SAN FRANCISCO BAY TIDES

Basic Mechanics: The tides of the Earth are caused by the gravitational attractions of the sun and moon. The basic physical laws underlying tidal forces are well known and don't need to be covered here except in gross overview. For those who want a quite detailed, technical discussion of the Bay's tides, refer to Tides, Tidal and Residual Currents in San Francisco Bay California - *Results of Measurements, 1979 - 1980* by and available from the US Geological Survey.

There are some terms which are useful when using tide tables or discussing tides. They can help you understand some of the complexities of tidal currents:

SPRING and NEAP tides are respectively the highest and lowest tides of the lunar cycle. Spring tides are produced when the moon is in alignment, or in syzygy, with the sun, as at the full and new moons. The neap tides are produced when the moon is directly out of alignment with the sun during the moon's waxing and waning quarter.

The PERIGEAN tides are those produced when the moon is at its perigee, or at its closest point to the earth in its elliptical orbit. Perigean tides tend to be relatively strong.

The TROPIC and EQUATORIAL tides are produced respectively when the moon is directly over one of the earth's tropics (Cancer or Capricorn), or when the moon is directly over the earth's equator. Tropic tides produce greater relative variations between high and low water, when equatorial tides produce relatively less.

A tidal EDDY is caused by the intrusion of some sort of barrier into the tidal current or the presence of some gap or irregularity in the shore by which the current is passing. The eddy is a rotary motion similar to a whirlpool. In the Bay, eddies can commonly be found on a flood tide east of the south support for the Golden Gate Bridge, northeast of Point Blunt, and south of the line between Land's End and Fort Point.

A tidal RIP occurs at any point where two bodies of water move past each other with different relative velocities. This can occur at the edges of an eddy which is moving perhaps opposite to the main tidal current. It can occur at the boundary where the flood and ebb tides meet, such as along the San Francisco waterfront within an hour before the tides change. If you know the nature of a rip, you can try to adjust your course in order to stay longer on the side of the rip whose current is more helpful to you.

You identify rips by their TIDE LINES or lines of shear between the currents. The rip is actually a line of small eddies between the water that runs at differential speeds. In the same way that the tea tends to concentrate in the center of a stirred teacup, the debris in water are held toward the center of these eddies. Tide lines can be quite difficult to identify. Looking for lines of foam or even different wave patterns extending along the line of the tidal current can give them away.

The TIDAL BORE, as the term is used on San Francisco Bay, is the rush of river water from the Sacramento River when it is running high. The bore can be seen, and sometimes heard, coming across the Central Bay, oftentimes hitting the San Francisco waterfront with an audible rush.

Bay Tidal Overview: The San Francisco Bay is a 400 square mile system connected to the Pacific Ocean solely by the Golden Gate, an opening of less than a mile. Through it rushes 3 times more water in a day than is carried by the Mississippi River in the same time. Peak currents of over 6 knots have been observed with an average maximum of over 4 knots. The currents that this produces are so powerful that most boats must avoid the Gate during times of peak currents or they will be swept through.

The Bay has what is called a double tide, consisting of higher high water, a lower high water, higher low water, and lower low water. Tides are generally expressed as height above mean lower low water (MLLW). The average range of tides at the Gate is 5.7 ft and the maximum range is 10.7 ft.

Tides produce only 80% of the total rise and fall of the Bay's waters. A low pressure system that situates itself over the Bay will cause a higher high tide. Every inch drop in barometric pressure causes a one foot rise in the tide. Strong onshore winds can drive the tides higher. Finally, significant differences in the flow of the Sacramento River from seasonal norms will correspondingly raise and lower the tidal mean from that which is listed in the tide tables.

The water flowing in through the Golden Gate tends to follow the ancient river channels which existed before the Bay was under water. The water floods through the Gate and splits into two parts, one flowing north through the San Pablo Strait and one flowing south into the South Bay.

Currents flowing to the north propagate like a wave moving upstream. It takes a total of 7.3 hours for the wave to reach Sacramento, 110 river miles from Fort Point in the Golden Gate. Since a normal tide has only a 6 hour duration, at some point upriver there is a node, or a point where the water is in flood on one side and in ebb on the other.

The South Bay currents propagate much more quickly down the main ship channel. Here the water retains its momentum and reflects from the shore. The reflection builds on the incoming tide and produces higher high water marks in places like Alviso than in Sausalito.

