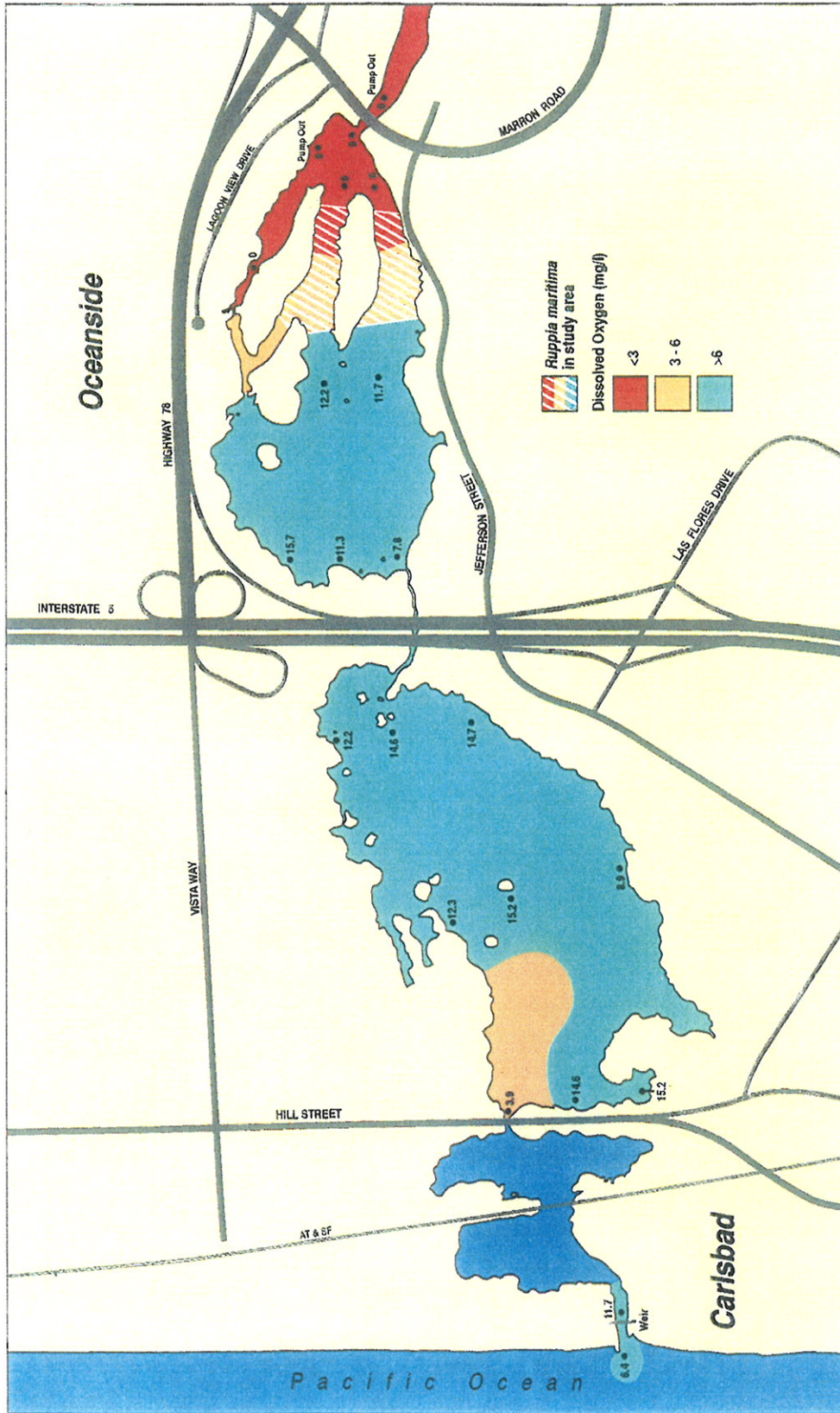


**Plate VI. Dissolved Oxygen (mg/l) at Buena Vista Lagoon,
0600, August 27, 1994.**

**Plate VII. Dissolved Oxygen (mg/l) at Buena Vista
Lagoon, 1400, August 27, 1994.**



Buena Vista Lagoon

Dissolved Oxygen (mg/l)

August 27, 1994

1400

Fecal Coliforms

On the morning of August 23, fecal coliform values in the spill area were 1.1×10^5 and $\geq 1.6 \times 10^6$ cfu/100 ml, compared to values of 2 to 50 cfu/100 ml in the outer lagoon and ocean (Figure 1-FC). Fecal coliform counts in the contaminated area increased during the next couple of days (Figures 2-FC and 3-FC) to as high as 1.3×10^7 cfu/100 ml, while counts in the outer lagoon and ocean remained low. After August 25, fecal coliform levels in the impacted area began to drop. Values in the spill area ranged from 1.2×10^5 to 8.2×10^5 mpn/100 ml in the evening of August 26 (Figure 4-FC) and mornings of August 27 and 28 (Figures 5-FC and 7-FC).

From August 26 to 28, extensive monitoring was conducted in both the inner and outer lagoons. Results of this monitoring confirmed findings from the dissolved oxygen plume tracking data as elevated coliform values were confined to the eastern end and northern channel of the inner lagoon (Figures 4-FC to 8-FC). On August 28 coliforms were high in the northern center of the lagoon indicating that the sewage contamination had broken through the narrow opening connecting the eastern portion of the northern channel and the center of the lagoon (Figure 8-FC). Values in the western portion of the inner lagoon, throughout the outer lagoon, and in the surfzone of the ocean remained low indicating that the contamination never reached these areas.

Results of coliform analyses for the 80 samples collected from the western portion of the inner lagoon, the outer lagoon, and surfzone of the ocean during this three day period provide information on the background coliform levels for Buena Vista Lagoon. These samples had counts ranging from 0 to 9000 mpn/100 ml, with 88% of the counts less than 300 mpn/100 ml (Figure 4-FC to 8-FC). The few, isolated values from 300 to 9000 mpn/100 ml are likely attributed to fecal contamination from vertebrates (such as birds) in areas of low water circulation. A strong diurnal pattern was seen in the coliform counts in the spill area on August 27 and 28 (Figures 5-FC to 8-FC). Values ranged from 1.2×10^5 to 6.0×10^5 mpn/100 ml in the mornings and from 6.0×10^4 to 2.3×10^5 mpn/100 ml in the afternoons. This pattern reflected the more favorable conditions for bacteriological growth during the night that resulted in higher counts in the early morning. During daytime, the light, higher temperatures, and lower dissolved oxygen reduced coliform growth.

Samples collected during the afternoon of August 29 indicated a continued decrease in coliforms as the highest count in the spill area was 9000 mpn/100 ml (Figure 9-FC). Counts again increased during the night and by the morning of August 30, values were as high as 1.2×10^4 mpn/100 ml (Figure 10-FC). From hereon, coliforms were sampled only during the afternoon surveys. Values continued to decline, ranging from 1800 to 6500 on August 30, from 170 to 1850 on August 31, and from 90 to 6000 mpn/100 ml on September 1 (Figures 11-FC to 13-FC). From September 2 through 8, values in the impacted area ranged from 40 to 600 mpn/100 ml (Figures 14-FC to 17-FC), and no contamination was indicated.

August 23, 1994 0800

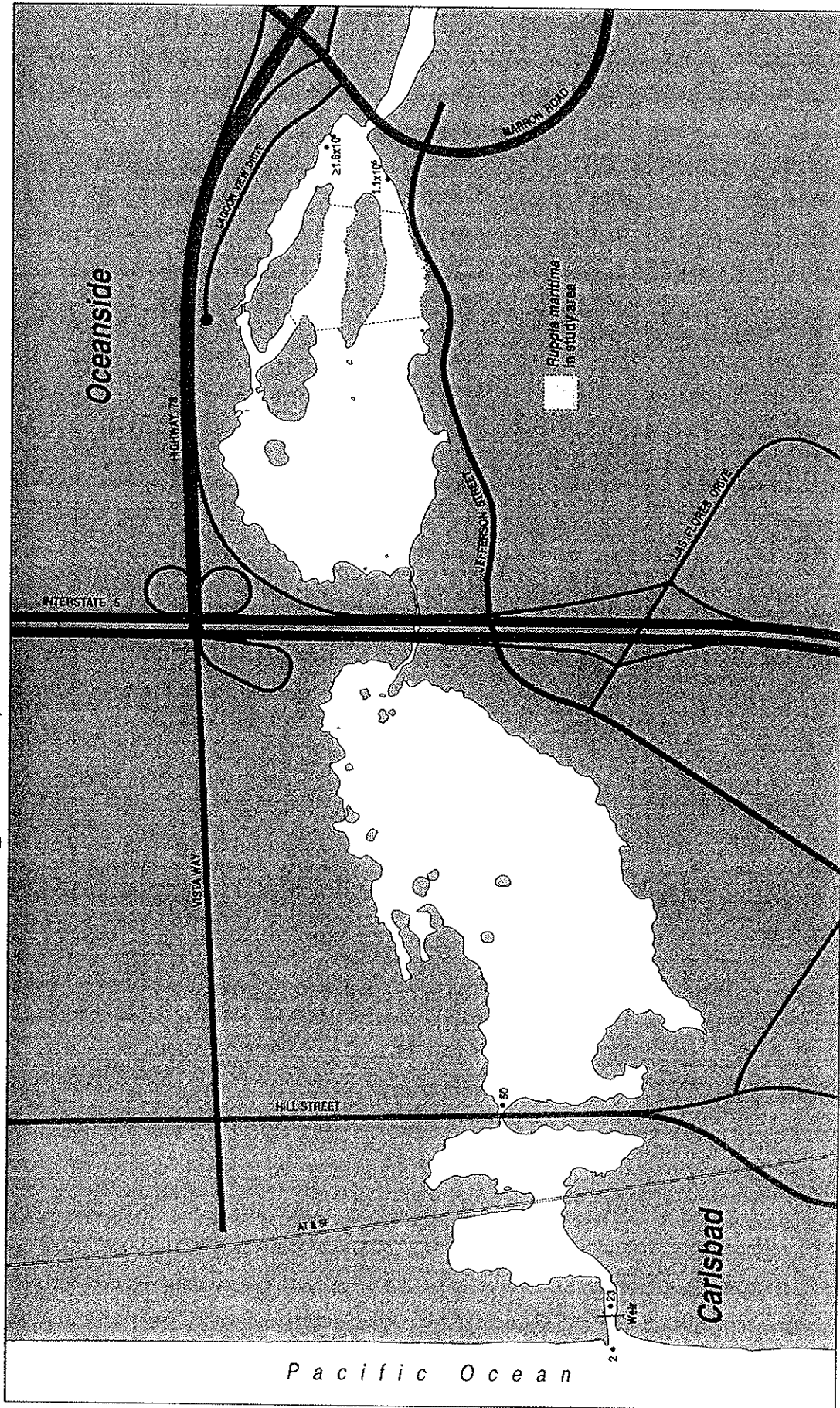


Figure 1-FC. Fecal Coliforms (cfu/100ml) at Buena Vista Lagoon, 0800, August 23, 1994.

August 24, 1994 0800

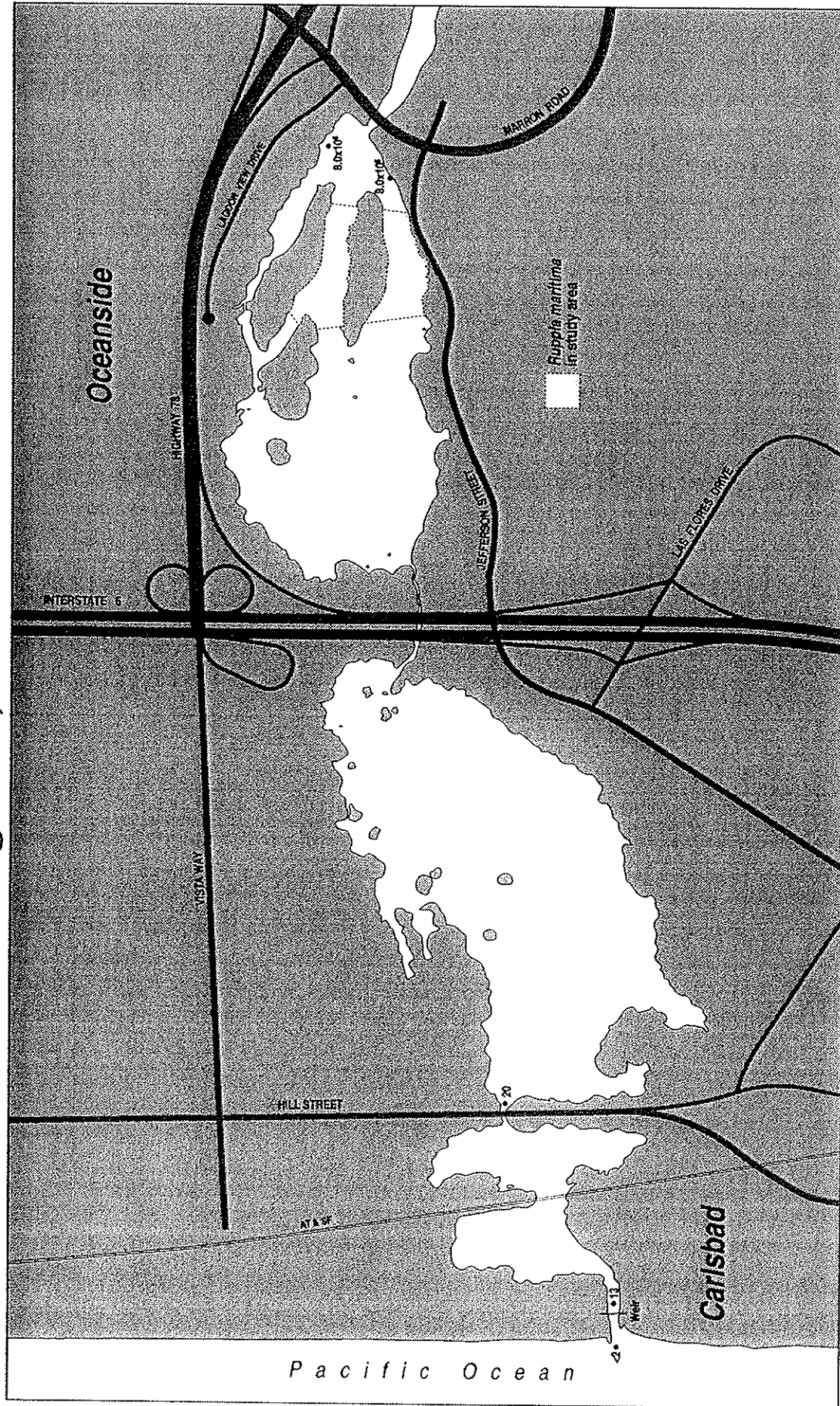


Figure 2-FC. Fecal Coliforms (cfu/100ml) at Buena Vista Lagoon, 0800, August 24, 1994.

