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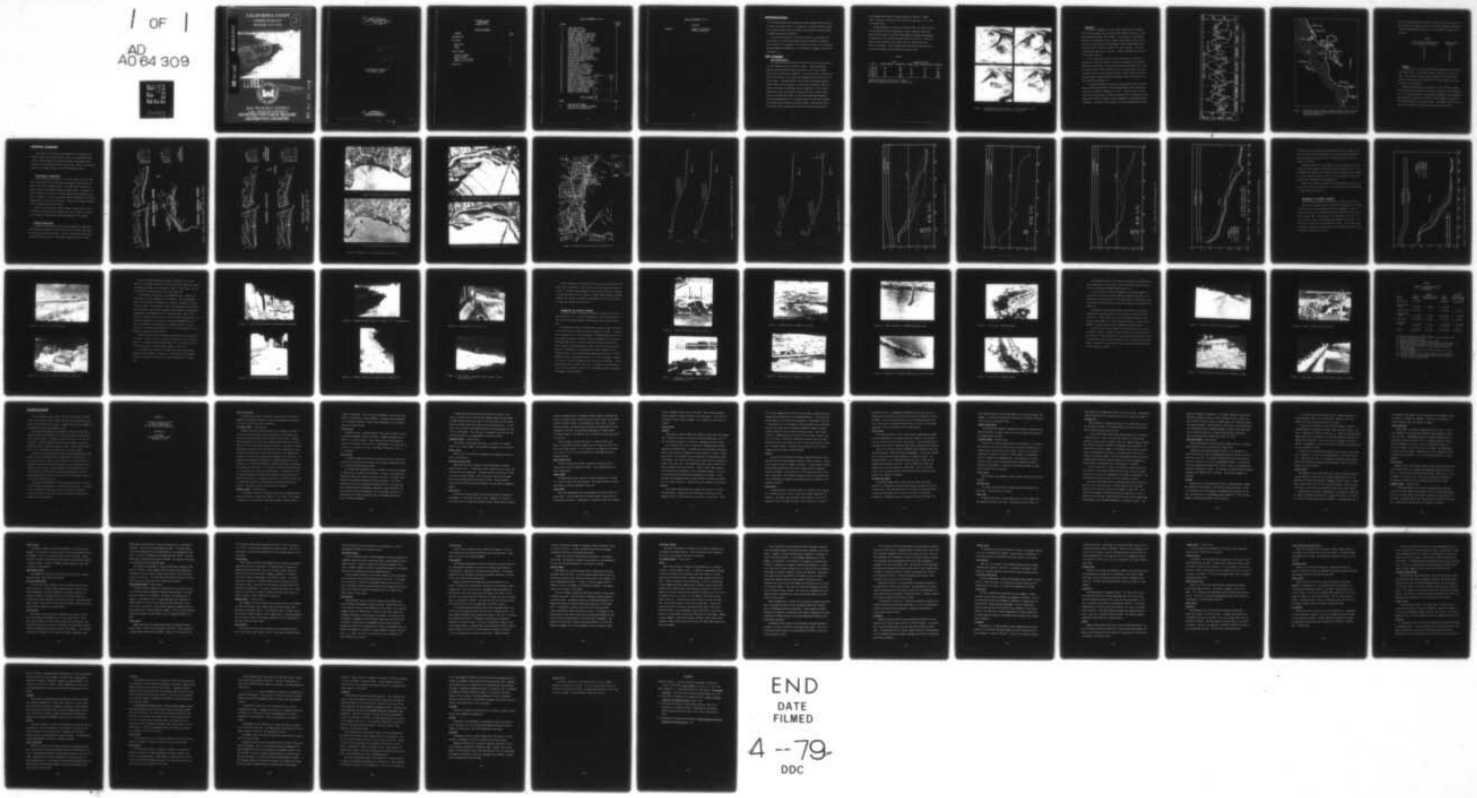

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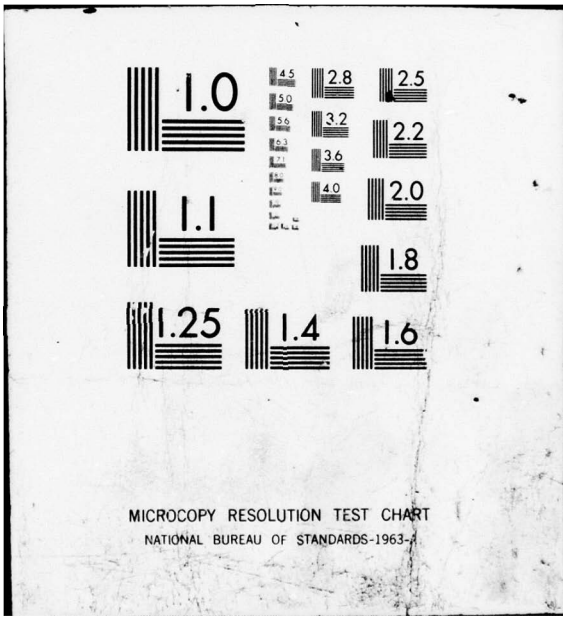
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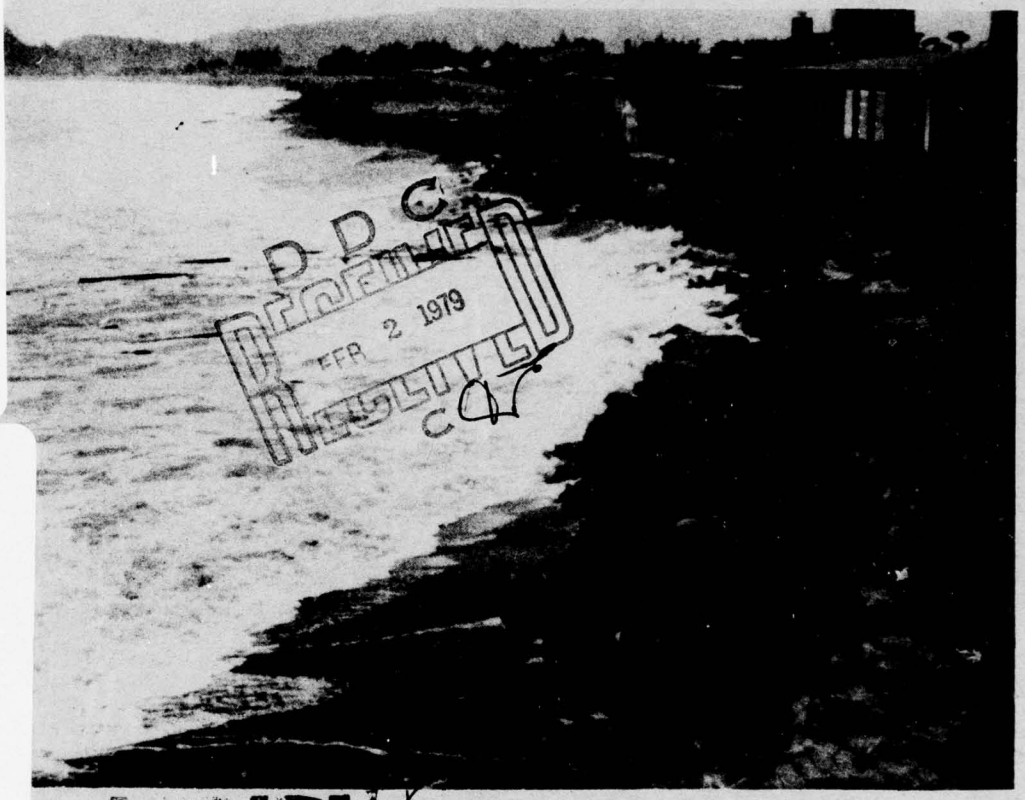
STORM DAMAGE
WINTER 1977-1978



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LOS ANGELES DISTRICT

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WINTER STORM DAMAGE ALONG THE CALIFORNIA COAST 1977-1978

(11) 1978

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SAN FRANCISCO DISTRICT
LOS ANGELES DISTRICT

(10) PREPARED BY
GEORGE W. DOMURAT
SAN FRANCISCO DISTRICT

CALIFORNIA COAST
STORM DAMAGE
WINTER 1977-78

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INTRODUCTION

California experienced significant coastal damage during the winter of January and February 1978. A combination of high astronomical tides, strong onshore winds, high storm waves, and excessive rainfall produced an aggravated erosional condition.

This report documents the causes and results of the dynamic conditions which led to the storm damage along the California coastline. Also included, as an appendix, is a section of a report by the California Coastal Commission summarizing the cost analysis of damage along coastal California.

THE STORMS

METEOROLOGY

The severe storms reaching the California coast were extra-tropical cyclones orginating in the vicinity of Japan. These disturbances normally proceed eastward across the Pacific to the Gulf of Alaska giving rise to strong wind conditions. The degree to which these storms affect the offshore area of California depends upon the location of the Pacific High. A southward shift in this Pacific anticyclone permits intense extra-tropical cyclones to follow a more southerly course and affect the central and southern areas of California. As the storms approach the coast, pre-frontal southerly winds are of high velocity, often in the 30-40 knot range. As the front passes winds normally shift counterclockwise out of a westerly direction with short duration of northerly winds immediately after the storm. The southerly 30-40 knot winds create a significant storm tide and allow storm waves to

attack higher than normal elevations along the coastline. Figure 1 shows a sequence of satellite photos taken on storm dates 7, 8, 9, and 11 of March, 1978.

During the months of January and February 1978, the coast of northern and central California experienced intense southerly winds from North Pacific storms. The Pacific High shifted southward approximately 400 miles from its location during the winter of 1976-1977. This permitted a more southerly storm track giving the experienced winds, waves, and rainfall. The following table lists winds and wave data for specific storm dates during January and February 1978:

TABLE 1

	WIND		SIGNIFICANT WAVE		
Date	Speed (Knots)	Direction	Height (Feet)	Period (Sec)	Direction
9 Jan 78	35	SW	14	18	SSW
13 Jan 78	35	SW	21	14	S
16 Jan 78	50	SW	18	16	WSW
9 Feb 78	45	S	20	16	SSW
10 Feb 78	40	WNW	16	12	SSW
13 Feb 78	40	NW	17	16	SSW

*Wind Data measured at Farallon Is. (NOAA)
*Wave Data obtained 60 miles west of Golden Gate

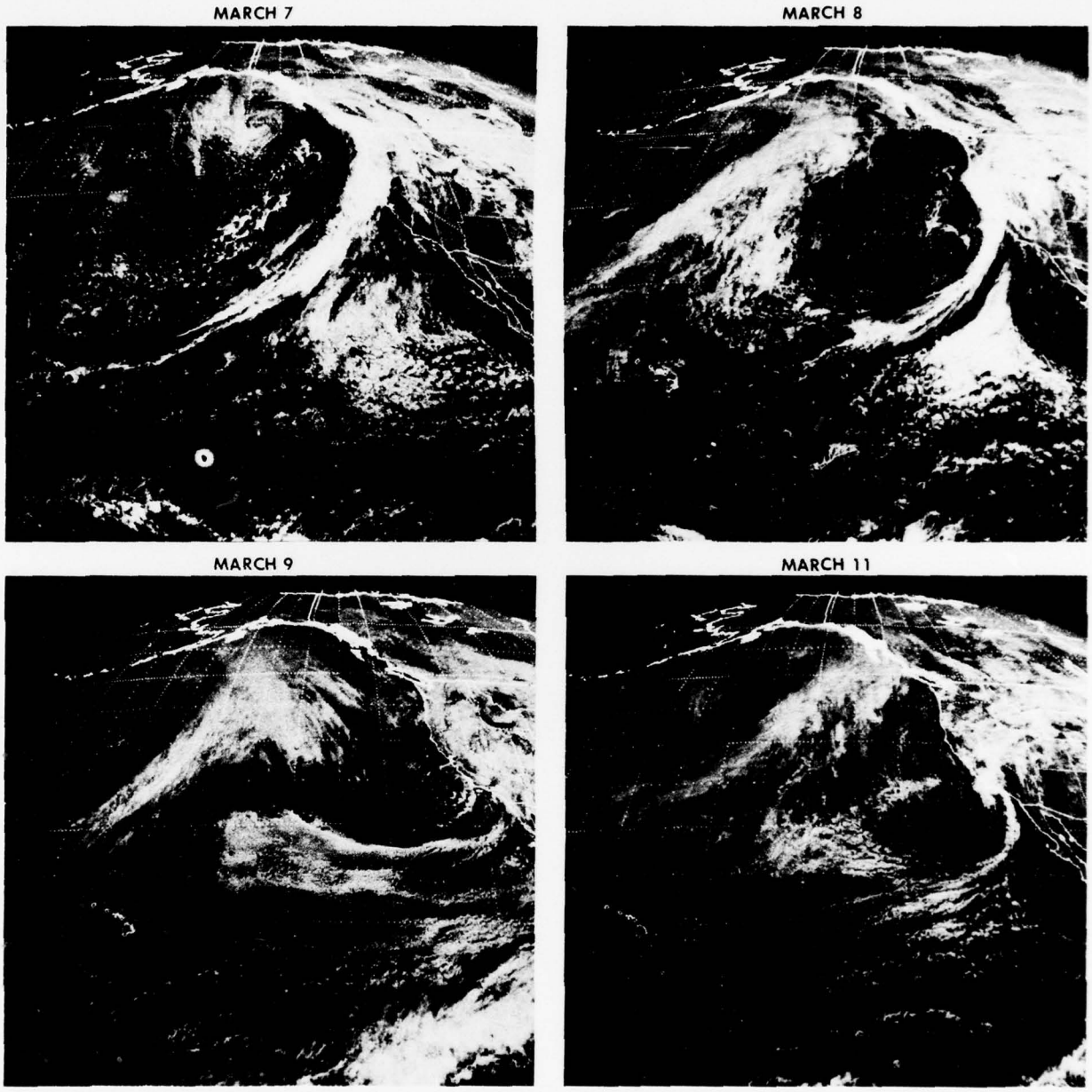


FIGURE 1 - EXTRATROPICAL CYCLONE SEQUENCE. (PHOTOS COURTESY OF THE NATIONAL WEATHER SERVICE, SATELLITE DIVISION)

WAVES

To provide documentation on wave energy this winter as compared with the two previous years, wave data were obtained from the U.S. Navy Fleet Numerical Weather Central (FNWC). For Station 3, in deep water offshore of San Francisco, daily values of wave height, period, and direction were tabulated for the seven-month period (October-April) for the years 1975-76, 1976-77, and 1977-78. The wave power (H^2T) was calculated and tabulated for each day. Figure 2 presents the variation of wave power with time.

It is of interest to note that the winter season of 1976-77 was somewhat more severe than that in 1975-76 as evidenced by the numerous high peaks of wave power, particularly during January-April, 1977. Also note that during the entire winter of 1977-78 the wave power is greatly in excess of that in the previous two years. Severe erosion occurred at numerous beaches along the northern California coast that normally are well protected (see Figure 3).

