U.S. ENVIRONMENTAL PROTECTION AGENCY

EFFECT OF SAN JUAN'S OUTFALL

DISCHARGES ON BATHING BEACH

WATER QUALITY

July 1974

SURVEILLANCE AND ANALYSIS DIVISION
REGION 2
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EFFECT OF SAN JUAN'S OUTFALL DISCHARGES ON BATHING BEACH WATER QUALITY

July 1974

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&

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ABSTRACT

The Surveillance and Analysis Division, Region II, New York, in cooperation with the Environmental Quality Board, Puerto Rico, conducted an extensive investigation of the ambient water quality associated with the beaches of San Juan, Puerto Rico. The program, which involved several semi-diurnal investigations and special outfall studies, was conducted between March 9 and 13, 1974. Total and fecal coliform measurements were used as bacterial indicators of potential health hazards associated with the use of these beaches for bathing and/or other water contact recreation.

Data gathered indicated areas of degraded ambient water quality in association with intermittent and continuous outfall discharges. The ambiguity in water quality information can be correlated with several variables; the intermittent nature of a number of the outfall discharges; the proximity of sampling stations to the outfalls; shore currents; and time of day or night. Based on the technical information gathered during this study, it is recommended that the beach area from approximately the Hyatt Hotel to Gertrudis Street be closed immediately to bathing and contact recreation and that immediate remedial action be taken to alleviate both the short and long term problem caused by the outfall discharges.

INTRODUCTION

In 1971, EPA's Athens' Laboratory, who at that time had responsibility for technical programs in Puerto Rico, conducted a series of investigations aimed at highlighting pollution problems in the Condado Lagoon, San Juan Harbor, and along the beaches of San Juan. The Environmental Quality Board (EQB) considered the results of these studies preliminary; therefore, in 1973 they requested the S&A Division, Region II, to conduct more intensive studies in order to better define the problems reported.

A three-phase program was planned and initiated in cooperation with EQB. This report, however, deals only with the San Juan beach study, as companion reports on the Condado Lagoon and San Juan Harbor have been separately prepared.

More than 12 miles of Atlantic Ocean sand beaches, from a public beach at the Capitol in Old San Juan at the west limit, extending eastward to the Belneario Isla Verde, adjacent to the International Airport, were involved in this study. (Figure 1) The area is devoted almost entirely to tourist and resident recreation and is bordered almost completely by resort hotels and condominiums —— both inhabited and under construction —— along with some private houses, parks, stores and restaurants servicing the area.

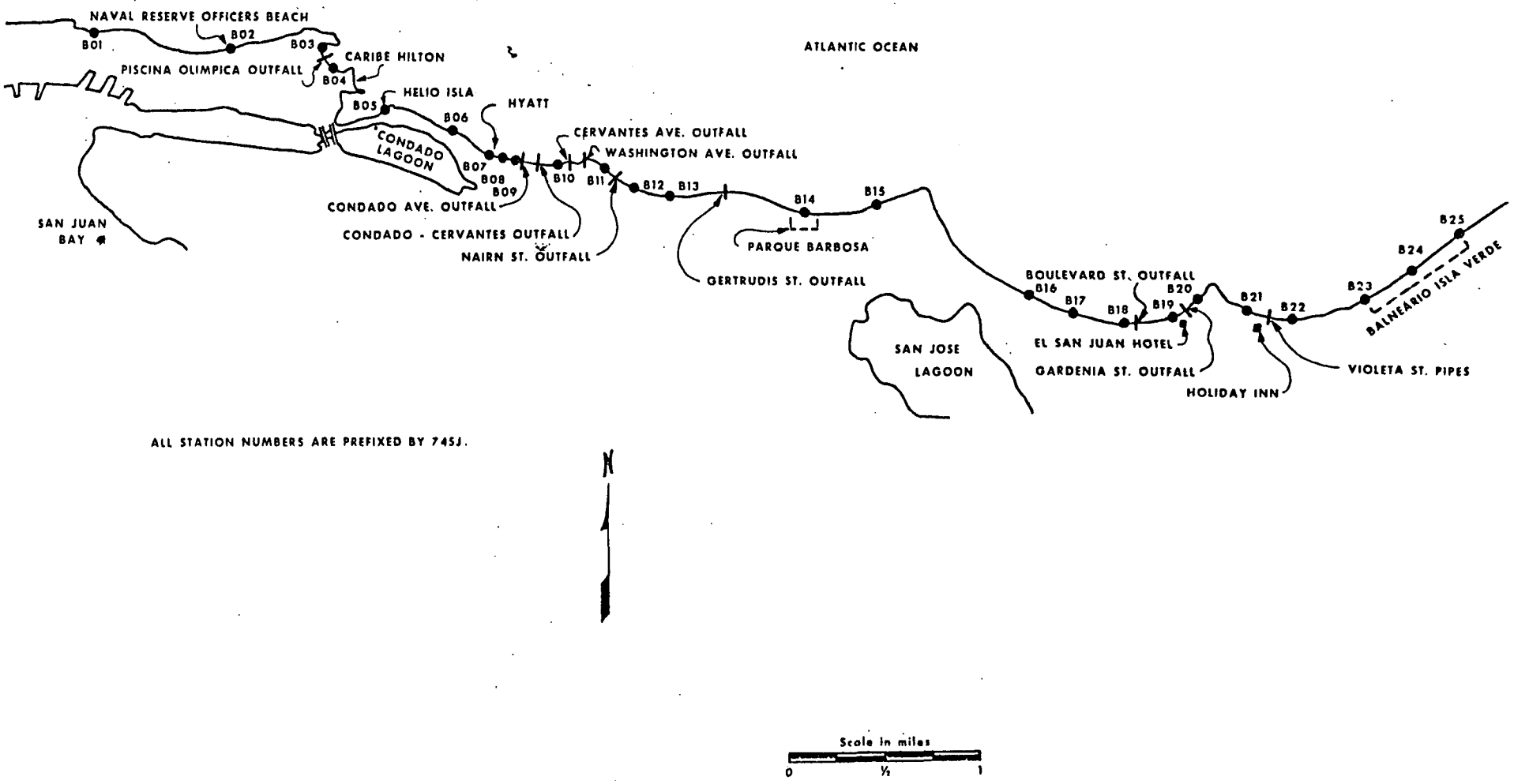


Figure 1

SAN JUAN BEACHES STUDY

OUTFALL AND SAMPLING STATION LOCATIONS

SAN JUAN BEACHES

SAMPLING STATION LOCATIONS

MARCH 1974

Station No.	Description
74SJB01	Beach at Capitol Building
74SJB02	West End of U. S. Naval Reserve Officers Beach
74SJB03	North Side of Beach at Piscina Olimpica
74SJB04	Pier adjacent to Caribe Hilton Hotel Beach
74SJB05	Beach adjacent to West End of Helio Isla Hotel
74SJB06	Small park next to El Mirado Condominium
74SJB07	Beach at Hyatt Hotel (formerly La Concha)
74SJB08	Beach at Atlantic Beach Hotel
74SJB09	Beach at Lindomar Hotel and Stella Moris Condominium
74SJB10	Beach at Puerto Rico Sheraton Hotel
74SJB11	Beach at Condado Del Mar Condominium
74SJB12	Beach at Playground Park adjacent to "Las des" Condominium
74SJB13	Beach at Foot of Calle Corrions Court
74SJB14	Center of Beach at Barbosa Park (Parque Barbosa)
74SJB15	Beach at Park Boulevard Condominium
74SJB16	Beach at new condominiums, ½ mile west of Racquet Club Condominium
74SJB17	Beach at condominiums (under construction), ¼ mile west of Racquet Club Condominium
74SJB18	Beach at west corner of Racquet Club Condominium
74SJB19	Beach at Americana Hotel

Station No.	Description
74SJB20	Beach just east of El San Juan Hotel
74SJB21	Beach 500 feet west of Holiday Inn (main building)
74SJB22	Beach 1000 feet east of Holiday Inn at new building (Mar De Isla Verde)
74SJB23	West End of Balneario Isla Verde
74SJB24	Center Beach at Balneario Isla Verde
74SJB25	East End of Balneario Isla Verde

NOTE: No stations were located within 100-150 feet of outfalls.