August 25, 1994 0800

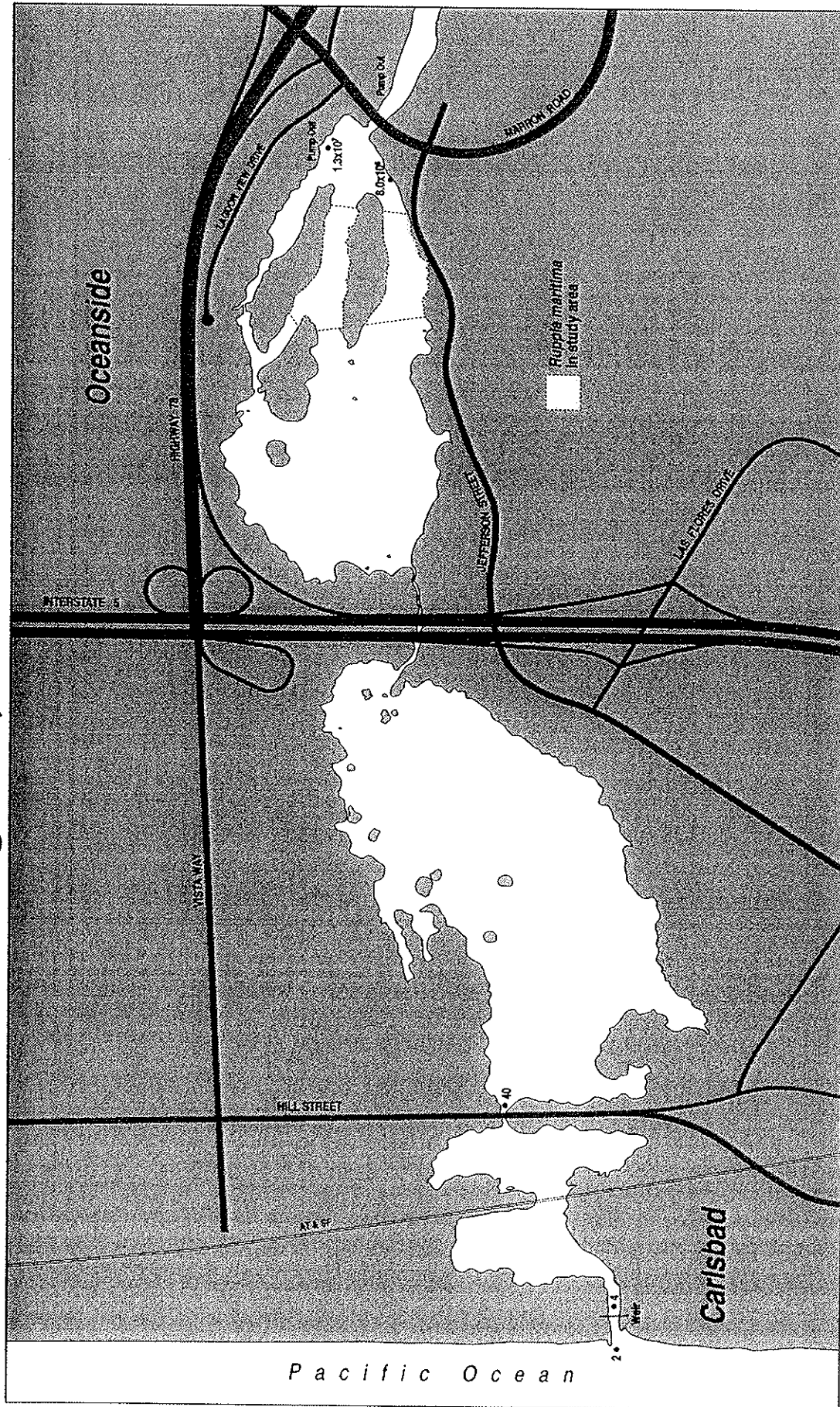


Figure 3-FC. Fecal Coliforms (cfu/100ml) at Buena Vista Lagoon, 0800, August 25, 1994.

August 26, 1994 1825

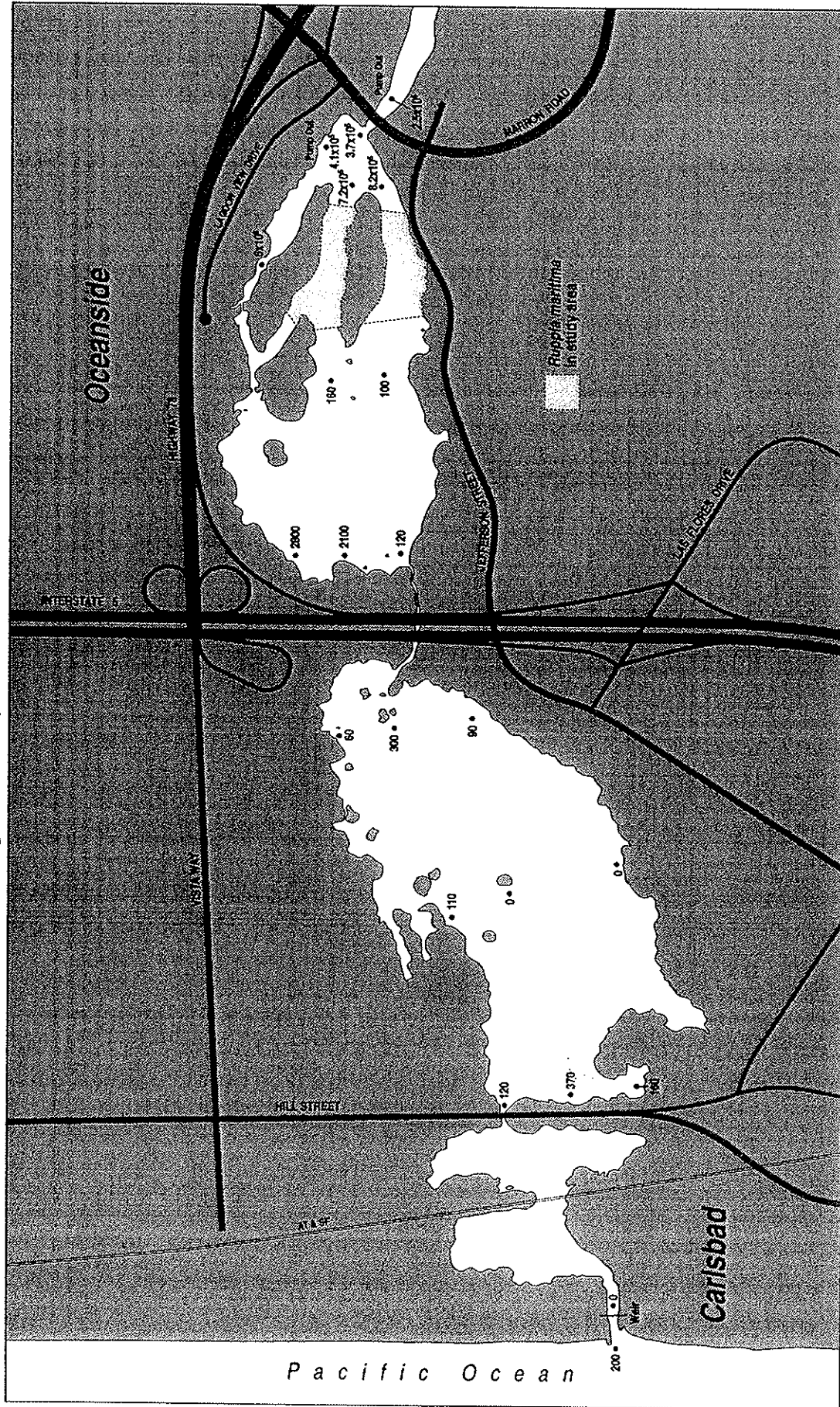


Figure 4-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1825, August 26, 1994.

August 27, 1994 0600

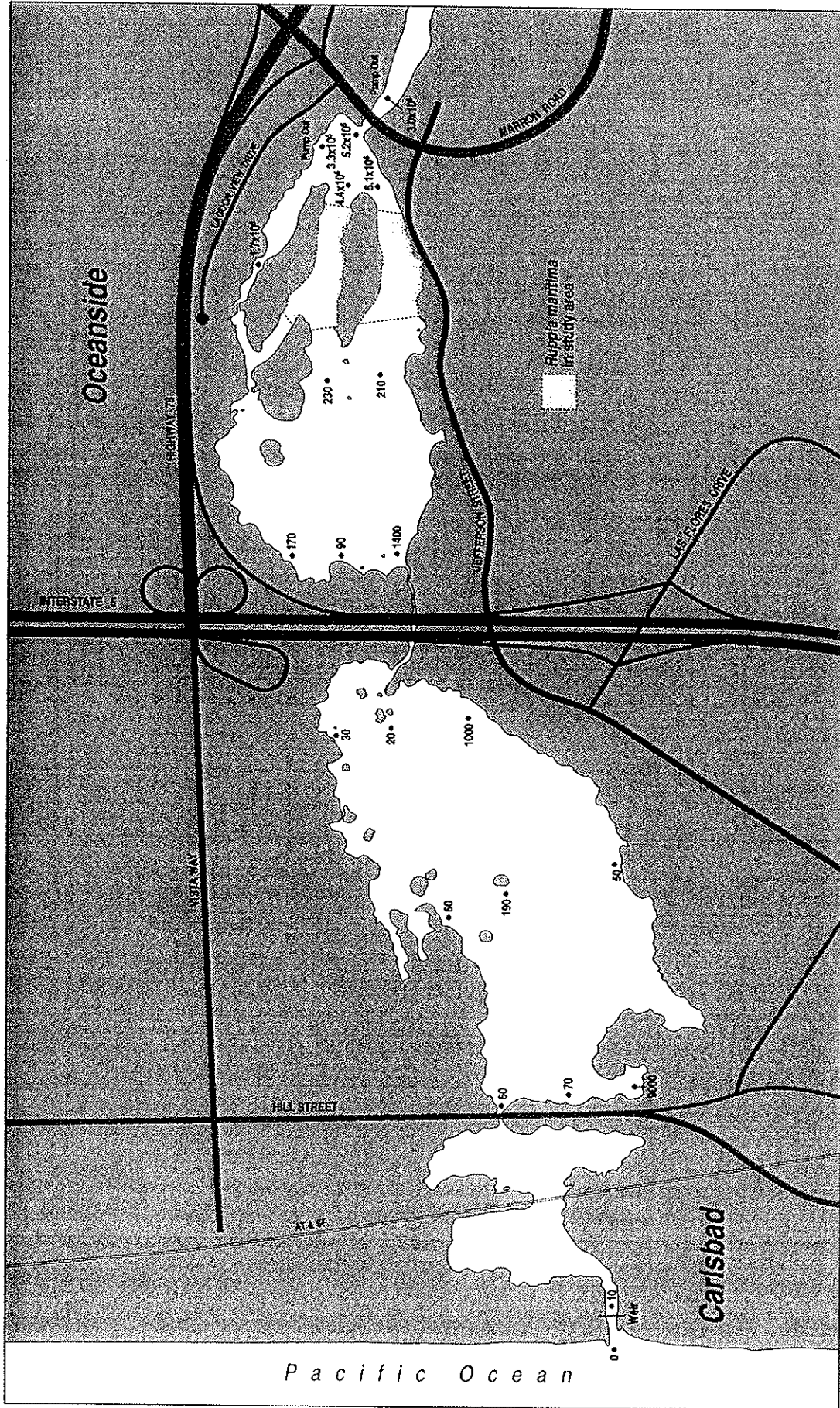


Figure 5-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 0600, August 27, 1994.

August 28, 1994 0600

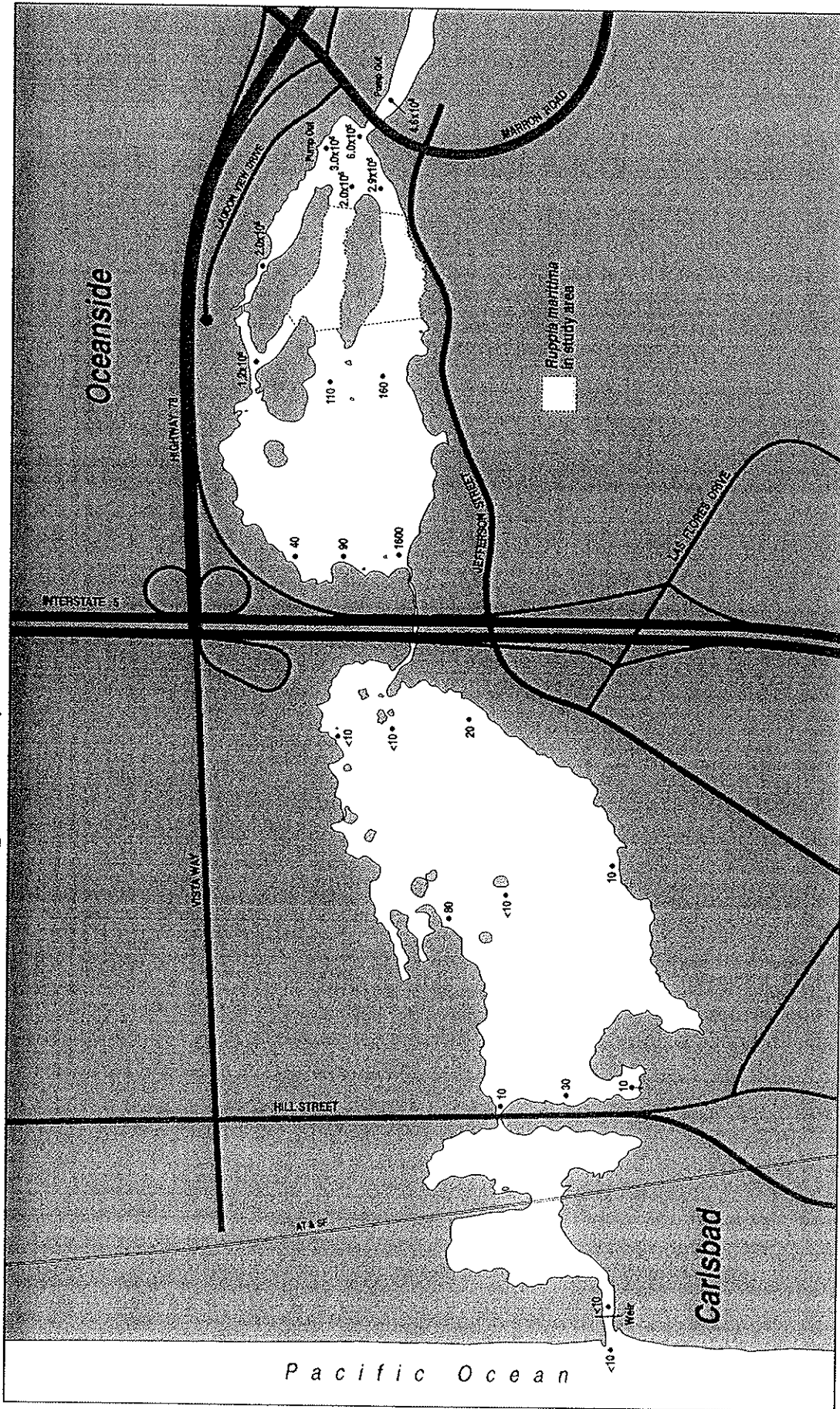


Figure 7-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 0600, August 28, 1994.