In southern California certain west-facing beaches such as Ventura-Oxnard, Santa Monica-Redondo, and Oceanside-Imperial Beach experienced many days of breakers averaging 5 to 6 feet. The source area of these swells was close enough to southern California and far enough south that waves could reach all southern beaches unimpeded by Point Arguello-Point Conception. These two Points normally block swells generated by storms

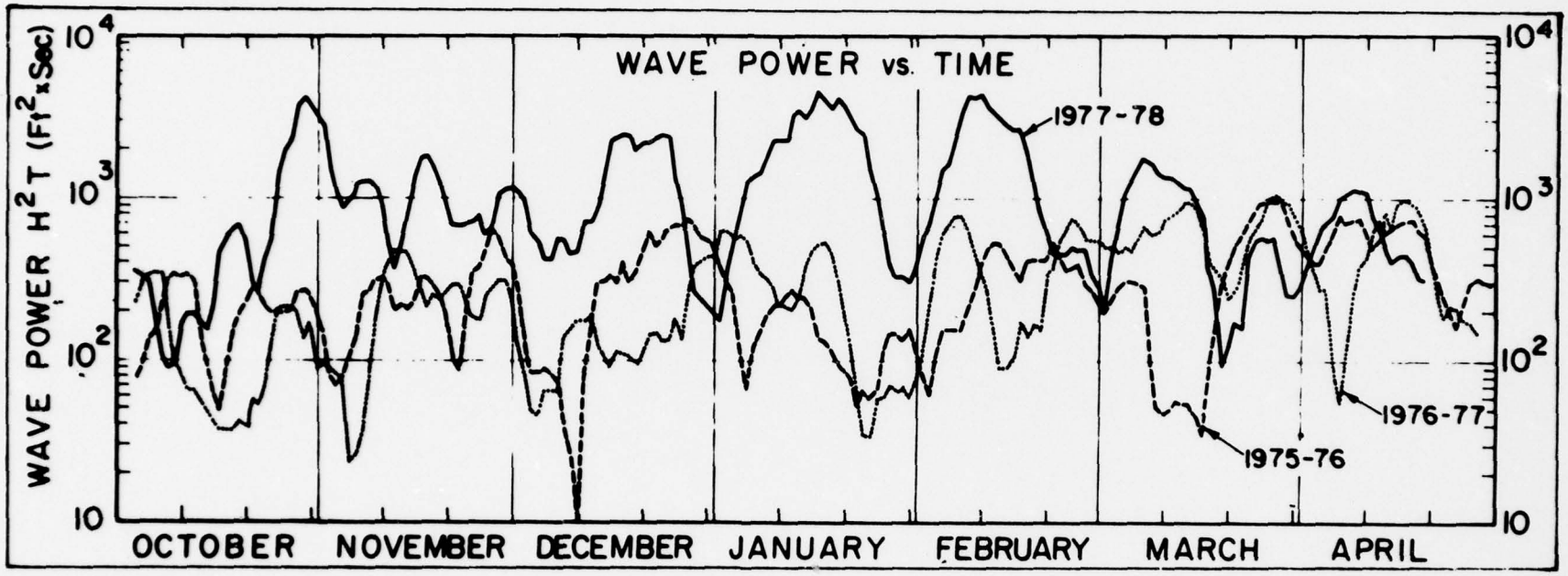


FIGURE 2 - FIVE-DAY MOVING AVERAGE OF WAVE POWER OFFSHORE IN DEEP WATER FROM SAN FRANCISCO, CA DURING THE SEVEN-MONTH PERIOD OF THE WINTERS OF 1975-76, 1976-77, AND 1977-78.

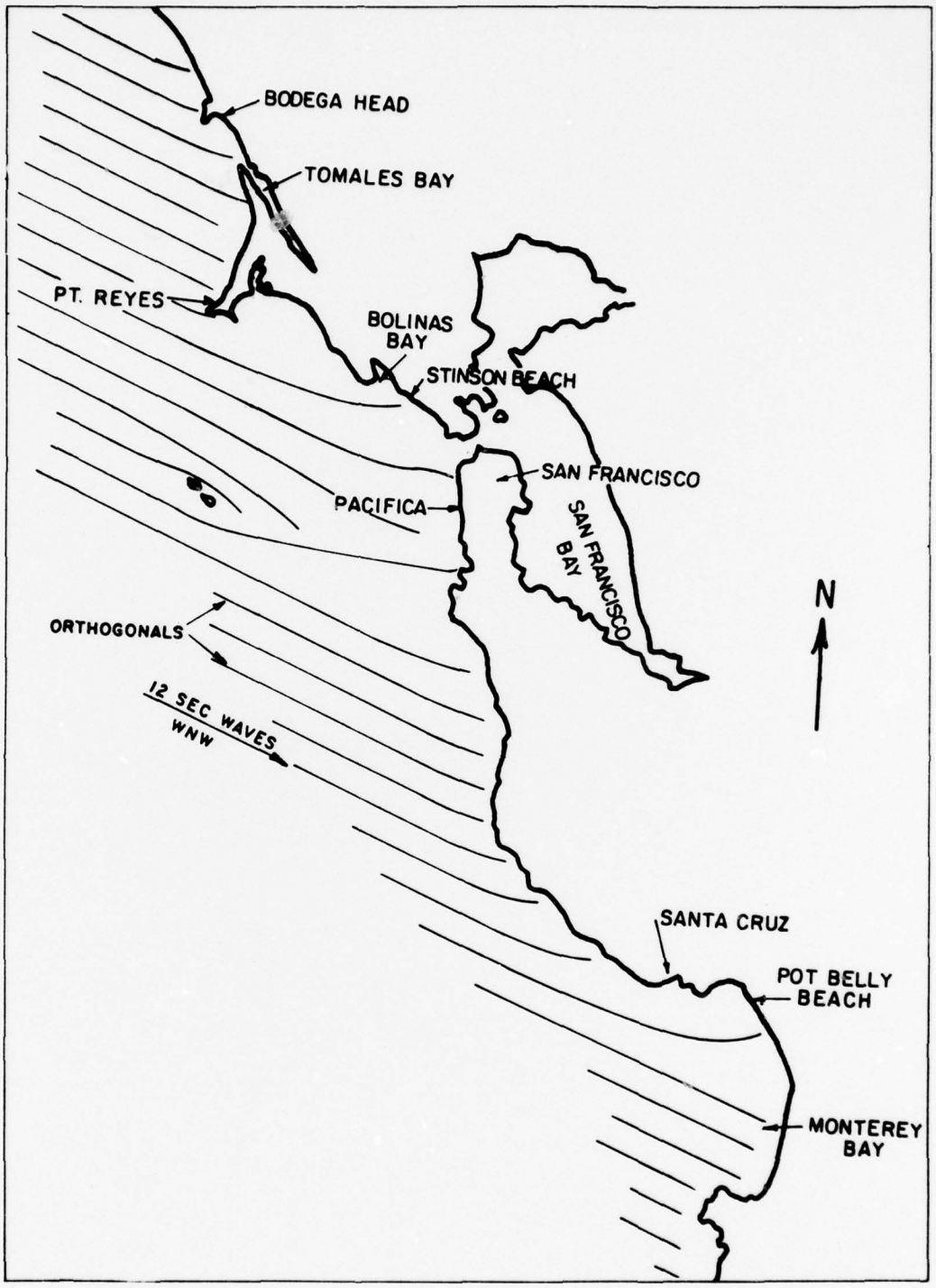


FIGURE 3 - REFRACTION DIAGRAM SHOWING THE NORMAL DEGREE OF WAVE EXPOSURE ALONG THE CENTRAL CALIFORNIA COAST (DIAGRAM IS FOR 12 SEC. PERIOD WAVES FROM WNW).

off the northern California coastline. Table 2 depicts the number of days between 12 December 1977 and 12 March 1978 in Southern California on which maximum observed breakers of a given height or greater were reported:

TABLE 2

Maximum observed breakers equal to or greater than n feet:	Number of days reported:
n = 15	5
13	7
12	15
11	16
10	23
9	25
8	31
7	53

TIDES

A significant factor which produced the magnitude of beach erosion this winter season is the increased height in water level along the coast. The southerly 30-40 knot winds coupled with the wave setup created a storm tide which allowed waves to attack higher than normal elevations of the coastline.

Predicted tidal heights for high water at San Francisco (Golden Gate) during the storm periods of January and February 1978 ranged from 3.7 to 6.9 feet above MLLW. The National Oceanographic and Atmospheric Administration estimated that offshore storms increased the observed tidal height about two feet above normal. The highest observed tide was 8.26 feet on January 9 when the predicted tide was 6.80 feet.

COASTAL DAMAGE

As a result of these Pacific disturbances, the combination of various natural forces (winds, waves, tides, etc.) accelerated cliff erosion, eroded coastal sand dunes and beaches, and damaged coastal structures. The following sections present both a verbal and pictorial account of the damage caused by the 1977-1978 winter storms.

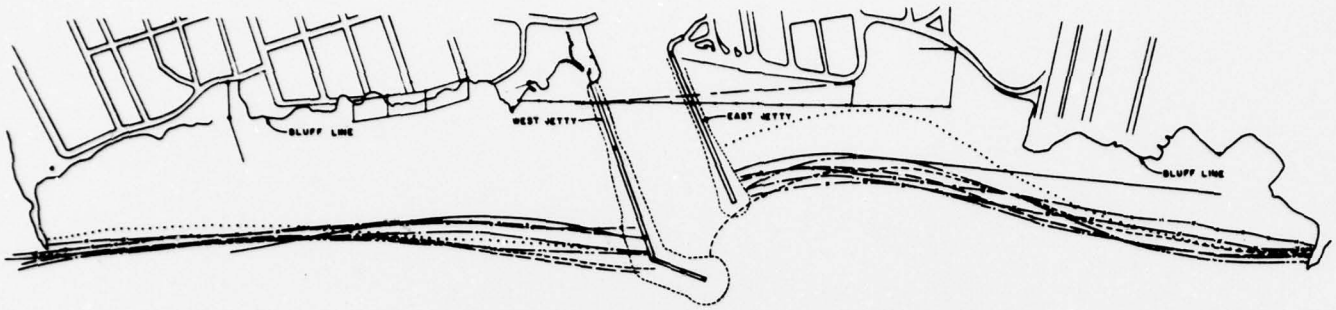
SEASONAL CHANGES

To the veteran beach observer it is a well known fact that large winter waves erode sand from the beach and deposit this material offshore in the form of submarine bars. Low energy waves move this material back onto the beaches during the summer season. The degree of winter erosion is a function of the wave energy being expended on the beach. Figures 4, 5, and 6 present the seasonal variations in shoreline configuration at Santa Cruz, California. Note the line marked February 1978 as compared with previous years.

Figures 7 and 8 show the seasonal change in beach width at Santa Cruz Pier for February and May respectively. Wave energy, as pictured in the figures is significantly different between the two seasons.

BEACH PROFILES

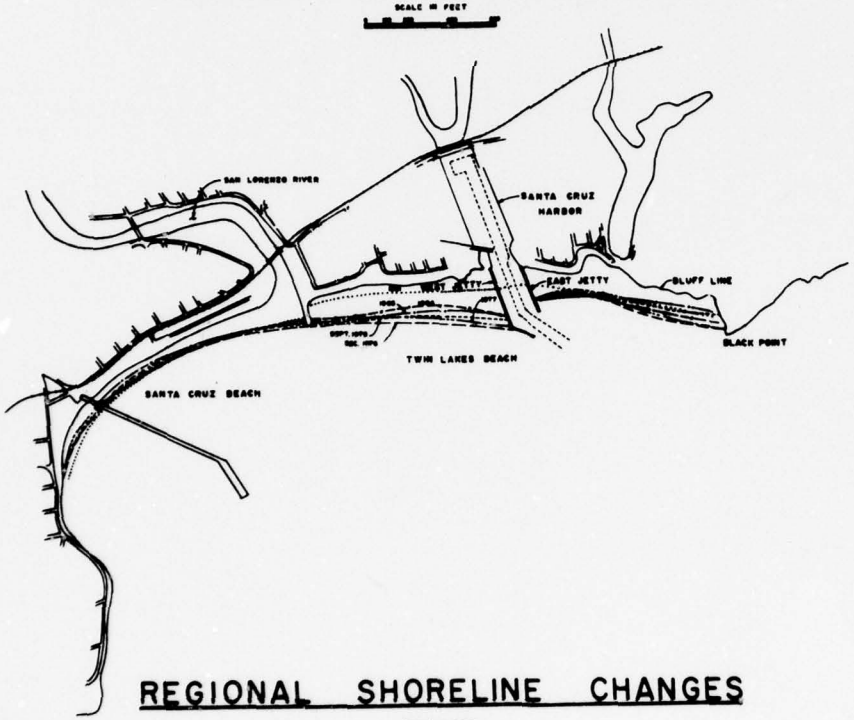
The extent of beach erosion may also be quantified by comparing beach profiles collected at Santa Cruz and also at various piers along the Southern California Coastline. Figure 9 locates the profiles presented in Figures 10 and 11. Note that in some areas up to 10 feet



LEGEND

SEPTEMBER	1976	
NOVEMBER	1976	
DECEMBER	1976	
JANUARY	1977	
FEBRUARY	1977	
MARCH	1977	
AUGUST	1977	
FEBRUARY	1978	

SEASONAL SHORELINE CHANGES



LEGEND

DECEMBER	1961*	
OCTOBER	1964	
AUGUST	1966	
SEPTEMBER	1976	
DECEMBER	1976	
APRIL	1977	

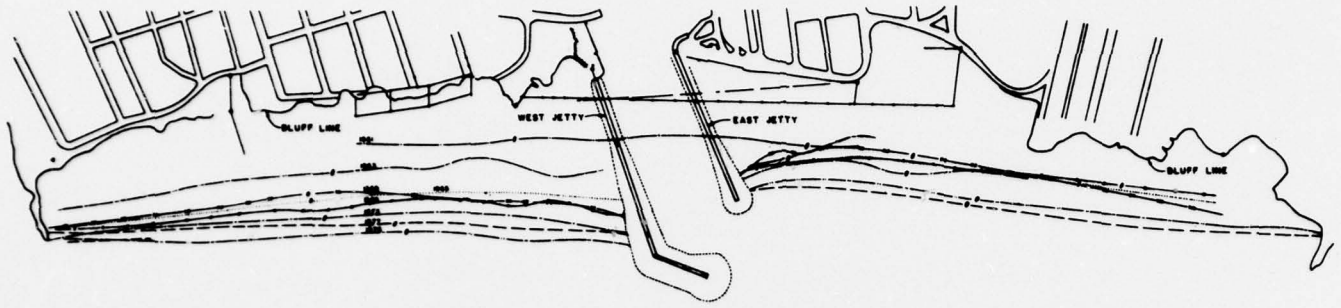
NOTES

1. ELEVATIONS AND SOUNDINGS ARE BASED ON THE DATUM OF MEAN LOWER LOW WATER.
*2. SHORELINE DRAWN FROM AERIAL PHOTOGRAPHS.

REGIONAL SHORELINE CHANGES

SCALE IN FEET

FIGURE 4 - SEASONAL SHORELINE CHANGES AT SANTA CRUZ, CALIFORNIA



LEGEND

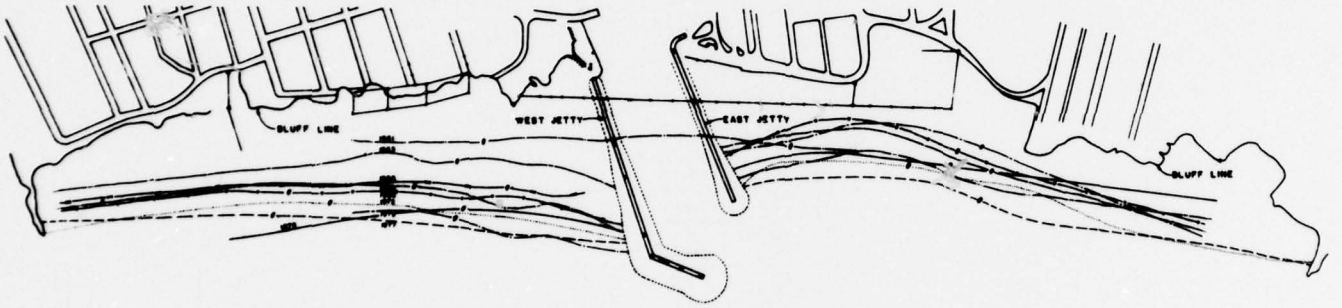
DECEMBER 1961
SEPTEMBER 1963
AUGUST 1965
AUGUST 1966
*JULY 1969
*SEPTEMBER 1973
AUGUST 1976
AUGUST 1977

NOTES

1. ELEVATIONS AND SOUNDINGS ARE BASED ON THE DATUM OF MEAN LOWER LOW WATER.
2. SHORELINE CONTOURS BASED ON CORPS OF ENGINEERS BEACH EROSION SURVEYS.

