San Fernando Valley State College

THE DECREASING SIZE OF SAN FRANCISCO BAY
A Study in Resource Utilization

A thesis submitted in partial satisfaction of the requirements for the degree of Master of Arts in

Geography

by

Philip John Stafford

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The thesis of Philip John Stafford is approved:

                                 Committee Chairman

San Fernando Valley State College

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ABSTRACT

THE DECREASING SIZE OF SAN FRANCISCO BAY
A Study in Resource Utilization

by

Philip John Stafford
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This thesis involves a study of man's changing utilization of a natural resource. Ever since the Gold Rush Period, there have been competing, and even contradictory, claims to the resources of San Francisco Bay. Today, the primary arguments concern the problem of reclaiming the margins of the Bay.

Because San Francisco Bay is also a source of minerals in the area, reclamation of the waterfront results in the displacement of some other resource use. Historically, land reclamation had little effect on other resource uses, since efforts were limited to the marshlands, tidal lands, and submerged lands adjacent to the shore. In time, this led to a general public apathy regarding the steady increase in reclamation rates. During the 1960's, these attitudes changed and became more 'conservation' oriented. Many regional planners were alerted to the very real possibility of complete reclamation of the Bay through filling. By studying the historical uses of the Bay since
1848, this thesis attempts to answer the question, "What is the best possible utilization of San Francisco Bay?"

There are four main divisions to the thesis: the physical and cultural setting of the Bay Area, the discussion of land reclamation, the effects of this reclamation, and future proposals calling for continued reclamation. The time periods used throughout the thesis distinguish between periods of rapid and slow reclamation rates.

In general, land reclamation in the study area has progressed haphazardly since its initiation in the mid 1800's. The rate of reclamation has, until only recently, been steadily increasing. Once public awareness to the problems of continued reclamation was aroused, several organizations were formed to make a detailed analysis of the Bay's capabilities and limitations.

The concluding remarks call for a modified utilization of the San Mateo Master Plan in that it attempts to achieve a balance between the competing interests. Final approval of any plan should be the result of an intensive study involving the physical limitations of the Bay. In this way, planned filling could continue to a predetermined point, where several factors are in balance and beyond which there could be no further filling. In this way, maximum utilization of San Francisco Bay will be assured.
INTRODUCTION

The changing shoreline of San Francisco Bay is an interesting example of the changing significance of the environment to man. Other areas are being confronted with the problem of multiple usage of a natural resource, but the problem seems to be more acute in the San Francisco Bay Area. Thomas, though studying another area, summarizes the situation by stating, "The problem is that the use of the Salton Sea is being interpreted by different people in different, and even mutually contradictory ways. . . . Compromise solutions are seldom easy, and the long term use of the Salton Sea will involve all the engineering, biological, political, and economic skills Californians can master."¹

To the Indians who inhabited the area and to the Spanish who discovered it, the Bay was both a source of food and a barrier to land transportation north or south or into the Great Valley. After the establishment of San Francisco as a major seaport, people began to utilize the transportation potential of this great inland waterway. This was especially true after the start of the California Gold Rush in 1848.

Once the area became more urbanized, people began to value the Bay for a number of reasons. Not the least
of these was simply admiration for the aesthetic beauty of the area. Libraries are well stocked with glowing reports on the beauty of the Bay Area. Associated with this value was the recognition of the Bay as a prime recreation site close to the metropolitan area. Even today, sailing or cruising the Bay in small boats is a popular form of relaxation.

As a result of the increasing population and technological advances, the function of the Bay took on another dimension after the turn of the century. For millennia, the South Bay had been the natural habitat for oysters. The many Indian shellmounds in the area attest to this. When these natural oysters were replaced by the more palatable eastern oyster, the value of submerged lands in use as oyster beds soared.

Unfortunately, another aspect of this urbanization has been pollution of the Bay. This in turn led to the demise of the lucrative oyster industry. However, the cement industry, utilizing shell deposits as a source of raw material, helped boost the economy. More important to this discussion is that the advent of the cement industry marked the first utilization of the Bay floor for mineral production.

The most dramatic use of the Bay began as a result of the rapid growth of the Port of San Francisco following the announcement of gold discoveries. In order to
facilitate the handling of several ships simultaneously, the merchants constructed piers into the Bay. Later, the intervening water spaces were filled to provide additional storage facilities. It was during this period that speculators began visualizing the possibility of reclaiming other sections of the Bay.

In later years, thousands of acres of land have been reclaimed, either through filling with soil or by diking the shallow tidelands. Originally, much of this land was intended for use as agricultural land or in the production of salt by solar evaporation. Today, the increasing population is producing pressures towards a more intensive use of the land.

The Problem

As in the case of the Salton Sea, all of these uses of the Bay (with the exception of oyster production) are still in effect. The problem of how much reclamation should be allowed in order to obtain maximum utilization of this natural resource looms as one of the most difficult in regional planning.

Since the first waterfront reclamation in 1848, to the present, reclamation of the San Francisco Bay waterfront has been progressing at ever-increasing rates. In many sections, the very existence of the Bay as a water resource is in jeopardy. If unplanned filling
of the Bay is allowed to continue, many vital uses would be brought to a close.

The problem of this thesis is to answer the question, "What is the best possible utilization of San Francisco Bay?" Granted, none of the literature written thus far has offered a totally acceptable plan. There has also been a lack of any comprehensive geographic study alert to the problems of land use in the area. Although this author does offer a possible solution to the problem in the concluding statements, the primary aim of this thesis is to present man's changing utilization of a natural resource, and the effect of this utilization on that resource.

Procedure

Land reclamation is taking place throughout the Bay Area, but for the purpose of this thesis, the study area (see Figure 1) is limited to the Bayshore of the San Francisco Peninsula. It encompasses Bay and shores of all of San Francisco, San Mateo, and Santa Clara counties. The decision to base this study on the area just mentioned is twofold. Firstly, this area is indicative of the most pressing problems with regard to reclamation; and secondly, the smaller area allows for a more thorough investigation.
Figure 1:
The Study Area
SAN FRANCISCO BAY AREA:
SOUTHERN PORTION
STUDY AREA

MAP SOURCE: ARMY CORPS OF ENGINEERS
The thesis encompasses the reclamation of land from 1848 to the present. The maps used to depict the stages of development are derived from the U.S. Army Corps of Engineers' comprehensive study of the San Francisco Bay Area. The time periods used in that report were retained, for convenience, throughout this thesis. Information was obtained largely from other library sources and from personal field investigation.

The field study undertaken by this author was primarily involved with substantiating and updating previously written reports and determining the land use of the area. The survey involved an orderly investigation of all the reclaimed land in the study area, from the San Francisco Marina in the north, to the Alviso-Milpitas area in the south.

In addition, the author interviewed Dr. D. Luten of the U.C. Berkeley geography department, and Mr. John Pasarello of Leslie Properties, Incorporated. Both were of assistance in providing their views on the future of the Bay.

The thesis has four basic divisions, in addition to the introductory and concluding remarks. The first of these describes the setting of the study area in both physical and cultural terms. In this way, one can comprehend the pressures calling for further reclamation of the shore area. The second discusses the reclamation of
land in the time period previously mentioned. Through comprehension of the past usage and attitudes concerning the Bay, one can evaluate those pressures mentioned earlier. The third division evaluates the effects of reclamation in relation to the economy as a whole, as well as to the physical and biological effects incurred by the water body itself. Paramount among these problems is that of water pollution. Fourth, future proposals involving filling or other means of reclamation are discussed. Even though some of these plans may never be implemented, they serve to show how man views this natural resource.

The concluding portion of the paper attempts to reconcile both the factions calling for continued filling and those demanding cessation of all reclamation. The conclusion to the problem mentioned earlier utilizes some of the plans now being proposed; however, they have been modified to allow what this author considers the best possible utilization of San Francisco Bay.
CHAPTER ONE: SAN FRANCISCO BAY

It is easy to understand how San Francisco Bay eluded discovery until 1769. The narrowness of the Golden Gate makes observation difficult even under the best of conditions. In addition, the northern California coast is beset by fogs during much of the year. Ship captains were forced to plot their courses farther out to sea in order to reduce the risk of being wrecked on the rocky coast. Once the navigators discovered the entrance to the Bay and entered it, the immensity of this arm of the Pacific became apparent.

The Physical Setting

The Santa Cruz and Marin Mountains form the southern and northern arms, respectively, of the Golden Gate. To the south, between the Santa Cruz and Diablo Ranges, lies the broad expanse of San Francisco Bay and the Santa Clara Valley. There is no distinct boundary between the Valley and the Bay, rather the one merges into the other. The drowning of the original structural valley is said to have taken place with the rise in sea level subsequent to the melting of Pleistocene glaciers. The original subaerial stream can still be traced beneath the Bay as the deepest portion of the channel.
The portion of the Santa Cruz Range of greatest interest to this discussion is that which forms the San Francisco Peninsula. This area, in contrast with the Santa Clara Valley, is predominantly hilly. A rather narrow band of land with a slope of less than five percent follows the shoreline. Only a small portion of this belt is suitable for industry, due to the bearing capacity of the soil.