August 29, 1994 1500

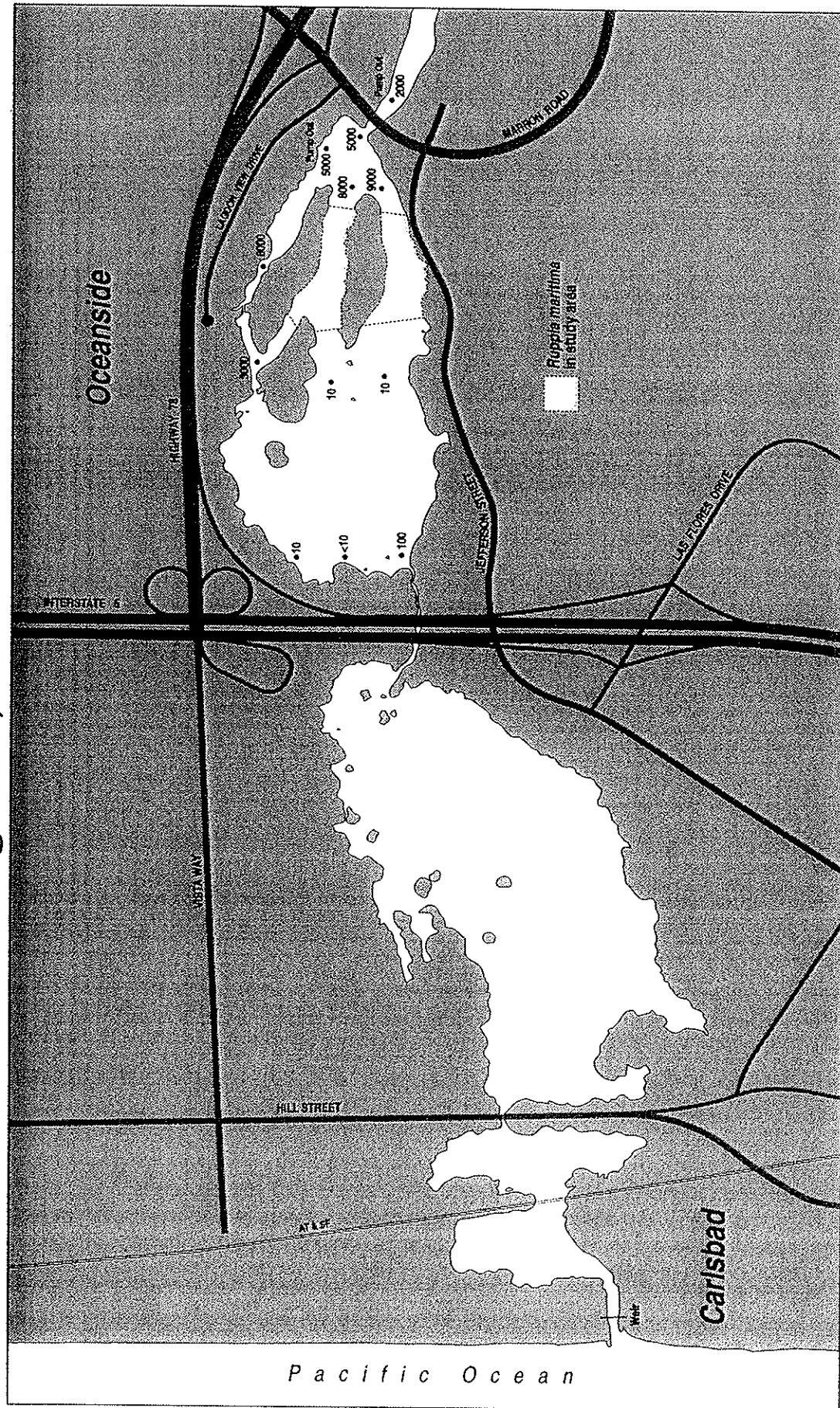


Figure 9-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1500, August 29, 1994.

August 30, 1994 0600

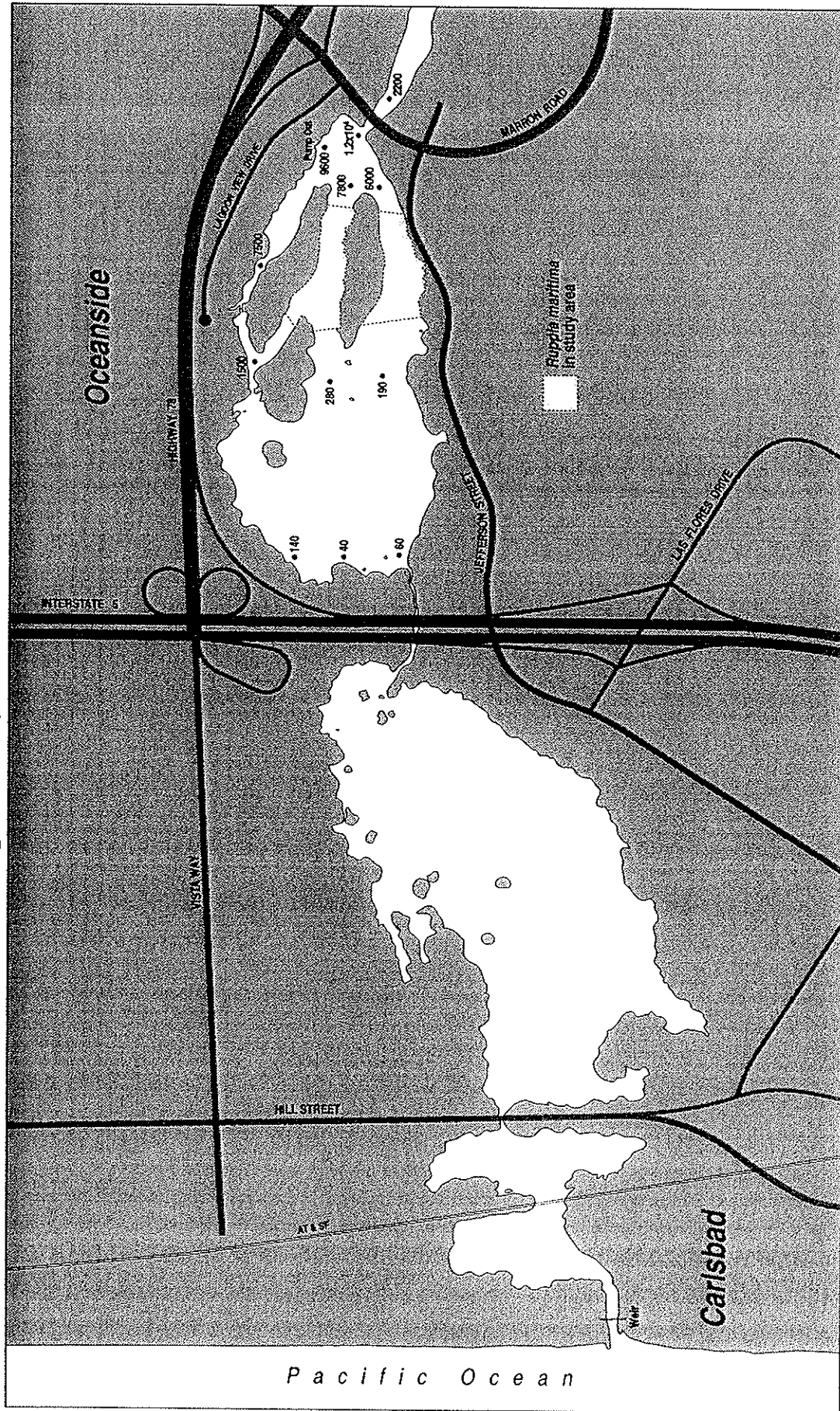


Figure 10-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 0600, August 30, 1994.

August 30, 1994 1330

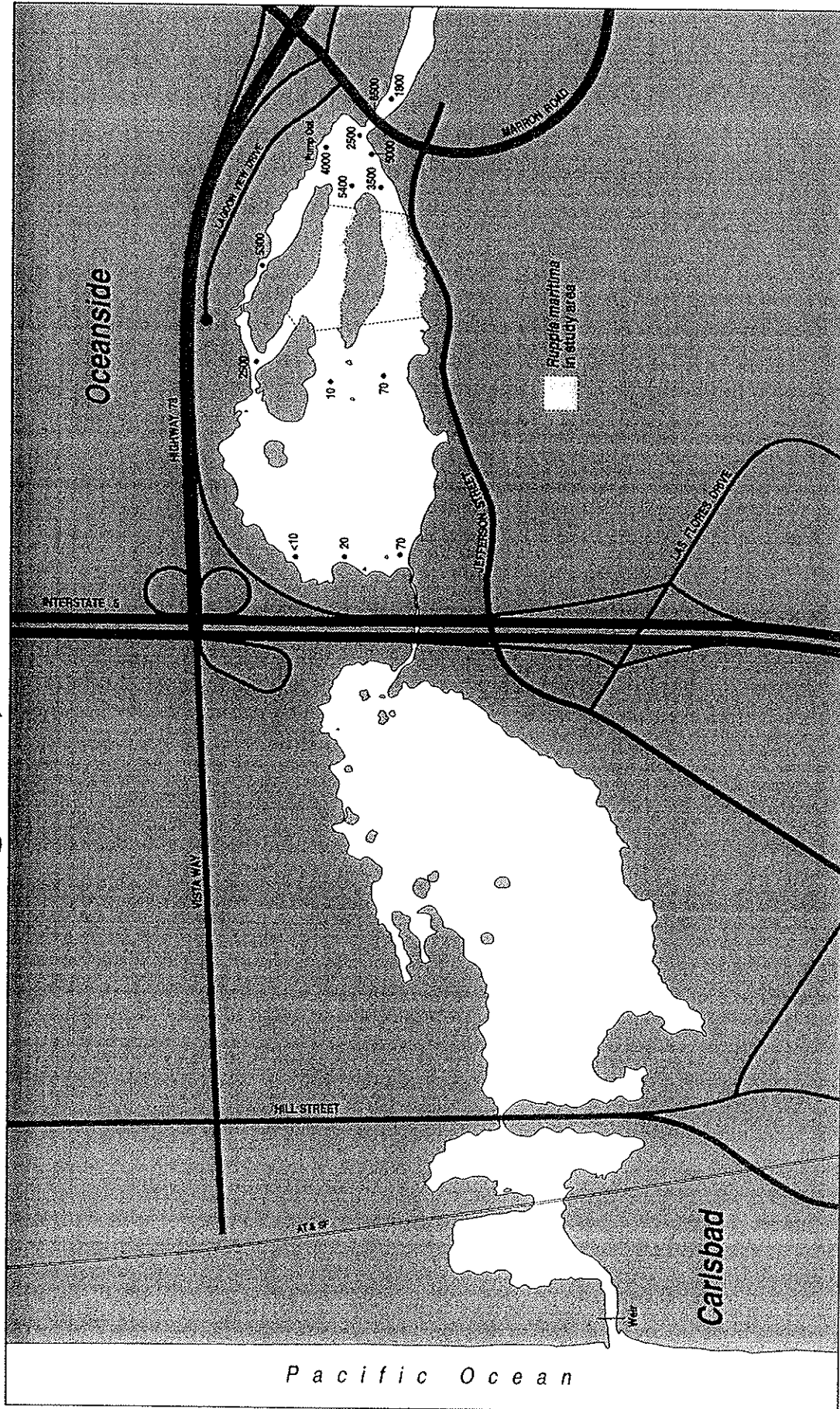


Figure 11-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1330, August 30, 1994.

August 31, 1994 1330

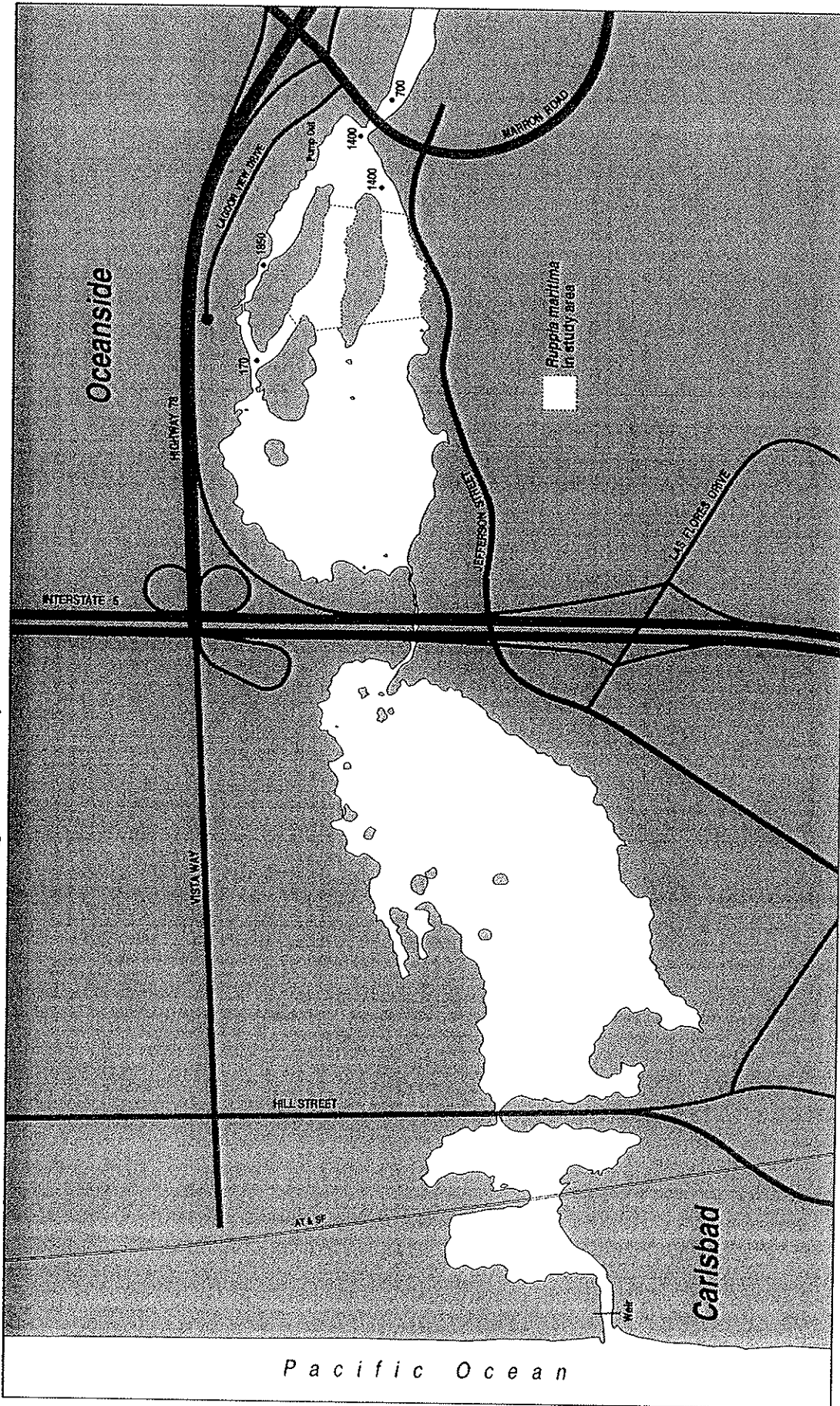


Figure 12-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1330, August 31, 1994.