SUMMER CONTOURS

SCALE IN FEET



LEGEND

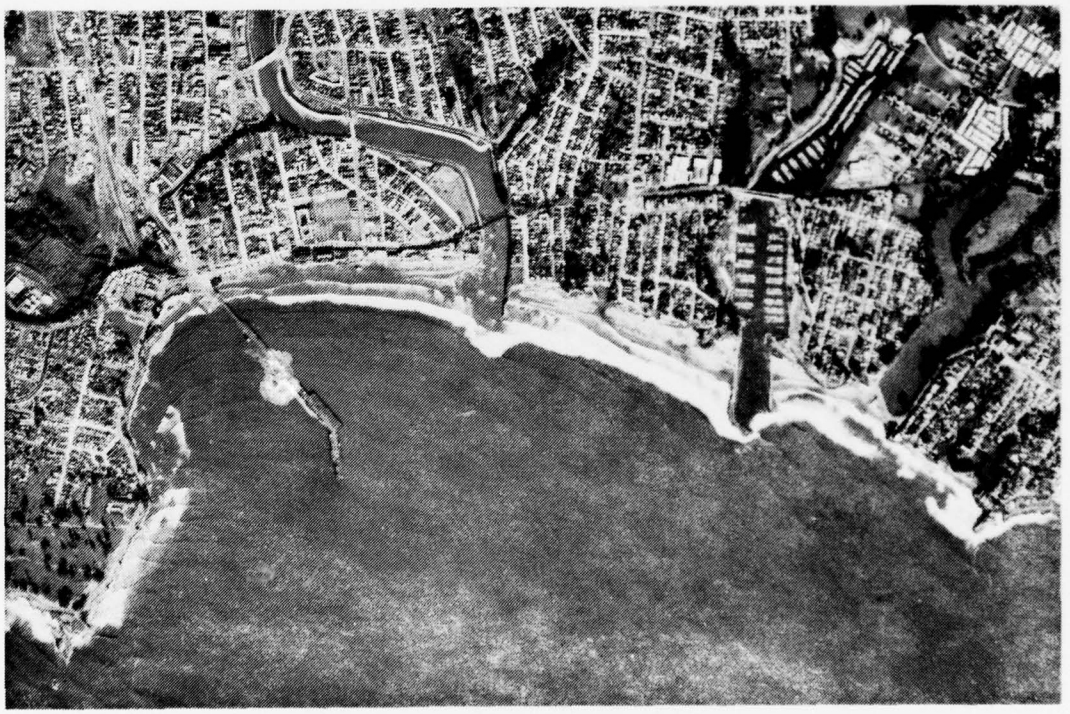
DECEMBER 1961
MAY 1963
FEBRUARY 1964
MARCH 1965
MARCH 1963
*DECEMBER 1972
MARCH 1975
APRIL 1977
FEBRUARY 1978

*SHORELINE DRAWN FROM AERIAL PHOTOGRAPHS.

WINTER CONTOURS

FIGURE 5 - SEASONAL CHANGES AT SANTA CRUZ, CA
(NOTE FEBRUARY 1978 LINE)

Summer Shoreline Configuration, October 20, 1977



Winter Shoreline Configuration, January 20, 1978

FIGURE 6 - SUMMER AND WINTER CONDITIONS AT SANTA CRUZ, CA

FIGURE 7 - SHORELINE CONFIGURATION - WINTER (TAKEN FEBRUARY 1978)

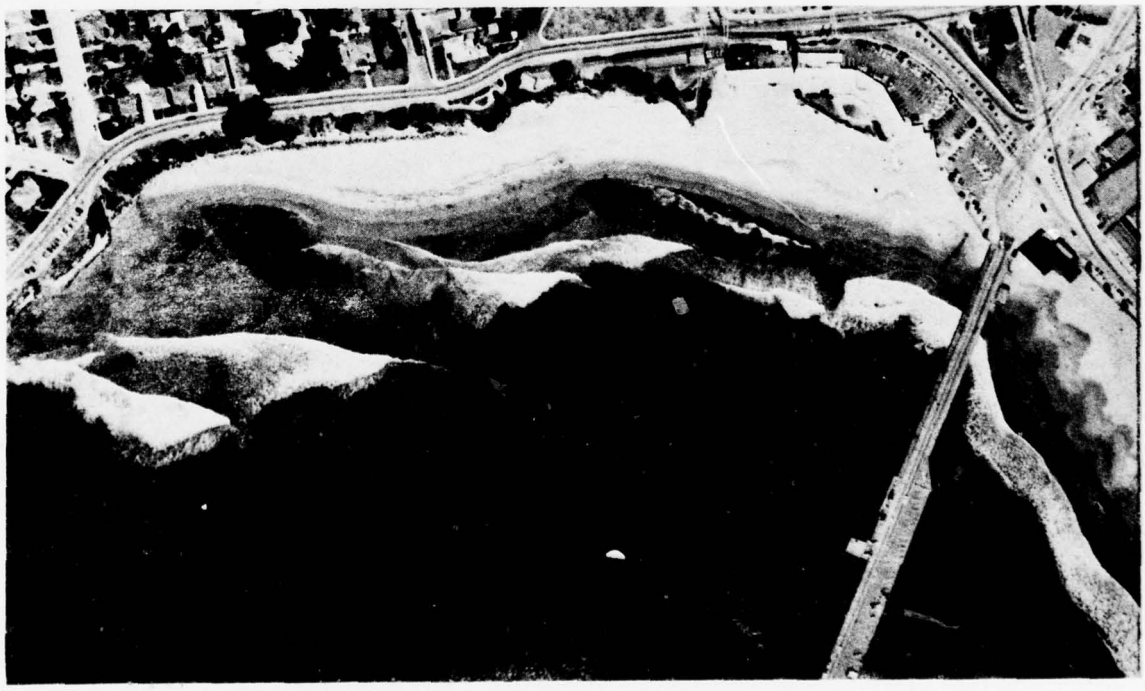


FIGURE 8 - SHORELINE CONFIGURATION - SUMMER (TAKEN MAY 1978)