This area of gently sloping land increases as one moves southward into the Santa Clara Valley. Here, there is a great deal of land suitable for all types of industry, as shown in Figure 2. The conversion of this land from agricultural to industrial and residential uses has progressed with relative ease, but in the study area level land is at a premium.

The other sections of the Bay System include San Pablo and Suisun bays. The reason for introducing them at this time, even though they lie outside the study area, is to impress upon the reader that the waters of San Francisco Bay proper form a part of a much larger system. The study area, in turn, is an even smaller segment of the system which has been artificially dissected for study purposes. One must bear in mind that this segment is constantly acting and reacting to the elements and processes, both physical and biological, that govern the entire system.
Figure 2:
Slope of the Land
SAN FRANCISCO
BAY AREA:
SOUTHERN PORTION

SLOPES

- GREATER THAN 30%
- 5 - 30%
- LESS THAN 3% - Suitable for all types of industry
- LESS THAN 1% - Without adequate bearing capacity for all industry
- LESS THAN 5% in SAN FRANCISCO - Without regard to bearing capacity

MAP SOURCE: ARMY CORPS OF ENGINEERS
No study of the land use of the Bay Region would be complete without at least a cursory glimpse at the underlying geology. In general, the harder rock of the Santa Cruz Mountains gives way to the alluvium of the foothills, and this in turn is replaced by the fine-grained muds of the Bay floor.

Much of the mountain belt is composed of the sandy Franciscan Formation which represents a readily available supply of material for reclamation by filling. One proposal, which will be discussed later, calls for the removal of the San Bruno Mountains and use of the material in filling the Bay. Because of the steep slopes in this region (30%+) utilization of the land has been limited to some residential and recreational uses, but for the most part it is still in its natural state.\(^3\)

The foothill region consists of the alluvium removed from the mountains. Slopes in this area vary, but in general do not exceed thirty (30) percent.\(^4\) Residential use of the land predominates on the steeper slopes, and industrial on the more level areas. The load bearing capacity of the soils is such that there is no limitation on the type of industrial development. Here again, the loosely consolidated soil material offers an excellent source for fill material.

A narrow belt of land with a slope of from 0-5 percent borders the Bayshore. However the nature of this
material is such that it can support only the lightest structures. The soils of this region form a transition between the coarser terrestrial, and the finer, looser sediments of the bay muds.

The sediments of the Bay floor are composed of approximately 57 percent clay (mostly colloidal), 29 percent silt, and 14 percent sand. Over the centuries, they have formed two distinct types of mud based not on their composition, but on their degree of compaction. The older bay muds are those at the bottom and in contact with the bedrock of the original structural valley. Composed of silty clay, sand, and some gravel, they vary in thickness from one to over two hundred feet. Consolidation has made this material stable enough to support pilings.

The younger bay mud overlies the older layer, and has an average age of from 2,500 - 7,000 years. Due to the high water content of this mud, it is very unstable. During times of agitation, such as construction or an earthquake, the material will commonly liquify and flow. A construction project in the East Bay, although outside the study area, exemplifies the situation. "During construction of the fill on the northern side of the toll plaza of the San Francisco - Oakland Bay Bridge in 1947, the mud was overloaded with sand and failed. The sand sank twenty feet and the underlying mud was forced sideways for more than five hundred feet."
If these muds are to be used for fill material, consideration must be given for the period of settlement. It takes at least twenty years for the younger mud to settle enough to support the lightest form of construction. Even so, the probability that the material will fail under stress remains high. Whenever available, sand, either terrestrial or submerged, is the preferred fill material. Unfortunately, the South Bay's supply of sand is limited. The only large supply is found in the San Bruno Shoal.

Finally, no discussion of the Bay Area would be complete without reference to the earthquake potential of the region. The two major faults extending throughout the area are the San Andreas on the west, and the Hayward on the east. Most alluvial material is highly susceptible to the destructive forces of earthquake waves. With the earthquake history of the area in mind, one can readily appreciate the instability of filled land in this situation.
The Cultural Setting

San Francisco Bay, perhaps more than any other natural resource, requires an account of the cultural environment as well as the physical. This is simply a function of the Bay's central position with respect to a large metropolitan area. Indeed, were it not for the Bay, there would not be a "Bay Area" today. The original impetus for the growth of San Francisco would be missing, and rather than having a "Balkanized" situation as exists today, there would be more homogeneity.

When Don Gaspar de Portola's men sighted San Francisco Bay for the first time on November 2, 1769, they could not have realized the full impact of their discovery. The Spanish were searching for a harbor on the coast of northern California, but their needs were for a protected anchorage and fort to guard the Manilla galleons rather than for a port of trade. Furthermore, the Bay's isolated position on the western side of a relatively unexplored and undeveloped continent did little to stimulate any large scale financial investment or settlement. The importance of the discovery was noted several years later, when in 1776 Padre Pedro Font wrote, "The port of San Francisco is a marvel of nature and might well be called the harbor of harbors . . . a harbor so
remarkable and so spacious that within it may be estab­lished shipyards, docks and anything that may be wished."

The relative importance of the Far West was not recognized by the eastern portion of the country until New England became a surplus producer of manufactured goods. At this time the need for an entrepôt on the west coast became apparent. Later, when gold was discovered in the interior of California, San Francisco became a focal point for the world's shipping lanes.

The city of San Francisco became the leading community of the Bay Area at an early date because of its proximity to the Golden Gate. Here, at Yerba Buena Cove, the captains could anchor their ships in deep water fairly close to the shore at high tide. Any venture into the other sections of the Bay required the use of pilots to navigate the shallow waters. Once established, San Francisco maintained its lead over the other Bay cities even after the arrival of the railroad to the East Bay.

It should not be assumed that human habitation of the Bay Area began with the Spanish. Indians of the Costanoan group have inhabited the region for the past 3,500 - 4,000 years. However, it is safe to say that except for the deposition of middens (composed largely of the oyster shell Ostrea Lurida), these people had very little to do with the alteration of the Bay shoreline. Any changes they made have been largely eradicated by the
subsequent European occupation. Those middens above the water level have been levelled for agricultural purposes; those under water dredged for their lime content. In fact no middens have been found in their pristine state and archaeologists hold little hope for the future discovery of any undisturbed sites.

The Spanish also did little to alter the appearance of the Bay shoreline. Christianizing the natives and the relatively small amount of trade undertaken did not warrant much in the way of shoreline reclamation. It was the rapid influx of people after the discovery of gold in 1848 that signalled the start of man's encroachment onto the shores and waters of the Bay.

The area under discussion has the greatest population density in the entire region. San Francisco and San Jose are the largest population centers on the Peninsula. A line connecting these two cities, literally the El Camino Real, forms the axis for the West Bay population. It is along this axis that the early cities evolved and developed, and this pattern prevails today. Daly City, for example, became important immediately after the earthquake and fire of 1906. Much of San Francisco was destroyed, and the populace moved south to Daly City while the city was being rebuilt. Redwood City, as the name implies, was an important center for the logging industry in the Santa Cruz Mountains. Belmont
developed from its original function as a stagecoach stop.\textsuperscript{15}

If one must decide on a first cause in the decision to reclaim land from the Bay, it would have to be the pressure exerted by a rapidly increasing population. In 1967 nearly four and one-half million people occupied the nine county Bay Area. This figure is three million more than it was thirty-five years ago, yet it is four million less than it will be thirty-five years from now.\textsuperscript{16} Population growth is placing ever-increasing demands on the area for industrial, residential, and recreational lands.

New industries attempting to locate in the Bay Area may require a specific location and site. As mentioned earlier, land with more than a five percent slope may be unsuitable to many types of industry. Other industries, such as chemical plants, petroleum refining, and steel mills, usually require a waterfront site.\textsuperscript{17} Such a site may be due to the need for water as an element in the production process, as a coolant, or as the only economical means of supplying the raw material or transporting the finished product. Rapid increases in the Bay Area population will create a demand for increasing amounts of waterfront industrial facilities.\textsuperscript{18}

Residential use of the Bayshore has not been an important factor until recently. Associated with the
recreational aspect to be discussed in a moment, land developers are offering homes built on reclaimed land and featuring private boat mooring facilities for many of the houses. Although not very important as of this writing, residential use of the shores could become more demanding with the passage of time. Use of the shore lands for residential use is presently desired, not required. 19

Associated with population growth is the increased amount of personal leisure time. As the work week continues to decline, this increased leisure will have to be reflected in an increased use of the Bay Area (and especially the Bayshore) for recreational purposes. As Scott mentioned in his study (1963), out of a total 276 miles of shoreline in the entire Bay Area, only four were being used for recreation. 20

Finally, one must consider the side effects of the increasing population, notably the disposal of wastes. Many areas simply take solid refuse to dumps far from the population centers. Although primitive, it is a widely used procedure. The San Francisco Peninsula is not as fortunate in that the few available dump sites are either filled, or will be filled in short time. As a result, sanitary landfill is being practiced in the Bay itself. This offers an expedient means for disposal of the waste, and also provides needed level land; however, it cannot be regarded as the solution.
FOOTNOTES FOR THE INTRODUCTION AND CHAPTER ONE


4. Ibid.


6. Ibid., p. 3.


12. Ibid., p. 134.
15. Ibid., p. 71.
20. Scott, op. cit., p. 68.
CHAPTER TWO: FILLING THE BAY

This chapter discusses both the natural filling processes and the development of land reclamation in the study area. As discussed earlier, the Bay is a part of a much larger functioning system. Although some of the material eroded and transported from higher elevations is deposited in the ocean, most of it settles out in the Bay itself.

