



The accompanying map shows the approximate boundaries of former shores, ponds, and tidal flats, and streams now filled or concealed, as well as the approximate area of former tidal flats, along part of the east side of San Francisco Bay, Calif. This map, showing areas that were formerly tidal flats or shallow parts of the bay, and therefore probably underlain by bay mud, can be useful in the planning of foundation investigations and the preliminary design of structures in these areas.

Most of the data on which this map is based were taken from copies of unpublished U. S. Coast Survey (now U. S. Coast and Geodetic Survey) planetable sheets No. XIX, 1855, and Nos. XXIV and XXV, 1856, on a scale of 1:10,000. These data were compiled on present-day topographic maps on a scale of 1:20,000 by use of a focalmatic projector; they were then slightly modified and supplemented by additional information taken from the unpublished Coast Survey map entitled, "Resurvey of San Francisco Bay," 1895, logs of borings, and aerial photographs on which scars of old tidal channels are visible. The shoreline features are shown on parts of the Oakland East, Oakland West, and San Leandro 7½-minute topographic quadrangle maps on a scale of 1:48,000. The base maps were published in 1947, 1949, and 1947 respectively; they show the culture and shorelines as of those dates.

The scale of parts of the copies of the U. S. Coast Survey maps was possibly distorted, and in many areas few landmarks are common to both the 1856 and the recent maps; the positions of the former shoreline features shown on the accompanying map are therefore approximate in many areas.

Landward of the former shorelines or tidal flats the ground consists of Merritt sand, or gravel and sand-silt-clay mixtures of the Temescal formation or the Alameda formation, all of Pleistocene age (Lawson, 1914; Radbruch, 1957). In general, these units are good foundation materials.

Most of the area between the present and former shorelines has been covered by artificial fill. These flat, filled areas are used extensively for industrial buildings of various kinds and for housing developments. In most places the artificial fill overlies soft bay mud. An exception to this generality is the fill west of the old shoreline between 53d Street in Emeryville and University Avenue in Berkeley. Here a low wave-cut scarp of gravel and sand-silt-clay of the Temescal formation or the Alameda formation marks the former shoreline; west of the scarp, artificial fill is underlain by material of the Temescal or Alameda formations, which was cut into a bench by the waters of the bay. Little or no mud was deposited on the bench before the fill was placed.

The bay mud, which underlies the fill in most places, consists predominantly of homogeneous, plastic, olive-gray, sandy, silty clay with a few small sand lenses, shells, and organic material. It ranges from a few inches to 85 feet in thickness. In general it is soft and fluid at the top, becoming increasingly consolidated with depth. Bay mud typically has a dry density near 50 pounds per cubic foot, and a moisture content of about 75 percent; dry density of bay mud ranges from 35 to 100 pounds per cubic foot, and moisture content from 20 to as much as 145 percent. Moisture content may be higher in mud containing abundant peat. Most of the mud is too soft to be a suitable foundation material. When any load, such as artificial fill, is placed on the mud, the mud consolidates with resultant settlement of the fill. If the fill is then loaded with heavy structures, additional consolidation of the mud may take place, with consequent settlement of the structures. If settling should be differential, damage to the structures can result.

The tidal channels of the still-exposed mud flats may present difficult foundation problems. The channels frequently change position, and some of those shown on the 1856 map have shifted to other locations. See, for example, the channels at the foot of Seminary Avenue in Oakland. Owing to tidal action, the abandoned channels are filled with mud softer and more poorly consolidated than the mud on the adjacent flats. When artificial fill is placed over an area containing recently filled tidal channels, the softer muds of the old channels will consolidate more than the mud of the rest of the tidal flat; the resultant uneven settlement of the fill could cause serious damage to roadways or structures. Fill placed in existing tidal channels will be thicker and will therefore have a greater total weight than fill placed on the areas between the channels. The mud underlying the channels will therefore consolidate more than the mud underlying the interchannel parts of the tidal flats, so that differential settlement of the fill may result.

Most artificial fill along the east shore of San Francisco Bay consists of Merritt sand that has been dredged or pumped from offshore underwater borrow areas. In some places, however, it may consist of bay mud, material from the Temescal formation, broken rock, or miscellaneous refuse. In general, controlled and properly compacted fill will form an adequate foundation for light structures.

REFERENCES

Lawson, A. C., 1914, Description of the San Francisco district, California: U. S. Geol. Survey Geol. Atlas, Folio 193, 24 p.

Radbruch, D. H., 1957, Areal and engineering geology of the Oakland West quadrangle, Calif.: U. S. Geol. Survey Misc. Geol. Inv. Map I-239.

Base map consists of parts of Oakland East, Oakland West, and San Leandro 7½-minute topographic quadrangle maps

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C. MR 0198 Former shoreline features compiled by Dorothy H. Radbruch, assisted by Mary Alice Turner, 1958

FORMER SHORELINE FEATURES ALONG THE EAST SIDE OF SAN FRANCISCO BAY, CALIFORNIA

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