If you are facing an adverse tide, follow one tried and true rule: stay out of deep water. In the shallow waters of the Bay, tidal currents slow considerably due to friction with the bottom. In the shoals of San Pablo and South Bays, they become less currents than displacements. Studies done by the Army Corps of Engineers indicate that except in the very deepest parts of the Bay , doubling the depth of the water over which you sail will give you a 50% faster tidal current.

Further information on local conditions can be found in the sections covering those areas. However, if you're looking for the kind of detailed information useful for racing, I recommend you take a shrimper or a tugboat captain out and buy him a few drinks. If you're going down to the local regatta to pump the participants, remember that only dead men tell fewer tales than Bay racing skippers

CHAPTER 2

Central Bay - Marin Shoreline

Marin contains some of the finest Bay sailing destinations. Sausalito has a superb location in the Bay and continues to support a diverse and productive marine community. Tiburon has the highest per capita income in California as well as many fine restaurants. Angel Island is a wonderful day sailing/hiking goal. Further north along the coast, Paradise Cove anchorage, is a picnic haven for cold, foggy days. Past the Richmond-San Rafael Bridge, the San Rafael Creek has a number of restaurants and marine facilities.

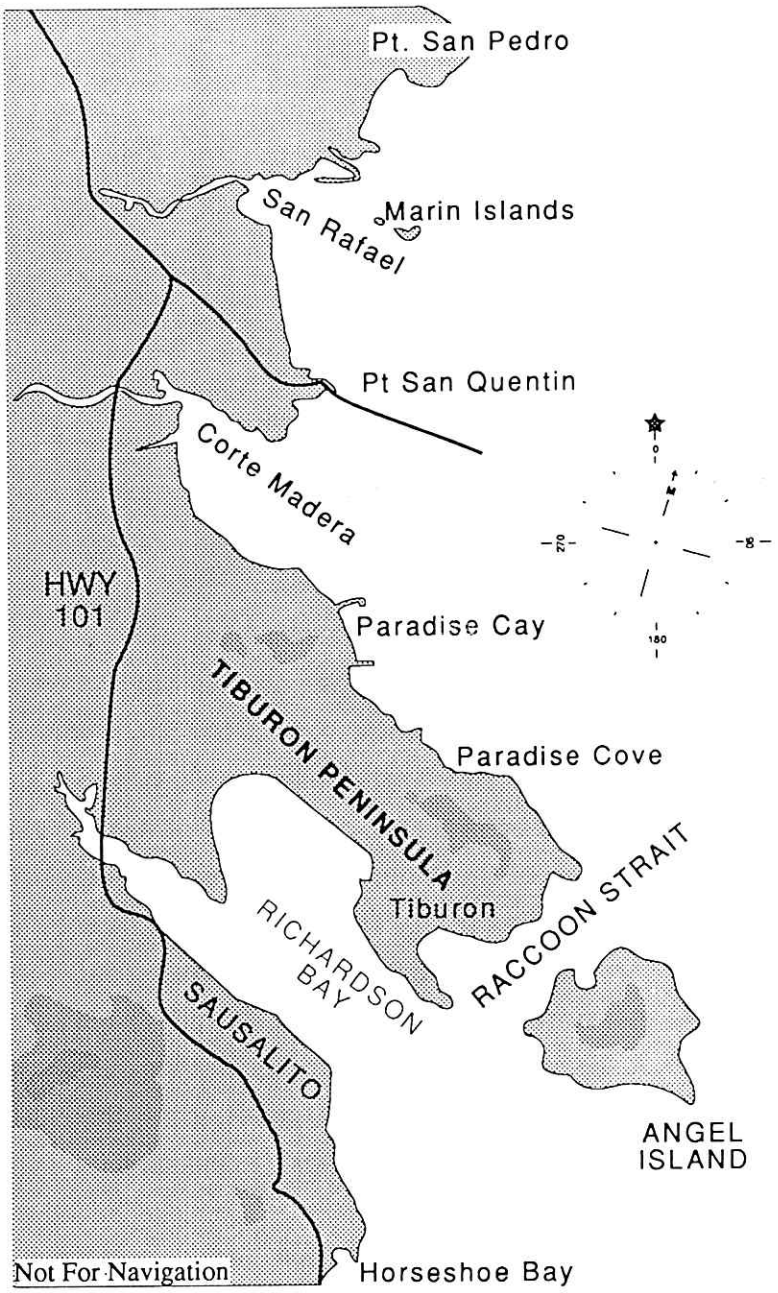

Figure 2-1: Marin Overview

Marin offers a wide range of sailing. You begin in the Golden Gate with its attendant fog, brisk wind, and strong tides. Coming around the Marin Peninsula, you enter Richardson Bay with Sausalito to port and Belvedere Island and Tiburon to starboard. Off the tip of Tiburon Peninsula is perhaps the most popular sailing destination in the Bay: Angel Island. Continuing up the eastern side of Tiburon, you first encounter pleasant anchorages at Paradise Cove. Further north you find Paradise Cay and then the Corte Madera Channel. Sailing under the Richmond-San Rafael Bridge past San Quentin, you reach the San Rafael Bay and the channel into the San Rafael Creek.