The section dealing with the planned reclamation studies where, when, and why land was reclaimed from the study area since 1848. In some cases, dry land has been formed by displacing the water with fill, in others, barriers or levees were used to protect the land from inundation by the tides. Whatever method was employed, it led to the decreasing size of San Francisco Bay. Figure 3 clearly depicts the extent of reclamation since 1848.

Natural Processes

It should be noted that San Francisco Bay, like any other body of water, acts as a receptacle for the eroded material carried in by streams. In the case of the Bay, there are two factors tending to increase the rate of deposition. First, there is a velocity decrease as the streams enter the calmer waters of the Bay, and
Figure 3:

Total land reclaimed, 1848-1968.
secondly, there is a tendency toward flocculation as the sediment enters the saline waters of the Bay.¹

During the late spring and early summer months, one can see the waters of the Bay change from a clean blue-green to a distinct mud-brown. Most of the sediment entering the Bay system comes from the interior valleys of California with the melting of the winter snowpack. Each year some 6,000,000 cubic yards of material are eroded from this region and are deposited in the Bay.² During the period 1957-1959 this rate averaged some 17,000 tons of sediment per day.³ Due to the sedimentation processes mentioned earlier, only thirty percent of the incoming material ever leaves the system through the Golden Gate.⁴

Bear in mind, however, that most of this deposition occurs in the northern sections of the Bay system.

Fortunately for the Bay Area, the amount of locally derived sediment is not as great. For one thing, the drainage basin is not as large. Local discharge of sediment into the Bay system has been calculated by Scott to be 2,000,000 cubic yards per year.⁵ Furthermore, the major streams of the South Bay, namely those of the Santa Clara Valley, have been dammed for reclamation purposes. As a result, less sediment is entering the study area than at any prior time. Over the centuries, approximately 4,700 million cubic yards of material have been deposited in the Bay south of Candlestick Point.⁶
Bernard Smith, a staff engineer for the San Francisco Bay Conservation and Development Commission (hereafter referred to as the Bay Commission), feels that although natural processes are filling the Bay, the rate is meaningless in economic or physical terms. He adds that it would take 2,800 years for the Bay to be filled by these processes at present rates. Clearly, any noticeable filling of the Bay is that brought about by man.

Associated with natural processes was the accidental filling of the Bay during the gold mining period, as a direct result of overloading the stream's sediment carrying capacity. This deposition is the same as the shoaling that is taking place today, only it occurred at a much greater rate.

Miners soon discovered that by playing powerful blasts of water onto the sides of the stream valleys the overburden could easily be removed, thus exposing the ore. Little consideration was given to the effects of this mud and debris-laden water on the lower reaches of the river system. Indeed, for many years there was no consideration given to the obvious scarring at the mine site. Scott calculated that 1,876 million cubic yards of debris from these mining slickens (mostly pulverized quartz waste) have settled in the waters of the Bay system. Of this, only sixty-four million cubic yards were carried
beyond the Golden Gate. 10

Although no one can ascertain the exact amount of debris deposited in the various parts of the system, it is fairly obvious that most of the shoaling took place in the northern sections (as explained earlier). It is well known that some of this material did reach the South Bay and that it changed the economy of the region.

As evidenced by the Indian middens of the area, the waters of the South Bay are conducive to the growth of oysters. In fact, the native oyster (Ostrea Lurida) formed a substantial part of the Indian diet. In 1870, the seed of the more palatable eastern oyster (Ostrea Edulis) was transplanted to the South Bay. 11 So suitable was this habitat that the oyster growers realizes substantial profits. Lands sold for use as oyster beds at one dollar per acre were worth up to one thousand dollars per acre within a year or two. 12

Due to the mining operations just mentioned, the lucrative oyster industry declined after the turn of the century. Today, there are no oysters produced in the South Bay. The decreasing profits from the oyster beds were reflected in the decision by the Morgan Oyster Company, in the 1920's, to dispose of its interests to the Pacific Portland Cement Company. This latter concern utilized the extensive shell deposits in the production of cement. 13
Land Reclamation

As mentioned in the introduction, land reclamation in the study area has been erratic. The time periods used in this chapter are intended to show that reclamation has taken place in response to a specific stimulus. Thus from 1848-1900 there was rapid development along the San Francisco waterfront due to the construction of port facilities. This was followed by very little reclamation between 1900 and 1925. The only projects of any size were involved with the preparations for an international exposition and construction of the port facilities at Redwood City. After 1925 there was extensive reclamation in the study area due to the need for land for salt ponds and agriculture. The period 1940-1958 not only involved reclamation for salt ponds, but also heralded the first use of reclaimed land for housing projects. Reclamation since 1958 has maintained this trend toward a more intensive use of the land.

1848-1900

If we carry on with the supposition that population is one of the more important pressures leading to reclamation, San Francisco should show the earliest evidence of this trend. Indeed this is so. Once mining
became king, the "City" was no longer self-sufficient and supplies had to be imported. If one considers the growth of San Francisco, it is easy to visualize how the demand for goods exceeded the supply. Prior to 1848 San Francisco was no more than a sleepy hamlet. In 1846 there were only forty inhabitants. By the middle of May, 1848, when the gold rush began, San Francisco had grown to village size. At this time there were approximately two hundred buildings and nine hundred inhabitants. By 1850 the population had grown to about thirty-five thousand. Only one decade later this figure had reached 56,800.

As mentioned earlier, the ship captains favored the harbor at Yerba Buena Cove. Although it protected the ships from the prevailing winds and currents, it did not expedite the loading and unloading operations. At low tide much of the cove was visible as mud flats, and the ships had to be anchored several hundred feet offshore. As a result, small lighters were required to carry small loads of cargo to the shore facilities.

Obviously, this system was too inefficient to handle large volumes of merchandise. To ease the situation, a few small wharves were extended into the cove. In May of 1849, a group of merchants united to form the Wharf Association. By pooling their resources, this group was able to build larger and more functional dock
facilities.

The first "Association" wharf, known as the Long Wharf, was merely an extension of San Francisco's Commercial Street. By 1849 it was eight hundred feet long, and several years later it was extended another several hundred feet. Although it represented an initial investment of 180,000 dollars, it proved so lucrative a venture that it had paid for itself within three months. Naturally, this quick return attracted other investors. By the end of 1850 there were nearly two miles of piers, representing a total investment of over 1,500,000 dollars. The larger of these were up to forty feet wide and could accommodate half a dozen vessels simultaneously. Piers were soon built to extend every street from Market Street south to Telegraph Hill.

The interest here is not in the piers themselves, but in the fact that the formalized encroachment on the Bay had begun. Although most coastal and estuarine waters in the country are under state or federal supervision, those of the Bayshore were ceded to the City of San Francisco by an act of the Legislature. This Act, passed on March 26, 1851, yielded all rights (for ninety-nine years) to the lands known as "beach and water lots". The only provision made was that the city return twenty-five percent of all monies gained from the sale or other disposition to the State.
In 1855 the State Legislature enacted the first of several laws permitting the sale of marshlands around the Bay to private investors, on the grounds that it be reclaimed for agriculture. These lands were among the thousands of acres classed as "swamp and overflowed lands", which Congress had granted to the state from the public domain in 1850. By definition, these areas were above the line of mean high tide.

Having finished the piers, the intervening water spaces were filled. The authors of the *Annals of San Francisco* remarked that in 1850, "This gradual march across the deep waters of the Bay is a peculiar feature in the progress of the city. . . . Year by year, however, the strange watery abyss [that water beneath and between the wharves] is being filled up by the removal of the sand hills behind, which may be said to be taken up and cast bodily into the deep." The reason for the fill in this location is fairly obvious. Businessmen now had the facilities to load and unload the ships with ease, but it was still quite a distance to the warehouse district. By building warehouses right on the waterfront, their whole operation would be even more efficient.