September 1, 1994 1330

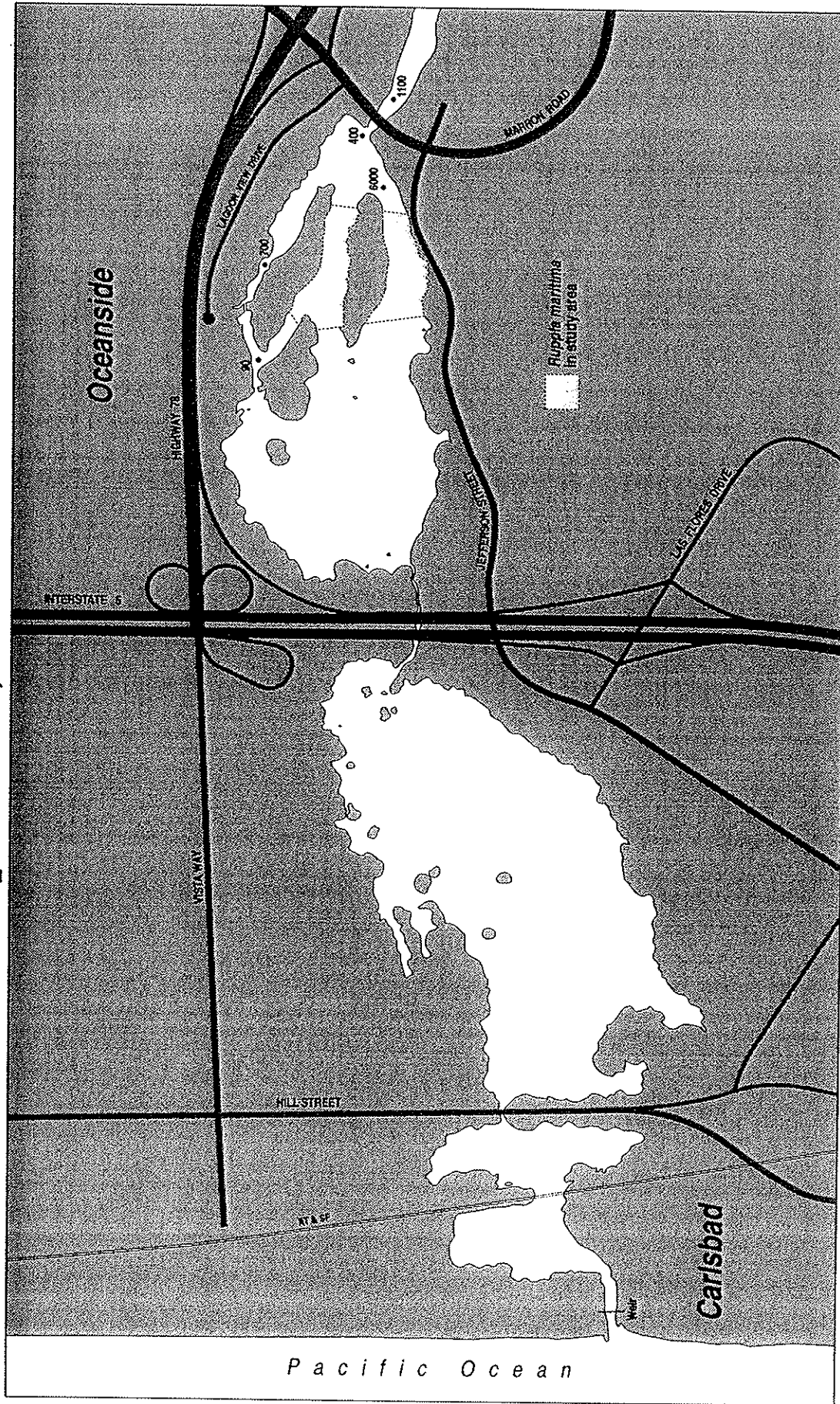


Figure 13-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1330, September 1, 1994.

September 2, 1994 1315

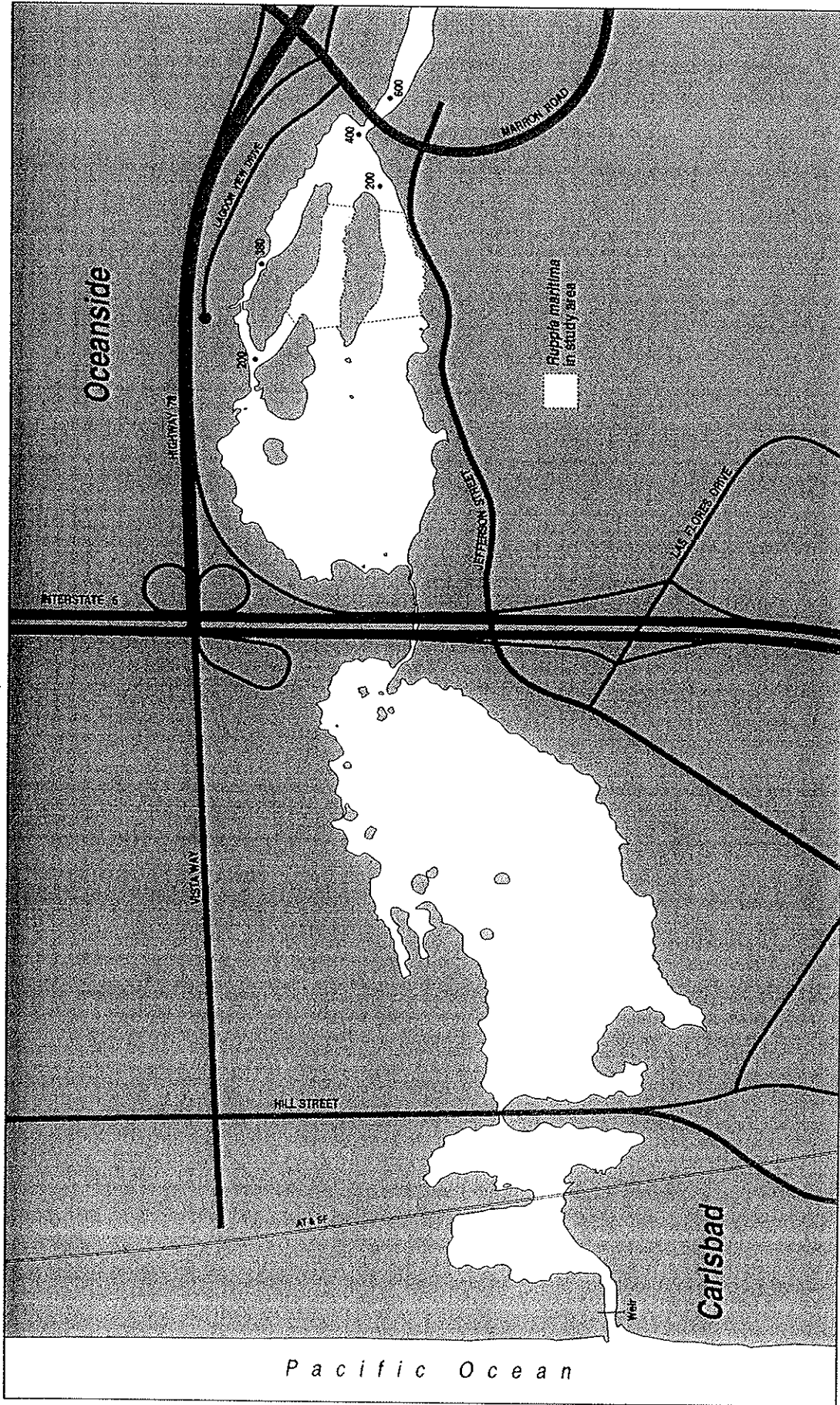


Figure 14-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1315, September 2, 1994.

September 4, 1994 1330

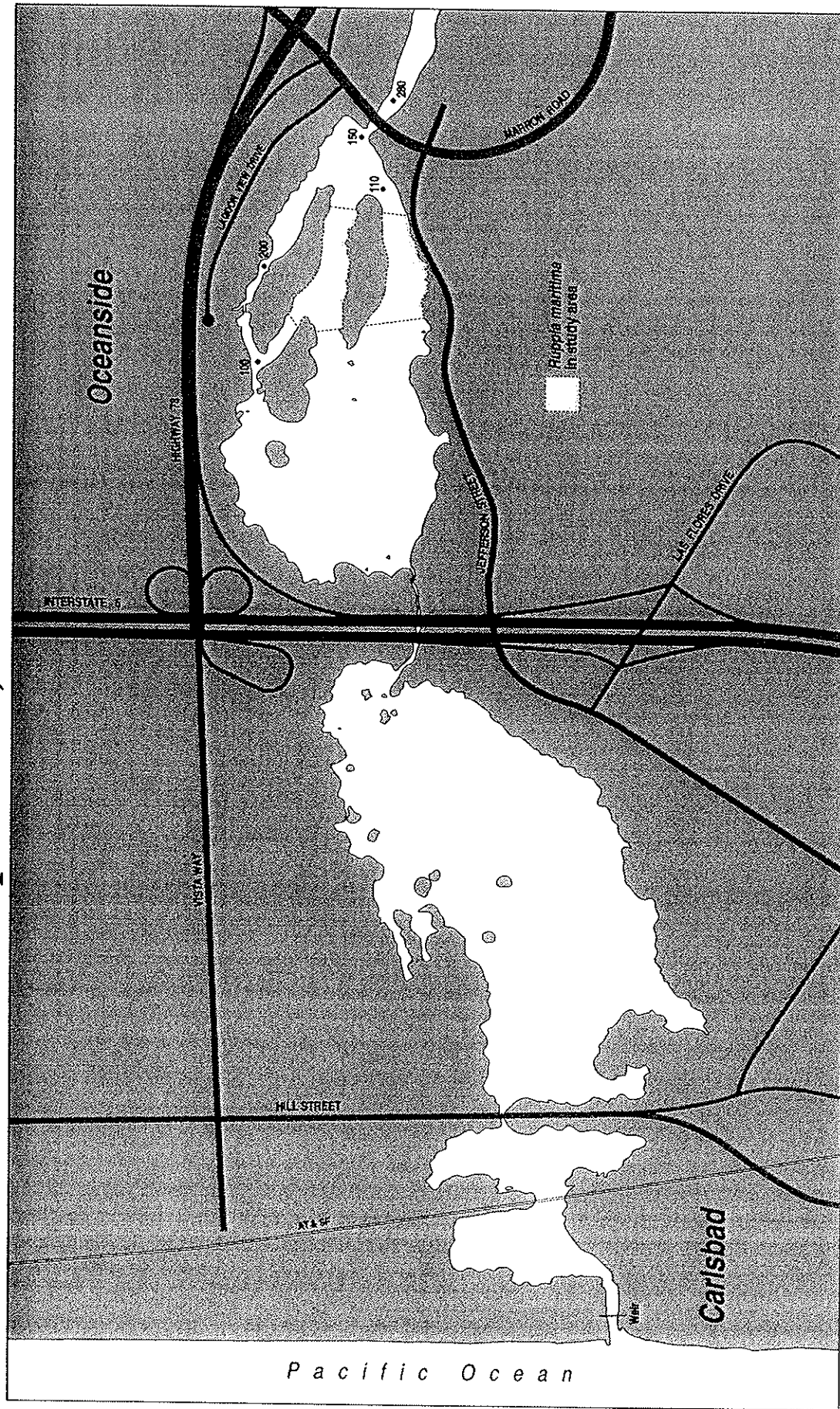


Figure 15-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1330, September 4, 1994.