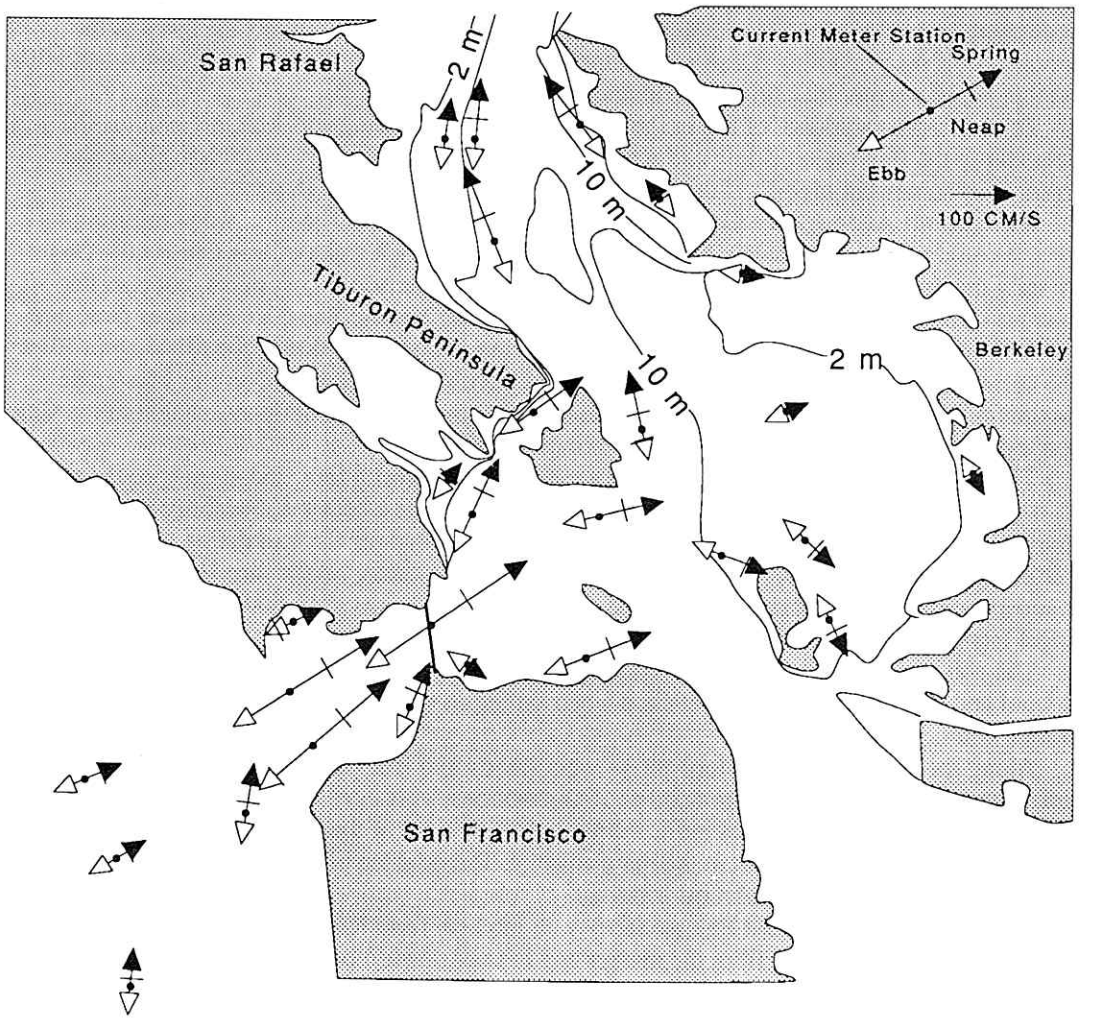

Figure 2-2: Tidal Currents - Central Bay

Weather: The Golden Gate is the only sea level break in the coastal mountain chain for over 100 miles north and south along the coast. As such, it forms a bottleneck which focuses and intensifies the prevailing northwesterly summer ocean breezes. The region from the Golden Gate to the Central Bay just east of Alcatraz has earned the name "The Slot" among local sailors. Conditions here are normally wet, windy, and cold during the summer months.

In July and August, winds are westerly 52% of the time during the day. Daily variations in wind speeds in the Slot are also quite regular. They are light in the morning, increase in velocity around 1 pm, and reach an average maximum around 5 pm.

The average maximum temperature in the Slot during the months of July and August is only 63° F. The average mean temperature varies by only 11° F during the entire year due to the moderating influence of the maritime breezes. The deep ocean upwelling off the coast in the summer cools the prevailing ocean air. Temperatures in the Slot don't peak until September, with October being warmer than all of the summer months.

There is a 5% incidence of fog in the Slot overall. In the Spring and Autumn months, the inversion in the Bay region is low and it caps the fog close to the water. By mid-summer, the inversion is somewhat higher off the ground and the fog becomes a high stratus.

Navigation: Although the Central San Francisco Bay is called The Slot, when referring to tides, it could more appropriately be called The Funnel. Through a gap of less than a mile flows not only the daily tidal volume of the San Pablo and San Francisco Bay systems, but also the contents of Sacramento/San Joaquin River and Santa Clara Valley. The Gate averages three and one-half times the volume on average, and over 14 times at its peak, that of the Mississippi River. The currents near the Gate are tremendous, both in force and complexity. Currents at average maximum flow are over 4.5 knots, and they can peak at over 6 knots. Sailboats caught in the Gate near a peak current will follow the current through the Gate.