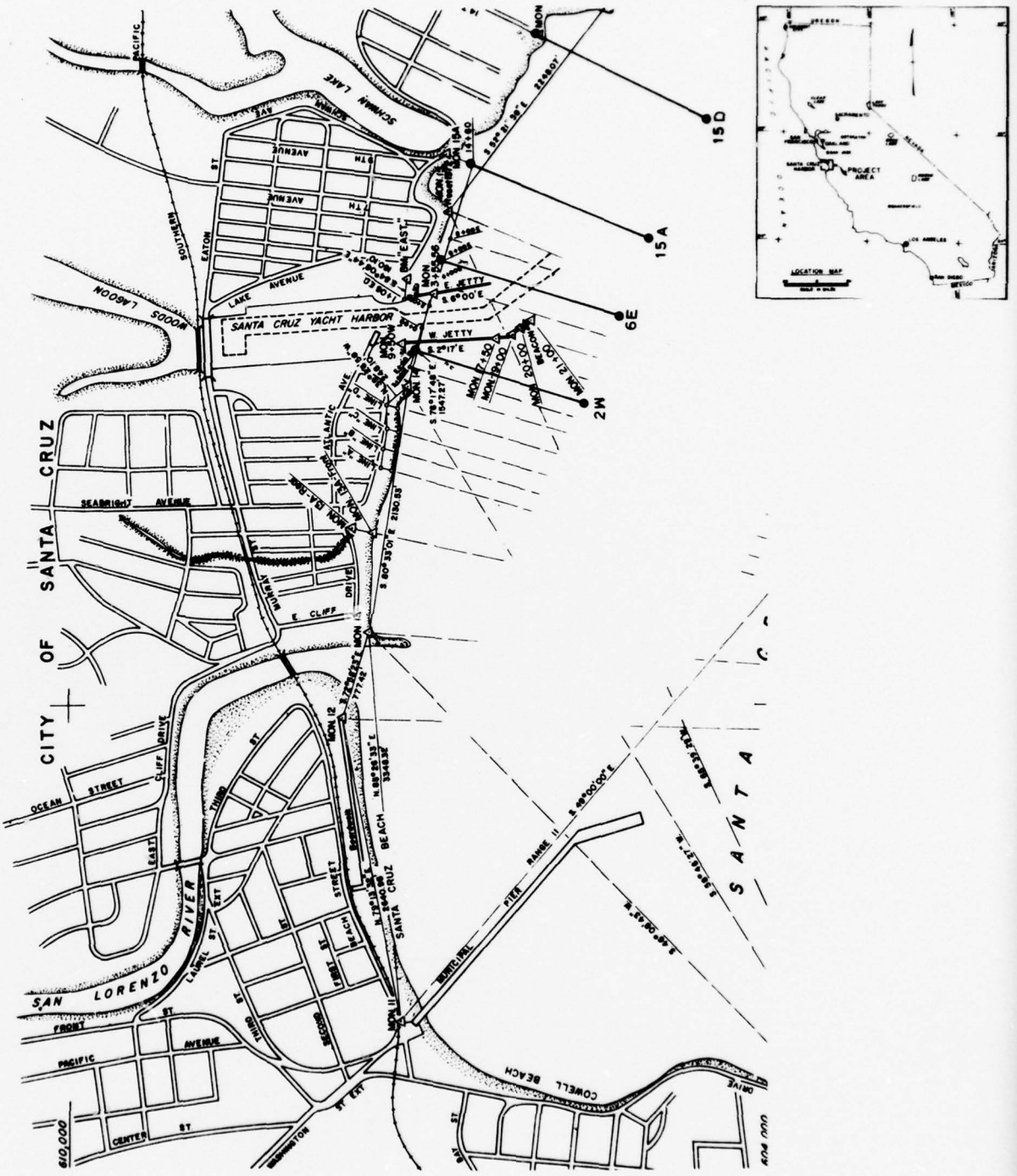


FIGURE 9 - LOCATION OF PROFILE LINES AT SANTA CRUZ, CA

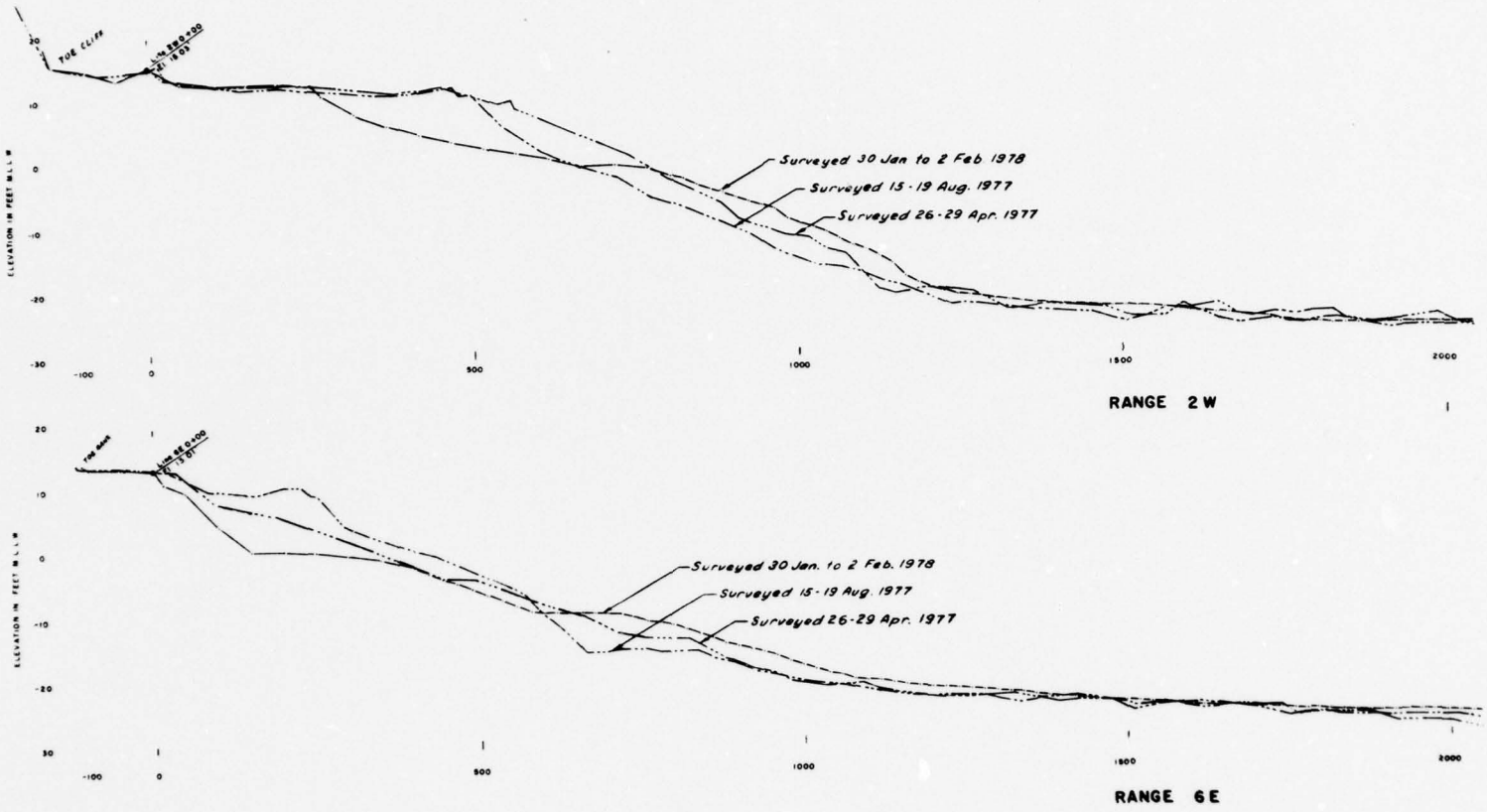


FIGURE 10 - HYDROSURVEYS OF BEACH AND NEARSHORE ZONE, SANTA CRUZ, CA

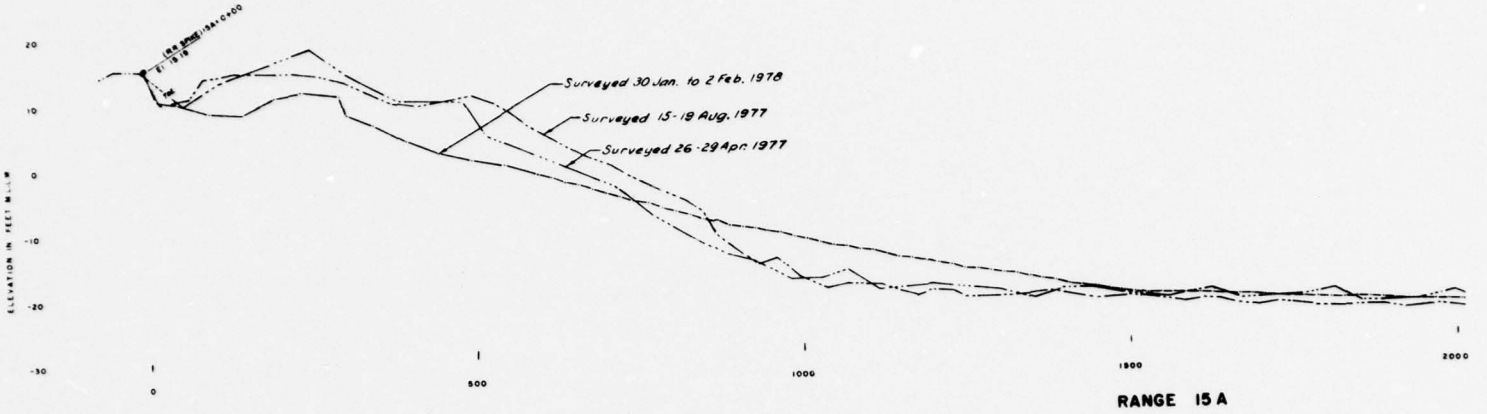


FIGURE 11 - HYDROSURVEYS, SANTA CRUZ, CA

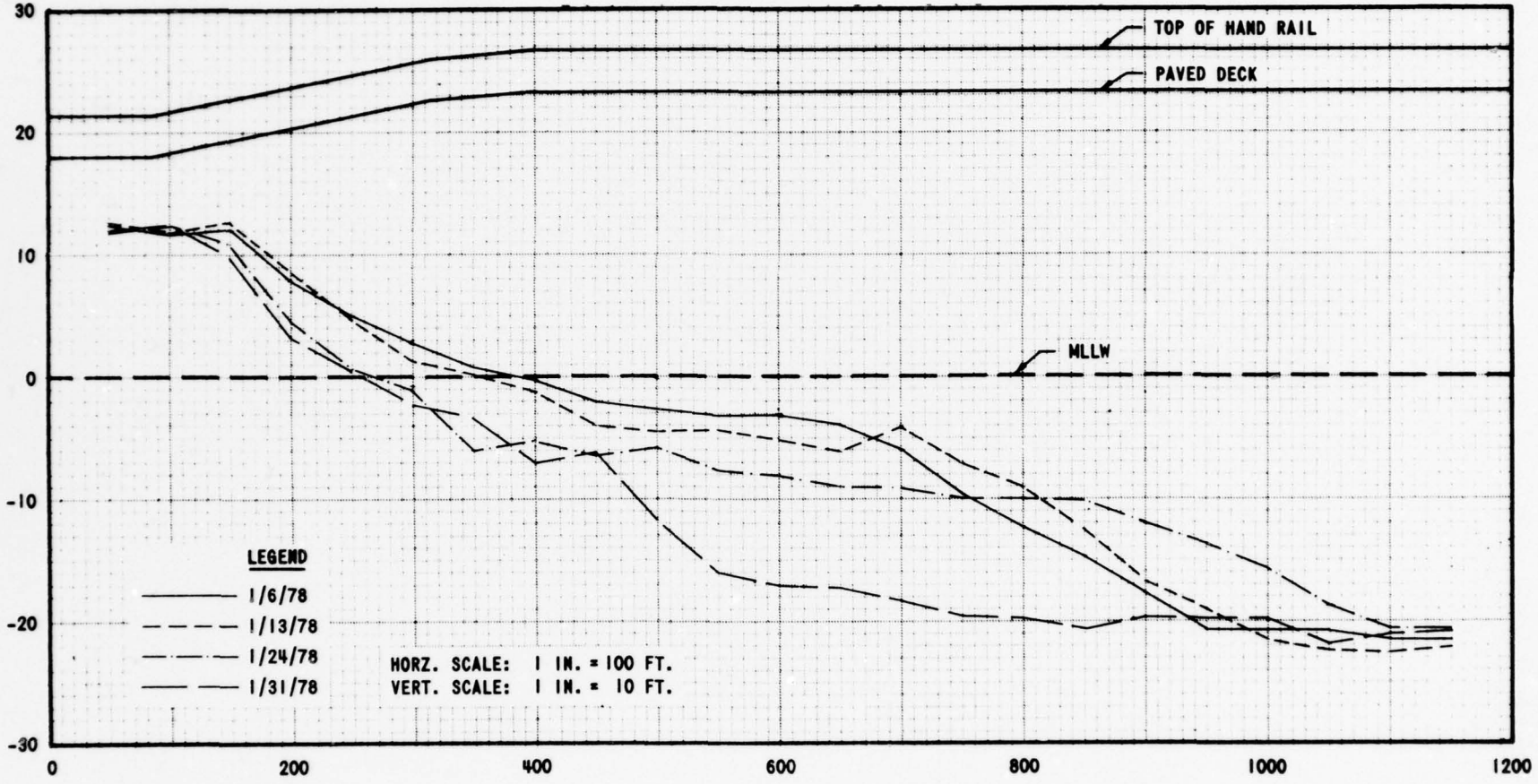


FIGURE 12 - IMPERIAL BEACH PIER PROFILES FOR JANUARY 1978

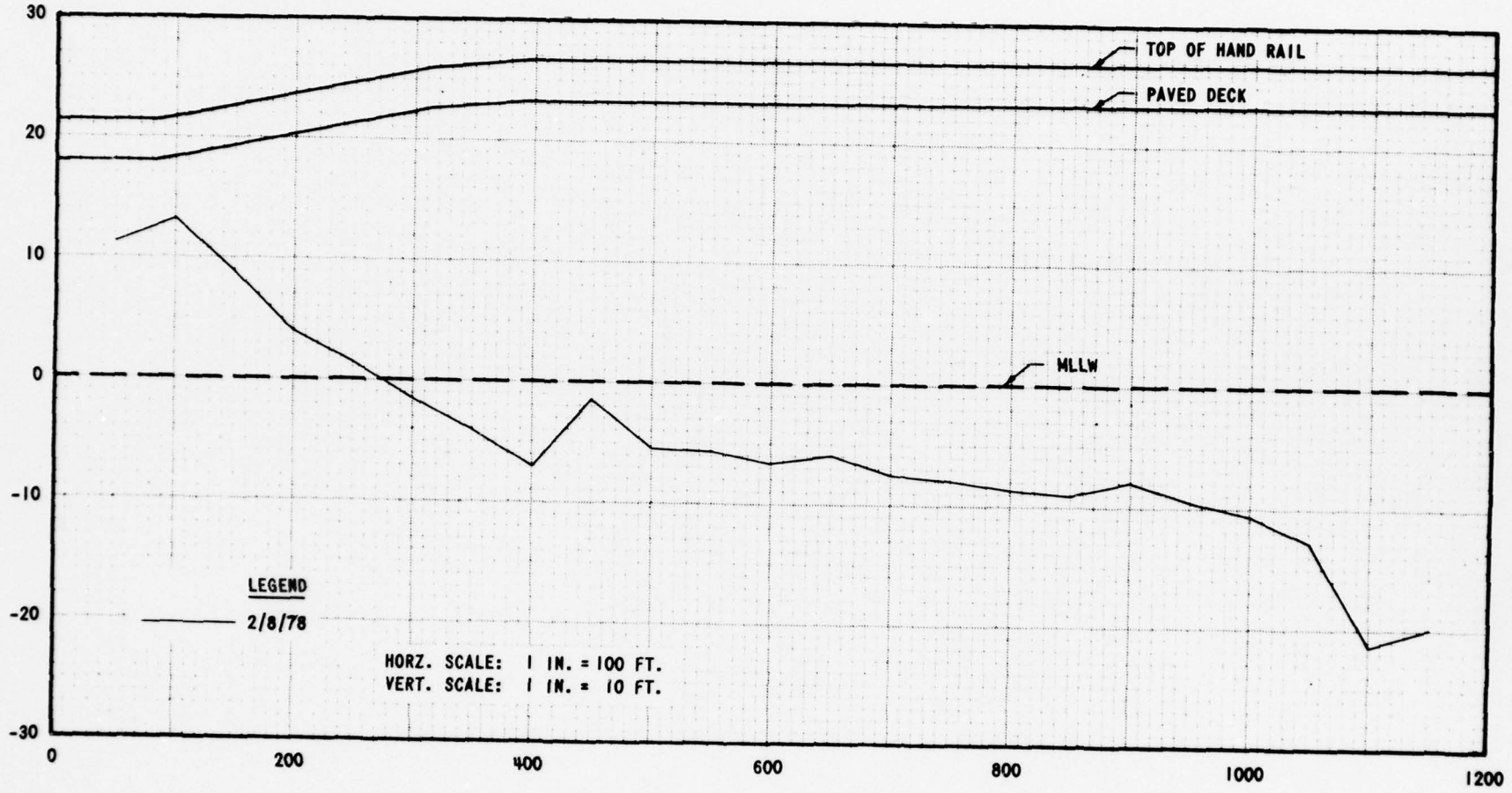


FIGURE 13 - IMPERICAL BEACH PIER PROFILE FOR FEBRUARY 1978

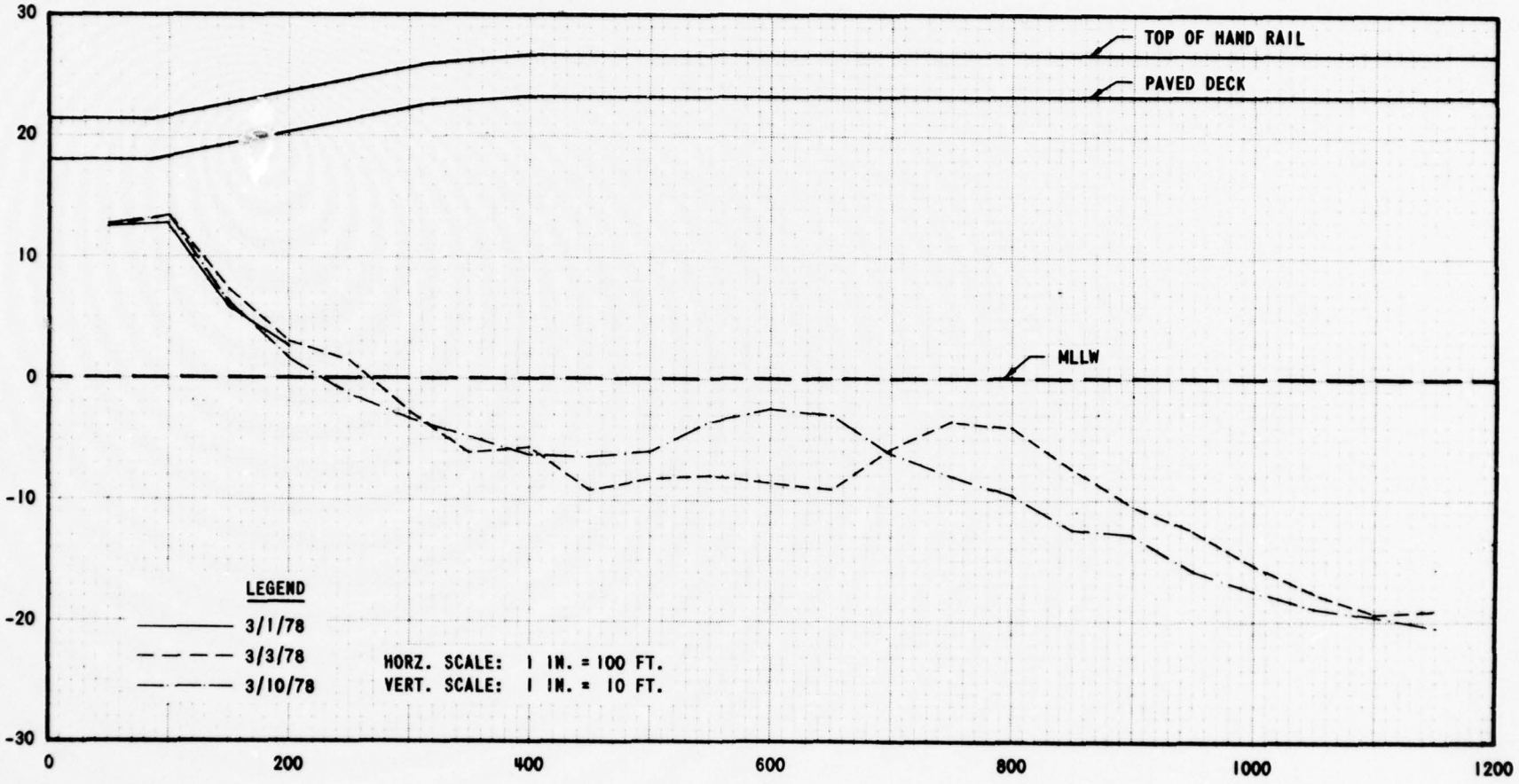


FIGURE 14 - IMPERIAL BEACH PIER PROFILES FOR MARCH 1978

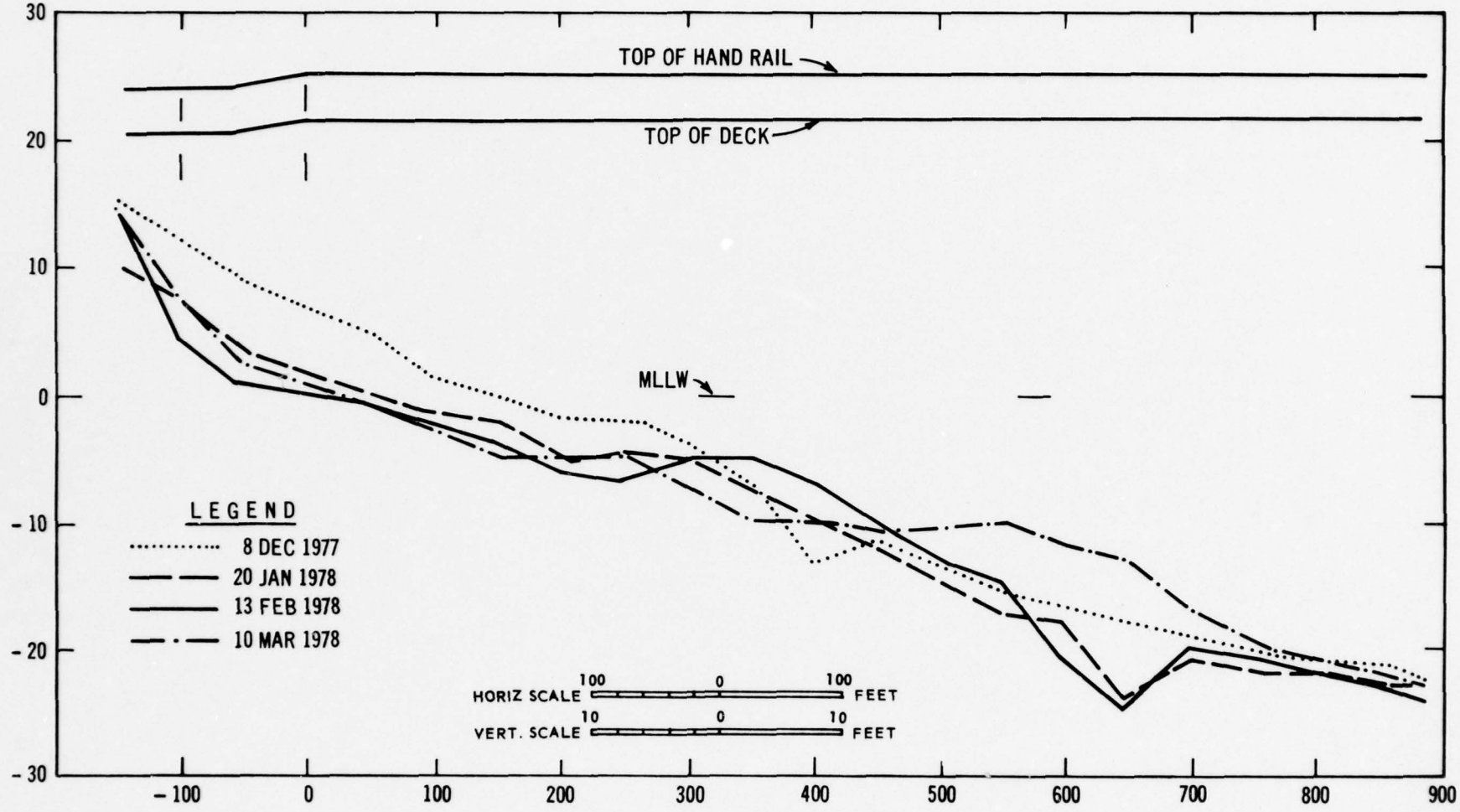


FIGURE 15 - PROFILES FROM HUENEME PIER IN SOUTHERN CALIFORNIA

(vertical) were lost between the period August 1977 and February 1978. Most of the loss can be attributed to the storms during January 1978. Material eroded from the beach face was deposited about 750 feet to 1,500 feet offshore.