September 6, 1994 1330

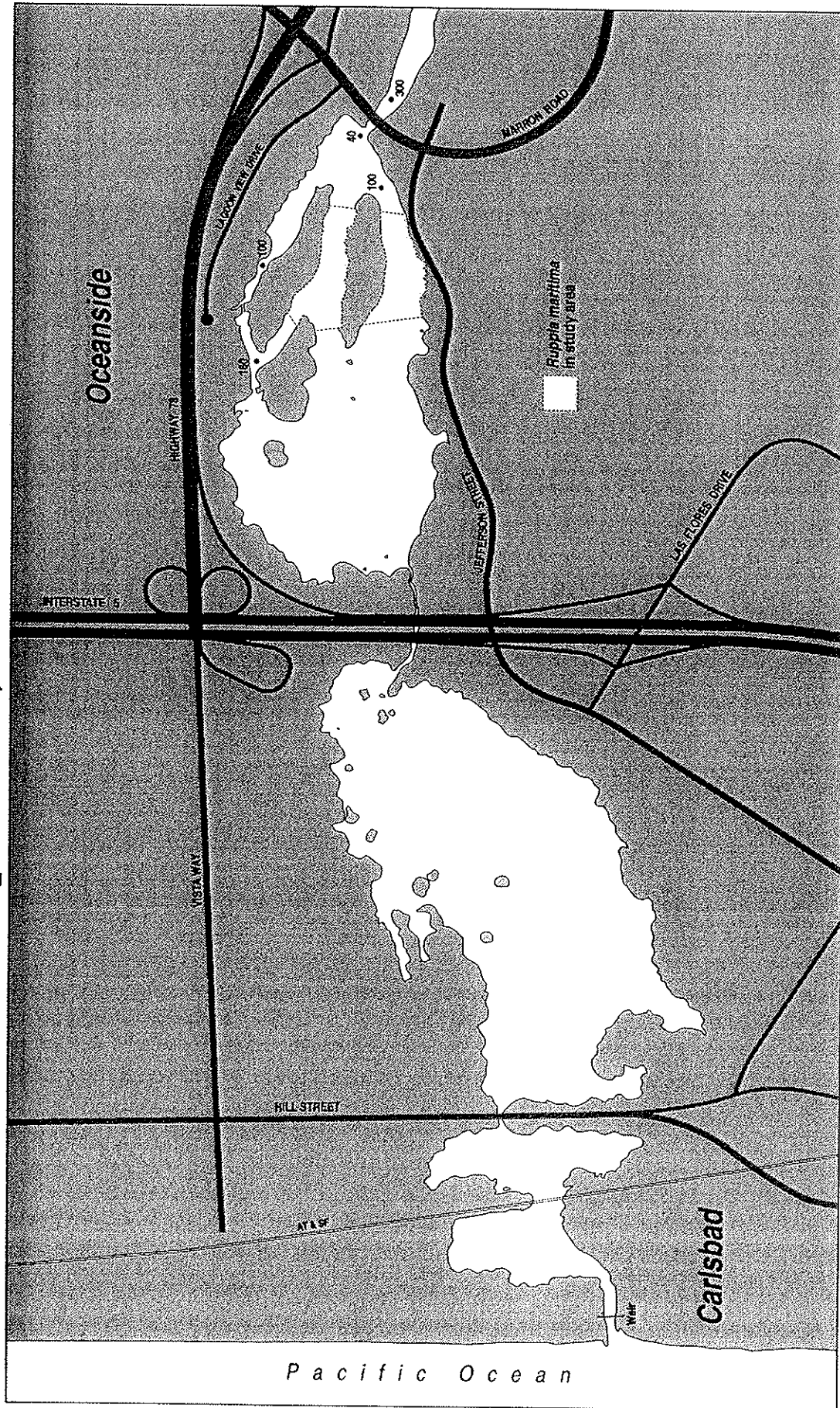


Figure 16-FC. Fecal Coliforms (mpn/100ml) at Buena Vista Lagoon, 1330, September 6, 1994.

Other Parameters

Depth for every station is provided by survey in Appendix A. Depth in the outer lagoon ranged from approximately 2 to 4 feet and was relatively uniform for the entire basin. In the inner lagoon, depth was more variable. The western portion of the inner lagoon near Interstate 5 was less than 1 foot deep, and the northwestern corner was about 7 inches deep. The central area of the inner lagoon was roughly 1 foot deep, while depths in the eastern area ranged from 4 to 12 feet. The deepest spot was at the eastern extreme, immediately west of Marron Road. East of Marron Road, the depth was just over 1 foot.

Dissolved oxygen and fecal coliforms were measured at surface, midwater, and bottom waters of the deepest area of the inner lagoon on selected dates (Tables 2 and 3). Immediately following the spill, dissolved oxygen at this location was 0 mg/l throughout the water column (Table 2). Dissolved oxygen increased in surface waters beginning on August 29 and in midwaters beginning on September 1. Dissolved oxygen in bottom waters remained at 0 mg/l for the entire monitoring period. On August 29, fecal coliforms were over twenty times greater in bottom waters than in mid- and surface waters (Table 3). Coliform counts at the surface were less than 1000 mpn/100 ml by September 1 but remained over 1000 mpn/100 ml in bottom waters until September 4. Counts were similar throughout the water column on September 4, 6, and 8.

Measurements of temperature and salinity at the water surface on August 28 (inner and outer lagoons) and 30 (inner lagoon) and on September 2 (inner lagoon) are presented in Appendix A. Surface temperatures were slightly cooler (21-26°C) on August 30 and September 2 (23-26°C) than on August 28 (25-31°C). No difference in surface water temperature was observed between the inner and outer lagoons. Salinity ranged from 1 to 4 ‰ for the entire lagoon and showed little variation over the three dates. Values were similar in the inner and outer lagoons, although the highest value (4 ‰) was found at the western extreme of the outer lagoon adjacent to the ocean.

Values for BOD, TKN, and chlorophyll-a measured in the inner lagoon on September 2 are presented in Appendix A. Values for BOD ranged from 7 to 15 mg/l in surface waters throughout the lagoon. Chlorophyll-a was comparatively lower (22 to 27 mg/m³) in the shallow waters of the western portion of the inner lagoon and higher (121 to 299 mg/m³), indicating higher production, in the central and eastern areas. Total Kjeldahl

Nitrogen was low (0.1 mg/l) in the shallowest area at the northwestern corner of the lagoon, but was similar (2.4 to 4.5 mg/l) throughout the rest of the lagoon.

These parameters were measured at surface, midwater, and bottom depths in the deep area at eastern extreme of the inner lagoon on September 2 (Table 4). Dissolved oxygen was high (21.8 mg/l) and BOD was low (13 mg/l) in surface compared to bottom waters, indicating production at the surface and depletion at the bottom. Coliforms were similar throughout the water column. Chlorophyll-a was high (299 mg/m³) at the surface, intermediate (160 mg/m³) in midwater, and low (29 mg/m³) in bottom waters. Like the elevated oxygen concentrations, the high level of chlorophyll-a at the surface indicates heavy production. Light is reduced in deeper waters, so chlorophyll-a is lower. Nitrogen was slightly lower in surface (2.8 mg/l) compared to bottom (4.3 mg/l) waters but was not a limiting factor.

Table 2. Dissolved oxygen (mg/l) for surface, midwater, and bottom waters at the eastern extreme of Buena Vista Lagoon, August 25 through September 16, 1994.

	August 25 1330	August 26 1330	August 29 1500	August 31 1330	September 1 1330	September 2 1315	September 4 1330	September 6 1330	September 8 1330	September 12 1330	September 16 1415
Surface	0	0	1.7	8.4	15.6	21.8	--	8.2	13.2	9.5	15.2
Midwater	0	0	0	--	0.3	0	5.2	7.3	2.5	4.1	0.03
Bottom	0	0	0	0	0	0	0	0	0	0	0

Table 3. Fecal coliforms for surface, midwater, and bottom waters at the eastern extreme of Buena Vista Lagoon, August 29 through September 8, 1994. Values are mpn/100ml.

	August 29 1500	August 31 1330	September 1 1330	September 2 1315	September 4 1330	September 6 1330	September 8 1330
Surface	5000	1400	400	400	150	40	90
Midwater	8000	--	1000	600	500	210	230
Bottom	1.7 x 10 ⁶	2.0 x 10 ⁶	3000	2000	300	190	20

Table 4. Dissolved oxygen, fecal coliforms, Biochemical Oxygen Demand (BOD), chlorophyll-a, and Total Kjeldahl Nitrogen (TKN) at surface, midwater, and bottom waters in the eastern extreme of Buena Vista Lagoon, 1315, September 2, 1994.

DEPTH	DISSOLVED OXYGEN (mg/l)	FECAL COLIFORMS mpn/100 ml	BOD (mg/l)	CHLOROPHYLL-a (mg/m ³)	TKN (mg/l)
Surface	21.8	400	13	299	2.8
Midwater	0	600	14	160	3.9
Bottom	0	200	200	29	4.3

CONCLUSIONS

Plume Tracking

Contamination from the sewage spill was confined to the easternmost portion and northern channel of the inner lagoon, with some leakage to the northern central area.

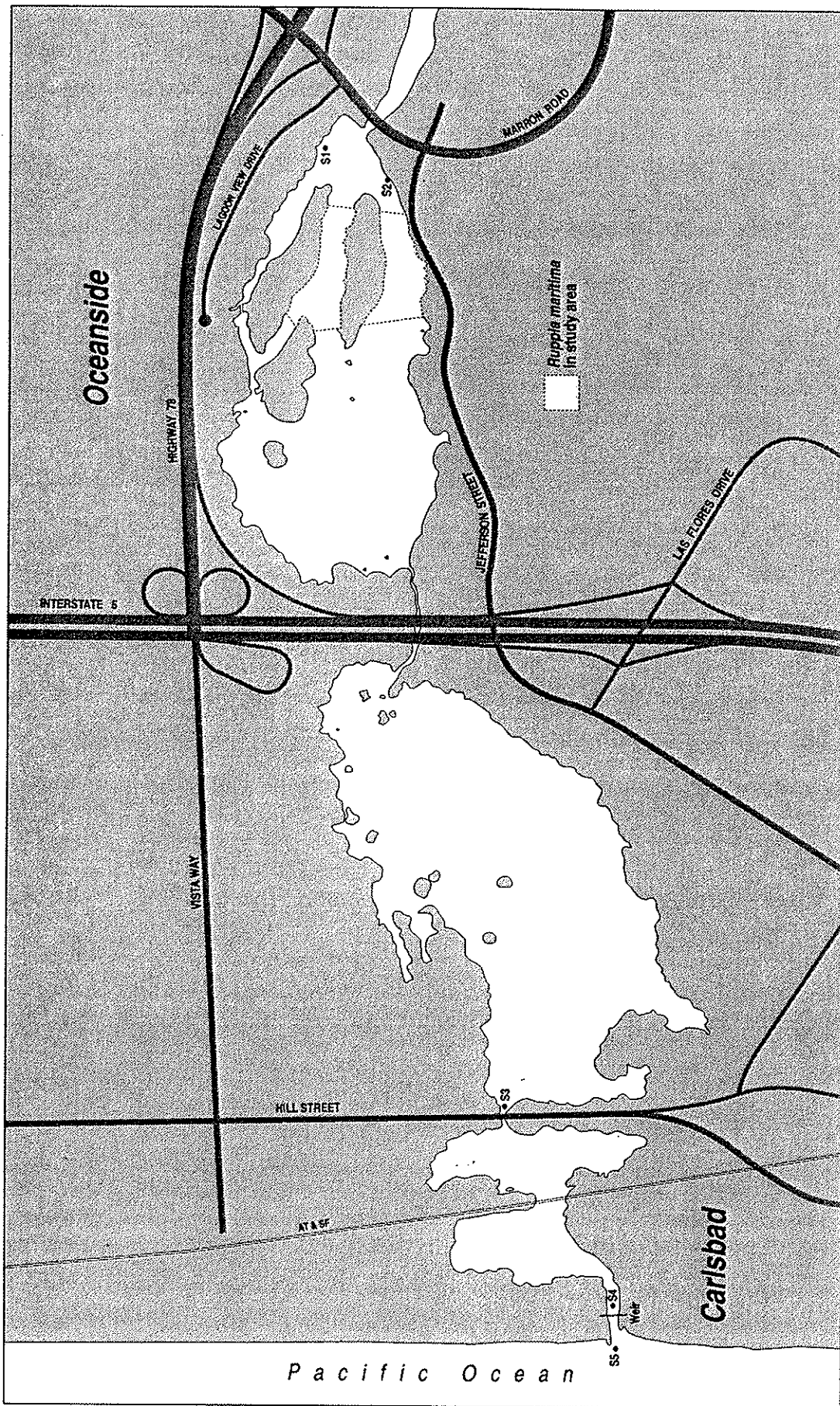
Dense vegetation prevented spreading of the contamination to the center of the inner lagoon. The central and western areas of the inner lagoon and the entire outer lagoon were not contaminated.

By September 1, surface water concentrations of dissolved oxygen were high throughout the inner lagoon. By September 2, fecal coliform levels in surface waters were low throughout the inner lagoon.

Background Levels

Background levels of dissolved oxygen in Buena Vista Lagoon were high in the midafternoon due to heavy photosynthetic activity. Oxygen was depleted during the night by heavy respiration, which resulted in low levels of dissolved oxygen in the early morning.

Fecal coliform counts ranged from 0 to 9000 mpn/100 ml in Buena Vista Lagoon, with most values less than 300 mpn/100ml.

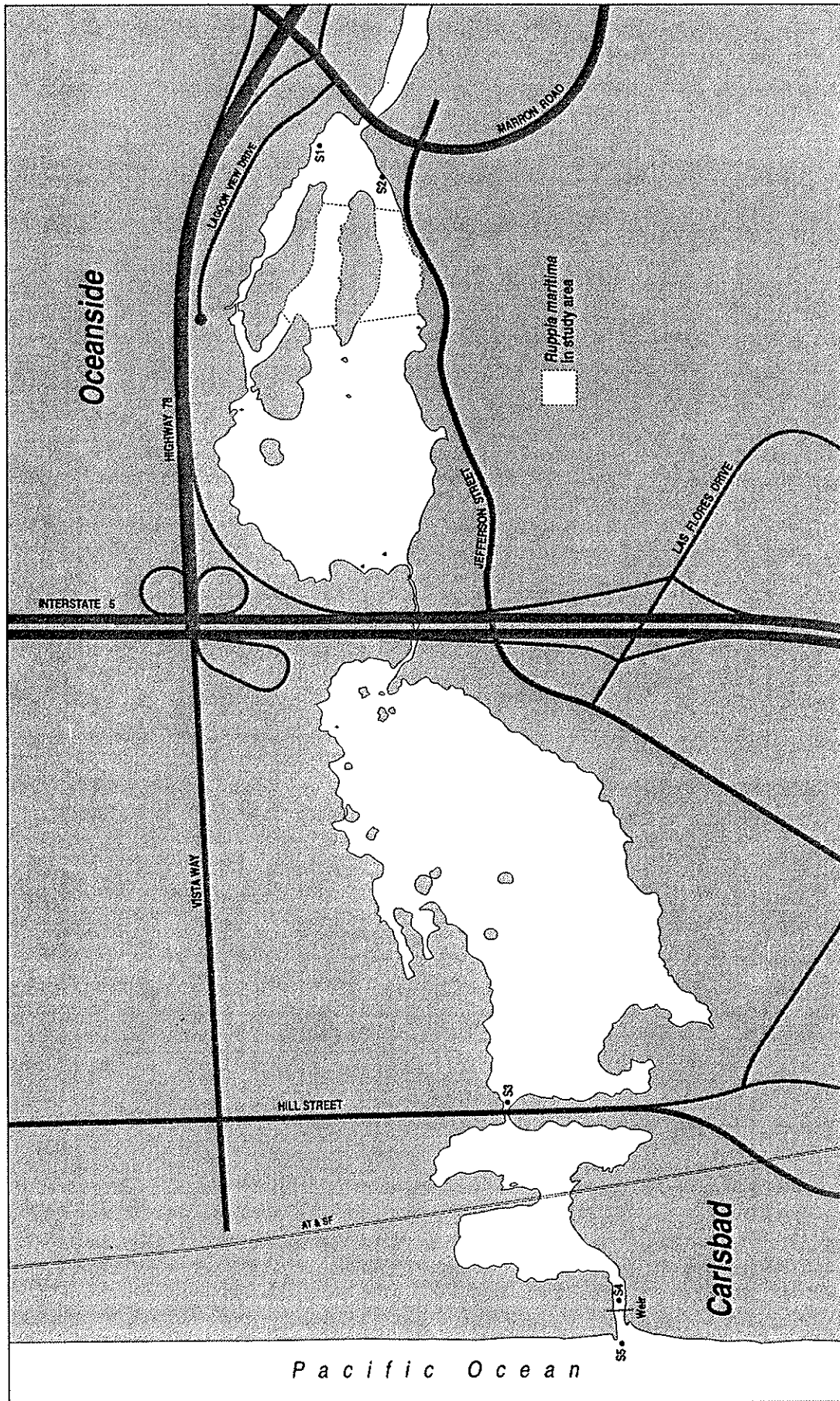


Buena Vista Lagoon

Stations
 August 23, 1994
 0800

Coliforms at Buena Vista Lagoon, 0800, August 23, 1994.
Values are cfu/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
S1	0822	$\geq 1.6 \times 10^6$	$\geq 1.6 \times 10^6$
S2	0817	3.0×10^5	1.1×10^5
S3	0825	500	50
S4	0838	30	23
S5	0842	4	2