The flood current into the Golden Gate generally runs directly into, and slightly to the north of, the Gate. Between Point Lobos and Fort Point, there exists a heavy rip reaching about one-quarter mile south from Point Bonita. Large eddies are formed off the foundation of the southern pier of the Golden Gate Bridge. Inside of the Bay, there are strong eddies directly west of Angel Island and east of Lime Point. There is a strong counter-clockwise eddy east of Point Blunt on Angel Island.

The ebb current generally moves against the prevailing wind in the Slot and the combination of wind and tide produces steep, wet chop when sailing to windward. The flood current brings calmer water.

Along the San Francisco waterfront, there is some relief from the tides near the shore due both to the depth of water and the number of obstructions. This band of slow water moves further from shore as the tide diminishes until, shortly before the turn of the tide, the current in these areas is moving opposite to that in the main channel. The tidal lee of Alcatraz Island provides only limited protection from adverse currents.

The hazards in the Central Bay are fairly well marked. Give hazard buoys a wide berth. Anita Rock extends some distance from the marker and is nearly awash on its north end at MLLW. Don't sail between Alcatraz Island and the bell buoy directly west of the island.

HORSESHOE BAY

In 1838 William Richardson obtained a huge land grant of over 19,000 acres from the Mexican Government. Only a part of this grant contained nearly the entire Marin Headlands. In 1855, Richardson experienced financial difficulties and sold the area around Lime Point to the US government. In 1897, the government established Fort Baker and a number of coastal artillery

