Chapter 4

THE INFLUENCE OF GOLDEN GATE FIELDS ON SHORELINE WATER QUALITY

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Introduction

The possibility of a new state park on the waterfront from Albany to Emeryville (see map, p. viii) is presently being investigated by the City of Berkeley. If established, it may be used for water contact and non-water contact recreation, fishing, marine and wildlife habitat preservation, preservation of endangered species and shellfish harvesting (Environmental Science, 1982). The quality of the shoreline water will put limitations on the potential uses as a park, especially water contact uses such as shellfish harvesting and water contact recreation. This report explores the effects Golden Gate Fields Horse Racing Track (GGF) may have on the shoreline water quality. Many factors of water pollution such as disease-causing organisms, synthetic compounds, inorganic compounds, mineral substances and plant nutrients, are of interest because of their effect on human health and the health of marine life. The pathogenic organisms include viruses, bacteria and parasites from animal and human sewage. The synthetic organic compounds are chemicals used in turf management and their reaction with other chemical compounds. The inorganic compounds and mineral substances include acids, heavy metals and precipitates from the atmosphere. Plant nutrients come from nitrogen and phosphorus in sewage and fertilizers (Ehrlich et al., 1970).

This report covers four possible sources of pollution from GGF: animal waste, human waste, herbicides and trace metals. I studied animal waste in detail because I had access to a lab. I was also able to test for trace metals, but no testing was done on herbicides.

History and Description of Golden Gate Fields

Golden Gate Fields is a horse racing track located on the East Bay shoreline at the end of Gilman Street, partially in Berkeley and partially in Albany (see map, p. viii). It was built in 1940 and is presently owned by Bay Area Sports Enterprises, which also owns Bay Meadows Horse Racing Track in San Mateo County. The land is currently rented from the Santa Fe Railroad Company, which owns extensive shoreline property. The entire complex covers 225 acres of shoreline landfill. The race track receives 11,000 visitors on weekdays and 18,000 on Saturday and is closed on Sundays and Mondays. The 1983 season began on February 8 and will extend until June 26. During this time the track's 1500 stalls are generally full (Krausch, 1983).

The horses reside in separate stalls containing hay mats, which are swept out by 10:30 each morning. The hay and manure is heaped into piles and taken to the Morgan Hill Mushroom Farm south of San Jose. GGF uses about 1,000,000 gallons of water each month to clean the horses and wash certain parts of the stable area, although the stalls are never washed out with water; thus, a potential source of contamination is eliminated. Most of the water drains directly into the bay. The runoff water from the stable area and part of the race track flows to the bay through a series of open-air troughs and underground drainpipes that are continually clogged with straw, grain and manure. Three drains flow into the bay directly and four flow into Codornices Creek, which lies to the east of the race track. The water quality of Codornices Creek is discussed in detail in the paper by Randal Ruth.

Past Studies

In 1972, the City of Berkeley received several complaints from the residents living near Harrison and 7th Street in reference to a foul smell wafting from the sewers below the street. After a brief investigation, the source of the odor was found to be a conglomeration of horse manure from GGF and sulfur, which was being released by a nearby factory. Both businesses were cautioned by the City of Berkeley and given letters of reprimand, which discussed the legal aspect of pollutant dumping. The problem seems to have been solved because there have been no further complaints (Lotter, 1983).

Golden Gate Fields was studied once again in March, 1981 by the Regional Water Quality Control Board for the San Francisco Bay Shellfish Program (Jarvis, 1981). The report examined the sewage collection, treatment and disposal systems of bay cities and organizations in order to evaluate their effect on the bay area shellfish beds, with the ultimate goal of possibly reopening some of the beds for shellfish harvesting. The Regional Water Quality Control Board examined the race track because their outfalls empty into the bay near prime shellfish beds. The Board took three samples on March 20, 1980, from sites A, B, and C (Figure 1), and one sample from Codornices Creek. There had been no rain during the five days preceding the sampling. The results indicated that the water leaving GGF's stable area had a high coliform count. The total coliform count was 240,000 coliforms per 100 ml of water and the fecal coliform count ranged from 35,000 FC/100 ml at Codornices Creek to 160,000 FC/100 ml at site C (Table 1). The recommended average permissible level in shellfish harvesting areas is 70 FC/100 ml (Table 2). The Regional Water Quality Control Board concluded that Golden Gate Fields' management of the stable area minimized potential problems but still contributed to the pollution of the water surrounding the shellfish beds (Jarvis, 1981). Thus, the shellfish beds could not be reopened.