Filling occurred so rapidly that Montgomery Street, which in 1849 had skirted the water, was in the heart of the town in a little more than one year. The general populace gave little heed to the filling operations being
undertaken. In fact, they felt that the urgent need for additional port facilities justified the action. Early complaints did arise, however, from those who had purchased the original 'waterfront' lots, for their land was now landlocked by the subsequent fills. Eventually ship captains also began to complain. It seems that in their effort to outdo the previously built piers, the builders had extended their facilities beyond the protection of the cove. These protests resulted, in 1863, in the establishment of the Board of State Harbor Commissioners which had authority over future developments. 28

Over forty square blocks were raised above low water level during this period. This was accomplished by dumping sand fill obtained from excavations in other parts of the city. A common sight along the San Francisco waterfront during this period was the steam paddy, a locomotive on temporary tracks which hauled the fill from the hills to the waterfront. 29

"By that means Sansome, Battery, and the intersecting streets to a considerable distance were gradually filled up, and firm foundations given for the substantial brick and stone houses that were beginning to be erected there. The town continued to move eastward, and new streets were formed upon piles further out into the bay ... as house after house was raised upon innumerable piles, while the steam paddy and railroad wagons, and horse carts without number, were incessantly bearing hills of sand piece-meal to fill up the hollows, and drive the sea far away from the original beach. Where
once ships of a thousand tons floated there
now rose great tenements of brick and mortar
securely founded on solid earth."30

The Board of State Harbor Commissioners began the
final adjustment to the pier complex in 1867. Work con-
sisted of construction of a sea wall located at what is
now the Embarcadero. In order to complete the project,
"A trench 60 feet wide was dredged to 20 feet below low
tide level, and the rock from Telegraph Hill and from
Sheep Island was dumped to reach a level of mean low tide.
A foundation of concrete was laid on top of the rock and
a wall of masonry placed on the concrete. Filling Yerba
Buena Cove was rapidly accomplished following the com-
pletion of this sea wall. The wall in its present form,
however, was not completed until 1913."31 Figure 4 clear-
ly depicts the completed sea wall.32

Although the remarkable advance of the shoreline
into Yerba Buena Cove overshadowed them, there were also
other reclamation efforts during this period. As shown
in Figure 3, portions of the Hunters Point district were
reclaimed to handle the development of the naval shipyard.
There were several small reclamation efforts north of
Brisbane; however, they were merely expedient locations
for dumping fill derived from other excavations. The
rationale for saying this is that the fills have never
been utilized until recently.

Thus far, the discussion has involved primarily
Figure 4:

Construction of the original Embarcadero at Yerba Buena Cove.
the reclamation of "tide and submerged lands". Tide-lands are those areas lying between mean high and mean low tide. This is the mudflat area which is exposed at low tide. Submerged lands, as the name suggests, are those areas continually below mean low tide. They are always beneath the water. Reclamation in the other portions of the study area during this period involved primarily the draining of marshlands for agricultural purposes. The Corps of Engineers defines this territory as that land "lying between mean high tide and 5 feet above mean sea level."33

Obviously, the more water there is to displace, the more fill is required for the project, and therefore the higher the cost of reclamation. With this in mind, one finds that only land which is to be intensively utilized can justify the expense of reclaiming tide and submerged lands. The marshlands can also be used intensively; however, the ease with which they can be reclaimed has resulted in their use for extensive endeavors. This accounts for the much larger tracts of land reclaimed south of the San Francisco-San Mateo county line. The large areas east of Millbrae and San Mateo were all used for agriculture. Figures 5 and 6 show (respectively) the methods used to reclaim submerged and marshland sections of the study area.

Present use of the land generally reflects its
Figure 5:
Reclamation of submerged land by filling. Note the use of a retaining wall to contain the fill.
Figure 6:

Reclamation of marshland by filling.
original intended use. The San Francisco waterfront, from the Embarcadero in the north to Hunters Point in the south, is still dominated by maritime activity. Until 1949, the area bordered by Broadway and the Embarcadero was the center of the San Francisco produce district. Fisherman's Wharf, the best publicized location in this area, may be classified as recreational as well as maritime.

All along the Embarcadero, port facilities occupy the shoreline areas. Piers along the waterfront are paralleled by the railroad lines and roads that serve them. Industry in the area tends to be light. Parking lots (Figure 7) and warehouses (Figure 8) abound. North of the Ferry Building there is a tendency for more shops and restaurants, as this is near to the Fisherman's Wharf area. To the south, the number of ship repair facilities increases. The area between Mission Rock and India Basin also contains several truck depots and an extensive railroad freight yard.

Use of reclaimed land south of San Francisco has also remained unchanged for the most part. The Brisbane fill has only recently been used to house some warehouses and factories of an industrial park. This fill will be discussed in greater detail in the section dealing with the use of reclaimed lands from 1958-1968. The Point San Bruno fill is still being used for industrial purposes.
Figure 7:

Present land use in the vicinity of the Embarcadero Freeway. The Ferry Building and pier complex is shown at the left.
Figure 8:

Present use of reclaimed land near Coit Tower. The tower and Telegraph Hill are visible in the upper right.
Largest of all concerns here is the Swift Meat Packing Company plant near Point San Bruno. Swift bought this land in 1853, not only because of the proximity to San Francisco (and its water and rail transport system), but also because it was so situated that the prevailing winds carried the offensive fumes of the slaughterhouses out over the Bay. The remainder of the area abounds with small industries. Especially numerous are clothing factories, such as the one owned by the Levi Company, metal salvage operations, and trucking headquarters. Large areas of reclaimed land near Burlingame and San Mateo are now completely used for residential purposes. One area near Burlingame consists primarily of apartment units and motels to service the International Airport.

South of San Mateo, there are several smaller projects. Those extending from Belmont to Atherton were reclaimed for construction of the El Camino Real. Further south, small areas were reclaimed near Palo Alto and Alviso, however, their use at the time of reclamation was slight. In fact, the Palo Alto fill was largely unused. The Alviso fill, although small, was more intensively used for commercial and residential development. In both cases, fill was used to increase the elevation of marshland.

In total, five square miles of land were reclaimed during this time period. Three of these were in San
Figure 9:
Land reclaimed 1848-1900.
Francisco and upper San Mateo counties. The remainder was in the South Bay. Figure 9 depicts the location and extent of the land reclaimed during this period.

1900-1925

In sharp contrast to the 1848-1900 period just described, there was very little reclamation in the study area from 1900-1925. No longer did the carloads of material move along the streets to be dumped into the Bay. Public sentiment, although not very strong during the earlier era, turned almost totally apathetic at this time. As we shall see, it was this apathy that led to the greatest strides in reclamation during the later periods.

Again, most of the reclamation operations were centered in the vicinity of the San Francisco waterfront. Very little land was added to the port facilities, for this land was no longer under private control. In fact, the only mention of a fill in the port area involves a small area at the base of Telegraph Hill. This operation took place immediately after the earthquake and fire of 1906 when a site was needed for disposal of some of the rubble.37

The largest reclamation effort was centered in the San Francisco Marina district where new land was needed for the Panama-Pacific International Exposition of 1915.38 A good portion of the fill was taken up by the
military at both the Presidio and Fort Mason.

Other reclamation during this period was used primarily to create additional shipping and transportation facilities. China Basin (near Mission Rock) was nearly completely filled during this period to accommodate the ship repair buildings and some loading and unloading equipment. Similarly, Islais Creek (near India Basin) was filled for use as a docking area. A small extension was made to the Hunters Point Naval Shipyard. As in the earlier period, all of the filling was accomplished by diking and subsequent filling of the lagoon.

The large area immediately south of the San Francisco-San Mateo county line involved the filling of a marshland area; hence, no dike was needed. Originally, it was to accommodate the old Bayshore Highway (Bayshore Boulevard today); however, it now also houses the Livestock Pavilion (Cow Palace) as well as many private dwellings.

Between Sierra Point and Point San Bruno, several very small areas were reclaimed. The lengthy fill immediately south of Sierra Point was used for the Bayshore Boulevard and later the freeway. Small areas at Point San Bruno were used for light industrial and warehousing activities.

The only other reclamation during this period involved elevation of some marshland in the vicinity of
Redwood Creek. This land, now traversed by Harbor Boulevard, is the Port of Redwood City. In addition, several other industries have based their operations there.

It was in 1924 that the Agricultural Lime and Compost Company (now the Bay Shell Company) began dredging operations in order to reclaim and process shells for livestock feed and soil conditioner. Also on this land, the Pacific Portland Cement Company constructed its plant in 1924. The reason for this location was proximity to the oyster shells (used for their lime content). By January, 1967, roughly 30,000,000 tons of shells had been dredged. Most of them came from the vicinity of the San Mateo Bridge; however, some were removed from the Dumbarton Bridge area. 39

In general, reclamation during this period was unimportant. Whereas earlier activity centered on the urgent need for land to satisfy the needs of industrial and transportation growth, in this period reclamation was primarily supplemental. It is important to note that this was the first time that new land had been created for recreational purposes, i.e. the Marina and Palace of Fine Arts. In total, only one and eight-tenths square miles of land were reclaimed from the upper portion of the study area. In the South Bay, the amount was negligible. 40 Figure 10 illustrates the reclamation undertaken during this period.
Figure 10:
Land reclaimed 1900-1925.
Whereas the previously described periods centered on an intensive use of the reclaimed lands, the era of 1925-1940 was noted for the extensive use of large tracts of reclaimed marshland. It is also interesting to note that the reclaimed land was not under the control of the state - the Board of State Harbor Commissioners only had authority over the Port of San Francisco. As far as the rest of the area was concerned, the state regarded the Bay as property rather than as a great natural resource to be protected, and, as pointed out earlier, much of the Bay had been made available to speculators following the opening of the Panama Canal. 41

In 1868 the State Legislature passed a statute placing the sale of "swamp and overflowed lands" into the hands of the State Surveyor General. Anyone wishing to purchase the lands needed only certification from the county surveyor to the effect that the land was above the low tide line. "Under this procedure the county surveyors of San Mateo and Alameda Counties, in particular, unblushingly certified as lands 'above low tide' thousands of acres that lay 6-18 feet below the surface of San Francisco Bay." 42 So much land was transferred to private hands during this period by unscrupulous means that the Legislature acted (in 1878) to prevent the further sale of lands to private persons, partnerships or corporations
within two miles of any city or town.\textsuperscript{43}

During the period 1925-1940, remarkably little reclamation took place in the city of San Francisco itself. The only fill, and a small one at that, was in completion of the Marina and Palace of Fine Arts Park. Farther south, Islais Creek and India Basin were completely filled with the exception of a narrow ship channel between Islais and Tulare streets. It was also in this area, between Ranking and Toland streets, that the San Francisco Wholesale Produce Market was relocated. With these two fills, the San Francisco waterfront was nearly complete. The fill south of Hunters Point was added during this era for use as residential and commercial land. This use - small retail stores and private dwellings - is still in effect today.