At Imperial Beach Pier an average of 3 feet (vertically) was lost during the period January 1978 to March 1978 (see Figures 12, 13, 14). At Hueneme Pier (Figure 15) in Ventura County, the beach lost an average of 5 feet vertically between the +12 to -10 foot contours. These pier profiles were taken weekly from Hueneme Pier.

Ventura Pier showed an average loss of approximately 5 feet (vertically) from the +12' elevation to -22' elevation a horizontal distance of 1,200 feet (see Figure 16).

DAMAGE TO NORTH COAST

Coastal damage was significant during the winter of 1977-1978.

The jetties of Humboldt Harbor near Eureka, California were ravaged by storm waves, sustaining damage in excess of $500,000. Figure 17 shows the south jetty at Humboldt Harbor with large waves from a storm during January 1978. The elevation of the structure is 15 feet above the storm water level. Wave heights were estimated at 30+ feet. The boulder in Figure 18 weighs approximately 20 tons. Wave energy moved the boulder from point of implacement to the opposite side of the jetty structure (a distance of 25 feet).

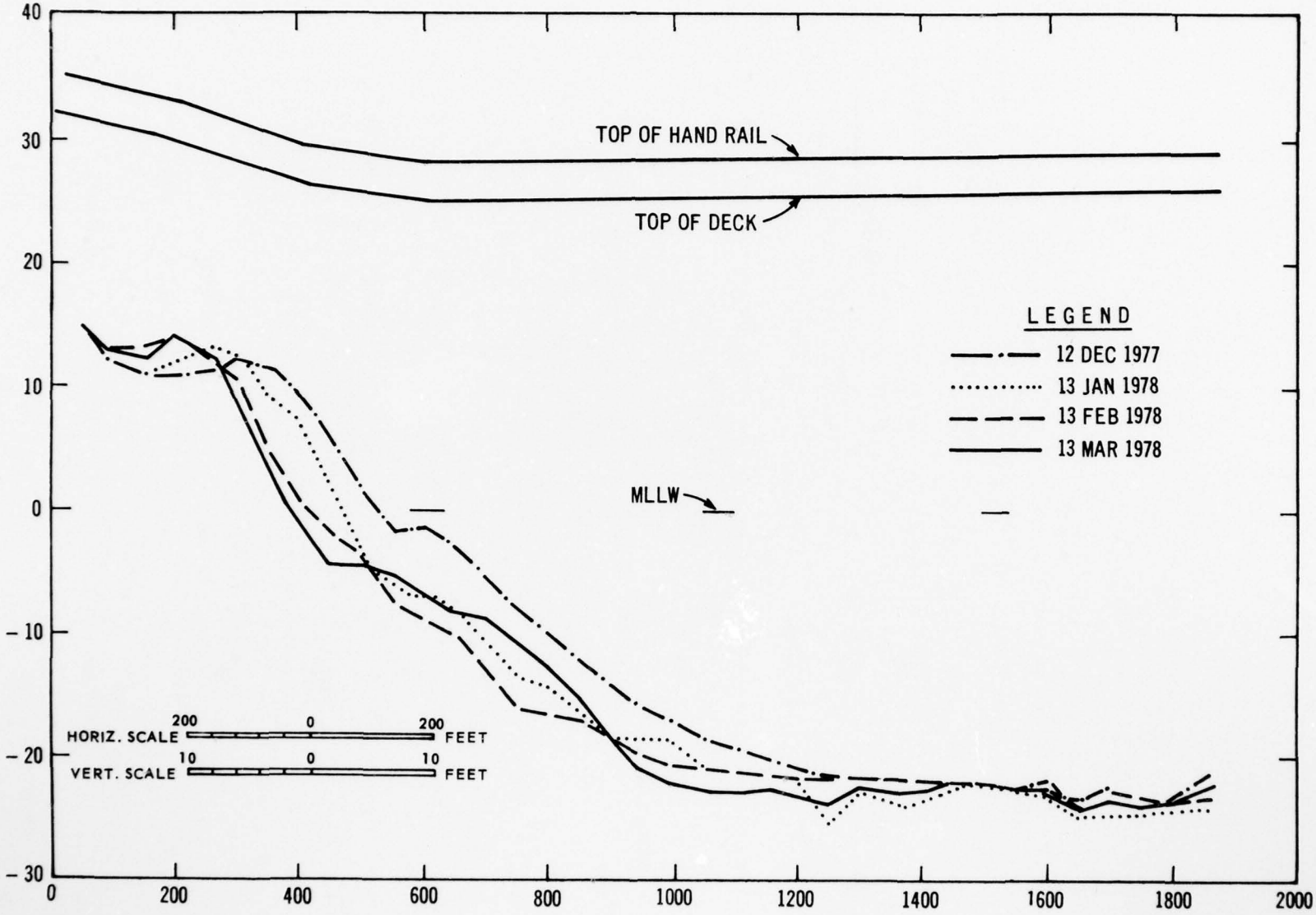


FIGURE 16 - PIER PROFILES FROM VENTURA PIER IN SOUTHERN CALIFORNIA

FIGURE 17 - SOUTH JETTY HUMBOLDT HARBOR

FIGURE 18 - DISPLACED 20 TON BOULDER, HUMBOLDT HARBOR JETTY

Figure 19 shows Morgan Point Bridge, four miles south of Cape Mendocino in northern California. Wave activity and associated currents undermined the bridge and nearby Mattole Road. In some areas, up to 20 foot widths of road surface were lost (see Figure 20).

Stinson Beach, California, is a residential-resort community located about 15 miles northwest of San Francisco. Private homeowners have built dwellings on Seadrift Spit, a sandspit vulnerable to southerly wave attack. Beach and dune erosion was extensive along the entire spit. Figures 21 and 22 depict property owners desperately fighting the incoming sea by sandbagging the toe of the dune scarp. Much of this portion of Seadrift Spit lost up to 60 feet of protective beach dune and vegetation during the storm period. Two 300-foot LONGARD tubes were used to supplement the sandbagging as a temporary method of erosion protection. This was later replaced by 1 to 3 ton rock riprap as a more permanent protective erosion device.

Significant cliff erosion took place along the coast near Pacifica, California. A large slide of a section of the 100-foot cliff exposed a corner of a residential dwelling (see Figure 23). To protect the toe of the cliff would have cost from $200 to $300 per linear foot.

At El Granada, CA, erosion of an eight-foot bluff threatened to undermine Coastal Highway 1 (Figure 24). Protection of the remaining portion of the bluff is vital if this main thoroughfare is to remain open.

FIGURE 19 - MORGAN POINT BRIDGE NEAR CAPE MENDOCINO, CALIFORNIA

FIGURE 20 - MATTOLE ROAD NEAR CAPE MENDOCINO, CALIFORNIA

FIGURE 21 - RESIDENTS PLACING SANDBAGS AT SEADRIFT SPIT, STINSON BEACH, CA

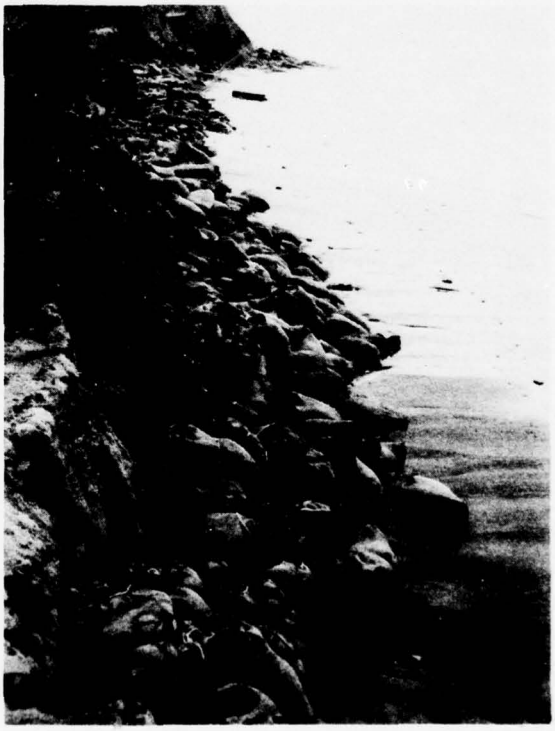


FIGURE 22 - SANDBAGS PROTECTING THE DUNE SCARP AT SEADRIFT SPIT

FIGURE 23 - CLIFF EROSION AT PACIFICA, CA

FIGURE 24 - BLUFF EROSION THREATENING COASTAL HIGHWAY 1 NEAR HALF MOON BAY, CA

Further downcoast in the Monterey Bay area, private homeowners were faced with the problems of cliff erosion and loss of beach and dune material. At Potbelly Beach (Figures 25 and 26) concrete patios collapsed and dwelling foundations were exposed. Potbelly Beach residents grouped together and financed the temporary implacement of 2-5 ton rock riprap as protection against further erosion.

DAMAGE TO SOUTH COAST

At Imperial Beach, in Southern California an average of 25 feet of beach width was lost. From pier measurements of the bottom profile it was estimated that approximately 100,000 cubic yards of beach sand was lost.

Oceanside Beach lost up to 300,000 cubic yards of beach fill placed in the area before the winter storms (see Figures 27 and 28). As can be seen in Figures 29, 30, 31 and 32 damage to Oceanside Municipal Pier and the navigation lights on the north and south breakwaters was extensive. The seaward 300 feet of the pier was destroyed along with the south jetty navigation light foundation. Rock at the end of the north breakwater was displaced so as to undermine the entire foundation of the navigation light. The Oceanside Harbor Department placed rock on storm damaged seawalls in the interior harbor at a cost of $18,000. Estimate for repair of the north breakwater and south jetty is $375,000. A total dollar figure for San Diego County area, as supplied by the California State Office of Emergency Services, is $15,600,000, of which $9,400,000 was damage to public property.

FIGURE 25 - ERODED FOUNDATIONS AT POTBELLY BEACH, CA

FIGURE 26 - UNDERMINING OF STRUCTURES BY WAVE ACTION
(POTBELLY BEACH, CA)