Methodology

Bacteria - Water contaminated with sewage may contain disease-causing organisms that can transmit dysentery, typhoid fever, cholera and infectious hepatitis, among other things. Since these pathogenic

SAMPLE SITE	TOTAL COLIFORM COUNT/100 ml	FECAL COLIFORM COUNT/100 ml
SITE A	240,000	92,000
SITE B	240,000	92,000
SITE C	240,000	160,000
CODORNICES CREEK	240,000	35,000

Table 1. Results of RWQCB's GGF Water Analysis.
Source: Jarvis, 1981.

organisms are often dissicult to isolate and enumerate, indicator organisms such as coliforms are used to signify the presence of fecal contamination.

Coliforms and fecal coliforms (those found in the intestinal tract of warm-blooded animals) are enumerated through the use of the most probable number (MPN) method (APHA, 1980). There are three parts to the most probable number method: (1) the presumptive test, (2) the confirmed test, and (3) the completed test (Cooper et al., 1976). Since the completed test is not usually necessary, I used only the first two parts of the MPN method. The current standards for bay area water quality are listed in Table 2.

Beneficial Use	Receiving Waters	Fecal Coliform, MPN	Total Coliform, MPN
REC-1	tidal	median <50/100 ml; no sample to exceed 400/100 ml	median <240/100 ml; no sample to exceed 10,000/ 100 ml
SHELL	tidal and nontidal	-	median <70/100 ml; 90 percentile <230/100 ml
REC-1	nontidal	log mean <200/100 ml; 90 percentile <400/100 ml	-
REC-2	nontidal	mean <2000/100 ml; 90 per- centile <4000/100 ml	-
MUN	nontidal	mean <20/100 ml	mean <100/100 ml

Table 2. Water Quality Objectives for Coliform Bacteria.
Source: RWQCB, 1975.

REC-1: Water Contact Recreation
SHELL: Shellfish Harvesting
REC-2: Non-Contact Water Recreation
MUN: Municipal and Domestic Supply

The enumeration of fecal streptococci in the water is useful in determining the origin of fecal contamination. A fecal coliform/fecal streptococci ratio of <1 indicates non-human warm-blooded animal contamination; a ratio of 3 to 4 indicates human contamination and a ration between 1 and 3 reveals either human or warm-blooded animal contamination (Cooper et al., 1976). I used the presumptive and confirmed tests of the MPN technique for enumeration of fecal streptococci. Standard Methods suggests using Pfizer agar for the confirmed test (APHA, 1980), but I used Ethyl Violet Azide Broth, because I was unable to obtain the Pfizer agar. My testing also differed from Standard Methods in that I had to freeze the three samples taken before racing season began (numbers A-1, B-1, C-1). I am not sure of the effect this may have had on my results.

Trace Metals - Metals are among the most persistent pollutants in our environment (Hayes, 1979). They are ubiquitous and are used in minute amounts by plants and animals. But when they are present in greater quantities, metals can become a health hazard.

Golden Gate Fields' runoff water was tested for three trace metals, lead, mercury and cadmium, on April 8, 1983, using the atomic absorption spectrophotometry method prescribed in Standard Methods (APHA, 1975). Our procedures varied slightly from Standard Methods in that we used the flame absorption spectrophotometry method to test for mercury, instead of the cold vapor atomic absorption method. APHA also recommends washing the sample containers with nitric acid, which we also did not do.

In the flame spectrophotometer method, the sample is aspirated into a flame, atomized and the amount of light absorbed by the atomized element is measured. Each element has its own absorption wavelength (cadmium absorbs at 228.8 nm, lead at 283.3 nm and mercury at 253.7 nm). The amount of energy of the wavelength that is absorbed in the flame is proportional to the amount of the element in the sample.

We used a number 360 atomic absorption spectrophotometer, which consists of a light source that will emit the line spectrum of an element (interchangeable, hollow cathode lamp), a flame to vaporize the sample, a method of isolating an absorption line (filter and adjustable slit), photoelectric detector and measuring equipment (APHA, 1975). For more detailed information, refer to the 14th edition of Standard Methods.