SAN JUAN BEACHES

OUTFALL LOCATIONS

Piscina Olimpica Outfall	At 24-inch pipe located behind Normandy Hotel. Gravity flow during high rainfall.
Condado Avenue Outfall	At 36 x 36-inch concrete pipe located at foot of Avenida Condado. Effluent hot, at 32°C flow about ½-1 inch deep. Continuous flow (Figure 4).
Outfall Between Condado Avenue and Cervantes Avenue	At 12-inch pipe at west wall to hotel complex. Discharge at wall, underground seepage and dry channel to beach. Apparent flow during rainfall only.
Ceravantes Avenue Outfall	At 42 by 42-inch concrete pipe located at foot of Calle Cervantes. Flow continuous at 12 inch of wetted area in center of pipe, 1-½ inch of flow.
Outfall Between Washington Avenue and Nairn Street	Two 4-inch metal pipes that extend into the water. Located west of Presbyterian Hospital at rocks. Submerged pipes.
Nairn Street Outfall	Square pipe, 36 by 36-inch with large hornlike breather located behind Condado Del Mar Condominium (Figure 4). Serviced by de Diego Pumping Station. Intermittent discharge.
Gertrudis Street Outfall	36-inch circular concrete pipe. Intermittent discharge constructed with large hornlike breather. Located at Foot of Calle Gertrudis. Serviced by the Ocean Park Pumping Station. Intermittent discharge.
Boulevard Street Outfall	Located at foot of street adjacent to Racquet Club Condominium. Concrete pipe, at 12 inches, that discharges onto the beach and channel flow to the ocean (Figure 4). Continuous discharge.
Gardenia Street Outfall	Twelve (12) inch concrete pipe partially buried in sand. Effluent escapes from loose joint in pipe and flows via channel to the ocean. Located behind the El San Juan Hotel. Continuous discharge.
Pipes Between Violeta Street and Marginal Street	Two PVC pipes at 6-inch diameter located 500 feet east of Holiday Inn and behind site of new building construction site. Intermittent discharge.

Since there were 10 potential discharge points along the stretch of beaches, six of which were known to be active —— four continuous and two intermittent —— the technical program, which was designed to measure the impact and significance of these outfall discharges, as well as the ambient conditions in the surf zone, was sub-divided as follows:

....Semi-diurnal studies, with a two hour sampling frequency of one continuous (Condado Avenue) and one intermittent stormwater outfall (Nairn Street). Samples were taken at the point of discharge and at four stations east and west of each outfall pipe. Stations were grouped so as to define the sphere of influence of these discharges. (Figs. 1A, 1B)
At the Nairn Street stormwater outfall, which is connected to the de Diego pumping station, discharges occur approximately once every eight hours during dry weather conditions. Studies were undertaken to characterize the impact, strength and volume of this typical intermittent discharge. To define impact, pre and post-conditions were examined, i.e., the outfall stations were sampled five times, at two hour intervals, prior to and after discharge.

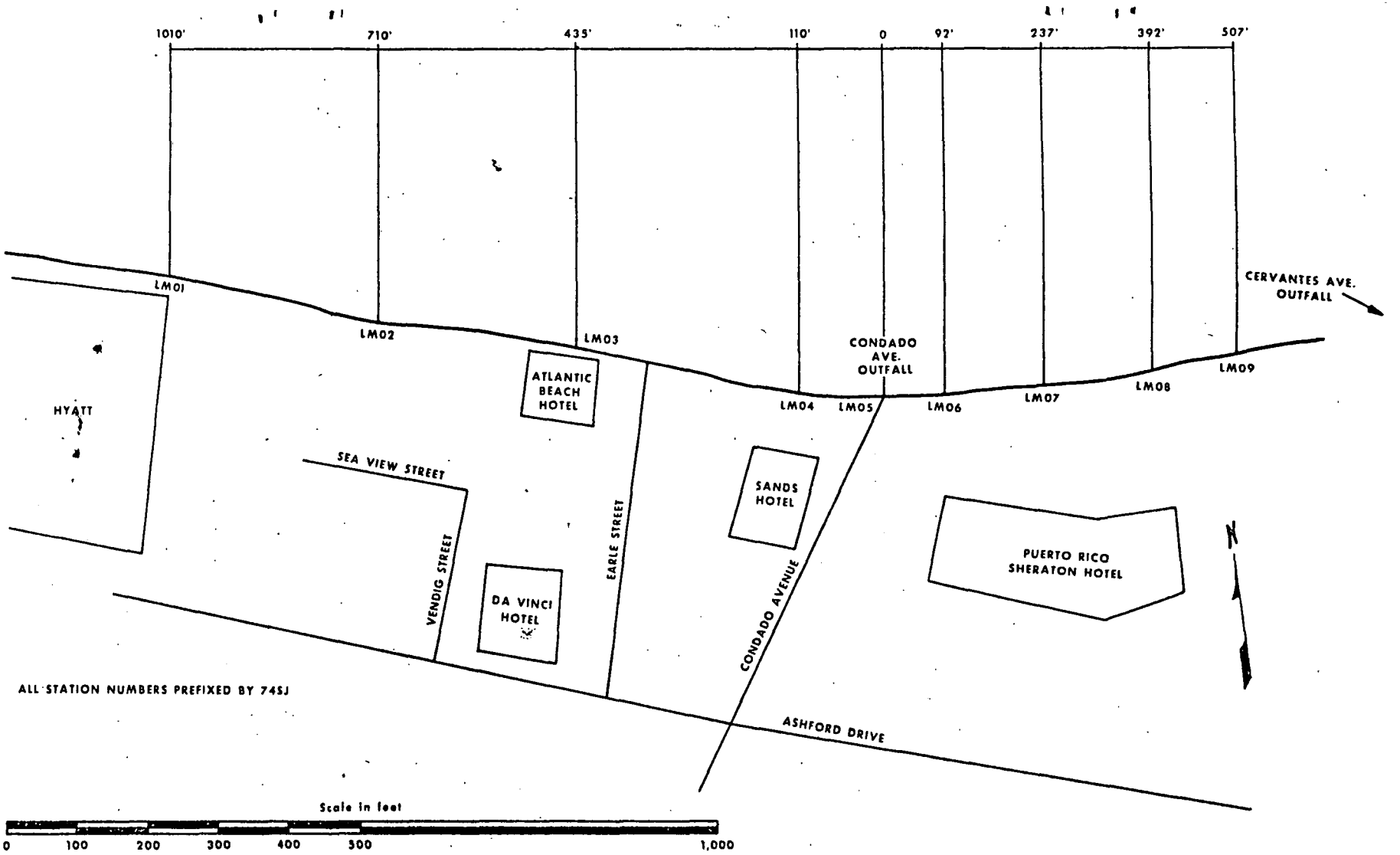


Figure 1A

SAN JUAN BEACHES
CONDADO AVENUE OUTFALL STUDY
STATION LOCATIONS

CONDADO AVENUE OUTFALL STUDY (CONTINUOUS)

SAMPLING STATION LOCATIONS

MARCH 12, 1974

Station No.	Description
74SJLM01	Hyatt Hotel Beach, 1010 feet west of outfall, most westerly station
74SJLM02	Sea View Hotel Beach, 710 feet west of outfall
74SJLM03	Atlantic Beach Hotel Beach, 435 feet west of outfall
74SJLM04	Stella Moris Condominium Beach, 110 feet west of outfall
74SJLM05	Lindomar Outfall, 36 by 36-inch cement pipe located at Foot of Avenida Condado
74SJLM06	Adjacent to rock jetty, 92 feet east of outfall
74SJLM07	West corner of Puerto Rico Sheraton main building, 237 feet east of outfall
74SJLM08	East corner of Puerto Rico Sheraton main building (off metal statue), 392 feet east of outfall
74SJLM09	East of Puerto Rico Sheraton Hotel, 507 feet east of outfall, 100 feet west of AFDA Outfall