FIGURE 27 - OCEANSIDE BEACH, OCEANSIDE, CALIFORNIA

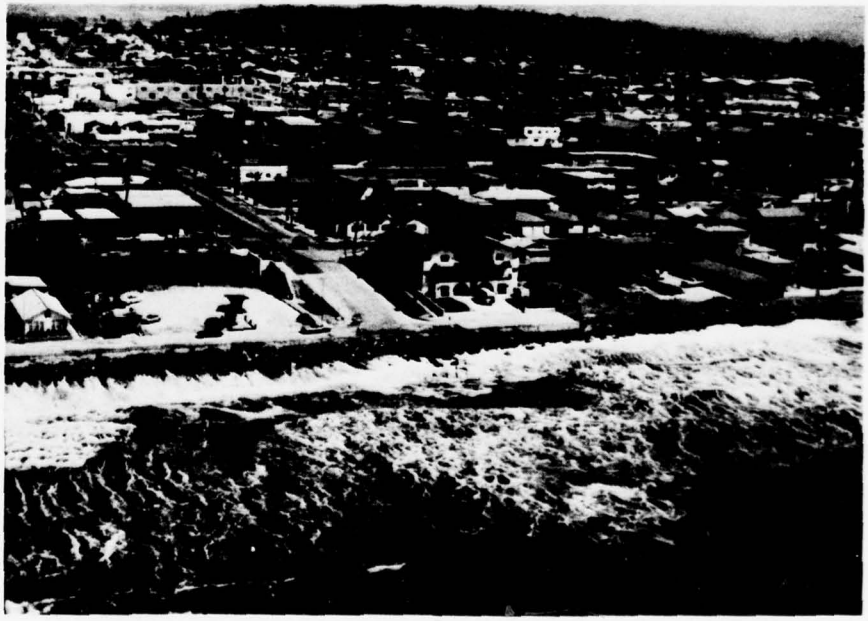


FIGURE 28 - BEACH EROSION AT OCEANSIDE, CALIFORNIA

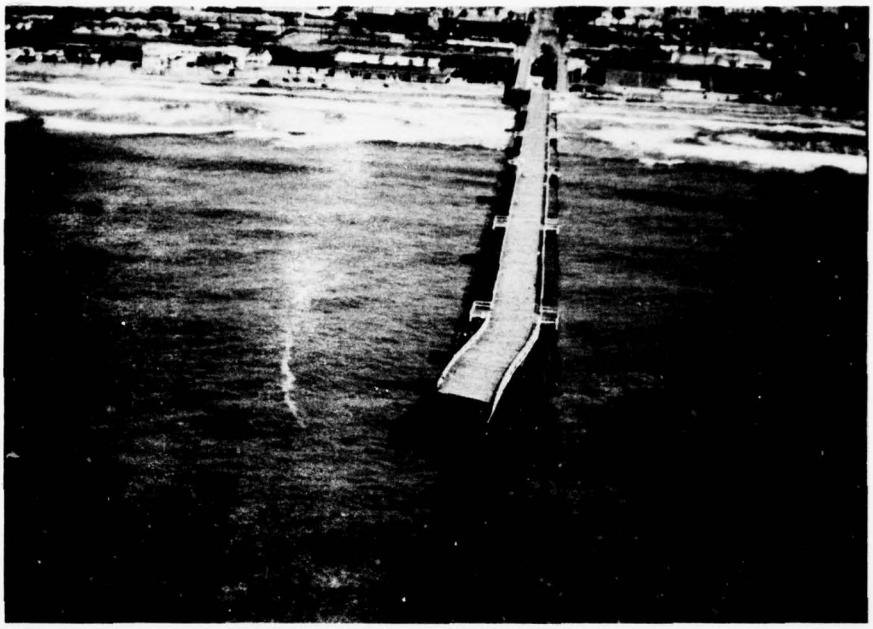


FIGURE 29 - DAMAGE SUSTAINED BY OCEANSIDE MUNICIPAL PIER

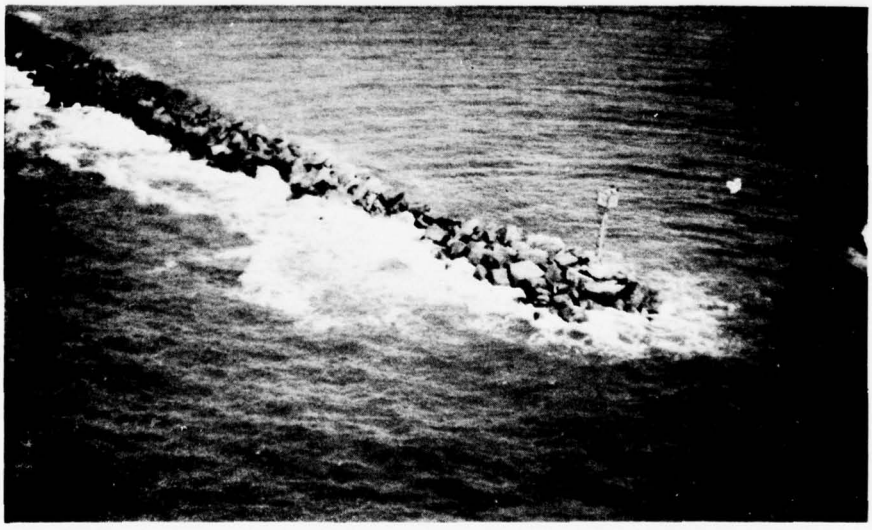


FIGURE 30 - NORTH JETTY, OCEANSIDE HARBOR AFTER THE WINTER STORMS

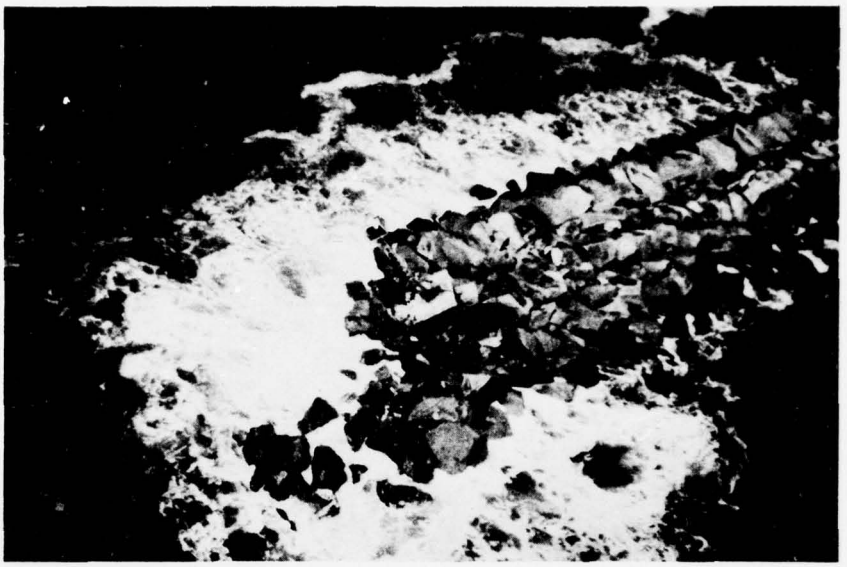


FIGURE 31 - SOUTH JETTY, OCEANSIDE HARBOR

FIGURE 32 - SOUTH JETTY, OCEANSIDE HARBOR

In Los Angeles County, the storm surf undermined the Redondo King Harbor parking area, and eroded a county bicycle path along the beachfront at Dockweiler-El Segundo beach (Figure 33).

As far as damage to coastal residences is concerned, Malibu experienced the worst wave erosion damage in Southern California. The Malibu area is another section of the coastline where historically very little beach existed and where man has built homes too far seaward (see Figure 34).

At Hueneme Beach in Ventura County, wave erosion of the beach necessitated the construction of a rock seawall to protect the city's picnic area. Ventura Marina lost a concrete-asphalt walkway on the upcoast jetty (Figure 35). As can be seen in Figure 36, the Old Coast Highway in Ventura County was also damaged by high storm waves.

Costs for protection and repair of coastal structures ran into the millions of dollars. Appendix A contains section of a draft report by the California Coastal Commission on the storm damage experienced along the California coastline with associated cost for protection and repair. TABLE 3 summarizes the wave damage cost by region (from the California Coastal Commission report).

FIGURE 33 - EROSION OF BICYCLE PATH AT EL SEQUNDO BEACH

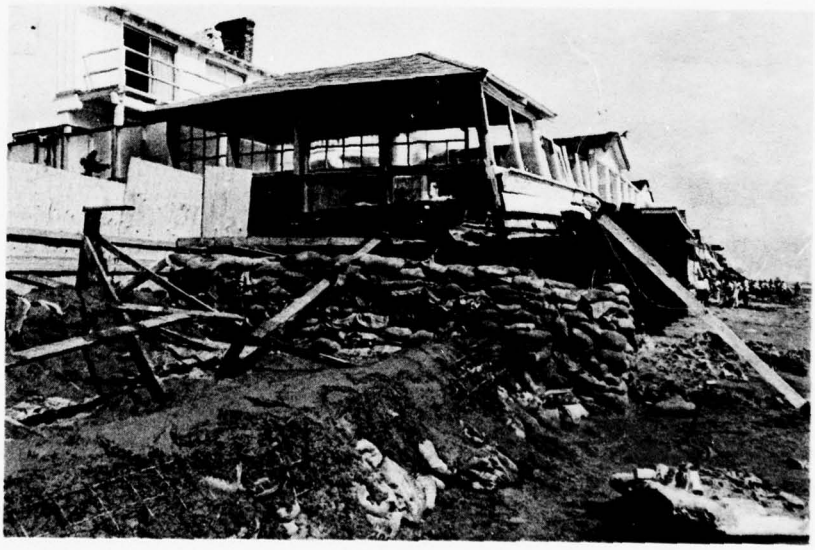


FIGURE 34 - COASTAL EROSION AT MALIBU BEACH IN SOUTHERN CALIFORNIA

FIGURE 35 - DAMAGE TO WALKWAY AT VENTURA MARINA

FIGURE 36 - WAVE DAMAGE, OLD COAST HIGHWAY VENTURA COUNTY, CALIFORNIA

TABLE 3

SUMMARY OF WAVE DAMAGE COSTS[1/]
BY REGION

Region	Private Damage	Public Assistance to Private Parties[2/]	Public Damage	FDAA Aid[3/] For Public Property Damage
North Coast	$ 85,000		$4,200,000	$3,261,000[4/]
North Central Coast	$ 604,000	$ 66,000	$ 510,000	
Central Coast	$ 853,200	[5/]	$ 196,000	$ 137,000
South Central Coast	$ 500,000	$ 8,000	$1,742,800	$ 8,000[6/]
South Coast	$2,150,000[7/]	$ 96,430	$ 606,100	$ 302,300
San Diego Coast	$ 700,000[8/]	$ 4,500	$1,026,300[9/]	$ 273,700[9/]
TOTALS	$4,852,200	$174,930	$8,280,800	$3,982,000

1/ Costs are estimates of losses, repairs, and/or emergency work.
2/ Does not include SBA loans.
3/ FDAA approved grants through July 25, 1978.
4/ Includes $3,225,000 in Federal Highway Administration (FHWA) aid.
5/ Public assistance was given, but the cost is not yet known.
6/ FDAA grant given to the City of Santa Barbara to remove destroyed homes.
7/ Includes $800,000 that may have been a combination of wave and other damage.
8/ San Diego County private property damage not well documented.
9/ Does not include an application from the City of Oceanside for $3.5 million from the FDAA.

CONCLUSION

Costs of emergency work, repair, and loss of property as a direct result of the 1977-78 winter storms along the coast of California were on the order of $20 million dollars. Coastal structures were damaged or destroyed and beaches were denuded of sand.

State-of-the-Art predictive techniques in meterology and oceanography preclude determination of extreme storm events causing significant coastal erosion. The degree or rate of erosion at any time is a function of climatic conditions and varies both seasonally and over periods of years. Cumulative effects of tides, winds, and waves play a major role in determining the erosion rate for any one season.

Erosion protection afforded by coastal structures depends upon the amount of dollars available for the construction of these devices. As is usually the case, private property owners do not have the funds to design and construct protection structures that can withstand constant exposure to wave energy. During emergency conditions make-shift protection schemes are used which do not provide permanent protection. Many homeowners devise their own protective structures which either fail or accelerate downcoast erosion.

A brochure describing basic coastal processes and shore protection techniques should be developed for California coastal areas. This would assist in making the public more aware of the potential hazards of living in the coastal zone and provide some guidance in alternative methods of shore protection.

APPENDIX A

A SECTION OF THE DRAFT REPORT ON WINTER STORM DAMAGE BY CALIFORNIA COASTAL COMMISSION

PREPARED BY

STEVE HOWE
CALIFORNIA TOMORROW INTERN
SEPTEMBER 1, 1978

NORTH COAST REGION

The North Coast Region includes the coastal areas of Del Norte, Humboldt, and Mendocino Counties. Wave related damage was reported in all three counties (see map for locations).

DEL NORTE COUNTY: Private Sector

Damage in Del Norte County occurred in the Crescent City area. A two mile stretch of coastal terrace just north of the Crescent City Harbor has experienced rapid cliff retreat in recent years. Judging from photographs of the area, lots along the bluff have been cut by as much as 25 to 50 percent over the last six years. Last winter's storms threatened one property owner with the loss of his home when the rain saturated bluff was cut at the toe by high waves. The combination of saturation and wave energy caused some sloughing of the bluff face. An emergency work permit was granted by the Coastal Commission for the placement of an additional foundation in order to prevent the residence from sliding the bluff face. As of July 21, 1978 no work had been done, as the site was still too wet for construction. A staff analyst from the regional commission estimated the lifespan of the structure to be less than five years. No seawall construction to protect the cliff face is anticipated because of the difficulty involved in anchoring the seawall. The present status of this project is unknown.

HUMBOLDT COUNTY: Private Sector

A development of homes in the King Salmon area of Humboldt Bay was flooded last winter by high tides January 9. The extent of the damage is unknown, as is information concerning insurance or other forms of

financial assistance. This particular development, constructed in the 1940's, is subjected to floods regularly. The Army Corps of Engineers has investigated schemes to protect this development, but no definite project has been approved.

Public Sector

Humboldt Jetties - During January of 1978, waves as high as 30 feet battered the Humboldt Jetties near Eureka. Damages sustained were in excess of .5 million dollars. Wave energy here was strong enough to move a 20 ton boulder from its point of implacement to the other side of the jetty, a distance of 25 feet. (See Shore & Beach Vol. 46 No. 3, G. W. Domurat.)

Mattole Road

In Southern Humboldt County waves destroyed portions of some shoreline rock slope protection and timber cribs causing considerable damage to the County maintained Mattole Road.

The roadway was undermined and up to one-half its width was damaged or destroyed for a distance of 5,700 feet. 250 feet of the roadway was completely washed away closing the road for ten days. The Morgan Point Bridge was undermined, weakening the bridge abutments. The cost of opening the road, which involved rebuilding 250 feet of one lane road and riprapping around the abutments, amounted to about $100,000. The County paid for the road opening out of its own budget but will be reimbursed by the Federal Government since the damage qualified for Title 23 Federal Aid monies.

Permanent protection measures have involved the staffs of the county, the Army Corps, and the Federal Highway Administration (FHWA). The FHWA informed the Corps on May 30, 1978 that they have the monies to restore shoreline protection along the two mile problem area. At that time, upon concurrence with Humboldt County, the Corps planned to terminate its involvement. The total cost of completely restoring the site has been projected to be approximately 2.9 million dollars.

MENDOCINO COUNTY: Private Sector

Last winter's waves washed away part of a seawall at a Georgia Pacific site in Fort Bragg. The estimated replacement cost is $85,000.

Public Sector

Public sector facilities were damaged at Fort Bragg and along two parts of State Route 1.

Noyo Harbor, Fort Bragg

High tides and waves combined to cause approximately $140,000 damage in Noyo Harbor. Pilings were broken, floats were torn loose, and a barrier wall was undermined. The Harbor District will receive $54,000 from Aetna Insurance Company. Other monies will come from the Harbor District and $36,500 from State disaster relief. Private property losses within the harbor were also reported, but the extent of damage is unknown.

State Route 1

Surf and wave action undercut the shoreline along two portions of the highway: at Juan Creek and Hardy Creek. Highway 1 was closed at Juan Creek, when the southbound shoulder slipped leaving cracks extending

across the southbound lane. Emergency opening required rebuilding the shoulder, sealing cracks, constructing water control dikes, and placing markers for public safety. The reopening cost was $4,350. Proposed restoration costs, including shore protection and engineering, has been estimated at $225,000. The California Department of Transportation (Caltrans) applied to the FHWA for Title 23 Federal Aid; the application was approved.

Similar damage occurred along Route 1 at nearby Hardy Creek. Again, the southbound shoulder slipped out and cracks across the southbound lane caused closure. Total restoration is estimated at $327,000. As of June 21, 1978, a Caltrans application to the FHWA for aid was pending approval.

NORTH CENTRAL COAST

The North Central Coast Region includes the coastal areas of Sonoma, Marin, and San Francisco Counties. The accompanying map outlines damage areas.

SONOMA COUNTY

Although Sonoma County received a disaster declaration, no damage as a result of wave action was reported. The seasonal process of beach sand removal, however, undoubtedly took place.

MARIN COUNTY

There was considerable wave related damage to private property in Marin County. The principal area of private property damage was the Seadrift/Bolinas region. Frank Kirby, of the Marin County Civil Defense

Office, estimated losses there at $232,000. Other reported damage to private property occurred in Tiburon and Dillon Beach. There were two incidents of public property damage: one in Bolinas and the other in Tiburon.

Private Sector

Seadrift

Nine homes at Seadrift Beach were plagued by high tides and pounding surf. Breakers as high as 12 feet were observed eroded away, 10 to 90 feet (horizontal distance) of sand dunes, endangering the nine homes.

The residents first tried to protect the remaining beach by sandbagging the remaining dunes. Following this they obtained an emergency permit from the Coastal Commission to enact measures to prevent further dune erosion. The residents hired a contractor to place Longard Tubing (a fiberglass tube filled with sand slurry) along the beach, running the length of the nine lots. This tubing was effective for a time but was easily undermined and torn by debris. Finally, Marin County workers placed riprap along the beach to form an emergency seawall. The cost of the county work was $66,000 and was absorbed by the county. It was estimated that homeowners spent at least $50,000 on protective measures prior to county assistance. Some SBA loans were approved in this area.

Bolinas

Five blufftop homes along Ocean Avenue were victims of a rapidly retreating bluff. Weakened by rains and waves, blocks of the cliff slumped as much as 10 feet during the worst part of the storms. Three

of the lots slumped within three feet of the homes, causing structural damage such as buckled floors and chimney separation. The houses were posted unsafe by the Bolinas Fire Department. An estimate of the loss is unavailable, but it is assumed to equal reconstruction of the homes. The other two homes were not exposed to immediate danger, although similar episodes of bluff retreat will pose a threat. Marin County proposed a $34,000 project to riprap 300 feet of beach to protect the toe of the cliff. The project was aborted, however, when the county determined three of the homes could not be saved and the other two were not in immediate danger. Assuming the three homes are total losses, damages here most likely exceeded $300,000.

Tiburon

Two waterfront restaurants in Tiburon reportedly suffered losses when high tides and waves damaged portions of shore protection. Details on the extent and type of damage are lacking. A single family residence was partially damaged when seas broke a seawall and the embankment behind it sloughed. This caused part of the structure's porch foundation to wash away. The contractor doing the repair work estimated the cost of restoring the seawall and replacing the lost foundation to be $12,000 to $15,000.