The reclaimed land north and east of Brisbane was completed during this period primarily because of construction for Bayshore Boulevard. The need for the eastern portion of the fill was due to the steep slopes of the San Bruno Mountains. The northern portion also handled a section of the roadway, but was basically intended for agricultural uses.\textsuperscript{44} Later, the agricultural use was phased out by the construction of a large industrial park containing electronics, tire, dairy, and other light industries.
South of Point San Bruno the land use is mostly industrial, due to the proximity of the San Francisco International Airport. Again, warehouses are the most conspicuous buildings. Airport Boulevard which bisects the fill is bordered by large fuel depots and hangars for servicing the airplanes. As with the fill near Brisbane, the original intended use of the land was agricultural.

It was during this period of time that the initial filling for San Francisco International Airport was completed. Originally San Francisco wanted an airport closer to the downtown area. In 1953 the city was authorized to reclaim the shoals north of Yerba Buena Island, "... for the establishment ... of a public airport ... and for wharfage and dock facilities in connection therewith." The new land, reclaimed by the dike and fill method under the direction of the U.S. Army Corps of Engineers, consisted of approximately four hundred acres. Originally San Francisco was to have used the land for an international exposition prior to converting the facilities into an airport. After the exposition, however, Treasure Island was turned over to the United States Government for use as a military facility. It was not until 1943 that the state allowed San Francisco to expand the existing airfield near Millbrae. As will
be discussed later, this project is still under way.

The reclaimed marshlands north of Burlingame were, and still are, used for housing, transportation, and commercial activities involving restaurants and motels serving airport customers. The shoreline of this portion of the fill is fronted by Bayshore Way but is otherwise still undeveloped. The unfinished nature of this section and the few small truckloads of rubble dumped in the area suggest to this writer that there will be additional efforts toward reclamation in the near future.

As Figure 11 shows, most of the reclaimed land during this period involved huge tracts south of Point San Mateo. Some of these lands were used for agriculture but most were primarily intended for use as vats in obtaining salt through solar evaporation. Some of the land diked off for this purpose was later filled due to the pressures of housing, industry, and transportation. 49

As mentioned earlier, marshland is land lying between mean high tide and five feet above mean sea level. Therefore, the Leslie Salt Company, which owns 36,000 acres in the South Bay does not have to fill land below the water level in order to reclaim it. The importance of this fact will be explained shortly.

Recently Leslie Salt Company sold some of its holdings near the western terminus of the San Mateo Bridge to a land developer. This area, known as Brewer
Figure 11:
Land reclaimed 1925-1940.
SAN FRANCISCO BAY AREA:
SOUTHERN PORTION
LAND RECLAIMED 1925-1940

MAP SOURCE: ARMY CORPS OF ENGINEERS
Island, was filled with 18,000,000 cubic yards of sand pumped from the San Bruno Shoal.\textsuperscript{50} Again Foster City, as the development is known, does not encroach onto the waters of the Bay. The elevation of the marshland reclaimed earlier for farming was merely increased to several feet above the water level.\textsuperscript{51}

A striking example of another type of extensive utilization of the marshland area is seen in the 'antenna farms' on Redwood Peninsula and near Mountain View. These represent International Telephone and Telegraph Corporation's press wireless operation.

The narrow waterfront fill south of Point San Mateo (also known as Coyote Point) is now a part of the Coyote Point Yacht Club as well as two smaller municipal parks: Bayside Park and Ryder Court Park. The remaining land, behind a most obvious levee, is being used for private dwellings.

San Carlos has also made use of some reclaimed lands by constructing an airport adjacent to the Bayshore Freeway at the Holly Street offramp. Although present facilities limit the size of the planes to small private craft, the present expansion of the terminal indicates that more land may be reclaimed in the near future. Also at the airport site, San Carlos has made use of reclaimed land in construction of its sewage treatment facility.
Little else can be said for this period. The remaining lands south of the San Carlos Airport are still largely used for the reclamation of salt. Some development has taken place along the freeway, but this is limited to motels, restaurants, and service stations. The only other exceptions are found in the areas claimed by Moffet Field as a right-of-way and those "... salt ponds and marshlands in the South Bay which the Audubon Society leases from Leslie Salt Company." 52

1940-1958

In general, it can be said that the reclamation efforts during this period were used to supplement or complete previous operations. This is most obvious in the city of San Francisco itself where both Fort Mason and Fisherman's Wharf were completed to their present state. Farther south, a large expansion of the Hunters Point Naval Shipyard required additional shoreline development.

Probably the most noteworthy example of reclamation in this period is the Bayshore Freeway between Candlestick and Sierra Points. In construction of this section, a lagoon was created between the freeway fill itself and the old Bayshore Boulevard to the west. Subsequently, a great portion of this lagoon was filled through disposal of refuse at the Brisbane dump. The
level land formed through this activity has been used for the Champion Speedway and a small freight yard for the Southern Pacific. Although much of the land is still vacant, construction of a series of oil tanks indicates that this condition will not persist much longer. In fact, it appears that the entire lagoon is to be filled in the near future through the continued disposal of refuse.

Land reclaimed at Oyster Point during this period was primarily for Bethlehem Steel Corporation's South San Francisco plant. This statement is not contradictory to the one made earlier regarding the bearing capacity of the soils. The 'heavy industry' portion of the operation is built upon bedrock, and the filled land is used for their rail lines, warehouses, and sewage plant.

There are three areas of reclaimed land in the vicinity of the San Francisco International Airport. It was during this period that most of the present runway system was constructed. The original southeast-northwest runways were extended farther into the Bay, and an entirely new system (southeast-northwest) was added. A small portion of the fill was used to house the sewage treatment plant at Millbrae.

As in the earlier period, the reclaimed land south of the International Airport was primarily used for Leslie Salt Company's evaporators. One noteworthy
Figure 12:

Land reclaimed 1940-1958
exception does exist. This is the sword-like body of water south of the San Mateo Bridge. It was constructed by Leslie Properties (the land planning department of Leslie Salt Company) in its development known as Redwood Shores. The pool will serve as one of the central attractions in a planned community that will eventually house sixty thousand persons. 53

Figure 12 illustrates the extent and pattern of land reclamation during this period. In all, three square miles of land were reclaimed from San Francisco and upper San Mateo Counties and 16.4 square miles in the area south of the San Mateo Bridge.

1958-1968

Land reclamation during this period was slight for several reasons. In the first place, the time period under discussion is shorter than any previously considered. Secondly, much of the easily reclaimable land had been developed by this time and extension of these earlier projects would entail far more costly methods. In the third place, this slowdown in the rate of land reclamation was due to the increased public sentiment against further unplanned filling of the Bay.

Most of the reclamation since 1958 involved the tidelands. Naturally, the increased amount of fill necessary to bring the project to the desired elevation,
and the difficulty in placing this fill on the unstable Bay mud has resulted in increased costs. Land reclaimed for use as salt ponds requires only the construction and maintenance of the levees. In 1959, an average sum for the construction of levees was nine to twelve thousand dollars per mile. Maintenance fees for one mile during this period averaged nine hundred dollars annually. Since most of the levees are privately owned, figures on cost and maintenance for any length of time are lacking.

In contrast, the filling of marshlands and submerged lands can cost from 4,100 to as high as 50,000 dollars per acre. This latter sum reflects the cost of constructing the previously mentioned fill for the Bayshore Freeway from Candlestick to Sierra Points. An average cost of 8,000 dollars per acre is considered standard. With this in mind, consider the cost of reclamation when an area as large as the San Francisco International Airport is involved. To 1953, 2,182 acres of land had been created from marsh, tide and submerged lands for a total cost of 13,890,000 dollars.