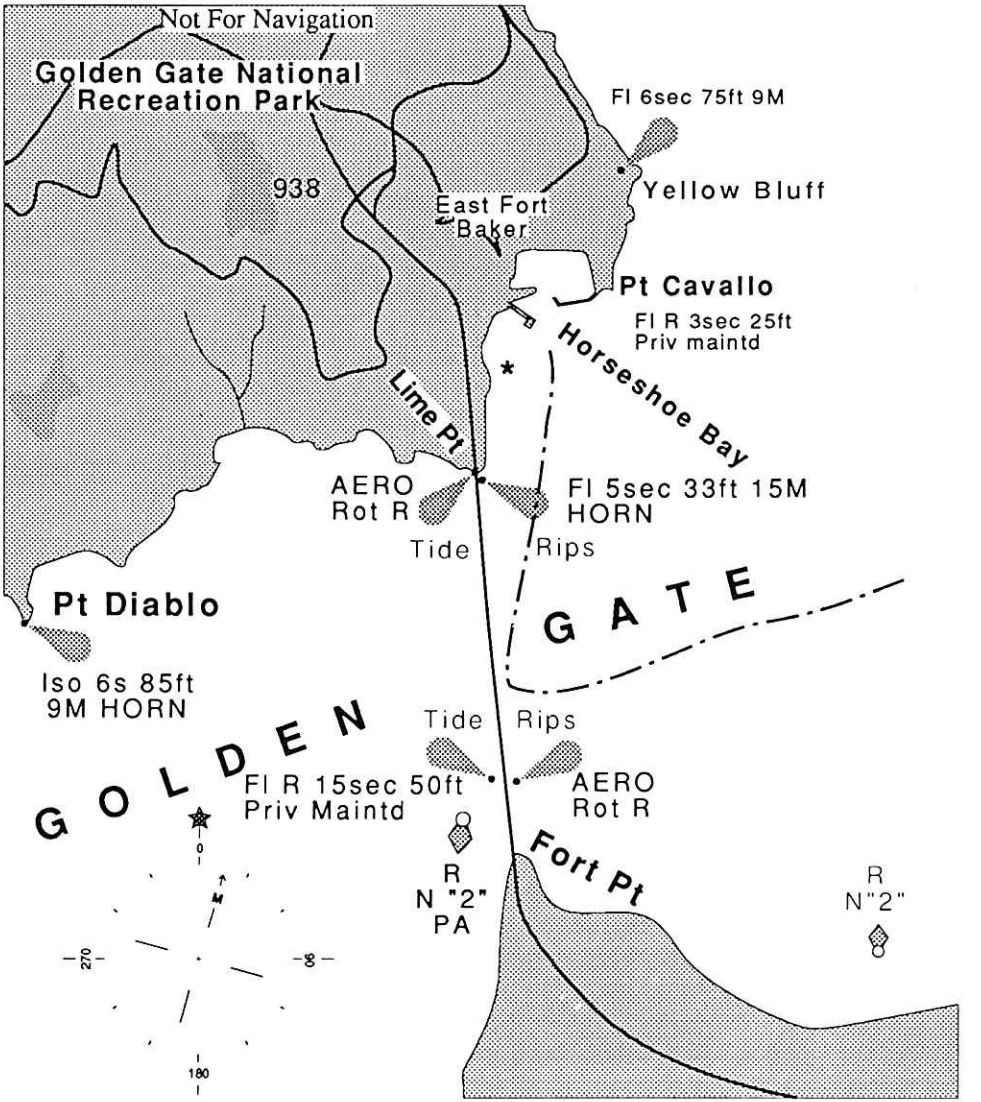

Figure 2-3: Golden Gate & Horseshoe Bay

batteries in the area for coastal defense. Because the army felt that Marin couldn't adequately supply the gar-rison, Horseshoe Bay was built as a landing point for supplies from San Francisco.

Six years later, in 1903, the quartermaster's wharf was built on the southwest corner of the Bay. This is now a fishing pier. During the early years of this century, the artillery garrison had "eyes" in the form of a balloon observation company. After this technology became obsolete, the bay was used as a base for minelaying and submarine defense facility during World War II, as well as the northerly anchor point for a submarine net that ran across the Gate during the war. Fort Baker became increasingly anachronistic with improvements in the means of war and, in 1975, the government turned over the harbor to the Presidio Yacht Club on the condition that they maintain the facilities. The Coast Guard recently has begun construction of a search and rescue base on the western shore of the bay.