Sampling at Golden Gate Fields

The water leaving the Golden Gate Fields stable area was sampled before racing season (on February 2, 1983) and during racing season (on February 22, 1983) to compare the level of coliforms with and without the presence of horses. The sampling site locations are shown in Figure 1. There was no rain for two days before either sample sets were taken, and on both days the samples were taken at low tide (1:00 pm and 2:00 pm respectively).

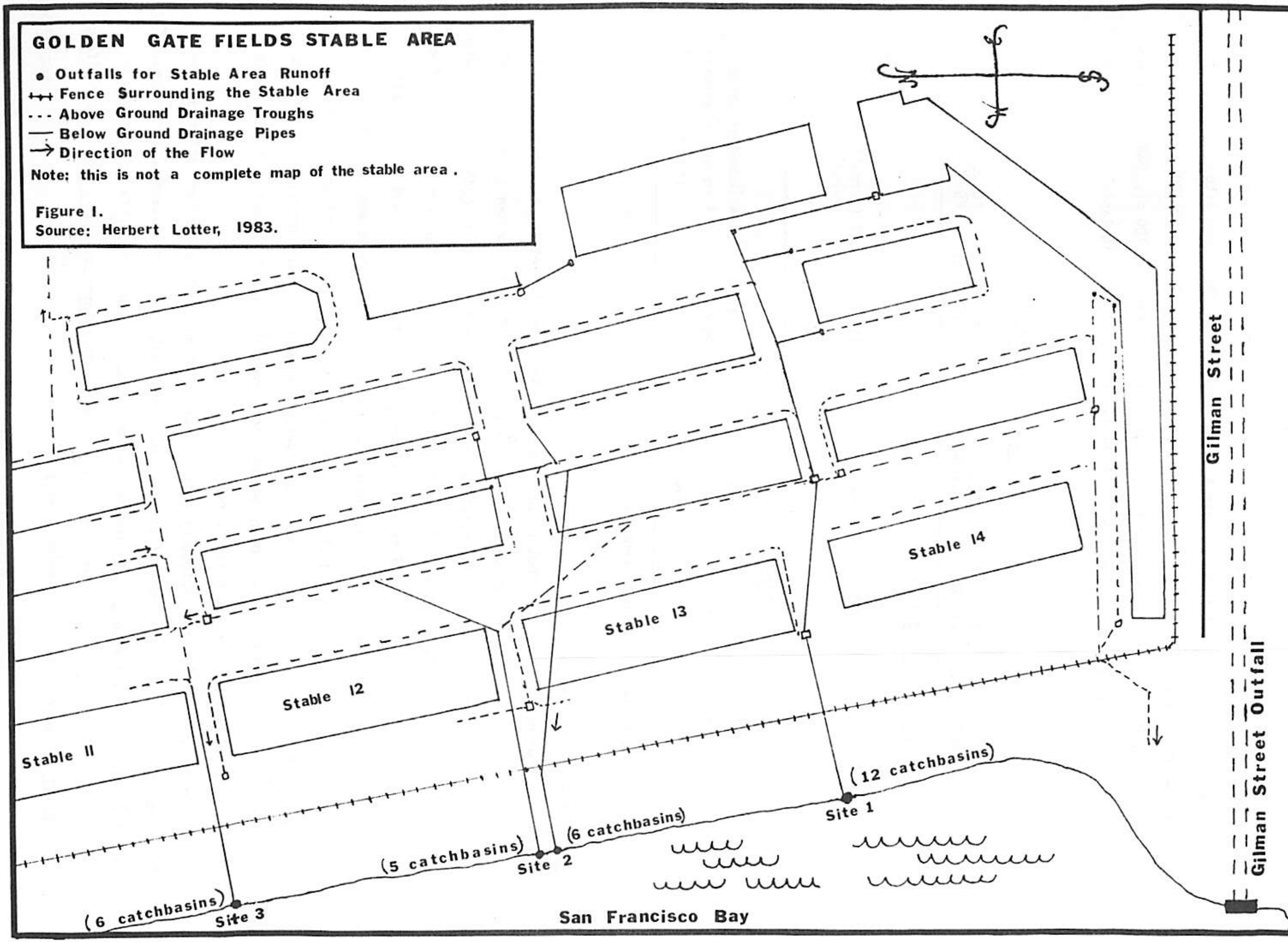

Figure I.
Source: Herbert Lotter, 1983.