Dillon Beach

A privately-owned recreational area lost a portion of its parking lot during May and June of 1977. Winter surf further aggravated the condition. The owners spent $10,000 to place riprap in front of the parking lot and are waiting for sand to fill in behind it in order to

resurface the area. A management spokesperson stated that they have experienced worse storms in the past and accept the likelihood of future incidents. They have rejected Marin County's proposed permanent solution to protection, feeling they cannot affort it and, from the owners' experience, that the proposal is not the best measure.

Public Sector

The Caltrans District 4 office reported that approximately $10,000 from the Department's storm damage budget was needed for riprap protection of a portion of State Route 1 near Bolinas. This was identified as a repeater area; that is, some maintenance work is expected here annually.

The City of Tiburon suffered a $500,000 dollar loss when high tides and waves eroded a 3,000-foot shoreline embankment. The erosion extended into a bicycle lane and caused collapse in a number of places. The estimated repair cost of $500,000 includes the cost of restoring the embankment and repairing the path. The City applied for County and Federal aid but did not qualify in either case. The City has spent $6,000 from its general fund for shore protection and will defer other repairs until funds are available.

SAN FRANCISCO COUNTY

No specific damage reports were filed for private and public properties. Recreational areas may have suffered, however, due to loss of beach sand. The Ocean Beach area of the Golden Gate National Recreational Area reportedly was a victim of a good deal of sand loss. According to a newspaper quote of a National Park Service Planner, "In

last winters storms, the ocean came right up to the western edge of the highway." It was also reported that Ocean Beach is steadily eroding at a rate of one to two feet per year.

CENTRAL COAST REGION

The Central Coast Region is comprised of San Mateo, Santa Cruz and Monterey Counties. Coastal areas of all three counties were subjected to damaging waves (see map).

SAN MATEO COUNTY: Private Sector

Severe cliff erosion occurred south of San Francisco, at Pacifica. Many homes are built on the bluffs that run along the coastline here. A combination of rain and wave action caused a section of the cliff to slough away, leaving the corner of a house exposed. The homeowner elected to remove the overhanging room. The estimated cost of protecting the toe of the cliff below the home is $20,000 to $30,000 (Domurat, Shore & Beach). Sources did not indicate whether the homeowner did have the toe protected.

Public Sector

Public property was damaged at Thornton Beach, Muscle Rock and Half Moon Bay.

Thornton Beach

A stairway providing access to Thornton Beach was washed out by high waves. The cost is not yet known.

Muscle Rock

A seawall protecting a refuse disposal site suffered damage when wave energy moved some of the rock. The seawall was built about 10

years ago and was damaged last winter for the first time. Approximately $50,000 (from Daly City's dump fees) were used to repair the seawall.

Half Moon Bay

THree incidents of damage were located in the Half Moon Bay area. Two incidents occurred at El Granada Beach and the third involved the City of Half Moon Bay's sewer outfall.

At El Granada Beach, winter waves caused erosion up to the Route 1 right-of-way line. Spray from the waves entered the traffic lanes. Caltrans estimates that, at present rates, the roadway's support embankment could be eroded by mid-1979, with pavement loss thereafter. Although there was little damage to the highway itself from last winter's waves, Caltrans feels it necessary to construct shore protection to mitigate the ongoing erosion. The Caltrans proposed project consists of constructing an 800-foot seawall southeast of the east breakwater at Half Moon Bay; the estimated cost of the project is $750,000.

In their study used to justify the proposal, Caltrans noted that last winter the El Granada Sanitary District spent $35,000 for riprap protection of a trunk line endangered by last winter's high waves. The trunk line has since been moved to a less vulnerable location.

Heavy surf uncovered the City of Half Moon Bay's sewer outfall and broke it apart in the surf zone. Treated effluent still was being diverted to the city golf course for irrigation in June, 1978. This same line was damaged 5 years ago and was then repaired at a cost of $39,000 to Half Moon Bay. Repair estimates for this year's damage range from $20,000 to over $100,000 depending on the method of repair. Half

Moon Bay, through the cooperation of the Sewer Authority Mid-Coastline (SAM) has proposed a project that will replace the city's present outfall system by hooking up with a new SAM outfall; this project is hoped to be grant fundable. Justification for this project is partially based on a feasibility study to determine whether it would be more cost effective to modify the SAM line to include Half Moon Bay's discharge or repair the existing line (report due by July 20, 1978).

SANTA CRUZ COUNTY: Private Sector

Reported incidents of private property damage occurred at southwest facing beaches just south of the City of Santa Cruz.

Eighteen private property owners along or in the vicinity of E. Cliff Drive spent a total of approximately $90,000 to protect the toe of their bluff top lots. An average of 150-200 tons of rock was placed at the base of each lot at a cost of approximately $27/ton. In some cases there was already some property loss, while in others the riprapping was basically a preventative tactic. The residents received Coastal Commission emergency work permits prior to the work. No structural damage was reported.

Seacliff

Further south, near Seacliff State Beach, extensive property damage was suffered by 22 residents of the Seacliff Beach Association. Based on a discussion with the consultant coordinating the restoration of the area, the total cost of wave damages exceeded $500,000. Losses included damaged or destroyed bulkheads, stairs and decks.

U.S. Army personnel from nearby Fort Ord assisted residents in protecting their homes from the high waves. Details on the type, amount, and cost of assistance are not yet known.

During the worst period of storm activity residents received Coastal Commission permission to protect their homes with riprap. The cost is estimated at $4,000 to $5,000 per lot. Twenty of the Association members have jointly contracted for a bulkhead reconstruction project to replace those destroyed. The cost per lot is estimated at $15,000 to $20,000. Replacement of stairs will run about $1,000 and deck reconstruction is estimated at $2,500.

Sixteen of the homeowners have applied for SBA loans to cover their cost of repairs. The status of the applications is not known at this time. Interviews with some of the homeowners indicated that some homeowners decided against applying for SBA assistance, while others were unaware of their eligibility.

Potbelly Beach

The manager of the Potbelly Beach Club indicated (through a letter received August 22, 1978) that last winter's damaging waves cost the homeowners approximately $250,000 in emergency work and repairs. Eleven homes, built between 1972 and 1974, sustained damages. Four homes lost their decks to high waves; the remainder suffered less serious losses.

Emergency work involved the emplacement of approximately 2,000 tons of riprap to dissipate the destructive energy of the waves. The cost of the riprap, including engineering, was $50,000. The restoration cost of

the homesites, which might involve reconstruction of bulkheads, stairs, and decks, is estimated at $200,000. An SBA loan of $197,700, at 3 percent interest, will help finance the project.

Pajaro Dunes Area

Pajaro Dunes is located in southern Santa Cruz County. In this area, homeowner's structures were threatened with inundation by high waves and tides. Sandbagging operations, costing $1,300 protected a condominium complex at Pelican Point. At nearby locations 5-6 homeowners sandbagged their lots at a cost of approximately $800 each. Structural damage at any of the sites in not known. The homeowners of the dunes area have formed a committee to work on a permanent solution to their erosion problems. So far, they have not arrived at a final proposal.

Public Sector

Parking lots at Seacliff State Beach were partially destroyed when winter waves washed out a bulkhead and undermined shoreward portions of the lot. The California Conservation Corps spent 1,320 hours, at a cost of $9,900, to protect the lot. The cost of restoring the parking lot and whether the project will receive FDAA funds is not yet known.

MONTEREY COUNTY: Private Sector

A sand mining company in the county experienced major shoreline erosion due to last winter's high swells. 45 feet of bluff property was lost and a concrete tunnel that housed a conveyor belt washed away with the bluffs. Reconstruction of the tunnel and the conveyor and relocation of an existing hoist and power pole was estimated at $8,000.

Public Sector

In Carmel, a seawall at Cook's Cove parallel to Scenic Drive was damaged. At one point, 175 feet of seawall was lost and another 80 feet was damaged. The cost of restoring this section is $79,000. Another portion of the wall required slope stabilization and storm drain repairs totalling $58,000. The City of Carmel has been approved a grant from the FDAA for reimbursement.

SOUTH CENTRAL COAST

Wave damage was reported in all the South Central Coast counties: San Luis Obispo, Santa Barbara and Ventura.

SAN LUIS OBISPO COUNTY

The only wave related damage in San Luis Obispo County affected public facilities. Although permit applications were filed with the Coastal Commission requesting permission to construct seawalls as a protective measure, the applications did not indicate whether the property in question suffered any loss this past year. The applications imply, however, that there are some coastal properties within the county facing potential damage in the near future.

Public Sector

According to the Army Corps of Engineers' April report, the Port San Luis breakwater was damaged, but a cost estimate was not given. Wave related damage in San Luis Obispo County was concentrated in the Pismo Beach area where the City of Pismo Beach received Federal Disaster Assistance Administration grants for some of the repairs. Work included constructing a temporary access ramp to the beach, replacing a sewer

outfall pipe, and restoring a trailer turnaround area to pre-disaster condition. This work cost approximately $13,000. A concrete ramp at the end of Oceanview Road was destroyed when it was undermined by high waves. The cost of removing the destroyed ramp was $25,000. The estimated cost of rebuilding the ramp is $100,000. The details of financing the restoration are not presently known.

The California Department of Parks and Recreation received a FDAA grant for $8,000 to repair damages within the Pismo State Beach area. The money was used to restore a beach access ramp at the end of Grand Avenue in Grover City. The storm waves had lifted the piles and the end of the ramp two to three feet above constructed elevation.

SANTA BARBARA COUNTY: Private Sector

The most notorious damage to the private sector was the total loss of two blufftop homes, southwest of downtown Santa Barbara. The homes were each valued at over $100,000. The cause of the destruction is thought to be primarily due to a super-saturated bluff condition, although erosion of the toe by wave action may have also been a factor. At the time of the slide, a city building inspector determined that six other homes were in varying degrees of danger. The City of Santa Barbara financed the removal of house debris and was reimbursed $8,000 by the FDAA.

Public Sector

Beaches and other recreational facilities were damaged in Santa Barbara County. Debris and silt removal at the city of Santa Barbara's shoreline park and Marina cost $12,000. Repairs to an electrical line

in the Marina, which involved securing the line to a rock foundation, cost $1,300. An FDAA grant provided the necessary funds. The City of Carpinteria received $2,300 through the FDAA for debris removal from the city beach.

State Beaches

The El Capitan, Graviota and Carpinteria State Beaches experienced damage from storm wave conditions. An abnormal amount of debris was deposited along the beaches. The cost of debris removal from these beaches was approximately $9,500. Damage to campsites, a lifeguard station and riprap at Carpinteria cost $6,000 to repair. At Graviota State Beach, repairs to a roadway, fence and shore protection cost an additional $5,400. The monies for the repairs to these beaches will be provided by an FDAA grant. The loss of recreational value, due to sand removal, is difficult to assess, although a loss will exist until the sand is replaced, either naturally or artifically.

VENTURA COUNTY: Private Sector

Wave damage to private property within Ventura County caused damage in excess of $300,000. Major impact areas were Mussel Shoal, Faria Beach Colony and Oxnard Shores. The following account is taken from the Army Corps Los Angeles District, April damage report. Detailed documentation of losses, repairs and financial assistance will be incorporated in the final version of this report.

Mussel Shores

Four ocean front homes were threatened by waves during the worst part of the winter (early January, 1978). The property owners had their

homes protected by the construction of a rock seawall at a cost of approximately $20,000 for the entire project.

Faria Beach Colony

Over 25 beachfront homes suffered damaged or destroyed seawalls and bulkheads, washed out stairs, patios and decks, broken windows and water soaked interiors. Based on construction estimates elsewhere in the state or similar repairs, the cost of restoring the homes to pre-disaster condition will probably be between $5,000-$10,000 each.

Public expense involved at Faria Beach consisted of Sheriff Department and Disaster Office staff being station at the site. At the peak of the storms 8 to 10 Sheriff's Department people were at the site to set up roadblocks, patrol to prevent looting and to assist those in dire need. More details on Sheriff's assistance will be included in the final version of this report.

Oxnard Shores

The Army Corps' report stated that "many private owners of sea front dwellings had damages in excess of $5,000. Oxnard Shores was one of the areas in Ventura County hardest hit by the storm." This area was damaged by waves in 1969 and 1972. After the 1972 storm season rock revetment was placed to protect many of the homes. As a result of the revetments, the damages from last winter's waves were less severe than previously. Further south, a condominium project known as Whalers Village had 1,500 tons of riprap placed to protect the dwelling unit and efforts are underway to construct a riprap bulkhead to protect the piers from _____ scour. The cost of this project will be included in the final version of this report.

Public Sector

Public losses in Ventura County consisted of damages to City and State beaches and recreational facilities associated with them. Highways in the area also sustained damages.

State Beaches

The California Department of Parks and Recreation received FDAA aid for approximately $135,000 to restore the following state beaches in Ventura County: Emma Wood, San Buenaventura and McGrath. The figures presented in this dicusssion represent the amounts approved by the FDAA. Costs do not include labor unless noted.

Damage at Emma Wood State Beach was the most extensive in the county. Pounding surf eroded much of the beach and recreational vehicle parking area. The concrete base of a lifeguard tower was washed away. Restoring the beach and parking area will require 1,700 cubic yards of fill and rock fill material and 2,700 tons of riprap; the cost, including labor, is estimated at $63,871. The road into the park was destroyed by wave action and will cost, including labor, $12,700 to replace.

At San Buenaventura State Beach major losses included damage to the Ventura Pier and Lifeguard towers and the cost of removing debris. The pier needed replacement piles, decking and bracing. The cost of materials was estimated at $22,300. A newspaper article stated an estimated $75,000 for the pier's repair. The cost of replacing a lifeguard tower and repairing another, including labor was approximately $4,500. Approximately 11,000 cubic yards of 12-inch diameter and smaller driftwood, (etc.) was deposited on the beach by storm waves. Removal involved

piling up the debris, burning it, picking up ashes and hauling it away at a cost of $12,415. To date, the FDAA has provided approximately $41,000 for work done at San Buenaventura Beach.

12,000 cubic yards of debris was also deposited at the McGrath State Beach. The method of removal was the same as at San Buenaventura but the cost here was estimated by a contractor at $17,800.

Highway Damage

Old Highway 101 suffered damages south of Hobson Beach and also near Emma Wood State Park. The storm removed some protective rock and storm waves deposited rock, debris and mud on parts of the highway, at times endangering motorists. At least 1.1 million dollars will be needed to restore the highway to pre-disaster condition. The funding status for the repairs is not known.

The City of Ventura received $8,300 from the FDAA to remove debris at Marina Cove Beach. The Army Corps of Engineers reported damage to the marina itself. Navigation lights on the detached breakwater were damaged and armor rock was badly displaced along parts of the breakwater. The asphaltic concrete walk on the north jetty was almost totally destroyed by waves overtopping the jetty. The manager of the Ventura Marina stated that repairs will cost $200,000-$300,000 and that repairs were the responsibility of the Army Corps of Engineers. The manager also stated that repairs were being deferred to a later date because the damage is not serious enough to warrant immediate repair.

SOUTH COAST REGION

The South Coast Region is comprised of the coastal communities of Los Angeles and Orange Counties. Public and private sector damage was reported in both counties (see map for locations).