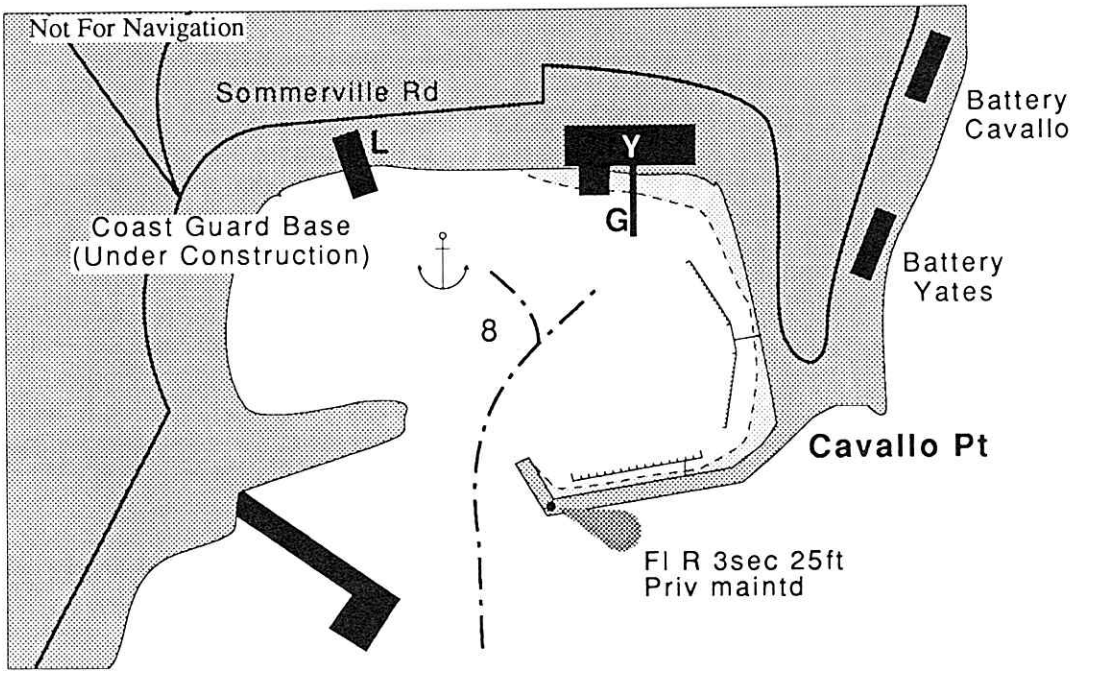

Figure 2-4: Horseshoe Bay

Navigation: Horseshoe Bay lies just one-half mile east of Lime Point at the mouth of the Gate. The approach can be tricky but not dangerous. The tides rip strongly just to the east of Lime Point, and the waters can be quite rough at times.

The bay lies directly in the lee of the Marin Headlands and as you approach the bay, you will enter their wind shadow during days with the normal prevailing winds. Another complicating factor is that the approach to Horseshoe Bay from the Slot is almost directly upwind. Locals therefore recommend that you first sail midway under the Golden Gate and then reach directly for the large rock at the mouth of the channel. Most motor the final distance.

Marina Description: The marina at Horseshoe Bay is similar to the one in Clipper Cove at Treasure Island. That is, it's for the use of present and retired military personnel who are members of the PRESIDIO YACHT CLUB. You are allowed temporary privileges here, however, if you are a member of a reciprocal yacht club. If you're not a member of a reciprocal yacht club, you're allowed general anchorage in the bay.

The controlling depth in the bay is 8 ft MLLW. If you qualify to use the facilities, tie up at the guest dock. A clubhouse and BBQ facilities are on site. The closest restaurant is in Sausalito, but qualifying visitors can get something at the short order style restaurant in the clubhouse. You should call ahead at (415) 561-7515 for more information.

If the area becomes more popular to day sailors and depending on what happens once the Coast Guard arrives, things might begin to get tight. At the present time, however, it doesn't seem to be a problem. The closest supplies are a long, albeit pleasant, 3 to 4 mile walk away in Sausalito, so you have to bring all your own things.

Points of Interest: The area around Horseshoe Bay is ruggedly scenic. There are a number of short hikes. For full information, you should contact the people at the Golden Gate National Recreation Area (GGNRA) at (415) 331-1540. Overnight camping is possible at sites only a mile and a half away.

To the south is the Lime Point lighthouse.This was the West Coast's first fog station, built in 1883. A light was added in 1900 and the entire station was automated in 1961. The freighter *Pacific Bear* collided with the lighthouse in 1960 and the station was somewhat damaged. Today the lighthouse is off limits but can be seen from the area around Horseshoe Bay.

To the east, you can walk down Sommerville Road toward Yellow Bluff past the abandoned artillery batteries in a bucolic setting, where you will probably meet nothing more disturbing than a huffing jogger. This road continues into Alexander Avenue which takes you to Sausalito.