The level of total coliforms prior to racing ranged from 200/100 ml at site A, to 4900/100 ml at site B. The number of fecal coliforms at site A was 0, site B, 500/100 ml and site C, 200/100 ml. During racing season the total coliform levels increased to 16,000/100 ml, 5400/100 ml and 2400/100 ml for sites A, B and C respectively, and the fecal coliform levels were 3500/100 ml, 3500/100 ml and 2400/100 ml for sites A, B and C. The results of the sampling are listed in Table 3.

MOST PROBABLE NUMBER/100 ml

SAMPLE NUMBER	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREPTOCOCCI	$\frac{FC}{FS}$ RATIO
Before racing: 2/2/83				
SITE A-1	200	0	0	-
SITE B-1	4900	500	1155	<1 (warm-blooded animal)
SITE C-1	2300	200	0	-
During racing: 2/22/83				
SITE A-2	16,000	3500	>2400	1.4 (human or animal)
SITE B-2	5400	3500	>2400	1.4 (human or animal)
SITE C-2	2400	2400	1155	2.07 (human or animal)

Table 3. 1983 Bacteria Test Results from GGF.

Discussion of Water Quality

Bacteria - The objective for water that is to be used for shellfish harvesting is a median of <70 TC/100 ml. If the water is used for water contact recreation (REC-1) the median is <50 FC/100 ml, with no sample to exceed 400 FC/100 ml. The total coliform median for REC-1 use is <240 TC/100 ml, with no samples to exceed 10,000 TC/100 ml. The water entering San FRancisco Bay from Golden Gate Fields' Horse Racing Track had a high level of fecal coliforms prior to racing season and a drastically increased level (80-fold increase at site A) during racing season. The levels are too high to permit water sports and shellfish harvesting at this time. The level of coliform contamination will probably vary greatly at any particular time during racing season, depending on the activities within the stable area: i.e., if the horses are being washed, the level of coliforms might be higher. The coliform level will also increase during a rain.

The fecal coliform/fecal streptococci ratio indicates animal or human contamination, but my results may not be accurate, because of differences in methodology from the standard procedures. The time of bacterial release also greatly influences the ratio, because Escherichia coli (the major intestinal coliform) has a half-life of 12 to 17 hours, while Streptococcus equinus has a half-life of approximately 10 hours (FIgure 2; Cooper, 1983).

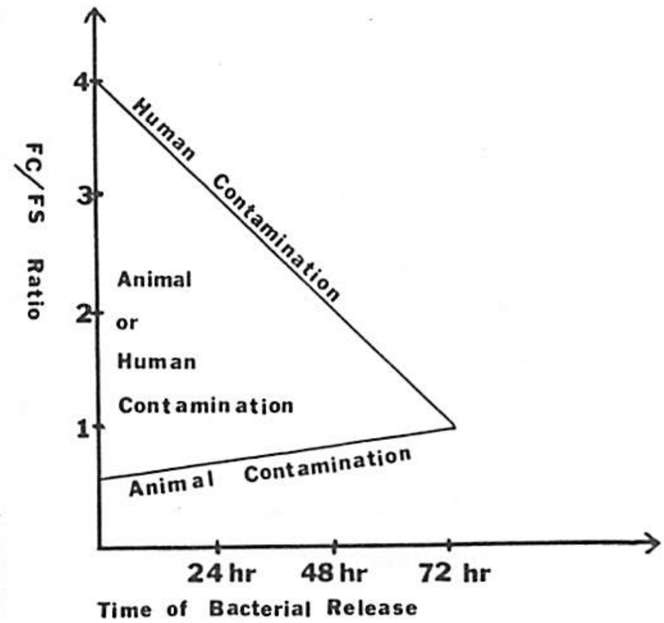

Figure 2. The Role Time Plays in the Contamination Origin Ratio.
Source: Cooper, 1983.

This past winter, GGF has had some problems with their sewage system because Berkeley's sewage system was backing up during the unusually heavy storms, which caused GGF's system to back up. A sump pump in the stable area collects the sewage, and two electric 500 gallon per minute pumps transport the material to the East Bay Municipal Utility District's interceptor system (Jarvis, 1981). The system has an emergency storage time of roughly six hours, and there are no built-in bypasses in the system. Problems in the collection operation cause an alarm to sound; after hours there is always a security guard present who will alert the grounds superintendent to any problems. The pumps are checked three times a day, but the alarm system is rarely checked. GGF's sewage disposal system appears to be adequate.