LOS ANGELES COUNTY: Private Sector

Malibu

High tides and waves at Malibu cost approximately 1-1.8 million dollars in private property losses. In addition, approximately $95,000 in public assistance from the National Guard and various L.A. County agencies was provided to Malibu residents during February and March of 1978. Federal assistance, such as SBA loans, is yet to be determined. Private damages and public expenditures at Malibu is still being investigated so the present figures may represent a fraction of the total. Malibu was the most publicized and hardest hit coastal area in the state. The publicity was due, in part, to the number of celebrities owning homes in the area. The Malibu coastline, which faces south and southwest, was directly exposed to last winter's high waves. Many of the beach homes are 30 to 40 years old and are built right on the beach. Protective works, such as bulkheads, proved ineffective or had deteriorated to the point where storm waves were going to cause damage. Damage included damaged or destroyed bulkheads, seawalls, beach access stairs, teahouses, decks, patios, piers and pilings, and some broken windows and interior flooding.

The Los Angeles County Building and Safety Department compiled a list of estimated damages resulting from slides, undermining, and inundation. Damage to at least 180 beach front addresses is estimated to total 1.34 million dollars. Of this damage, $500,000 was for wave damage. The balance of the estimate is for damage to structures that suffered a combination of damage, from waves and mudslides. In addition, there were at least 50 homes not on the County list that suffered wave damage to pilings, bulkheads, stairs, and teahouses. Discussion with contractors and consultants with clients in the area indicate a conservative damage estimate of approximately $10,000 per house. Therefore, the total cost of wave damage in the Malibu area is at least 1-1.8 million dollars. This does not include any emergency work which was not listed on county records. Cost totals for emergency work (e.g. riprap) should be available at a later date and included in the final version of this report.

Public expenditures to protect private property included the deployment of the National Guard and the Los Angeles County Fire, Sheriff, Road, and Building and Safety Departments. These agencies provided personnel and machinery to administer and construct emergency protection. Volunteers, including students from nearby Pepperdine University, also aided Malibu residents.

The National Guard invested 1,871 man-days at Malibu from March 4 to March 7 to assist residents in protecting their homes. The cost of the National Guard operations was approximately $70,000 and came from the State Emergency Fund.

The Los Angeles County Fire Department also aided Malibu residents during the winter storms. Newspaper reports indicate that as many as 60 Fire Department employees were on the beach at any one time. The only Fire Department cost documented to date is $7,200 for overtime salaries. Fire Department officials emphasized that this figure represents a minimum of the total involvement cost. The majority of Fire Department assistance came during the day when workers were on their normal shifts. At night, the crews were greatly reduced; the overtime cost reflects this reduction in forces. Further investigation may reveal a more accurate account of the true cost involved.

Employees from the L.A. County Sheriff's Department responded to the Malibu area to assist storm victims. Overtime Sheriffs' salaries totalled approximately $11,400; again, records were not maintained for time worked during an individual's normal work shift. Mileage, supplies, and helicopter flight time cost about $5,500.

A spokesperson from the L.A. County Road Department estimated that 20,000 to 30,000 County purchased sand bags, at a cost of approximately $3,400, were used by County agencies, residents and volunteers to protect homes along the beach.

El Segundo

Southern California Edison spent approximately $250,000 to place 200,000 tons of riprap along 2,500 feet of beach frontage. Last winter's waves eroded the beach right up to the fence that borders the power plant. A spokesperson for S.C. Edison indicated that the riprap appears to be a permanent protection scheme, although a few years of observation may indicate otherwise.

Redondo Beach

At Redondo Beach riprap was placed to protect an apartment building at a cost of approximately $10,000. Details should be available at a later date and will be included in the final version of this report.

Public Sector

There are six locations in Los Angeles County where wave damage incidents were reported. They are: Leo Carillo State Beach, Santa Monica, El Segundo, Redondo, Long Beach and Avalon (Catalina Island).

Leo Carillo State Beach

The State Department of Parks and Recreation spent $1,300 to remove debris, reshape the beach, and replace some concrete steps that were washed away by the storms. The funds were reimbursed by the FDAA.

Santa Monica

The City of Santa Monica municipal pier was damaged. Pilings, bracing, struts, beams and ladders were damaged or destroyed. The cost for repairing the pier was estimated at $80,000 by a spokesperson for Santa Monica's General Services Department. He also stated that a Federal grant will provide $65,000 for the restoration. Santa Monica applied to the FDAA for a $4,300 reimbursement for debris removal but the application was denied on the grounds that the debris was a normal winter condition.

El Segundo

At Dockweiler - El Segundo Beach a County maintained bicycle path seaward of the Southern California Edison and Chevron properties sustained damages in excess of $140,000. This figure represents emergency

protection ($1,400), construction of a detour ($25,000), and the cost of relocating the path (approx. $120,000). Details on the financing of the work are not yet known. Further investigation will provide a more detailed documentation of the types and costs of any damages and protection projects in this area, and will be included in the final version of this report.

Redondo Beach

High waves and rough surf weakened or removed rock protection along the breakwater and parking area at King Harbor. The utility trough, sewer main, struts, and braces were either broken or weakened at the city pier. The FDAA granted approximately $46,000 for repair of these damages.

Long Beach

Long Beach Harbor was damaged by waves. The armor rock at Pier J was undermined when waves removed underlying soil, and 541-foot long rock dike along the Queen Mary berth site slid into the harbor. The cost of repairing these works is approximately $150,000. A contractor suggested that the dike's elevation be raised 4 to 5 feet at an added cost of $37,500. City owned dredging equipment was damaged during the storm. The cost of repairs was about $14,000. The FDAA has approved Long Beach's application for a Federal grant.

Avalon

Extensive beach erosion occurred at the city maintained beach. The City of Avalon's request for FDAA aid to finance beach renourishment was denied on the grounds that the erosion was a normal winter condition and not eligible for disaster relief.

ORANGE COUNTY: Private Sector

Private property was damaged at the Surfside Colony and Newport Harbor areas of Orange County (see map).

Surfside Colony

According to the Army Corps April storm report 15-50 feet of beach was eroded during the storm. Property owners hired work crews to build an artificial sand berm and maintain it for the duration of the storm. The cost to protect the houses is not yet known but will be in the final version of this report. The City of Seal Beach spent $430 for sandbags and pumping storm water.

Newport Harbor Area

Winds up to 92 mph caused considerable confusion and damage to boats within Newport Harbor. The extent of damage to boats is not known. City of Newport Beach employees retrieved loose boats and made rescues. The City will receive approximately $1,000 from the FDAA for reimbursement of their emergency service.

Public Sector

Seal Beach

The municipal pier's lower deck was destroyed by high waves. A sewage tank, pumps, an electrical panel, a landing and storeroom were the damaged facilities on the deck. The cost of repairing the pier is estimated at $39,000. The FDAA approved a $35,000 grant to Seal Beach for repairs. The City also applied to the FDAA for $48,000 to finance a sand replenishment program. The FDAA denied this application.

Sunset Beach Sanitation District

High tides, rough surf and storm water runoff combined forces to clog pumps at the sanitary lift station with debris. The debris jammed and damaged the lift pump. The FDAA granted $28,000 to repair the lift station.

Huntington Beach

Damage to the Municipal fishing pier included broken and lost piping, a washed out catwalk and weakened and gouged pilings and bracings. This damage qualified for $9,300 from the FDAA.

Newport Beach

Three piles were broken and a ramp and landing were partially damaged at the Newport Pier. The estimated cost of restoration, including some miscellaneous repairs, is $13,000. FDAA aid will pay for the pier repair. The City also requested FDAA assistance to pay for the removal of debris on Ocean and Bay Beaches. The City cost was about $9,500. The FDAA approved a grant of $2,200 and stated that the rest of the damage occurred outside the disaster declaration dates.

San Clemente

Eleven piles were torn loose at the San Clemente Pier. Replacement cost was estimated at $19,000. The cost of removing storm borne debris on city beaches was $8,500. The FDAA approved San Clemente's disaster aid applications and the City will receive full funding for reimbursement of these losses.

Other known Orange County locations suffering damages were the Aliso and Dana Point Harbor Beaches and a park in Laguna Beach. Orange County requested FDAA aid for $6,400 to replenish sand at Dana Point Harbor and $1,500 to repair a curb, gutter, sidewalk and stairway at Aliso Beach. The FDAA approved the application only for the Aliso Beach work. The City of Laguna Beach received approximately $1,600 in FDAA funds to repair damage to beach access stairs within the park.

SAN DIEGO COUNTY REGION

The entire San Diego County was hit hard by last winter's storms. The California State Office of Emergency Services reported the total monetary loss county from inland flooding, slides, and wave damage was 15.6 million dollars. Of this 6.2 million was private and 9.4 million public. The figures were not broken into coastal and interior damages, however. More specific statistics should be available from the SBA and FDAA and will be presented in the final version of this report.

Private Sector

Private property damage in San Diego County occurred along the coastal bluffs between La Jolla and Oceanside. Homes were damaged or threatened in Oceanside, Carlsbad, Del Mar, and La Jolla. The Atchison, Topeka and Santa Fe Railway Company tracks were undermined near Del Mar.

Oceanside

In Oceanside, high surf conditions threatened one apartment building and damaged another. More than 150 tons of rock was eroded from a city-owned revetment that protects the Villa Marina apartment complex. Although the cost of replacing the rock is not known, it is estimated to

have cost $4,000. Another apartment building was hit by 10-foot breakers that sent water and rocks throughout the first floor, causing eight residents to evacuate. Damage was estimated at nearly $500,000. City crews were on the scene to assist. Public expenditure at the site is not presently known, but will be included in the final version of this report.

Carlsbad

In Carlsbad 13 homeowners received permission from the San Diego Coast Regional Commission to protect their properties. Stairs, bulkheads, and rock protection were damaged or destroyed. Rock revetments were constructed to prevent further structural damage and/or property loss. Details on the monetary losses involved and the financing of repairs are not presently available, but will be in the final report.

Del Mar

Structural damage as a result of wave attack in Del Mar last winter was moderate. The cost of damage is not yet known. The Del Mar City Council authorized the construction of a temporary berm to assist property owners in protecting their beach front homes. The FDAA granted $4,500 reimbursement for Del Mar's emergency services.

Santa Fe Railroad

Portions of the Santa Fe railroad tracks were undermined near Del Mar. Rains and wave action caused bluff failure in two different locations. Approximately $20,000 was spent placing riprap at the toe of the bluff. Permanent work involves construction of retaining walls and backfilling the sites. Cost estimates and financing information will be made available by the railroad company, and will be included in the final version of this report.

La Jolla

Six property owners in the La Jolla area faced the dual threat from rain soaking the bluffs and waves attacking it from below. The resulting damage to property was caused by slope failure. Emergency measures involved riprap slope protection, and permanent repairs called for some slope stabilization and structural repairs. Typical costs were $20/ton for riprap and ranged from $6,000 and $175,000 for slope stabilization and structural repairs.

In summarizing San Diego County's private property damage, reports from local newspapers and the Army Corps' April storm report indicate that many locations in the county suffered extensive beach sand loss. In some area, as much as four vertical feet of beach was washed away. As a result access stairs, undermined decks, and riprap were lost. Locations noted in newspapers included Del Mar, Solano Beach, La Jolla, and Encanitas. Further investigation should provide detailed dollar loss and repair financing statistics.

Public Sector

State Beaches and City and County recreational facilities suffered damage at Oceanside, Carlsbad, Encanitas, Del Mar, and San Diego.

State Beaches

State beaches qualified for $210,000 in FDAA aid to repair wave damage at San Onofre, Carlsbad, Moonlight, San Elijo, Cardiff, and Silver Strand State Beaches. These beaches, as well as others in the county, also suffered tremendous losses due to storm water runoff, but these costs are not included in this report.

Three lifeguard towers were lost and 16,000 cubic yards of debris were removed at San Onofre State Beach. The cost of replacing the towers was $3,000 and debris removal cost $83,500. The FDAA granted the needed money.

_____ action undermined a parking lot and washed out a campsite and drainpipe. The total cost to restore the site, including slope stabilization and emergency shore protection, was approximately $45,000.

A parking lot, paved path, and a drainage ditch were lost at Moonlight State Beach. Emergency protection of a lifeguard station and a parking lot, consisting of riprap and sandbagging, cost $2,600. Restoration of the parking lot, path, and drainage was estimated at $4,700.

An embankment and 300 linear feet of chain link fence was washed out at San Elijo State Beach. The FDAA granted approximately $14,500 to repair, replace, and protect the embankment and fence.

A lifeguard tower at Cardiff State Beach was destroyed and replaced with $741 from the FDAA.

Sewerlines, guard towers, and restroom slabs at Silver Strand State Beach were damaged. The cost of emergency operations (sandbags, ect.) was approximately $7,000, while restoration of damaged facilities cost about $30,000. The cost of moving beach sand where it would not wash away and then back to its normal location was approximately $18,000. The remaining reports of known public property wave damage in San Diego County are taken from FDAA disaster aid applications and newspaper

accounts. Public property was damaged in Oceanside, Carlsbad, Encanitas, Del Mar, San Diego, and Imperial Beach. Further damage reports and associated costs are pending investigation, and will be included in the final version of this report.

Oceanside

The Oceanside area was particularly hard hit. Over 300,000 cubic yards of beach sand dredged from the harbor and placed on the beach in 1978 were washed to sea by storm waves. The south jetty lost 30 feet off its end and the entire length was weakened by waves. The end of the north breakwater was also badly damaged exposing the navigation light foundation. Contractor estimates to repair the jetty and breakwater ranged from $280,000 to $375,000. The FDAA determined that 20 percent of the damage occurred prior to the disaster declaration and will only approve 80 percent restoration funding. The exact amount of FDAA funding is not presently known.

The Oceanside Small Craft Harbor District received approximately $43,900 from the FDAA to repair damages within the inner harbor. The cost of replacing seawall rock and a beacon light was $17,300. Damage to docks, water connections, and electrical outlets cost $23,200 to repair. Miscellaneous repairs cost about $3,400. These repairs included debris removal, and riprap protection of the Chevron station fuel line, a Coast Guard station, and a sportfishing ramp.

The City of Oceanside applied to the FDAA for 3.5 million dollars to repair the municipal pier and part of a parking lot. Waves eroded a 50 by 300 foot section of pier parking area. The cost of replacing the

lot is approximately $15,000; this project was found ineligible for aid because the damage occurred before the declared disaster date. Approximately 300 feet of the seaward end of the municipal pier was destroyed by waves. Preliminary estimates indicated a restoration cost of $450,000. The FDAA will provide funding for repair of the pier but the exact amount is not yet known. The FDAA reimbursed the City of Oceanside $2,300 to cover the loss of recreational equipment destroyed by wind and waves at the northern part of the city beach.

Carlsbad

The City of Carlsbad received $700 from the FDAA to rebuild a beach access stair damaged by pounding surf.

Del Mar

Along with the reimbursement for emergency services (see private sector, Del Mar), the city received FDAA funding totalling $3,200 for removal of sand and silt from Coast Boulevard to the beach.

San Diego

Information on public property damage under San Diego city jurisdiction is incomplete, but will be included in the final report.

Emergency vehicle access to Black's Beach was destroyed by storm surf conditions resulting in closing the beach. Repair costs are not known. At South Mission Beach, 100 cubic yares of 1/4 to 1/2 ton riprap was placed on the beach to protect a lifeguard tower footing. The cost will be included in the final report.

Imperial Beach

Piles and a boatramp at the Imperial Beach Pier were damaged. Emergency protection cost $1,800. The cost of repairing the pier and boatramp is approximately $18,500, bringing Imperial Beach's storm costs just over $20,000. The FDAA approved funding for $17,500.

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