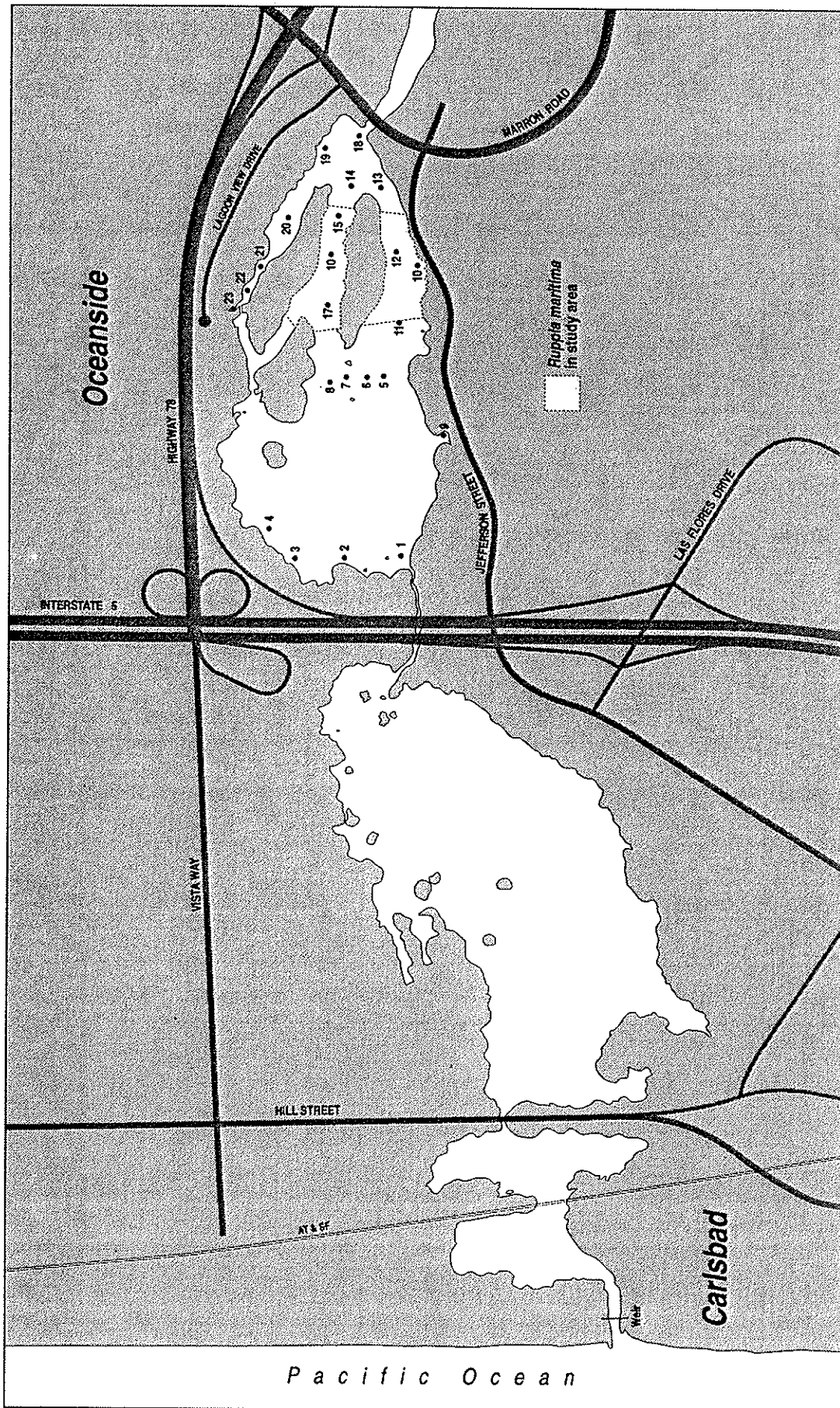


Buena Vista Lagoon

Stations
 August 24, 1994
 0800

Coliforms at Buena Vista Lagoon, 0800, August 24, 1994.
Values are cfu/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
S1	0815	2.4×10^7	8.0×10^6
S2	0824	5.0×10^7	8.0×10^6
S3	0836	300	20
S4	0848	170	13
S5	0852	<2	<2

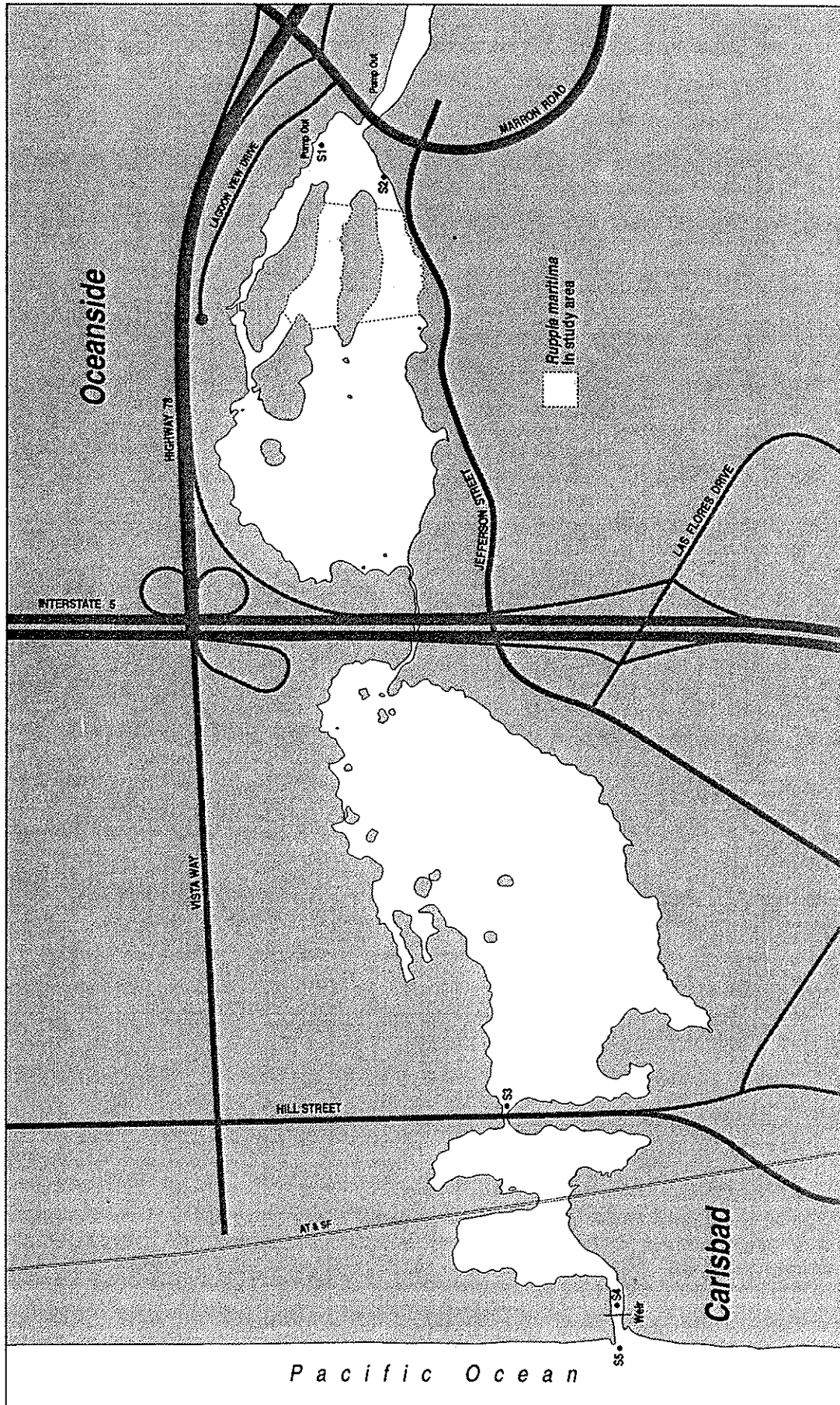


Buena Vista Lagoon

Stations
 August 24, 1994
 1500

Dissolved oxygen at Buena Vista Lagoon, 1500, August 24, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1705	0.9	9.7
2	1655	0.8	10.8
3	1652	1.1	10.8
4	1649	0.8	11.5
5	1617	1.5	11.9
6	1626	0.8	12.7
7	1638	1.0	8.9
8	1643	0.8	9.2
9	1709	1.0	9.1
10	1824	2.7	13.9
11	1822	3.0	15.8
12	1818	3.0	17.2
13	1815	3.5	0
14	1813	3.5	0
15	1745	2.5	12.6
16	1729	2.7	18.1
17	1717	1.5	17.3
18	1810	9.0	0
19	1753	6.3	0
20	1750	7.0	0
21	1756	3.3	0
22	1758	3.3	0
23	1803	2.5	0

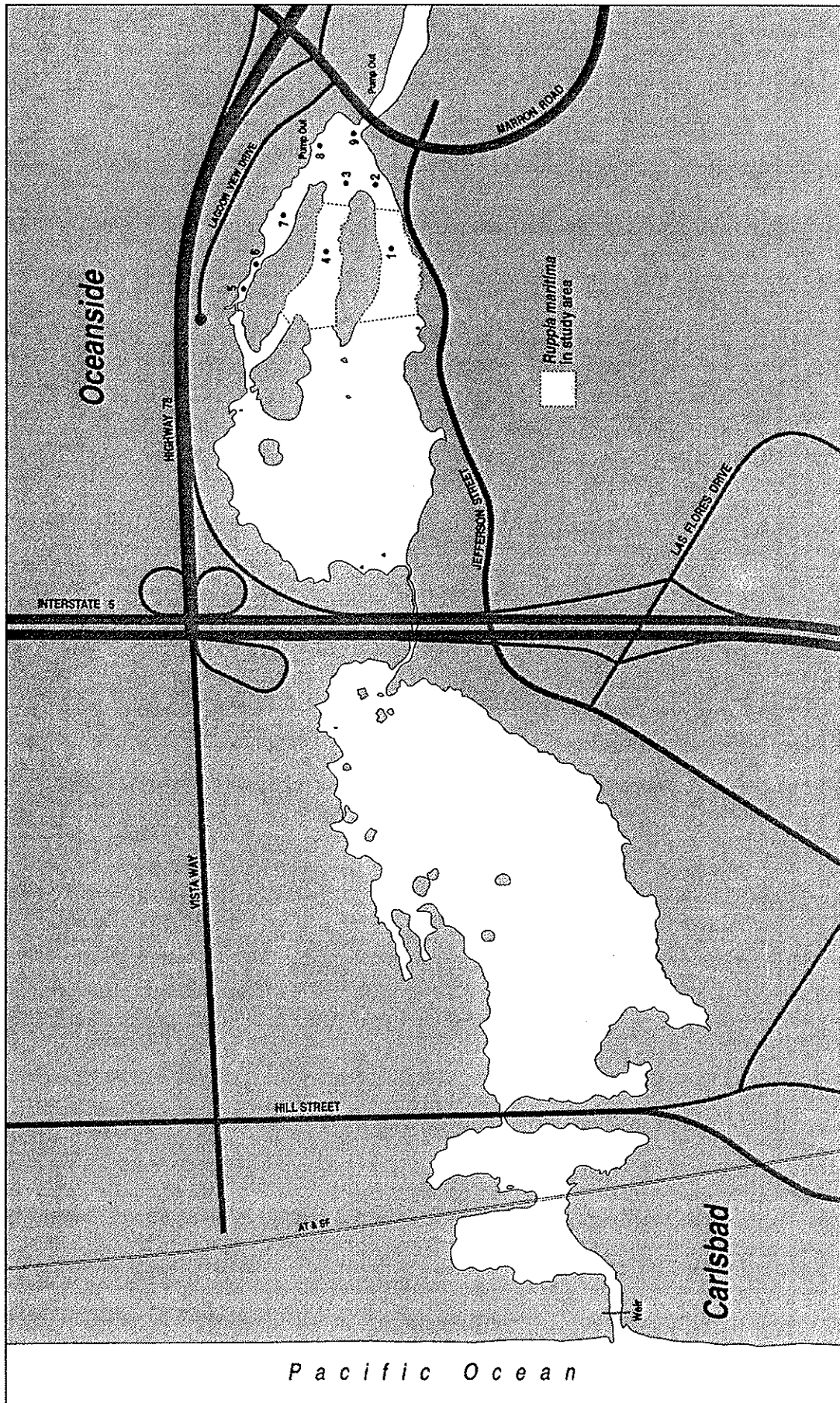


Buena Vista Lagoon

Stations
 August 25, 1994
 0800

Coliforms at Buena Vista Lagoon, 0800, August 25, 1994.
Values are cfu/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
S1	0814	1.3×10^7	1.3×10^7
S2	0825	8.0×10^6	8.0×10^6
S3	0834	300	40
S4	0843	900	4
S5	0850	2	2

