

249-311 PACIFIC AVENUE COASTAL BLUFF STABILIZATION

SOLANA BEACH, CALIFORNIA

► OWNER

Pacific Avenue Homeowners

► DATE OF COMPLETION

Professional Services: 2001

► PROJECT COST

Professional Services: \$222,500



A 352-foot-long section of sea cliff failed along a section of coastline during the 1997-98 El Niño storm season, when upwards of 15 feet of lower sea cliff retreat undermined the upper terrace deposits and triggered an upper-bluff failure to within 3 feet of the bluff-top residence. The loss of the protective sand beach, which caused accelerated lower sea cliff erosion, also lowered the shoreline elevation at the base of the sea cliff to only 1 to 2 feet above sea level. The shoreline stabilization necessitated arresting both marine and subaerial erosion. In order to stabilize the 85-foot-tall coastal bluffs, the computed additional required lateral restraint was on the order of 41 kips per lineal foot, with the upper row of tiebacks spaced on 10-foot centers having a design load of 230 kips per anchor. The reconstruction of the upper 55 degree sloping coastal bluff was further complicated by the need for geogrid reinforcement, with insufficient embedment length available for the required geogrids. This then required a rear structural beam to restrain the significant tensile forces imposed by the geogrid to retain the 60-foot-tall upper sloping coastal bluff.

The free-form structural shotcrete tied-back wall, which was carved and colored to blend in with the adjacent coastal bluffs, was built entirely during

the winter months between storms and high tides. A footing key cut into the bedrock, a wall drainage system, and other associated components at the base of an unstable coastal bluff necessitated a complex temporary shoring system to provide construction-period site safety.

In addition to the design challenges, numerous permitting hurdles were also overcome through a variety of agencies, including the local community, the California Coastal Commission, the State Lands Commission, the U.S. Army Corps of Engineers, the Regional Water Quality Control Board, the U.S. Fish & Wildlife Service, and the National Marine Fisheries Service. A detailed alternatives analysis was required to justify both the need for the project and to demonstrate that the project, as proposed, was the minimum level necessary to protect the bluff-top improvements. After the completion of the project, regulatory and resource agency staff were all pleased with the natural appearance of this major coastal structure.

TerraCosta Consulting Group was both the civil and geotechnical engineer-of-record for this project, which was awarded the 2001 *Marine/Waterfront Concrete Structure Award* by the American Concrete Institute.