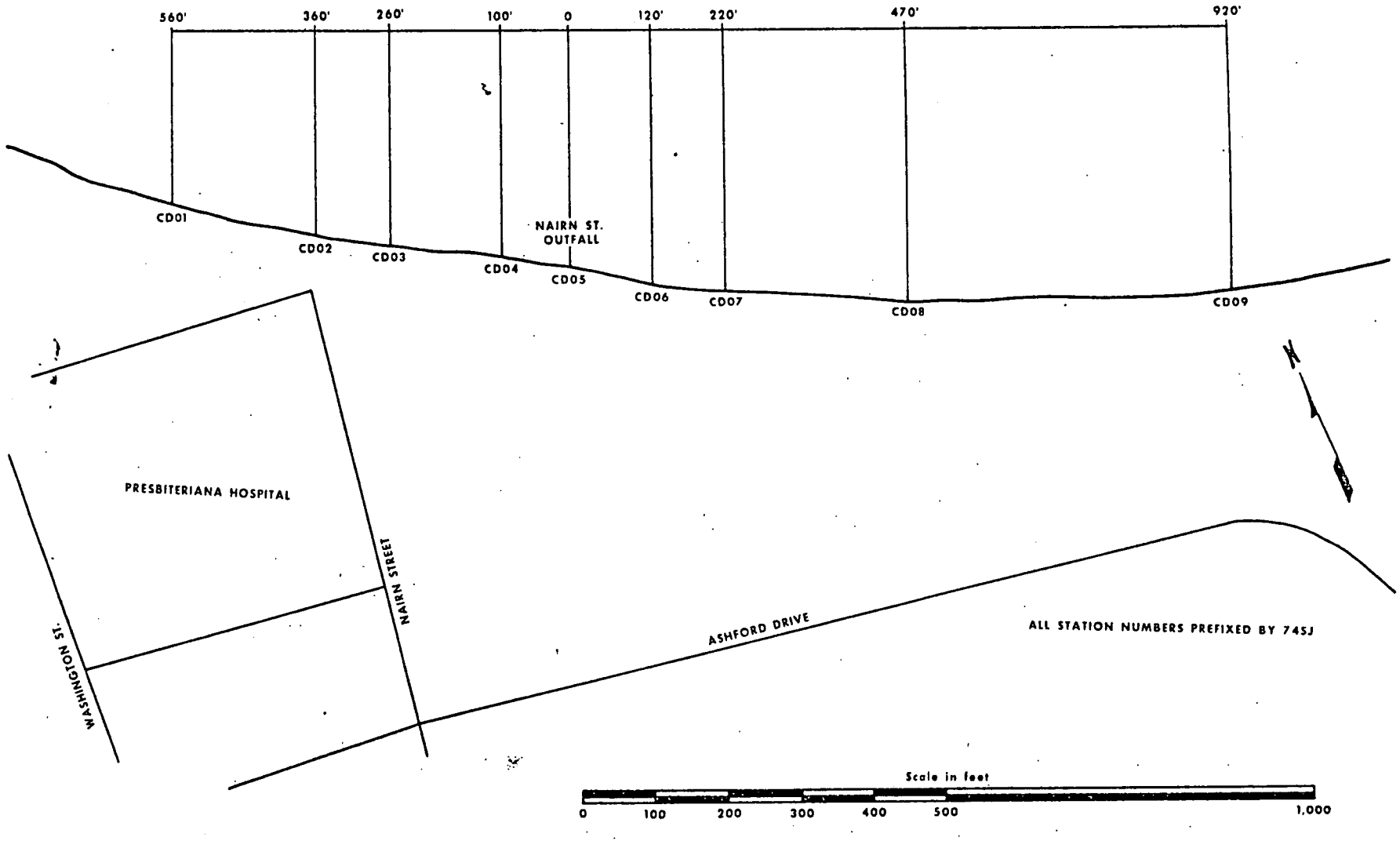


Figure 18

SAN JUAN BEACHES
NAIRN STREET OUTFALL STUDY
STATION LOCATIONS

NAIRN STREET (STORM) OUTFALL STUDY

SAMPLING STATION LOCATIONS

MARCH 6 & 13, 1974

Station No.	Description
74SJCD01	Most westerly station, 560 feet west of outfall, near hospital
74SJCD02	Foot of Calle Nairn, 360 feet west of outfall
74SJCD03	Off Condado Del Mar swimming pool, 240 feet west of outfall
74SJCD04	100 feet west of outfall at rear fence gate
74SJCD05	At outlet to submerged outfall located behind Condado Del Mar Condominium. Serviced by de Diego Pumping Station
74SJCD06	120 feet east of outfall
74SJCD07	220 feet east of outfall
74SJCD08	470 feet east of outfall and adjacent to Playground Park
74SJCD09	Most easterly station, 920 feet east of outfall

SAN JUAN BEACHES

PUMPING STATIONS

de Diego Pumping Station	Located at Jose de Diego across street from Pierre Hotel. Normally pumps at 8-hour intervals and more frequently during rainfall. Operated by Commonwealth Department of Public Works and Transportation. Operator on duty 24 hours. Pumping records are kept. 4.5 pumps rated at 34,000 gpm. Pumps to outfall located behind the Condado Del Mar Condominium. Pumps an average of 450,000 gpd during dry weather flow.
Ocean Park Pumping Station	Located at Santa Ana and McLeary. Small station with one pump which is rated at 775 gpm. Normal pumping schedule is three times a day at 6 AM, 2 PM, and 10 PM at 1/2 hour per pumping. More frequently during rainfall. Pumps an average of 69,750 gpd. A second is being prepared for installation at the pumping station. Pump may run for 1-2 hours during rainfall. This station is operated by the City of San Juan. No written records are kept of pumping schedule.

Ambient water quality samples were taken at 25 stations along the 12 mile stretch of beach. (Fig. 1) No station was located within 100 to 150 feet of an outfall pipe, and no data collected during the special outfall studies were used in the compilation of the ambient bacteriological levels.

Samples were taken by wading into the surf zone and stations were sampled twice a day, once in the morning and again in the afternoon, for three successive days. Total and fecal coliform assays were performed using the membrane filter (MF) technique, as specified in Standard Methods for the Examination of Water and Wastewater, 13th edition, 1971.

CONCLUSIONS

Ambient Study

In beach sections where there are no outfalls, fecal coliform counts were consistently low at all times. In areas adjacent to outfalls higher fecal coliform counts were found, systematically higher in the morning than in the afternoon.

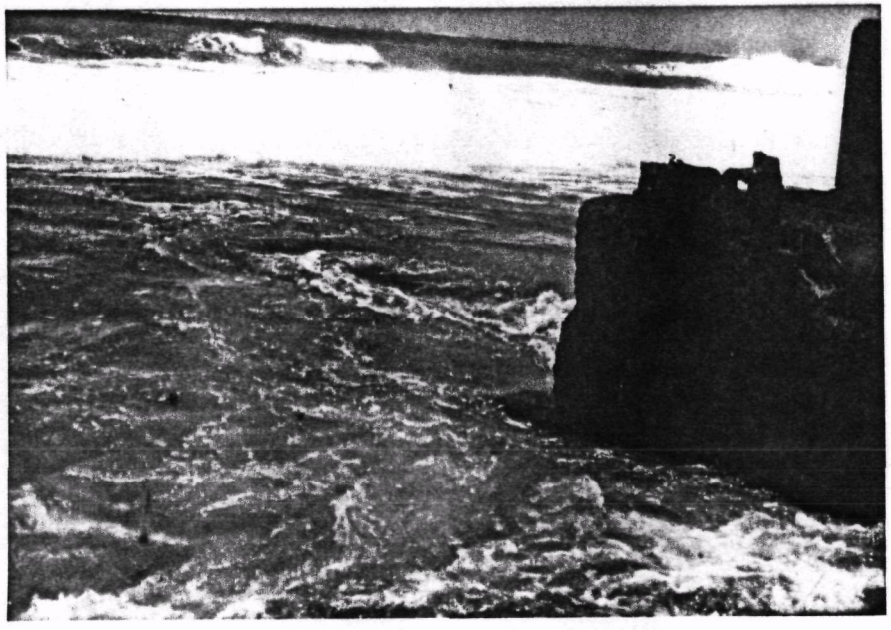
A statistical evaluation of the bacteriological data clearly sub-divides the 12-mile beach area into three "quality" zones two of which indicate excellent ambient conditions and one which is degraded. Zone 2, or that area containing six outfalls (Stations 74SJB06 - small park next to El Miraco Condominium - through 74SJB13 - beach at foot of Calle Corrions Court) showed a morning-afternoon variation, with high fecal coliform counts in the morning decreasing with time. These high-morning fecal counts, if considered independently of the afternoon low counts, indicate a health hazard for half of these stations. The other two zones, located east and west of Zone 2, do not show or indicate potential health problems. If additional morning samples with comparable fecal coliform levels were collected, these stations would be in formal violation of the existing Puerto Rico water quality standards.