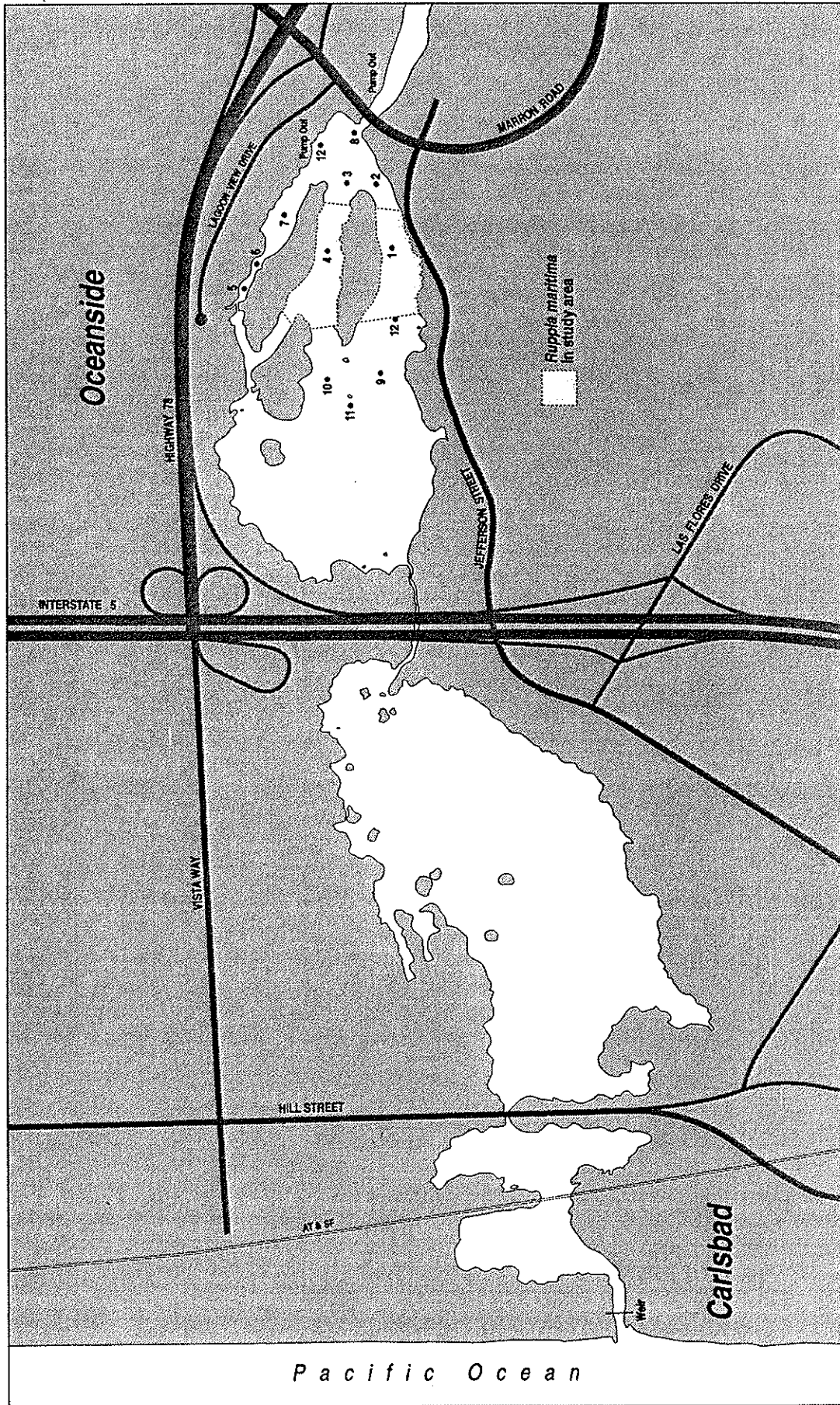


Buena Vista Lagoon

Stations
 August 25, 1994
 1330

Dissolved oxygen at Buena Vista Lagoon, 1330, August 25, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1 Surface	1400	2.7	15.9
1 Bottom	1400	2.7	16.7
2 Surface	1410	4.0	0
2 Bottom	1410	4.0	0
3 Surface	1421	6.3	0
3 Midwater	1421	6.3	0
3 Bottom	1421	6.3	22.6
4 Surface	1439	2.8	17.0
4 Bottom	1439	2.8	0
5 Surface	1455	2.5	0
5 Bottom	1455	2.5	0
6 Surface	1502	2.0	0
6 Bottom	1502	2.0	0
7 Surface	1511	2.5	0
7 Bottom	1511	2.5	0
8 Surface	1519	3.0	0
8 Bottom	1519	3.0	0
9 Surface	1528	10.0	0
9 Midwater	1528	10.0	0
9 Bottom	1528	10.0	0

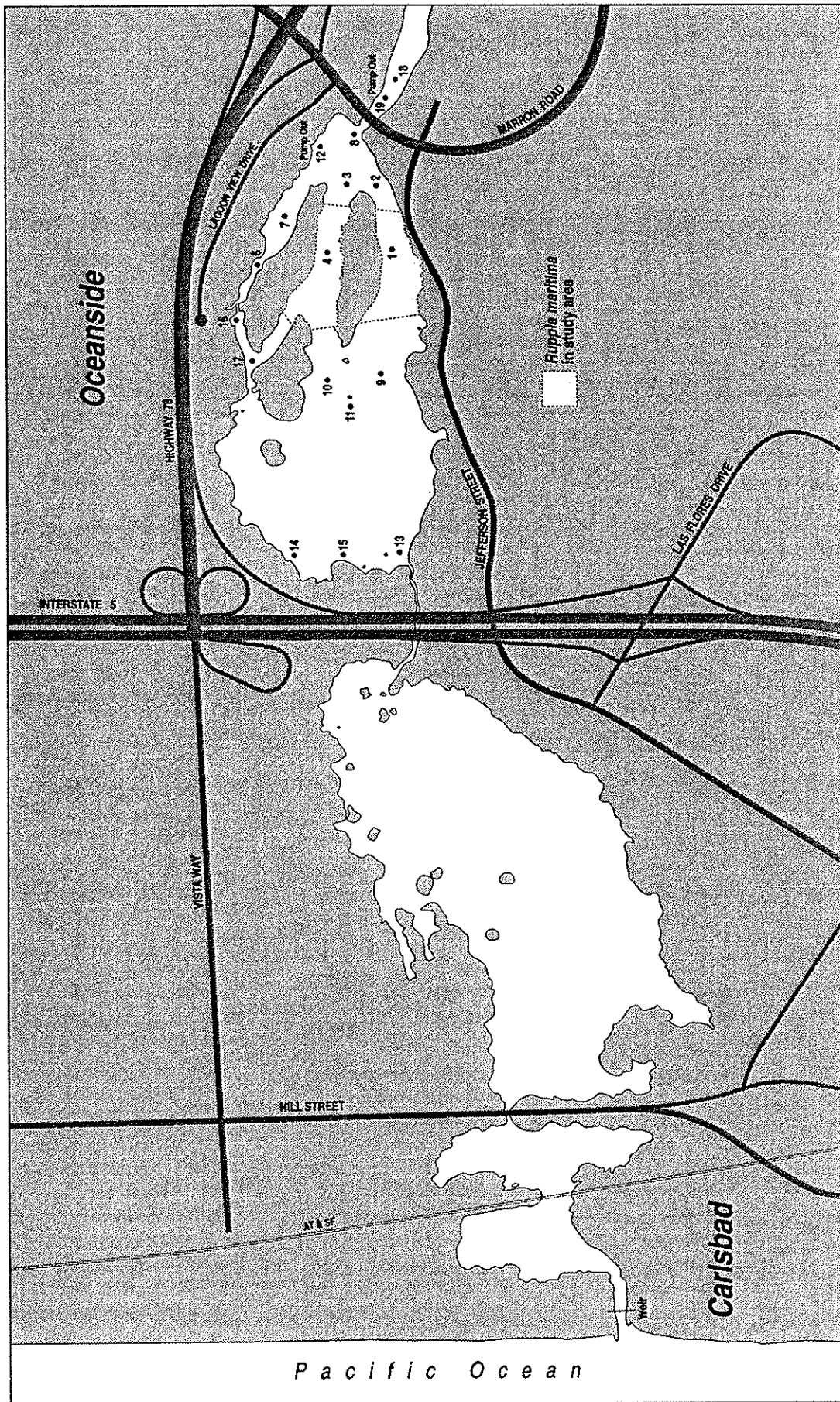


Buena Vista Lagoon

Stations
 August 26, 1994
 0630

Dissolved oxygen at Buena Vista Lagoon, 0630, August 26, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1 Surface	0628	3.0	2.5
1 Bottom	0628	3.0	3.0
2 Surface	0710	3.0	0
2 Bottom	0710	3.0	0
3 Surface	0701	4.0	0
3 Bottom	0701	4.0	0
4 Surface	0652	2.0	1.5
5 Surface	0724	2.0	0
6 Surface	0730	2.0	0
7 Surface	0735	3.0	0
8 Surface	0743	10.0	0
8 Midwater	0743	10.0	0
8 Bottom	0743	10.0	0
9 Surface	0810	1.2	4.7
10 Surface	0802	1.3	2.2
11 Surface	0818	0.8	4.0
12 Surface	0636	3.0	5.9
12 Bottom	0636	3.0	5.7

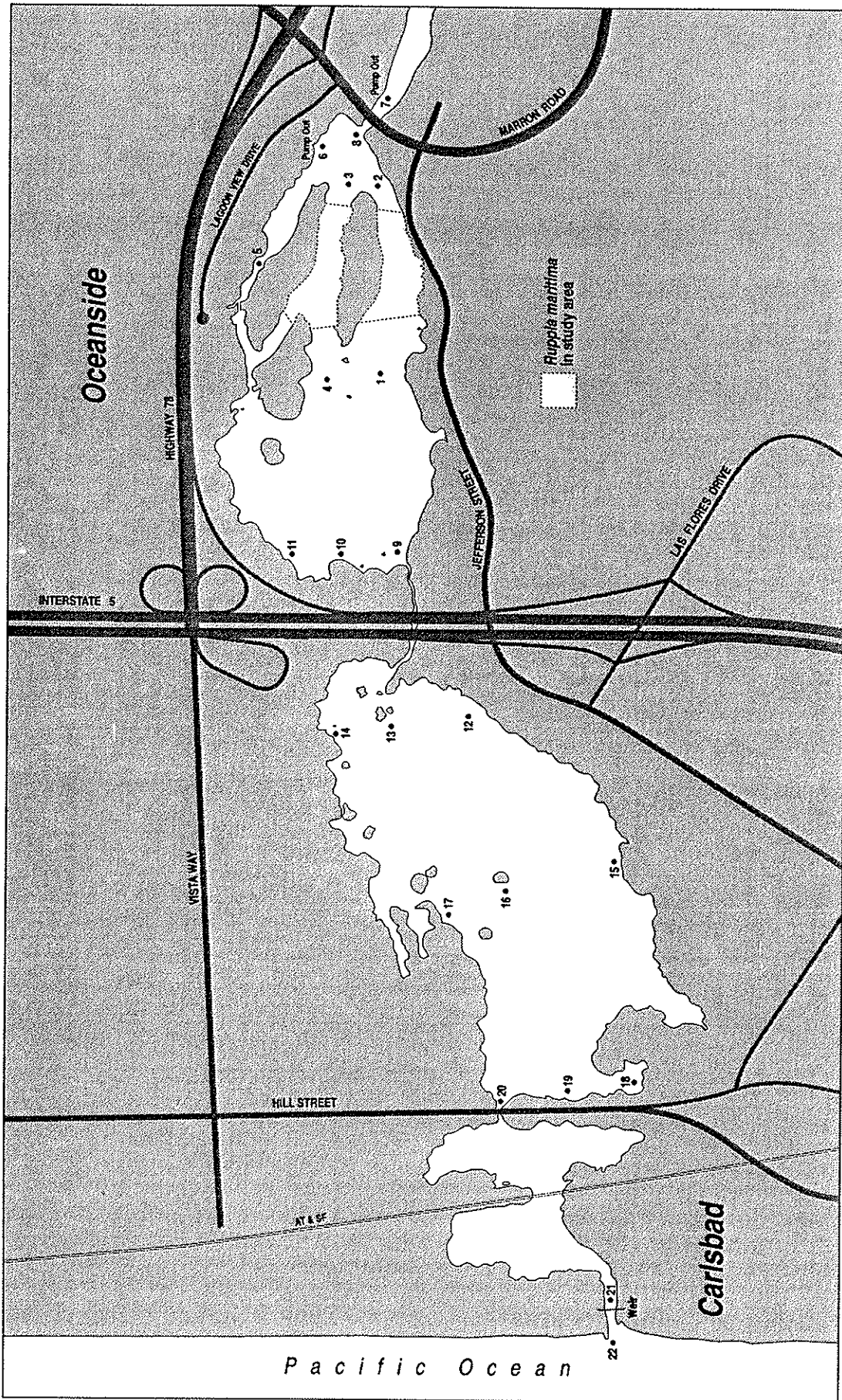


Buena Vista Lagoon

Stations
 August 26, 1994
 1330

Dissolved oxygen at Buena Vista Lagoon, 1330, August 26, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1 Surface	1331	3.0	10.5
1 Bottom	1331	3.0	10.9
3 Surface	1456	5.0	0
3 Bottom	1456	5.0	0
4	1449	1.5	12.2
6	1507	2.0	0
7	1512	3.0	0
8 Surface	1537	12.0	0
8 Midwater	1537	12.0	0
8 Bottom	1537	12.0	0
9	1341	1.0	7.9
10	1353	1.3	8.0
11	1357	0.9	11.3
12 Surface	1515	7.5	0
12 Bottom	1515	7.5	0
13	1403	0.8	8.4
14	1415	0.8	9.6
15	1409	0.8	9.3
16	1431	2.0	0
17	1443	2.3	2.4
18	1527	3.0	6.3
19	1532	1.5	0