Thus, from these results it would seem the origin of fecal contamination is from warm-blooded animals, particularly because most of the ratios are very close to 1 (Table 3).

Trace Metals - Different types of metals occur naturally in our environment at various concentrations in the atmosphere, surface and ground water, soil and living organisms. These elements are referred to as trace metals when they appear in small quantities in the biosphere. We have increased the concentrations of some through the use of drugs, biocides and gasoline additives (Erhlich et al., 1977). Three trace metals that are of great interest because of their effect on human health are lead, mercury and cadmium. When tested at Golden Gate Fields the results were negative. The pH was measured at 5, which is slightly acidic. A less acidic condition is more favorable for aquatic organisms: one ranging between 6.5 and 8.5. The pH can be important because many aquatic organisms have very little tolerance for changes, especially those concerning the level of acidity.

Herbicides - Golden Gate Fields is using less herbicides now than ever before, because of stricter government regulations for the use of these harmful chemicals. Some herbicides act as if they were plant hormones and cause metabolic changes, resulting in the death of the plant, while another group causes the death of the plant by interfering with its photosynthesis process (Ehrlich et al., 1977). Not much is known about their effects on plant metabolism. They have an impact on animals indirectly, since all animals depend on plants for their existence, especially herbivorous animals that eat only certain plants.

Herbicides are usually water soluble, because they are designed for easy dispersal in the environment. They flow into gutters, then empty into creeks such as Codornices, and flow onward until they reach San Francisco Bay. But this is only part of the cycle. They also seep into the soil and infiltrate the ground water. Herbicides move downward, with the water, pulled by capillary action and gravity towards underground aquifers and other water storage areas such as San Francisco Bay. When the herbicide reaches the bay it may be absorbed by aquatic plants that are consumed by aquatic organisms that may eventually be consumed by humans.

Since GGF is so close to the shore, it has the potential to affect the bay water. Only one herbicide is used at GGF, Fenocil, which is distributed by National Chemsearch (Box 217, Chemsearch Ave., Irving, Texas 75061), (EPA Microfiche, 1981). Fenocil is a terrestrial herbicide used in a water-soluble, concentrated form. Its active ingredients are heavy aromatic naptha, bromacil and trichloroacetic acid (EPA, 1981). Fenocil's toxicity rating on a scale of one to four (one being most toxic) is two (EPA, 1981). I was unable to obtain any information on Fenocil, but bromacil and trichloroacetic acid are listed in the Herbicide Handbook (Hilton et al., 1974). Trichloroacetic acid ($C_2HCl_3O_2$), also known as TCA, is used to control grass seedlings, perennial grasses and cattails. It is absorbed rapidly by the roots, is readily removed from foliage by rain and is easily leached. It translocates easily and tends to accumulate in growing tissue. Bromacil ($C_9H_{13}BrN_2O_2$) is usually used with other herbicides to control annual and perennial grasses, broadleafed weeds and certain woody species. It can be sprayed in solution or spread dry. Unfortunately, I was unable to locate any information on heavy aromatic naphtha, or the combined consequence of the ingredients, which can be radically different from their solitary effects.

GGF also uses Turf Supreme lawn fertilizer by Best Fertilizer Co. (Krausch, 1983). Fertilizers can also affect the water quality by the addition of nitrogen and phosphorus to the water cycle. The added nutrients use up the oxygen supply in the water, thereby harming the aquatic organisms (Ehrlich et al., 1977).

Conclusion

Past reports on GGF indicate their runoff water has a high coliform count, but there seem to be no major pollution problems. Their disposal of human waste seems adequate, there is no sign of lead, cadmium or mercury in their runoff, and they use only one biocide. The question still remains as to what should be done about the high coliform count. Should they be required to reroute their waste water to the sewage treatment plant, or should they be allowed to continue to pollute the surrounding water? The Gilman Street outfall, located approximately 50 meters from GGF's first outfall, has a coliform count roughly 100 times greater than that of GGF's runoff, and it also has a substantially greater flow (see Teresa Simonitch's paper in this section). Having GGF treat their runoff water is a waste of money at this time if the storm drains are allowed to continue to pollute as they have been. Tom Holsen presents suggestions on how to clean up the storm water in his paper in this section. It is hoped that the City of Berkeley will be able to establish the shoreline as a park to preserve and redevelop the natural beauty of the bay. There are still many obstacles to overcome, but with careful planning and the cooperation of waterfront landowners, Berkeley may have its park some day.