Much of the land being reclaimed at present is paid for by the homeowner in that sanitary landfill represents an expedient means of disposing of refuse. As Scott says:

"Thus far the encroachment has been on a fairly small scale. But consider that day after day each person in the Bay Area - and there are
now almost four million residents in the nine county metropolitan region - produces approximately four pounds of refuse that must be gotten rid of, half of which is putrescent. In the entire area the total is 8,000 tons daily."57

He goes on by saying that:

"Between now and the year 2015, the amount of refuse produced in the Bay Area will be sufficient to cover, to a depth of eight feet, more than thirty-four square miles of land or water - if the sanitary land-fill method of disposal should continue to be used."58

Those fills at India Basin, Sierra Point, Oyster Point, and the refuse dumps at Burlingame, San Mateo, and Palo Alto are all using the sanitary landfill method. This merely involves the deposition of a layer of garbage and then covering it with a layer of clean fill the same day. In this way both the objectionable odors and the problem of rats and insects is kept to a minimum. Where the fill is being dumped directly into the Bay, as at San Mateo, a restraining wall or fence must be constructed so as to prevent any of the lighter material from floating away. However, there is the additional problem of water pollution in this case. As the refuse decomposes, the liquids so formed drain into the Bay with every low tide.

Menlo Park is presently dumping its refuse onto land owned by the Leslie Salt Company. This land, once salt ponds and already diked, is being reclaimed on a twenty acre site at a rate of one-half acre per month.
This filled land will be incorporated into a one hundred and seventy-five acre recreational development being planned by the San Mateo County Planning Commission. At Hunters Point and Candlestick Point, clean fill is being used to reclaim the land. In the case of Candlestick Point, the fill material is coming from the point itself. The San Francisco airport is also presently using clean fill to extend its northeast-southwest runway system from 9,700 feet to 11,870 feet. The project will require 1,000,750 cubic yards of fill. Interestingly enough, there is only one reclamation project that is both under construction and also being utilized. This involves the fill due west from Point San Mateo. The eastern portion of the fill was completed two years ago and is presently housing a Drive-in theatre and a tire company warehouse. The western and central parts of the project are still under construction. The aim here is for a small shoreline park with boating facilities to complement the existing beach at Coyote Point Park.

In the extreme southern section of the study area there are no projects dumping fill directly into the Bay. However, there is a large dump operated by Los Altos across from the San Jose-Santa Clara sewage treatment plant. Nearby, there is also a large private dump owned by the Owens-Corning Fiberglas Corporation.
Both dumps are in the process of increasing the elevation of the marshland by approximately twelve feet.

Figure 13 shows the extent of land reclaimed during this period.
Figure 13:
Land reclaimed 1958-1968
SAN FRANCISCO
BAY AREA:
SOUTHERN PORTION

LAND RECLAIMED
1958-1968

UNDER CONSTRUCTION
PROPOSED

Scale on Miles
FOOTNOTES FOR CHAPTER TWO


2. Scott, *op. cit.*, p. 25


4. Ibid., p. 20.

5. Scott, *loc. cit.*


9. Ibid.


12. Ibid., p. 5.

13. Ibid.


18. Ibid.


21. Kemble, op. cit., p. 82.

22. Ibid.


24. Scott, op. cit., p. 3.


27. Ibid.

28. Lewis, op. cit., p. 87.

The residents of San Francisco, in the November 5 elections, 1968, voted to return control of the harbor to the city.

29. Ibid., p. 86.


32. Lewis, op. cit., p. 158.

34. Ibid.


It is interesting to note that much of the Bay was sold during this period to speculators expecting great developments after the completion of the Panama Canal.


41. Scott, *op. cit.*, p. 3.

42. Ibid., p. 4.

43. Ibid., p. 10.


46. Ibid.

47. Ibid.

48. Ibid., p. 15.
52. Ibid., p. 69.
54. U.S. Department of Commerce, op. cit., p. 84.
55. Ibid.
56. Ibid.
57. Scott, op. cit., p. 27.
58. Ibid.
60. Ibid., p. 32.
CHAPTER THREE: THE EFFECTS OF RECLAMATION

Thus far this study has been primarily descriptive. It has shown how, when, and where the various sections of land have been reclaimed from the Bay. This chapter will be devoted to an explanation of how these efforts have affected the Bay and the surrounding area. As mentioned in the introduction, any change in one part of this dynamic system results in an alteration and compensation within the rest of the system.

The General Economy of the Bay Region

One must consider the impact of the increased land area on the total economic development of the Bay Region. Land has been created from an otherwise barely usable resource - both at the shoreline and at the source of the fill. Homes and industries have been built within the region which otherwise might have been forced to seek other locations. The Army Corps of Engineers feels that,

"It is expected that the many advantages offered to industry by the South Bay Counties - developed industrial parks and other suitable plant sites, transportation facilities, desirable residential sites, service industries, research facilities, and utility services - will assure that the larger share of industrial and business newcomers to the Bay Area will locate in the South Bay area for the next several decades."
Thus, the general economy of the region is being upgraded by the reclamation of land. In fact, the preceding chapter has been a testimonial to this. Since the population of the San Francisco Bay counties is expected to double before the turn of the century, it seems only natural that reclamation of the baylands is often regarded as the only solution to the problem of limited space.

**Land Ownership Patterns**

This increase in the amount of usable land has also brought to the surface a problem that has been dormant for some time. As mentioned earlier, thousands of acres of waterfront land were sold to various private agencies and cities. Today, the result is an extremely confused situation in which there are many 'owners' of the Bay. Thus, if the Leslie Salt Corporation were to reclaim their holdings for residential or other use, they could do so with relative impunity - as long as the fill did not displace any water. ²

At present, twenty-two percent of the entire Bay Area is in private hands; twenty-three percent is owned by the cities and counties; fifty percent by the state; and five percent by the federal government. ³ Although there is a greater percentage of privately held land in the study area, the 'patchwork' ownership pattern
is clear. Furthermore, those areas which lie closest to the shore in shallow water and which can be reclaimed most easily are in private hands. This entire pattern of land ownership evolved from the state's earlier belief that, "... tidelands and marshlands were virtually worthless in their natural condition and thus should be filled or reclaimed." Mel Scott summarizes the situation by saying that the "... power of decision over the planning and development of the Bay is so divided and so diffuse that the Bay is hardly being governed at all." 

Public Opinion and Bay Area Government

Filling the Bay has also had the effect of arousing public opinion. This is a relatively recent development preceded by general public apathy on matters concerning the Bay. "It is not surprising that 243 square miles of Baylands in the entire nine county Bay Area could be filled between 1850 and 1957 (at an ever increasing rate) with little or no public reaction until the start of the 1960's." Much of the popular literature resulting from this increased public concern about the Bay was designed to appeal to certain special interest groups. As an example, Scannell's article "The Great Bay Debate" is clearly designed to provoke the sportsman into activity
to save the Bay. Other articles in newspapers and popular magazines have had the effect of focusing the public's attention on problems in those sections of the Bay already noted for tourism, hunting, or sightseeing.

Although the authors of these articles did not come up with any significant proposals for the management of the Bay's resources, the publication of their articles had the effect of increasing the public's awareness of the serious nature of the problem. This led to the formation of the San Francisco Bay Conservation and Development Commission (Bay Commission) in 1965. This body has the authority to refuse permission for future reclamation involving filling the Bay. In addition, it undertook a thorough study of the Bay and is presenting its findings, along with a proposal for future action, to the state.

More than anything else, the study of problems associated with filling the Bay has shown that there must be some regional authority with jurisdiction over the entire Bay before any proposals for control can be effective. The situation today merely reinforces Scott's earlier statement that the Bay is 'Balkanized.'

**Industrial Development**

The increasing public awareness of the problem has also led to the realization that the Bay is valuable in its present state. Hunters and fishermen claim that
their interest in the Bay Area contributes forty million dollars annually to the economy. Boaters add another thirty million dollars to this amount each year. If filling were allowed to continue unchecked, it would mean the loss of at least seventy percent of the shorebirds using the Pacific Flyway. This in itself would be a tragic loss, but it would also entail the loss of a good portion of the previously mentioned revenues.

Total filling of the Bay would also lead to the total destruction of the salt industry and a drastic reduction in the Bay Area cement industry. The study area is at present an important producer of sand, salines (salt, magnesium compounds, bromine, and gypsum), shells and blue clay. It was estimated that in 1961 the value of the entire Bay Area production of minerals amounted to eleven million three hundred thousand dollars. Furthermore, the loss of the salt industry would lead to the loss of many other salt-using industries.

Also affected by the continued filling would be the Ideal Cement Company which owns 30,000 acres of land (mostly submerged) between Millbrae and Alviso. Since most of this land is less than thirty feet deep, it provides a lucrative opportunity for reclamation. If maximum utilization of this natural resource is desired, the deposits of shells and sand would have to be removed first. Otherwise it would mean the premature demise of a
prominent Bayshore industry. Even though pollution of the South Bay prevents the growth of oysters at this time, there are enough shells in the existing deposits to supply the cement industry for several decades. Clearly, the economic value of any reclamation effort would have to surpass that of the existing operations.

**Effects on Tidal Action**

A more physical effect of the filling is in the movement of water due to the tides, known as the tidal prism. It is this seiche action that is responsible for most of the flushing action in the South Bay, since there is little water flowing into the area from natural streams (discussed earlier). Bernard Smith of the Bay Commission feels, "that tidal action ranks as a great natural resource to be preserved at all costs." Stagnation and pollution in the shallows, particularly in the South Bay, are present problems that can dangerously increase with the diminution of the tidal force.