Just to the east of the marina, you reach East Fort Baker and its collection of 19th century buildings. Further east you pass by the site of Rancho Saucelito, the home of the original European owner, William Richardson.

SAUSALITO

Sausalito gained a reputation in the 1960's and 1970's as a haven for free-thinkers, bohemian artists, and those partaking of eccentric liberal lifestyle. Drawn by the beautiful views and great location, many came to live and more came to visit. Today Sausalito has as high a density of marine activity as anywhere in the Bay. In addition, the diversity of the community remains true to its history.

Sausalito was part of the 1838 Mexican land grant comprising most of the Marin Headlands to William Richardson. The grant, Rancho Saucelito ("little willows"), was anglicized and became the city's name. Rancho Saucelito's owner provided the name for Richardson Bay. Over the next 30 years Richardson lost most of his wealth through mismanagement and mishap. In 1868, the Sausalito area was sold to a group of entrepreneurs who formed the Sausalito Land and Ferry Company. The land was divided, and the section of the city known as Old Town developed

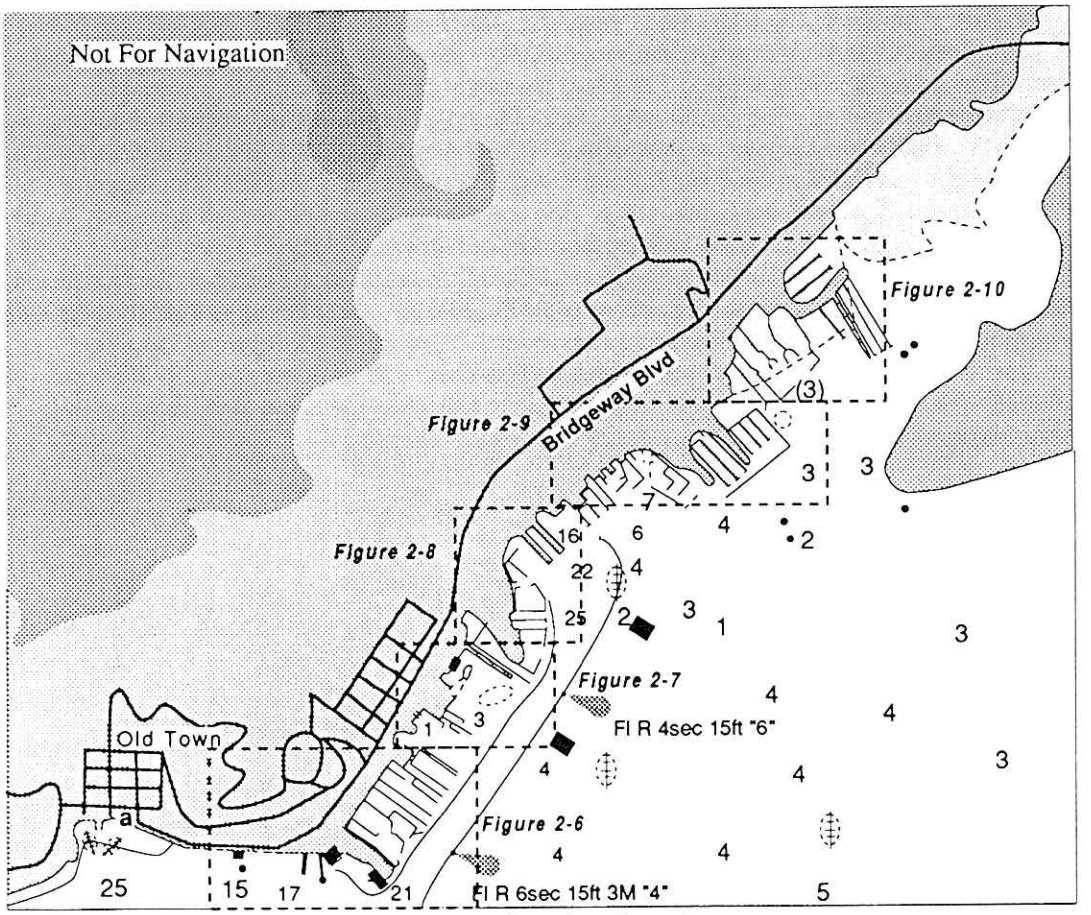

Figure 2-5: Sausalito Overview
a) Chart House/Valhalla Inn