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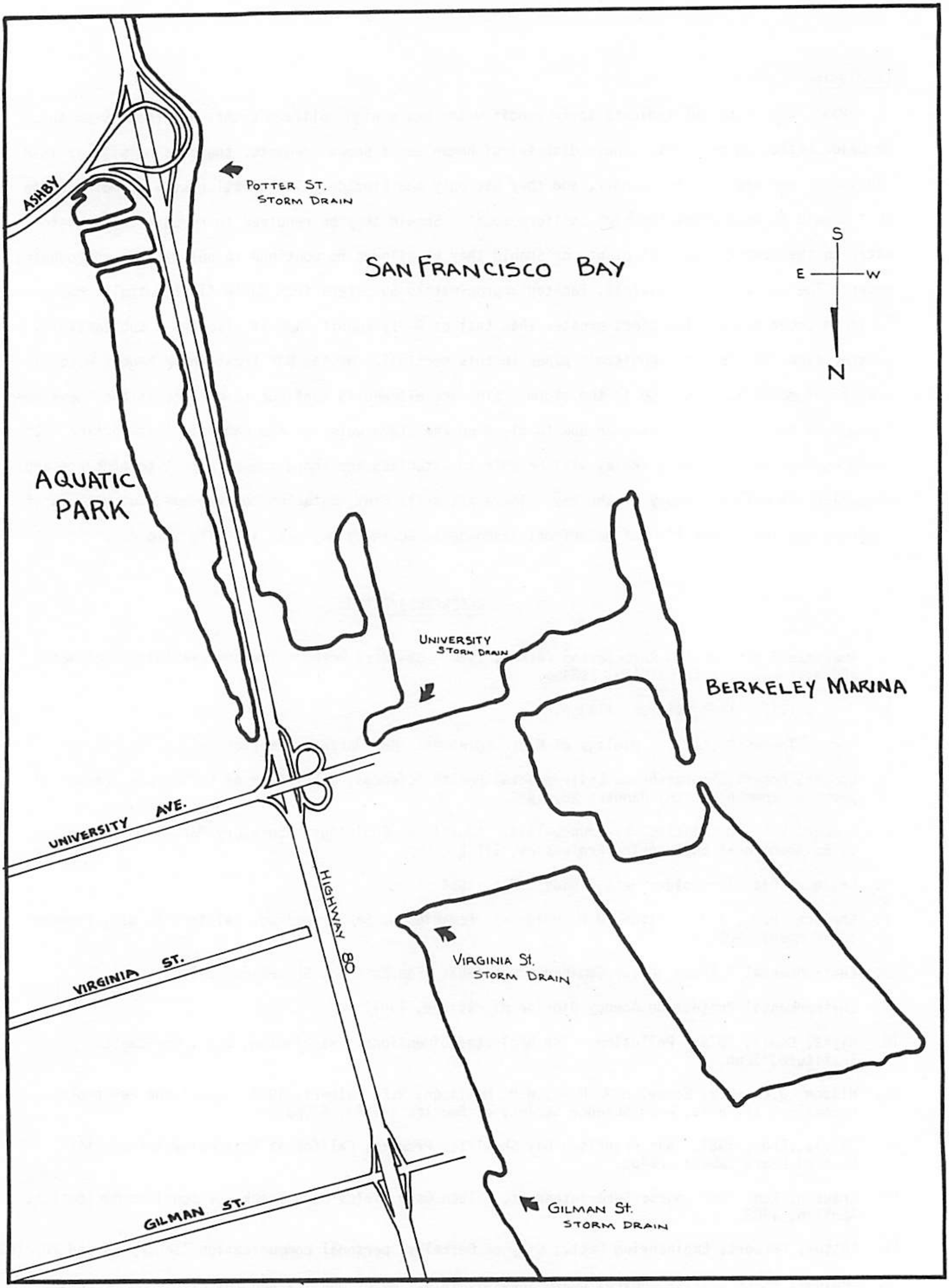

Figure 1. Berkeley Storm Drains Emptying into the San Francisco Bay