The reason for this is apparent. Of the 1,250,000 acre feet of water entering the Golden Gate with each high tide, only a fraction enters the South Bay. Since the South Bay is a closed arm of the system, the water merely rocks back and forth. This in turn leads to a buildup of pollutants in the southern sections of the study area. Today, it takes ten days for the
pollutants introduced at Alviso to reach the San Francisco International Airport and twenty days to reach the Golden Gate.\textsuperscript{15} Thus, if the filling were to proceed to the six foot contour, the speed of these currents would be reduced from 75-90 percent.\textsuperscript{16} Associated with this would be the increased sedimentation due to lower velocities.

\textbf{Disposal of Sewage}

One of the more important considerations in any future reclamation is pollution by industrial and domestic sewage. As mentioned earlier, it is felt that reduction of the tidal prism will cause a corresponding decrease in the flow of pollutants out of the Bay.

There are twenty-two sewage treatment plants in the study area, twelve of which offer only primary treatment facilities. The remaining ten sites offer secondary treatment or better.\textsuperscript{17} All of the plants are located close to the Bay, since it is the destination of the treated wastes. Also, the lower elevation at the Bay-shore permits gravity to supply the energy needed to transport untreated sewage to the plant.

The most modern treatment plant in the study area is the one operated jointly by the cities of San Jose and Santa Clara. The need for such thorough treatment in the South Bay area is apparent when one takes
into consideration the enormous seasonal waste from Santa Clara Valley canneries. Prior to the opening of the new treatment plant in 1964, the original facility had to allow all influent sewage beyond the plant's capacity to pass untreated into the Bay. The result was an offensive stench over the entire South Bay, especially during the months from July to October. Today, only a severe flood would cause the Santa Clara Valley Water Pollution Control Board to permit the discharge of untreated wastes into the Bay.

San Francisco, on the other hand, still has only two primary treatment plants serving the entire city. While primary treatment removes the solid matter, it does not have the facilities to reduce sewage into simpler molecules through decomposition. Even so, every time it rains San Francisco plants cannot handle the increased volume of water, and, as a result, untreated wastes are injected into the Bay. Only recently (October, 1968), San Francisco was issued a court order to provide a plan which would stem future contamination. As Kneese states, "... the limit upon society's ability to avoid water pollution is not technical." The sad fact remains, however, that the principal elements of primary and secondary treatment have remained unchanged for forty years.

Since both domestic and industrial sewage are
being discharged, one must be prepared to cope with both conservative and non-conservative pollutants. Conservative pollutants are those that are not altered by biological processes occurring in natural waters. Most often they are the inorganic chemicals such as chlorides and metallic salts. Non-conservative pollutants are those "... substances that are changed in form and/or reduced in quantity by the biological, chemical, and physical phenomena characteristic of natural water."  

The conservative elements in the sewage usually pass right through the primary and secondary facilities unchanged. They will not be discussed in detail here, except to say that in many cases they are poisonous to aquatic plants and animals. This, in turn, compounds the pollution problems by killing one of the primary sources for re-oxygenation.

The non-conservative pollutants are torn down, by oxidation, until they are no longer harmful. If a sewage plant offers only primary treatment, this oxidation must take place within the waters of the Bay. Secondary treatment provides for initial oxidation to take place within the facility through either the trickling filter or activated sludge methods. As with the primary treatment, this method also calls for some of the oxidation to take place in the receiving body of water. Tertiary treatment, in contrast, allows for total reduction
and removal from the sewage of all pollutants within the treatment plant. Even though tertiary treatment would remedy the pollution problems of the study area, none of the cities have installed the necessary facilities. High cost is the primary deterrent.

The waters of the Bay have an average range of from 6.8 to 9.5 parts of oxygen per million parts of water (ppm). Since fish and other marine life need at least 4.5 ppm. to survive, this leaves only 2.3 to 5 ppm. for the complete oxidation of wastes. Bear in mind that the lower figures occur in the southern portion of the study area. The rate at which the dissolved oxygen is drawn off by the pollutants is referred to as the biological oxygen demand (BOD). BOD is also affected by toxins, such as the conservative pollutants mentioned earlier, which may limit or inhibit bacterial action, and by temperature. Higher temperatures accelerate the degradation of wastes; however, the oxygen level of warm water is lower than that of cold water. It is obvious that if the pollution levels are to be kept low, the amount of oxygen available for BOD must be maintained at high levels.

The preceding section has shown that there is a direct relationship between tidal movement, oxygenation, and the level of pollution in the South Bay. Should anything interrupt the amount of oxygen entering the water,
pollution would increase. Oxygen enters the water through the churning action of the waves, absorption by the water surface, exposure of mud flats when the tide is out, and aquatic vegetation. Therefore, reclamation on anything other than land above the water level will reduce the oxygen absorption. Once the oxygen level falls below 4.5 ppm, pollution occurs at the expense of other marine life.

Solid Waste Disposal

The effects of using refuse as fill material was mentioned briefly in the earlier chapter. Here, it was found that dumps situated on the Bayshore allowed the leaching of rotted material into the water. According to Scott, "In the entire area the total is 8,000 tons daily, and as the population steadily increases to the 14,000,000 predicted by the second decade of the twenty-first century, the daily accumulation of solid wastes will rise to 28,000 tons, or enough to fill 1,400 of the very largest dump trucks now used to transport refuse." Bear in mind that these figures are for the entire nine county Bay Area and that the problems of the study area are compounded due to the greater population densities and fewer sites available for refuse disposal. Figure 14 illustrates the sanitary landfill method for disposal of refuse.
Figure 14:
The Sanitary Landfill method of garbage disposal.
Another form of refuse is the naturally occurring silt. Since ocean-going vessels must reach as far south as the Port of Redwood City, and smaller vessels as far as Alviso, it is necessary to maintain dredged ship channels. Interestingly enough, the dredged material is dumped in a deeper section of the Bay just west of Treasure Island. Here, the stronger currents carry some of the debris out to sea. As mentioned in the earlier section dealing with natural filling of the Bay, the incoming tides return much of the material. Only thirty percent ever reaches final deposition in the Pacific Ocean.25

With this in mind, it is easy to understand the U.S. Army Corps of Engineers' willingness to dump the silt onto dry land. "Occasionally, an owner of some of the tidelands and submerged lands sold by the state in the 1860's and 1870's asks the Corps of Engineers to dump dredged material on his property, and the engineers, always looking for places to get rid of silt, willingly oblige him."26 Due to the limited bearing capacity of this material, and the time required for settling, not every landowner wants this kind of fill. "The dredging operations of the Corps of Engineers nevertheless contributes, year in and year out, to the diminution of the Bay."27
FOOTNOTES FOR CHAPTER THREE


   Section 66632 of the McAteer-Petris Act declares that a permit for filling is needed only if a person or governmental agency wishes to, "... place fill in the bay or to extract submerged material from the bay ... ."


4. Ibid., p. 3.

5. Scott, op. cit., p. 93.


15. Ibid., p. 15.

16. Ibid.

17. Personal Field Survey, August, 1968.


19. Ibid., p. 15.

20. Ibid., p. 16.

21. Ibid.

22. Smith, op. cit., p. 16.


24. Scott, op. cit., p. 27.

25. Ibid., p. 25.


27. Ibid.
CHAPTER FOUR: FUTURE USE OF THE BAY

The future utilization of San Francisco Bay rests primarily with man's decisions. If he decides to literally 'conserve' the Bay, then he has the power to maintain the status quo. If, on the other hand, he decides to reclaim the land, then it is within his power to do so. Figure 15 shows those sections of the Bay in which reclamation is economically feasible at the present time. Several proposals now before the various governmental agencies tend to indicate that the rate of reclamation will increase within the next several decades.

Bay Barrier Plans

One of the oldest plans involving San Francisco Bay is the Reber Plan. Basically, this proposal calls for construction of barriers (dams) across the major bodies of water. Thus, there would be a dam extending from San Francisco to Oakland, one from Oakland to Richmond, and one from Richmond to Sausalito. In so doing, fresh water would be impounded behind the tidal barrier, and alleviate the water supply problems of the area. To date, it seems as if the bulk of the Reber Plan will not be initiated. The problems of pollution, siltation, and wildlife would all be magnified, especially in the South
Figure 15:
Areas susceptible of reclamation.
Bay. In addition, special provisions would have to be made for supplying saline water to, and removing the brine from, the Leslie Salt Company. Also, the delay and inconvenience to shipping would not be economically justifiable.¹

The attraction of the barrier-reservoir combination still prevails in the South Bay, where both the San Mateo County Master Plan and the Santa Clara Valley Preliminary Waterfront Development Plan call for such facilities. In both cases, the barrier would be located near the Dumbarton Bridge and the resulting reservoir would involve only the extreme southern end of the South Bay. Again, the major criticism of the project is the insufficient supply of fresh water entering the South Bay to offset the effects of evaporation and absorption.²

Continued Filling of the Bay

By far the most extensive proposals for the future development of the Bay involve continued filling. Since the Bay Commission has put a freeze on many filling operations, San Mateo County "... makes no recommendations for uses in the Bay beyond tidal marshlands ..."³ Those tidal and marsh lands not affected by the authority of the Bay Commission are all included in a major reclamation proposal.