The systematic coliform count variation with time cited above shows that water quality surveillance could either emphasize the potential health hazard or neglect it, according to the times that samples are taken.

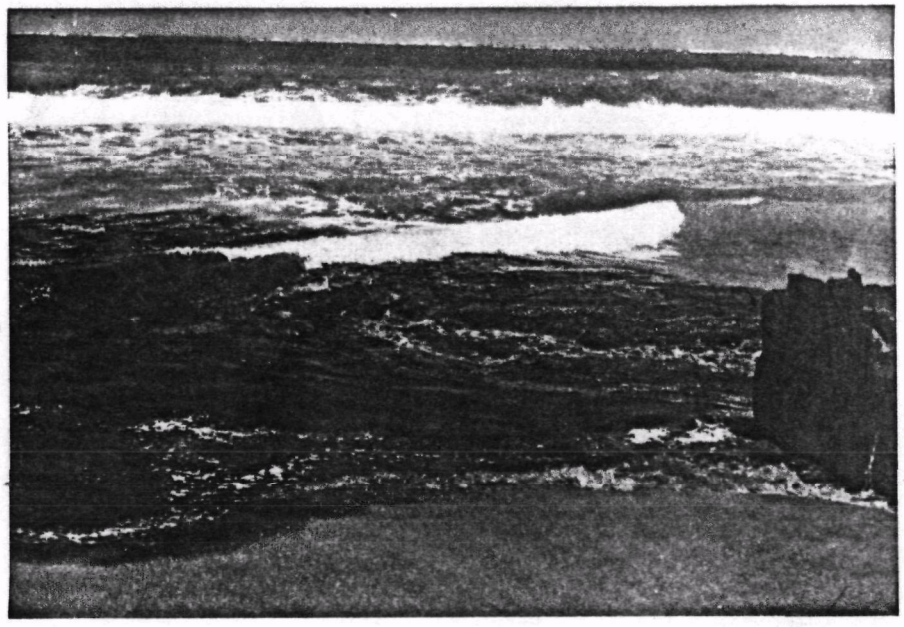
Outfall Studies

The outfall studies once more demonstrated that coliform counts in the vicinity of the discharge can vary over several orders of magnitude during the day, similar to, but not as strongly systematically as in the ambient study.

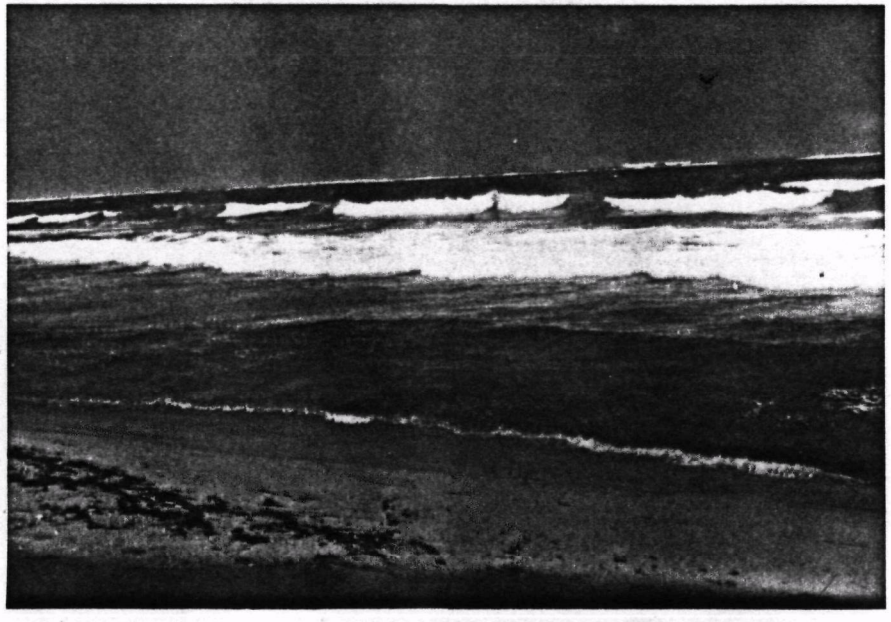
A special study of a pumped intermittent outfall showed that, during and for a brief time after pumping, odor and receiving water discoloration provisions of the water quality standards were violated. (Figure 2) The coliform counts of the effluent and the pattern of coliform count versus lateral distance from the outfall pipe in their vicinity conclusively implicate the outfalls as the sources of existing and potential health hazards.



Before pumping 1307 hr

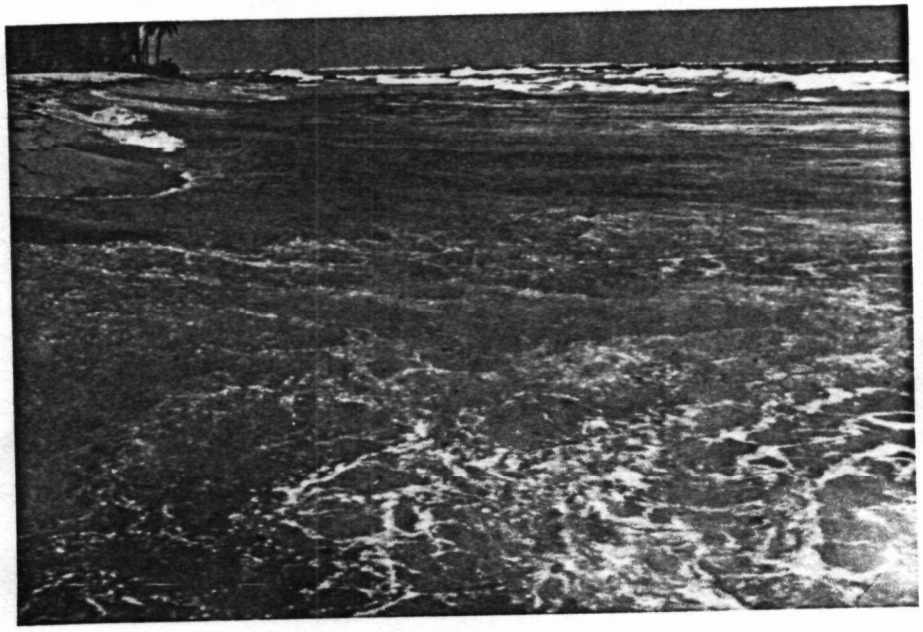


Just after start of discharge 1310 hr

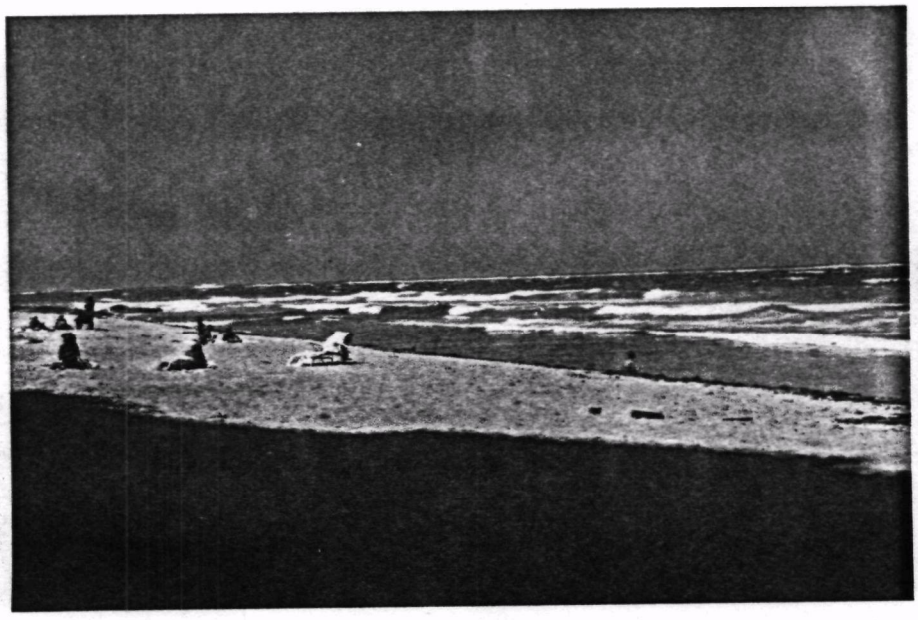


About 200 ft west of outfall 1311 hr

Fig. 2 Nairn Street Outfall
Before & after pumping study March 13, 1974



200-400 ft west of outfall 1311-1320 hr



200-400 ft west of outfall 1321 hr

Fig. 2 Nairn Street Outfall - cont'd.
Before & after pumping study March 13, 1974

