveyor for the King of Arizona Mine, and in private practice at Los Angeles. In 1907 he entered the engineering department of the city of Los Angeles where he was principally engaged as highway engineer in charge of paving work until the year 1915. From 1916 to 1921 he was associated with Warren Brothers as district engineer on promotion and consulting work for asphalt pavement projects in California and Nevada.

In January, 1922, he began his service with the California Highway Commission as Assistant Engineer, specializing on asphalt pavement work. In September, 1923, when the Construction Department was organized, Mr. Pope was appointed head of this department as Construction Engineer in charge of the Materials and Research Laboratory and of all highway construction, except major bridges. The laboratory assignment was terminated in 1928 when the Materials and Research Department was organized. As Construction Engineer, Mr. Pope also had charge of the State Prison Camps, involving supervision of the construction of many miles of heavy mountain roads and of problems concerning the rehabilitation of prisoners.

To his keen, analytical mind and his constant interest in research can be attributed many of the improved methods of construction of our highways. His continued effort and study are primarily responsible for the development of the modern high type asphalt concrete pavement as now constructed by the State. His numerous technical and scientific papers, articles, and discussions contributed materially to the knowledge of highway engineering and are widely recognized as authoritative.

He was an active member of the American Society of Civil Engineers, serving as president of the Sacramento Section in 1924 and on numerous committees. He was also a member of Sacramento Lodge No. 40, Free and Accepted Masons, the Sutter Club, San Francisco Engineer's Club, California Museum Association, and a former member of the Sutter Tennis Club and the Del Paso Country Club.

Early on Sunday morning, March 20, 1938, Samuel Alexander Hart succumbed to the effects of a long illness at his home in Sacramento, California. Although in poor health for a number of years, he had continued his duties in the office of the State Engineer as Senior Engineer, Supervision of Dams, till less than three weeks before his death.

The son of Henry Eldredge and Anzolette (Hayward) Hart, he was born at Stockbridge, Wisconsin, December 14, 1885, where he received his early education. In 1903 he came to California and completed his preparation for college, entering the University of California with the class of 1910, but the necessities of self support prevented his graduation until 1911 when he received his B.S. degree.

Although he graduated in mining, Mr. Hart chose to follow irrigation and hydraulic engineering, devoting the major portion of his professional career to these two branches.

From the time of his graduation until the United States entered the World War, he followed engineering work in Northern California and Arizona, served as Chief Engineer of the Waterford Irrigation District for three years; Assistant Engineer of the South San Joaquin Irrigation District for two years, chiefly on the construction of Woodward dam. After the war he was employed in private practice with Joseph W. Gross, Consulting Engineer, for fifteen months, a few months with the State Division of Engineering and Irrigation on reconnaissance surveys and from February, 1922, to November, 1928, he was employed in the Engineering Department of the City of Sacramento, rising from the position of Assistant Engineer to that of City Engineer. From November, 1928, to April, 1930, he served as Sanitary Engineer for the City of Berkeley in charge of the design and construction of a storm sewer system. Upon completion of this work he was appointed to the position of Senior Engineer of Hydraulic Structure Design on Supervision of Dams in the Division of Water Resources, Department of Public Works, continuing in this position till his death.

Mr. Hart joined the war forces of the United States in August, 1917, and was commissioned First Lieutenant of Co. H, 23rd Engineers. The regiment went overseas on March 30, 1918, and was engaged for the greater part of the time in building and maintaining communications to the front lines. The regiment took an active part in the battles of St. Mihiel and the Meuse-Argonne, returned to the United States and was disbanded in June, 1919, Mr. Hart receiving his honorable discharge on the 17th of that month.

On August 5, 1921, he married Elsie A. Silman who, with their two sons, Samuel A. Jr., and William E., survives him.

Mr. Hart was a member of Union Lodge No. 58, Free and Accepted Masons of the State of California, the Scottish Rite Bodies of Sacramento and the Ben Ali Shrine. He was also a member of the American Society of Civil Engineers and affiliated with the Sacramento Section. His friendly greeting and genial smile will be missed by his friends and associates.

**STATE OF CALIFORNIA**  
**Department of Public Works**

Headquarters: Public Works Building, Twelfth and N Streets, Sacramento

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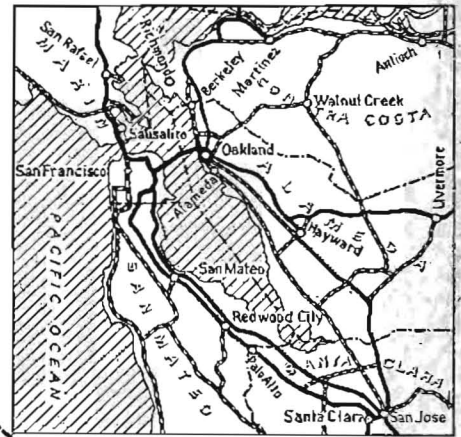
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