In some cases the fill would be dredged from the
floor of the Bay as was done at Foster City. Here, the sand dredged from the San Bruno Shoal was pumped onto Brewer Island. Some 18,000,000 cubic yards of material were required to raise the level of the entire island several feet above the water level. In other cases, the fill will be derived from the nearby hillsides. San Mateo County already plans to remove most of the material comprising the San Bruno Mountains for deposition into the Bay. This project would involve some 636,000,000 cubic yards of fill.

Much of the San Mateo Master Plan is being put into effect at the present time. All of the reclamation involving that county in the discussion of land reclamation from 1958 to 1968 complies with the basic aims of this plan.

Foster City, a planned residential and industrial community which will eventually house 35,000 people, recently opened its first units. On nearby Redwood Peninsula, Leslie Properties is in the process of developing its own community - Redwood Shores. This shows some diversion from the Master Plan, in that the area was to have remained in its natural state, either as a park or wildlife refuge, until 1990. Also on the Redwood Peninsula is the Marine World aquarium. The entire complex will eventually encompass 4,400 acres and, as mentioned earlier, house an additional 65,000 people.
Farther south, both San Carlos and Palo Alto are expanding their airport facilities. Palo Alto is also moving ahead with its plan to use land reclaimed by sanitary landfill to complete a shoreline park.

Perhaps indicative of things to come is the decision by International Telephone and Telegraph Corporation to sell 115 acres of 'antenna farm' on Redwood Peninsula to Leslie Properties. This sale represents a change from a low intensity to a high intensity land-use. Although Leslie Salt plans to remain in the salt business for some time, there is no doubt among planners that salt production will be severely curtailed in the coming decades. Only last year (1967), San Mateo County increased the assessment on some Leslie lands to a market value of 20,000 dollars per acre to encourage urban development of the salt evaporation ponds.

When completed according to the San Mateo Master Plan, the shoreline of the study area will be more streamlined. There will be a new freeway along the waterfront, known as the Bayfront Freeway. In many cases it will be three to four miles east of the present Bayshore Freeway. Land in between these two roads will be used for an orderly array of industrial, residential, recreational, and wildlife areas.

Likewise, the Santa Clara County Preliminary Shoreline Development Plan calls for use of the shore in
Figure 16:
Circular flushing concept.
CIRCULAR FLUSHING CONCEPT
SOUTH SAN FRANCISCO BAY
AS SUGGESTED BY
ALAMEDA COUNTY PLANNING DEPARTMENT
new boating facilities and parks. Less industrial use is planned for this area due to the problem of land subsidence. As with the San Mateo Plan, there will be a barrier constructed at the Dumbarton Bridge. Included in this barrier are ship locks to accommodate the planned enlargement of the ports at San Jose and Alviso.9

In addition to the plans already being initiated, there is one which especially reflects the long-range planning now being considered. This involves construction of a mid-bay island, primarily in the shallow southeastern portion of the Bay. Since the area involved (see Figure 16) lies in water from five to fifteen feet deep, "Conversion of the shoal area would involve fairly deep fills, probably combined with diking ..."10

"The possibility of using the shoal area as a site for a future mid-bay airport was mentioned earlier. Both San Francisco Airport and Oakland Airport are located largely on filled land. At present there is no need for an additional major air facility, and expansion plans of the two existing facilities will meet the needs for the immediate future. By the year 2000 however, the four counties fronting the South Bay will contain about 6 million inhabitants and per capita use of passenger and air cargo services will increase substantially. Therefore it seems likely that at some time in the future the need may arise for a mid-bay air facility, either as an alternate or as a supplement to other airports, and technical advances in flying may make this feasible ..."11

Many planners regard use of the Baylands for airports as desirable because of the decreased noise over the residential areas.12
The mid-bay island plan has also attracted attention for possible future use as a central waste treatment plant and/or refuse disposal center serving several communities. The value of this scheme lies in the feasibility of constructing large, highly efficient waste disposal operations for the entire South Bay. As mentioned earlier, the cost of constructing individual treatment plants at each city both increases the cost and decreases the efficiency of treatment.

In addition to use of the island for an airport, disposal, penal, or mental hospital facilities, the plan also provides for regulated flushing of the South Bay. This aspect is clearly demonstrated in Figure 16. This author feels that the problem of flushing the South Bay will remain; the island will, by virtue of its presence, decrease the tidal prism drastically. Whether the volume of water entering with the tides will be sufficient to make this project operable must be studied, preferably at the Army Corps of Engineers' Bay Model at Sausalito.

After reading testimony given by civic leaders at the San Francisco Bay Conservation Study Commission hearings, one theme remains prominent throughout. Most speakers feel that although a supervisory agency is needed, there is no real agreement on the form that this governmental unit should take. R. Liukkonen, the San Mateo County Planning director, believes in home rule for
the county. He feels that San Mateo County should resist a state imposed moratorium on filling, but should welcome state co-operation in regional planning. Opposing this view is the one held by John Sutter, President of the Citizens for Regional Recreation and Parks. He feels that the Legislature should impose a moratorium on all filling in the Bay until a complete planning study is made. If there is any agreement among these factions, it centers on the fact that there is definite need for further study of the problem.

Mel Scott, in his testimony before the same Commission, stated that public interest "... demands the use of the Bay in the greatest possible variety of ways. I think there is room here for people, fish, birds, boats, ships, and perhaps some factories. The problem is to find the right balance."
FOOTNOTES FOR CHAPTER FOUR


3. Ibid.


5. Ibid., p. 39.


11. Ibid.


15. Ibid.
CONCLUSIONS

It has been shown that planning for the future use of San Francisco Bay presents a dilemma. These problems stem largely from the historical use of, and attitudes towards the use of, this natural resource. Whereas those attitudes prevailing from 1848 until about 1958 were quite liberal with regard to reclamation, those from 1958 to the present have been generally more conservative in nature. This conservative trend has been reflected by the surge of detailed reports dealing with physical conditions and changes in the Bay brought about by filling. The formation of groups such as the Bay Commission and Save the Bay Association also serve as testimony to this changing awareness.

Reclamation, for the most part, has been quite haphazard, responding to the specific needs of specific times rather than on a methodical and constant plan. This was shown to be the case in the early development of the San Francisco waterfront between 1848 and 1900, when reclamation proceeded at an almost frantic pace. Then, between 1900 and 1925, when the demand for additional land was not so great, reclamation was much less noticeable. Between 1925 and 1958 reclamation progressed rapidly, but for extensive rather than intensive purposes.
Today, a great deal of this previously reclaimed land is under close scrutiny for possible intensive utilization in the near future.

It was not until quite recently in the development of the Bay that man began to value the Bay as a resource to be protected rather than mercilessly exploited. Once this realization occurred, much of the damage had already been done. Cities recognized the value of the reclaimed land itself, but generally did little to study its effects on the Bay system. As a result, every major city and several private companies now maintain sewage treatment facilities on the shore of the Bay. As described earlier, this treatment, in many cases, leaves much to be desired. Sewage pollution definitely ranks as one of the greatest problems confronting the development of the area.

Compounding this problem is the effect of the fill itself on the flushing action of the tides. Whereas the northern portions of the Bay system have some influent streams, the South Bay is primarily a closed arm of the sea. So slow is this flushing action that in many portions of the extreme South Bay the water is practically stagnant. Then, when one considers that many sections of the shoreline are primarily composed of putrefying refuse, the immensity of the problem becomes apparent.
Future planning could solve a great number of these problems, or at least reduce their effects, but as stated in many of the reports read by this author, the cost is still prohibitive. In general, however, the plans proposed thus far are merely continuations of earlier procedures. The primary motivating force guiding this planning still appears to be the extension of the land surface in order to realize greater financial returns. One consolation is that the future plans, if carried out, will be more orderly, and their effects on the area as a whole more easily ascertainable.

As mentioned in the introduction, the primary aim of this thesis has been to understand man's changing use of a natural resource. In this endeavor, the thesis has been conservation oriented. The word 'conservation', as used here, must be in the fullest sense, for what may be conservation to the author need not strike a similar response in the reader. With this in mind, several conclusions need clarification.

Firstly, the author feels that if maximum utilization of this resource is to be attained, some reclamation must continue. Any traveller to the South Bay, especially in the Alviso area, would have trouble justifying the permanent maintenance of present land uses. Granted, it is in this area in which nature preserves, if there are
to be any, must be established.

Secondly, any future proposal must be approved by a governmental agency having jurisdiction over the entire Bay Area. It has been shown that all three counties within the study area arrived at their plans independently. This problem is even further compounded when one considers that each of the nine counties in the Bay Area is also working independently. Furthermore, all proposals should be subjected to a thorough simulated test on the Corps of Engineers' Bay Model.

Thirdly, the author feels it most important that planning departments recognize the limitations of their environment, rather than base their plans on expected or needed revenue. It is felt that only in this way can San Francisco Bay remain a resource with many diverse values.
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