RECOMMENDATIONS

1. The beach areas extending from station 74SJB06 (small park next to El Mirado Condominium) to station 74SJB13 (beach at foot of Calle Corrions Court) be posted and closed to bathing.
2. The potential health hazard associated with the outfalls requires the rapid elimination of these discharges to the beaches and the surf zone as the long term solution. The preferred way to eliminate the potential danger and the aesthetic degradation of the affected areas is to re-route the discharge, preferably to a point of treatment, and complete removal of the outfall structures.
3. Another less desirable alternative would be to remove all illegal connections and extend the outfalls out past the surf zone to allow for dilution as well as eliminate the near shore problems of direct contact with the effluent.
4. An intermediate "stop-gap" measure would be to chlorinate or otherwise disinfect the effluents prior to discharge. However, before such an approach were instituted studies would have to be undertaken to demonstrate that the level of the chlorine residual in the effluents would not cause irreparable harm to the sensitive reef communities.[7]

DISCUSSION

A 1971 survey by Region IV's personnel, EPA, Athens, Ga. of the San Juan beaches[2] indicated violation of ambient water quality standards* over a section of the beach area lying between stations 74SJB09 (beach at Lindomar Hotel) and 74SJB13 (beach at foot of Calle Cirrions Court). Some Athens' stations were located in close proximity to outfalls, raising the possibility that the high coliform counts did not represent general ambient conditions but rather reflected only localized effects due to the outfalls.

Accordingly, one purpose of our study was to disassociate the ambient conditions from those of the outfalls per se. To do this, no station for the ambient study was closer to an outfall than 100-150 feet; separate studies were conducted at and near the outfalls.

Total and Fecal Coliform

This disassociation was essentially successful, as can be seen by comparing the results of the ambient study with those of the outfall studies.

The tabulated data (Tables 1,2, and 3) include six individual collections (samples) for each of the twenty-five ambient stations, and five collections (samples) for each of nine outfall stations. These data also include the geometric mean for each station. The following discussion considers only fecal coliform since present bacterial standards for contact uses are based solely on fecal coliform.

Although the geometric mean values in the first instance suggest that none of the ambient stations violated water quality standards during our 3-day study, such an interpretation is misleading with regard to present and potential health hazards as the following discussion of the data will bring out.

---

*As few as five samples per month is acceptable under the standards.

Examination of the tabulated data shows that:

1. The beaches can be divided into three sections:

   a. A middle section with relatively high fecal coliform counts, and containing six outfalls: Stations 74SJB06, small park next to El Mirado Condominium through 74SJB13, Beach at Foot of Calle Corrions Court.

   b. The section to the west, containing one outfall with low fecal counts: Stations 74SJB01 - beach at Capitol building through 74SJB05, beach at Helio Isla Hotel.

   c. The section to the east, containing two outfalls",* with low fecal counts, but with some influence from the outfalls: Stations 74SJB14 - beach at Parque Barbosa through 74SJB25, beach at east end of Balneario Isla Verde.

2. The elevated fecal counts are directly associated with outfalls; the fecal count distribution pattern is consistent with the observed east-to-west longshore current.

3. Fecal coliform counts during the ambient study, especially in the middle section, are systematically higher in the morning than in the afternoon (Tables 1, 1A, 1B). In the outfall studies counts varied dramatically throughout the day (Tables 2 and 3).

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*A set of pipes, between Violeta & Marginal Street, is apparently the discharge for pumping ground water from the excavation of new construction. It is not considered an outfall for the purpose of this discussion.

TABLE 1

SAN JUAN BEACHES STUDY

March 9-11, 1974

Total and Fecal Coliform/100 ml

Total Coliform MF

Date/Time	B01	B02	B03	B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25
9 March AM	680	6 B	21	25	220	1400 B	6800	20000	46000	1800 B	5000	6200	400	3 B	5 B	160 B	170 B	150 B	5 B	10 B	3 B	1 B	120 B	3 B	20 B
9 March PM	1 K	3 B	80 B	1 B	10 B	5 B	10 B	15 B	26	18 B	230	44	330	2 B	2 B	4 B	200	240	23	1 K	10 B	1 K	9 B	1 B	5 B
10 March AM	12 B	30	11 B	2 B	108	2300	2800	7200	18000 B	3200	2400	450	300	5 B	3 B	76 B	580	400	4 K	4 K	100 K	4 K	4 B	-	8 B
10 March PM	7 B	1 K	1 B	3 B	21	4 B	150 B	36	44	2 B	300	12 B	220	1 K	2 B	24 B	-	88	4 K	4 B	4 B	16 B	44 B	68 B	8 B
11 March AM	4 B	1 B	12 B	1 B	192	230	720	4400	5100	690	5000	77	230	14 B	3 B	12 B	48 B	1180	12 B	24 B	12 B	16 B	4 B	4 K	8 B
11 March PM	3 B	1 B	2 B	2 B	12 B	2 B	330	4700	300	48	28	33	610	1 K	1 K	4 B	8 B	24 B	4 B	4 B	12 B	8 B	4 K	28 B	4 B
Geometric Mean	9	3	9	3	48	56	435	1082	1063	138	698	125	327	3	2	20	95	182	7	5	11	4	12	7	8

Fecal Coliform MF

Date/Time	B01	B02	B03	B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25
9 March AM	1 K	1 K	1 K	1 B	13 B	68 B	172	240	364 B	88	116	176	18 B	1 B	1 B	10 B	13 B	10 B	3 B	1 K	1 K	1 K	3 B	1 K	1 K
9 March PM	1 K	1 K	1 B	1 B	1 B	2 B	1 B	1 B	1 K	2 B	6 B	3 B	22	1 K	1 K	1 K	1 B	6 B	15 B	1 K	1 B	1 K	1 K	1 B	3 B
10 March AM	1 K	1 K	1 K	1 K	4 B	168	184	480	820	468 B	160	84	28	1 K	1 K	7 B	28 B	38	1 K	1 K	1 K	1 K	1 K	1 K	1 K
10 March PM	1 K	1 K	1 K	1 K	1 K	1 K	4 B	1 B	2 B	1 B	17 B	1 B	14 B	1 K	1 K	1 K	2 B	2 B	1 K	1 K	1 K	4 B	2 B	33	1 K
11 March AM	1 K	1 K	1 B	1 K	1 K	14 B	62 B	104	92	112	460	7 B	44	3 B	1 K	1 K	6 B	80 B	1 K	2 B	1 B	2 B	1 K	1 K	1 B
11 March PM	1 K	1 K	1 K	1 B	5 B	1 B	1 B	23	1 K	1 B	3 B	1 B	35	1 K	1 K	1 K	1 K	1 K	1 B	1 K	1 K	1 K	1 K	9 B	1 K
Geometric Mean	1 K	1 K	1 K	1 K	3	8	14	26	20	14	55	8	25	2	1 K	2	4	8	2	1	1 K	1	1	3	1

B *Colony count outside acceptable analytical range.*
K Less than.
NOTE: All stations have prefix 74SJ

TABLE 1A

MAXIMUM VALUES FREQUENCY OF FECAL COLIFORM COUNTS

Ambient Study - 3 Days AM & PM

Station Group	Time	Max.	Number of Samples Showing > 400/ 100 ml	200-400/ 100 ml	100-200/ 100 ml	50-100/ 100 ml	< 50/ 100 ml
74SJB01	AM	13	0	0	0	0	15
-74SJB05	PM	5	0	0	0	0	15
74SJB06	AM	820	4	2	8	5	5
-74SJB13	PM	35	0	0	0	0	24
74SJB14	AM	80	0	0	0	1	35
-74SJB25	PM	33	0	0	0	0	36

TABLE 1B

GEOMETRIC MEAN FECAL COLIFORM COUNTS

AMBIENT STUDY - AM & PM

Geometric Mean (3 Samples) F.C./100 ml

Station:	74SJB06	74SJB07	74SJB08	74SJB09	74SJB10	74SJB11	74SJB12	74SJB13
AM:	83	139	275	425	223	245	89	30
PM:	1	2	8	1	1	9	2	24

Condado Avenue Outfall; P. R. Sheraton Outfall

Nairn Street Outfall

Cervantes Avenue Outfall; Washington Avenue and Nairn Street Outfall

Gertrudis Street Outfall

TABLE 2

NAIRN STREET OUTFALL STUDY

March 6, 1974	Total Coliform (/100 ml) CD01	CD02	CD03	CD04	CD05*	CD06	CD07	CD08	CD09	Fecal Coliform (/100 ml) CD01	CD02	CD03	CD04	CD05*	CD06	CD07	CD08	CD09
0900	73	5600	560	3800	2.7×10^5	840 B	360	740	490	20	450	66 B	210	5900	105 B	37	103 B	83 B
1100	38	68	2800	8.5×10^5 B	8.0×10^5 L	480	2100	2000	580	06 B	16 B	127 B	4.5×10^4	2.1×10^5	180 B	220	110 B	140 B
1300	120 B	280	720	5.8×10^4	3.0×10^5	220	200	83 B	74	20	9 B	112 B	2200	8600 B	17 B	11 B	10 B	08 B
1500	140 B	31	2000	2200	4.7×10^5	60	280	360	150 B	14 B	02 B	124 B	80 B	2.0×10^4	12 B	21	12 B	14 B
1630	200	52	120 B	2700	4.1×10^4	300	370	480	600	16 B	01 B	09 B	160 B	260	26	18 B	14 B	39
Geometric Mean	62	177	770	1.6×10^4	2.6×10^5	276	436	480	285	14	11	64	767	8886	40	32	30	35

Before/After Pumping Study

March 13, 1974	Total Coliform (/100 ml) CD04	CD05	CD06	Fecal Coliform (/100 ml) CD04	CD05	CD06	
1300	1800 B	1300 B	150 B	108	50 B	32	Before pumping
1300	1.5×10^5 B	5000	10400 B	9500 B	280	920	20' after start of pumping
1400	2.1×10^4	7800	1.6×10^4 B	1280	1200 B	440	60' after start of pumping

* Sample collected from receiving water at point of discharge.
B Colony count outside acceptable analytical range.
L Greater than.
NOTE: All stations have prefix 749J

TABLE 3

CONDADO AVENUE OUTFALL STUDY

March 12, 1974

Time	Total Coliform (/100 ml) LM01	LM02	LM03	LM04	LM05	LM06	LM07	LM08	LM09	Fecal Coliform (/100 ml) LM01	LM02	LM03	LM04	LM05*	LM06	LM07	LM08	LM09**
0800	6500	8700 B	$2.2x10^4$	$2.3x10^5$	$9.8x10^7$ B	980	1600 B	2100	4000	284 B	840	2100	7400 B	$6.0x10^6$	59	108	108	284 B
1000	3700	$1.4x10^4$ B	3200	$3.1x10^4$	$1.2x10^7$ B	1040	2200	2800	3100	188	460	352 B	1040	$2.0x10^6$	128	168	392 B	192
1200	140 B	210	240	6400	$6.0x10^6$	184	120 B	76	560	9 B	27	9 B	264 B	10^6 B	11 B	7 B	5 B	13 B
1400	51	1020 B	2100	$3.5x10^4$	$2.0x10^6$	660	230	480	670	1 B	78 B	108	600	$3.1x10^5$	30	10 B	20	14 B
1600	79	28	250	3300	$3.1x10^7$	16 B	16 B	230	160 B	19 B	2 B	4 B	60	$4.4x10^6$	1 K	5 B	6 B	13 B
Geometric Mean	423	939	1547	$2.21x10^4$	$1.34x10^7$	288	274	548	1083	25	70	125	593	$1.75x10^6$	12	23	30	42

* Sample was collected from hole in outfall pipe before dilution.
** The Cervantes Avenue outfall (continuous) is located 100 ft. east of LM09.
NOTE: All stations have prefix 74SJ
B Colony count outside acceptable analytical range.
K Less than.

4. Fecal counts also had significant day-to-day variation. Compare:

Beach at Lindmar Hotel	74SJB09 :	geometric mean	3/9 - 3/11	= 20/100 ml
	74SJLM04:	" "	3/12	= 593/100 ml
Beach at Condado del Mar Condominium	74SJB11 :	" "	3/9 - 3/11	= 55/100 ml
	73AJCD04:	" "	3/6	= 767/100 ml

This day-to-day difference also includes any differences due to the higher sampling frequency in the outfall studies, which would be more apt to pick up times of higher fecal counts.

Although the data do not specifically identify the reason for the higher morning counts in the ambient study, the following reasons appear most probable.

1. Differences in mixing during flood and ebb tides. High water occurred at about 1000 hours; low water, at about 1500-1600 hours. Morning samples were taken between 0800 and 1030 hours; afternoon samples, between 1200 and 1430 hours.
2. In the case of the intermittent (storm water) outfalls, the morning samples may show the effects of pumping early that morning or late the previous day (Table 5 & Figure 3).
3. For continuous discharges, the counts may reflect variations in the rate of discharge and the strength of effluent.
4. Progressive "die-off" during the day may have occurred from the solar ultraviolet irradiation.

TABLE 5

Avenida de Diego Pumping Station Schedule - March 2-13, 1974

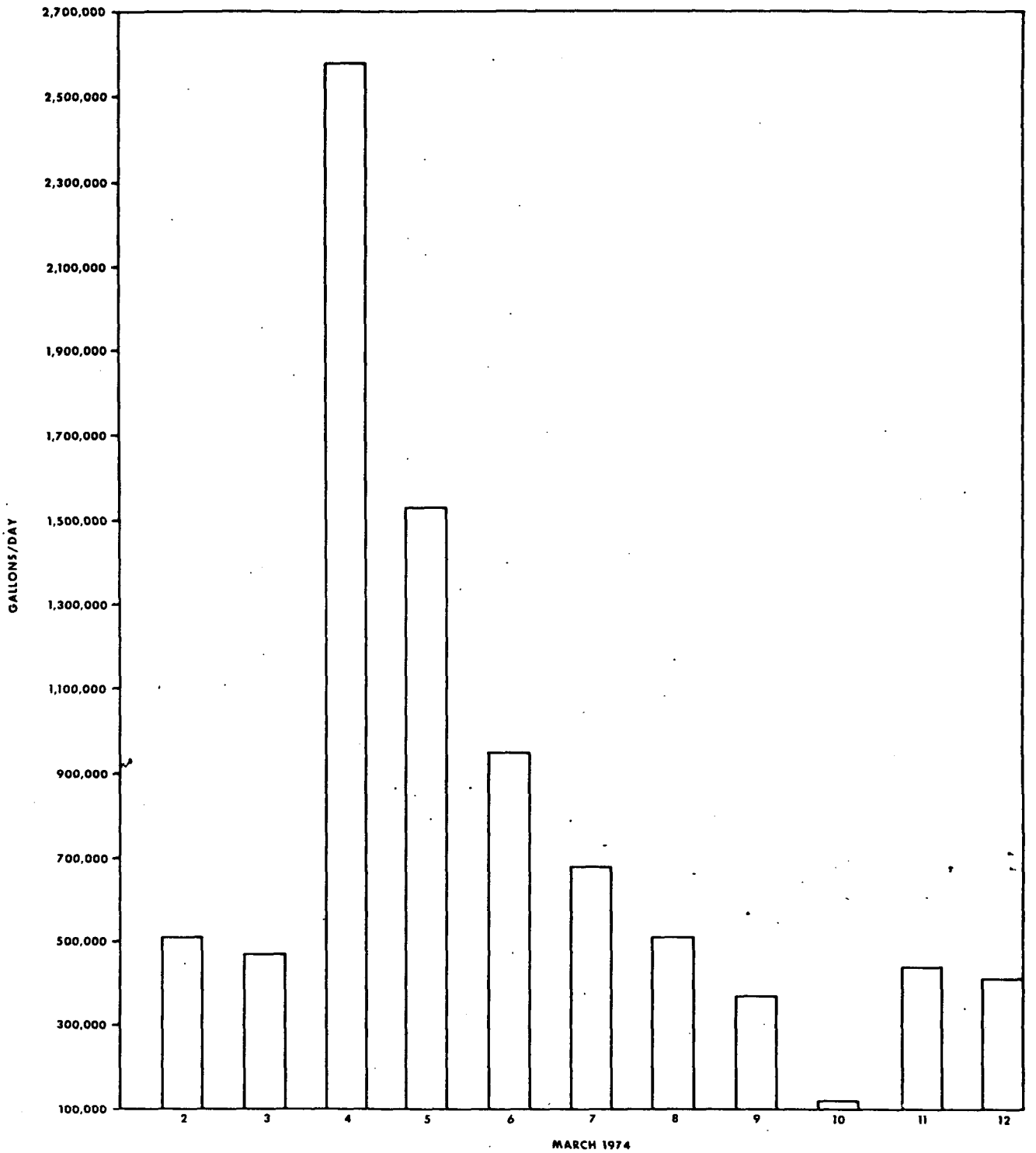
Pumps Rated at 34,000 GPM

Date	Pumping Intervals (hrs.)	Total Pumping Time (min.)	Total Gallons	Total Gallons /Day
3/2/74	0244-0247	3	102,000	
"	1515-1523	8	272,000	
"	2145-2149	4	136,000	
"				510,000
3/3/74	0640-0644	4	136,000	
"	1226-1229	3	102,000	
"	1450-1451	1	34,000	
"	2115-2118	3	102,000	
"	2315-2318	3	102,000	
"				476,000
3/4/74	0200-0206	6	204,000	
"	1430-1439	9	306,000	
"	1722-1725	3	102,000	
"	1815-1824	9	306,000	
"	1902-1912	10	340,000	
"	1944-1956	7	238,000	
"	2006-2016	10	340,000	
"	2112-2123	11	374,000	
"	2230-2240	10	340,000	
"	2359-2400	1	34,000	
"				2,584,000
3/5/74	1120-1125	5	170,000	
"	1611-1615	4	136,000	
"	1641-1648	7	238,000	
"	1706-1717	11	374,000	
"	1742-1748	6	204,000	
"	1839-1842	3	102,000	
"	2245-2248	3	102,000	
"	2320-2326	6	204,000	
"				1,530,000
3/6/74	0200-0205	5	170,000	
"	0415-0423	8	272,000	
"	0910-0921	11	374,000	
"	1712-1716	4	136,000	
"				952,000
3/7/74	0335-0339	4	136,000	
"	1008-1010	2	68,000	
"	1237-1239	2	68,000	
"	1920-1925	5	170,000	
"	2102-2109	7	238,000	
"				680,000

TABLE 5 - cont'd.

Date	Pumping Intervals (hrs.)	Total Pumping Time (min.)	Total Gallons	Total Gallons /Day
3/8/74	0400-0405	5	170,000	
"	1641-1648	7	238,000	
"	2300-2303	3	102,000	
"				510,000
3/9/74	0630-0633	3	102,000	
"	1450-1455	5	170,000	
"	1125-1128	3	102,000	
"				374,000
3/10/74	2234-2237	3	102,000	
"				102,000
3/11/74	1325-1330	5	170,000	
"	2335-2400	5	170,000	
"	0600-0603	3	102,000	
"				442,000
3/12/74	1322-1330	8	272,000	
"	1745-1749	4	136,000	
"				408,000
*3/13/74	0138-0141	3	102,000	
"	1306-1311	5	170,000	
"				272,000

*Incomplete records this date.



DE DIEGO PUMPING STATION

PUMPING RECORD - MARCH 2-12, 1974

Figure 3

Regardless of the reason, however, it is clear that shoreline contamination by the outfalls varies significantly throughout the day, and during our survey contamination was much more severe in the morning. In fact, the trend shown in Table 1B indicates that at least four of the eight stations in the middle beach section are potentially in violation of the standards and they present an overall bacteriological health hazard.

This, and the previously cited day-to-day variability, emphasize that cursory water quality sampling can disguise or amplify this hazard according to whether sampling times coincide with the low-count or the high-count conditions.

Color and Odor

During the Nairn Street outfall study on March 6, a dark, odorous discharge was observed at about 1100 hours**. A special, short-term study was arranged for March 13, in which the de Diego pumping station initiated pumping for our benefit at a prearranged time. Thus, we could sample and observe before, during, and after pumping.

During the approximately 5 minute duration of pumping, about 170,000 gallons were discharged. Table 2 contains the bacteriological data from this brief study.

Visually more dramatic was the intense dark stain which spread rapidly westward. The photographs in Figure 2 record the appearance and travel of the discharge***. An odor typical of domestic sewage was present again.

**This time does not agree with pumping times recorded by the operators. See Table 5.

***The yellow coloration in the water "before pumping" is natural and is owed to extensive sand entrainment by the turbulent surf. This near-shore sand entrainment is evident to varying degrees at nearly all the beach stations.

The stain and odor from the Nairn Street discharge violate the color and odor provisions of the Puerto Rico standards.

Aesthetics and Further Health Hazards of Outfalls

Figure 4 contains photographs of five of the outfalls. The structures are not attractive, and are out of harmony with the recreational use of the beaches. More disconcerting is the sight of effluents cutting open channels through the sand as they flow over the beach to the ocean. As we were sampling, we saw people step into the effluent in these open channels as they crossed. This also presents a potential health hazard, if the skin on the feet is not intact, because of the high fecal coliform counts of these effluents. See Table 4, Condado Ave., Cervantes St., Boulevard Ave., Gardenia St. outfalls.

Table 4

San Juan Beaches

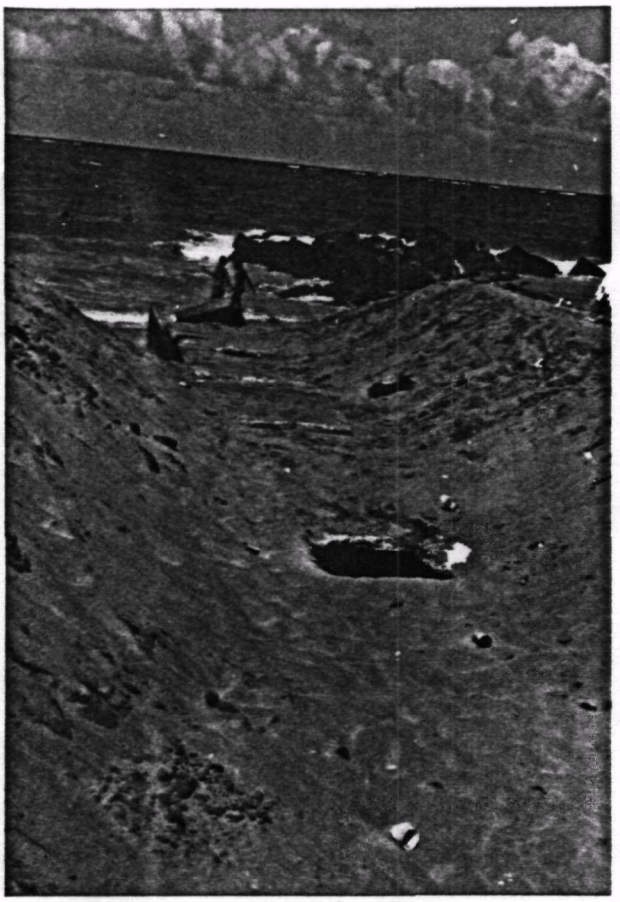
Outfall and Pumping Station Data - March 5-13, 1974

Name	Date	Lab No.	MF Total Coliform /100 ml	MF Fecal Coliform /100 ml
Condado Avenue Outfall	3/5/74	33002	34,000,000	1,600,000B
" " "	3/10/74	33216	94,000,000	760,000B
Cervantes Avenue Outfall	3/9/74	33214	39,000	210
" " "	3/11/74	33146	260,000	3,700
Boulevard Street Outfall	3/5/74	33001	4,000,000	110,000B
" " "	3/10/74	33217	80,000,000L	54,000
Gardenia Street Outfall	3/9/74	33215	400B	10K
" " "	3/11/74	33432	68,000	5,300
*de Diego Pumping Station	3/13/74	33405	18,000,000B	10,000,000
**Ocean Park Pumping Station	3/13/74	33406	800,000L	60,000

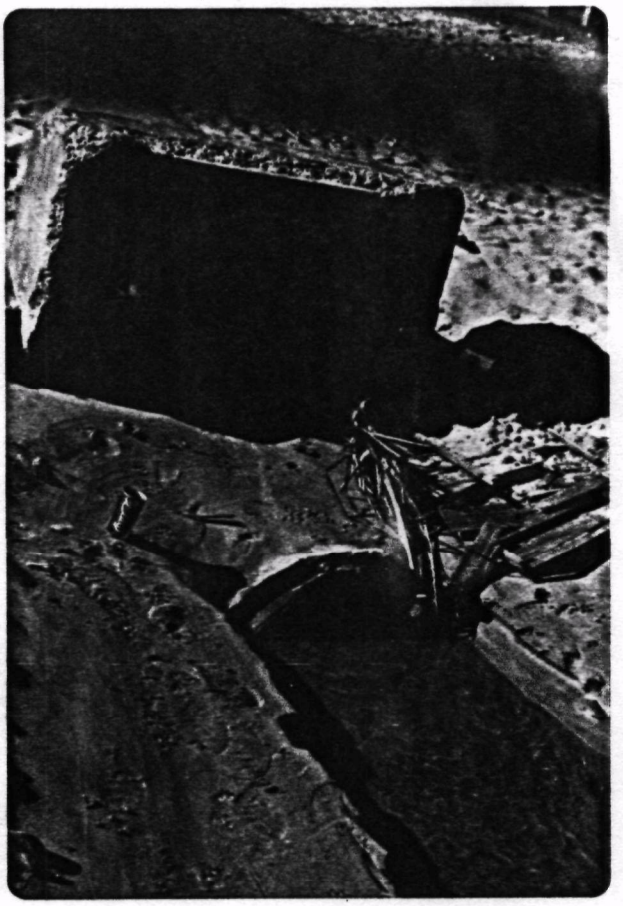
*The de Diego Pumping Station normally pumps three (3) times a day at 8-hour intervals. Pumping is more frequent during rainy weather.

**The Ocean Park Pumping Station normally pumps three (3) times a day (at 6 AM; 2 PM and 10 PM). Pumping is more frequent during rainy weather.

B = Colony Count Acceptable Analytical Range
K = Less Than
L = Greater Than



Condado Avenue Outfall

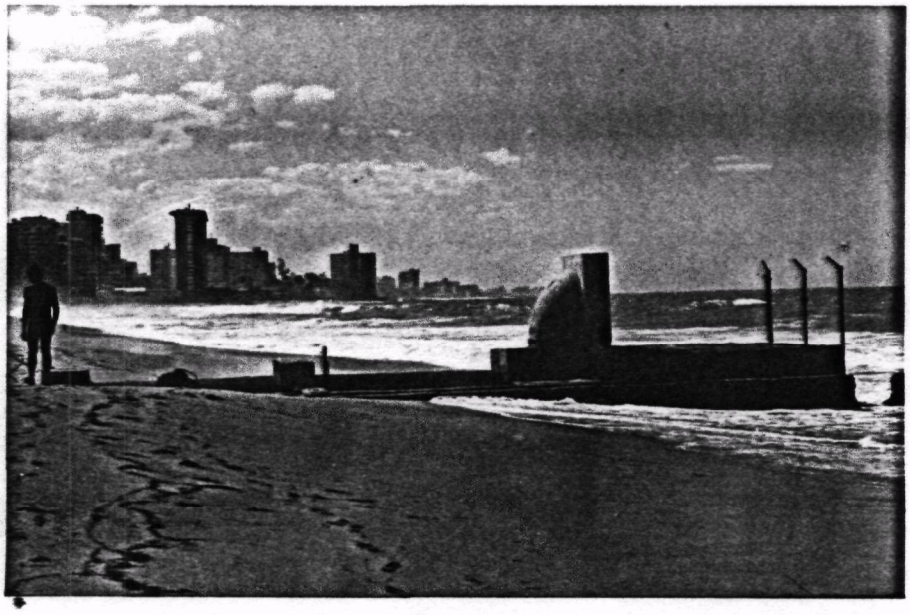


Boulevard Street Outfall

Nairn Street Outfall

Fig. 4 Outfalls, San Juan Beaches - March 1974

Gertrudis Street Outfall



Gardenia Street Outfall

Fig. 4, Outfalls, San Juan Beaches - March 1974 - cont'd.

SUMMARY

The beach studies show that the incidence of substantial total and fecal coliform counts correlates with location of continuous and intermittent outfalls on the beach. Most strongly affected is the section of beach where six outfalls are located (74SJB06, small park next to El Mirado Condominium; 74SJB013, beach at foot of Calle Corrions Court).

In this outfall area, coliform counts vary greatly and systematically throughout the day, and from day-to-day. This variability leads to an interesting situation in the evaluation of hazard to health.

On the one hand, examination of the detailed sample-by-sample results show that at least half of the beach area, between stations 74SJB06, small park next to El Mirado Condominium and 74SJB13, beach at foot of Calle Corrion Court cited, poses a health hazard for at least part of the day.

On the other hand, a "by the book" geometric mean treatment masks the fine detail and presents a picture of a marginally "safe" beach. For example, fecal coliform densities of 364, 480, 820, 468, and 460 were observed in the middle section of beaches 74SJB06, small park next to El Mirado Condominium, and 74SJB13, beach at foot of Calle Corrions Court at the AM sampling period.

Fecal coliform bacteria originate from warm blooded animal's intestinal tract and their presence in water indicates the potential presence of pathogenic bacteria and viruses. As fecal coliform levels increase, there is a greater probability that human pathogens, such as Salmonella will be present. The fecal coliform standard of 200 was selected because this number is compatible with data which indicate low probability of enteric pathogen occurrence.[3,4,5] Data from estuarine waters[6] indicate that at the 200 fecal coliform level, there is a 28.4 percent occurrence of Salmonella. When the densities increase above 200, (200 - 2000) there is a 44 percent probability of Salmonella. On the basis of these studies, one can estimate increasing health hazards to bathers who swim at these beaches during the time of elevated densities of fecal coliform bacteria.

Besides the above indicated health hazards and the violations of fecal coliform standards, one outfall violated the color and odor standards. To maintain the full recreational, economic, and aesthetic values of these beaches, it is necessary to eliminate the effects of the outfalls. Solutions recommended include as an interim measure, disinfection of the effluents, re-routing the flow to treatment plants; extending the outfalls seaward for greater dilution, and removal of illegal connections.

WATER QUALITY STANDARDS

A partial list of the Puerto Rico standards for Class SB usage (coastal waters, direct human body contact) are as follows:

1. Fecal coliform monthly geometric average counts (5 sample minimum) not to exceed 200/100 ml., and no more than 20 percent of the samples over 400/100 ml.
2. No aesthetically unacceptable color change except by natural causes.
3. No odor producing substances introduced in amounts to interfere with primary contact recreation.

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