Buena Vista Lagoon

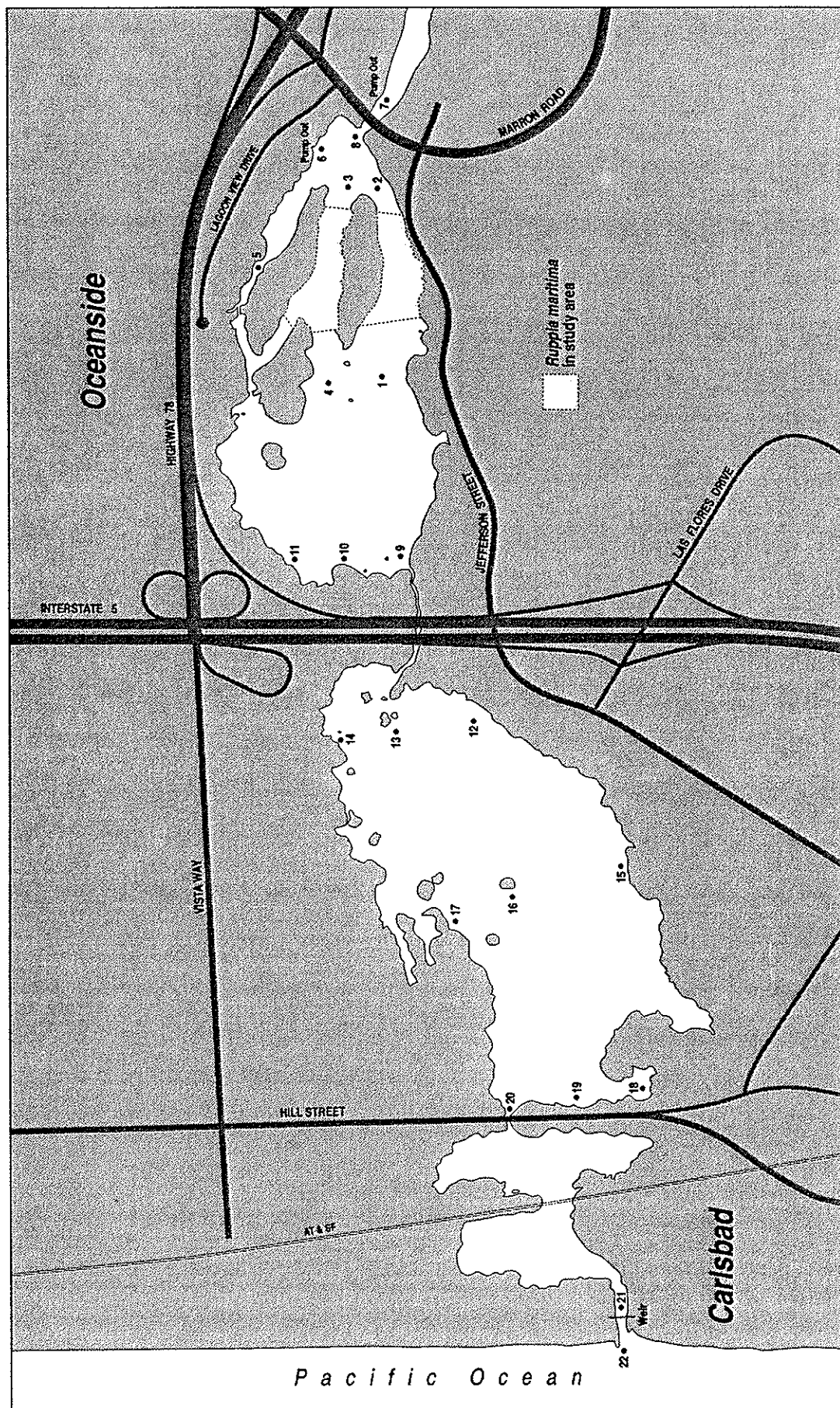
Stations
 August 26, 1994
 1825

Coliforms at Buena Vista Lagoon, 1825, August 26, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	1959	$>1.0 \times 10^5$	100
2	2020	$>8.0 \times 10^5$	8.2×10^5
3	2015	$>8.0 \times 10^5$	7.2×10^5
4	1955	300	160
5	2010	5.1×10^5	5×10^5
6	2012	$>4.1 \times 10^5$	4.1×10^5
7	2022	2.9×10^5	2.5×10^5
8	2026	4.0×10^5	3.7×10^5
9	1935	200	120
10	1940	1.0×10^4	2100
11	1945	2.0×10^4	2800
12	1856	100	90
13	1903	300	300
14	1906	100	60
15	1848	---	0
16	1844	<10	0
17	1840	100	110
18	1830	2.0×10^5	160
19	1825	1.0×10^4	370
20	1834	2.0×10^5	120
21	1735	1.0×10^3	0
22	1737	6.0×10^4	200

Dissolved oxygen at Buena Vista Lagoon, 1825, August 26, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1959	3.0	7.5
2	2020	3.0	0
3	2015	5.0	0
4	1955	1.5	7.9
5	2010	2.5	0
6	2012	7.5	0
7	2022	3.0	0
8	2026	10.0	0
9	1935	0.8	7.3
10	1940	0.8	7.9
11	1945	0.8	8.0
12	1856	3.5	17.4
13	1903	3.5	16.5
14	1906	3.5	9.7
15	1848	3.5	11.2
16	1844	4.0	11.4
17	1840	3.5	5.6
18	1830	2.0	10.0
19	1825	4.0	3.1
20	1834	3.0	18.0
21	1735	2.0	11.6
22	1737	--	7.1



Buena Vista Lagoon

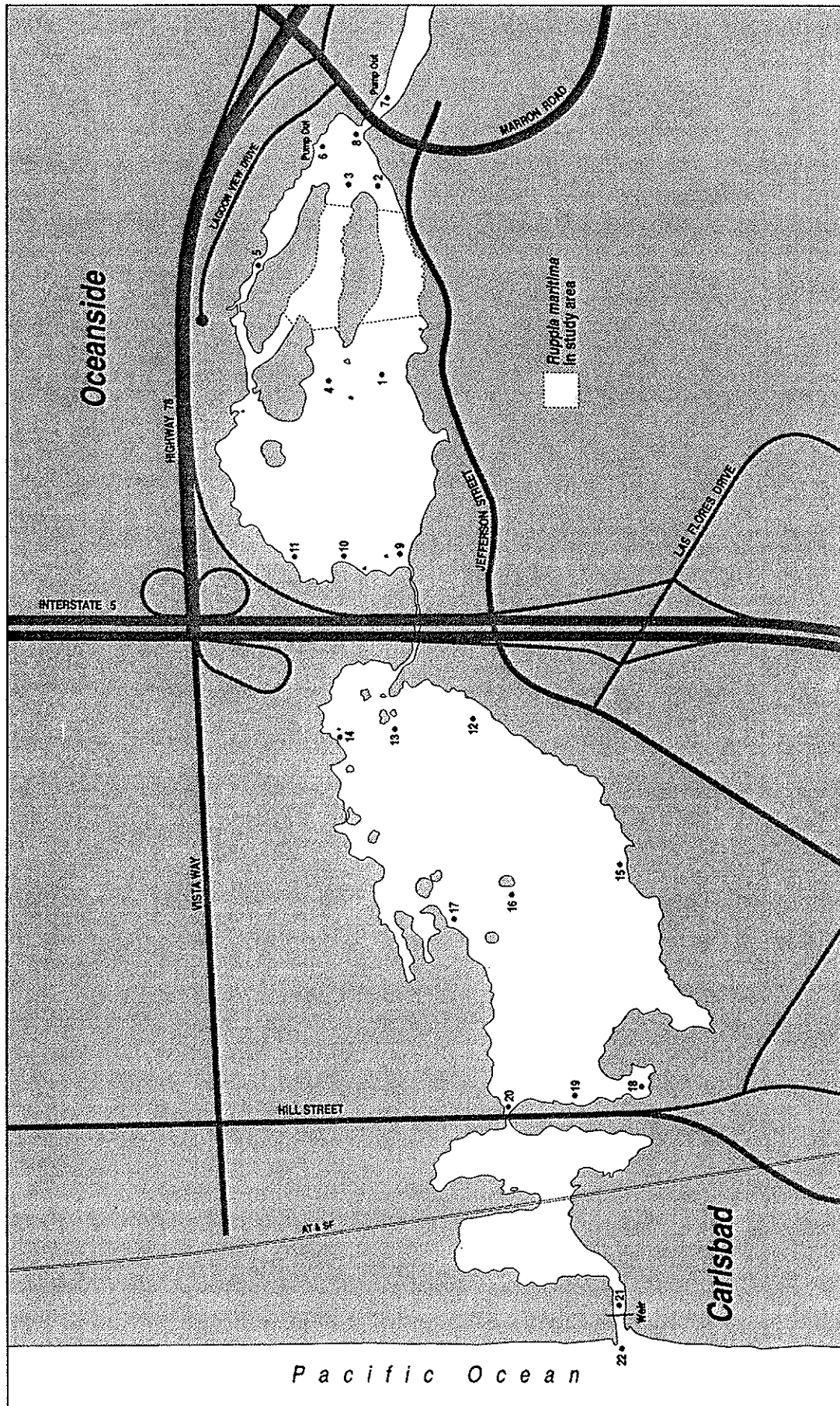
Stations
 August 27, 1994
 0600

Coliforms at Buena Vista Lagoon, 0600, August 27, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	0701	200	210
2	0716	5.0×10^5	5.1×10^5
3	0717	5.0×10^5	4.4×10^5
4	0656	230	230
5	0736	3.3×10^5	1.7×10^5
6	0731	4.7×10^5	3.3×10^5
7	0724	9.6×10^5	3.0×10^5
8	0727	1.7×10^6	5.2×10^5
9	0636	2.0×10^4	1400
10	0642	100	90
11	0645	200	170
12	0902	1.0×10^4	1000
13	0905	1000	20
14	0907	30	30
15	0851	50	50
16	0848	200	190
17	0841	$>1.0 \times 10^5$	60
18	0818	1.0×10^4	9000
19	0822	70	70
20	0827	400	60
21	0943	10	10
22	0950	<10	0

Dissolved oxygen at Buena Vista Lagoon, 0600, August 27, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	0701	1.0	3.6
2	0716	3.0	0
3	0717	5.0	0
4	0656	1.0	1.8
5	0736	4.0	0
6	0731	7.0	0
7	0724	1.3	0
8	0727	10.0	0
9	0636	0.8	1.6
10	0642	0.8	4.1
11	0645	0.8	3.6
12	0902	3.5	0.2
13	0905	3.0	3.2
14	0907	3.0	0
15	0851	4.5	5.6
16	0848	3.0	2.4
17	0841	4.0	0
18	0818	2.0	0.1
19	0822	2.5	0.1
20	0827	4.5	0.1
21	0943	2.0	9.0
22	0950	--	7.1



Buena Vista Lagoon

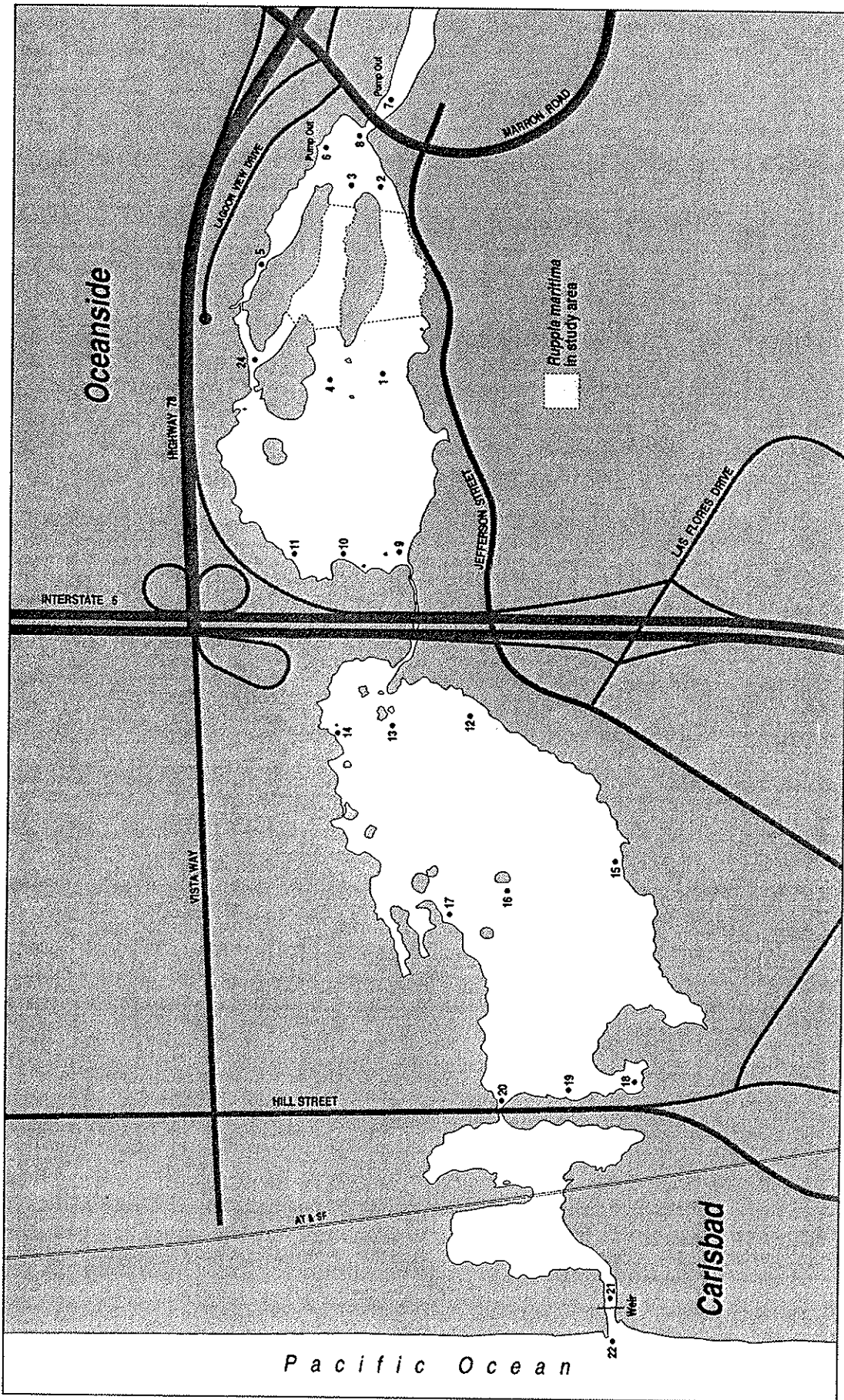
Stations
 August 27, 1994
 1400

Coliforms at Buena Vista Lagoon, 1400, August 27, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	1625	30	30
2	1633	1.6×10^5	8.6×10^4
3	1634	6.0×10^4	7.4×10^4
4	1615	600	670
5	1653	2.6×10^5	7.2×10^4
6	1638	2.2×10^5	8.5×10^4
7	1643	8.0×10^4	6.3×10^4
8	1648	8.0×10^4	9.7×10^4
9	1604	1.0×10^4	6000
10	1607	<10	0
11	1610	100	30
12	1816	30	30
13	1819	<10	0
14	1821	20	20
15	1809	<10	0
16	1803	<10	0
17	1759	<10	0
18	1745	10	10
19	1749	<10	0
20	1752	200	80
21	1410	<10	<10
22	1414	<10	0

Dissolved oxygen at Buena Vista Lagoon, 1400, August 27, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1625	0.9	11.7
2	1633	3.5	0.0
3	1634	4.0	0.0
4A	1615	1.0	12.2
4B	1615	1.0	12.8
4C	1615	1.0	12.7
5	1653	2.0	0.0
6	1638	7.0	0.0
7	1643	1.3	0.0
8	1648	9.0	0.0
9	1604	0.9	7.8
10	1607	0.9	11.3
11	1610	0.3	15.7
12	1816	3.5	14.7
13	1819	3.5	14.6
14	1821	3.0	12.2
15	1809	3.0	8.9
16	1803	3.5	15.2
17	1759	2.5	12.3
18	1745	2.5	15.2
19	1749	2.0	14.6
20	1752	4.0	3.9
21	1410	2.0	11.7
22	1414	--	6.4



Buena Vista Lagoon

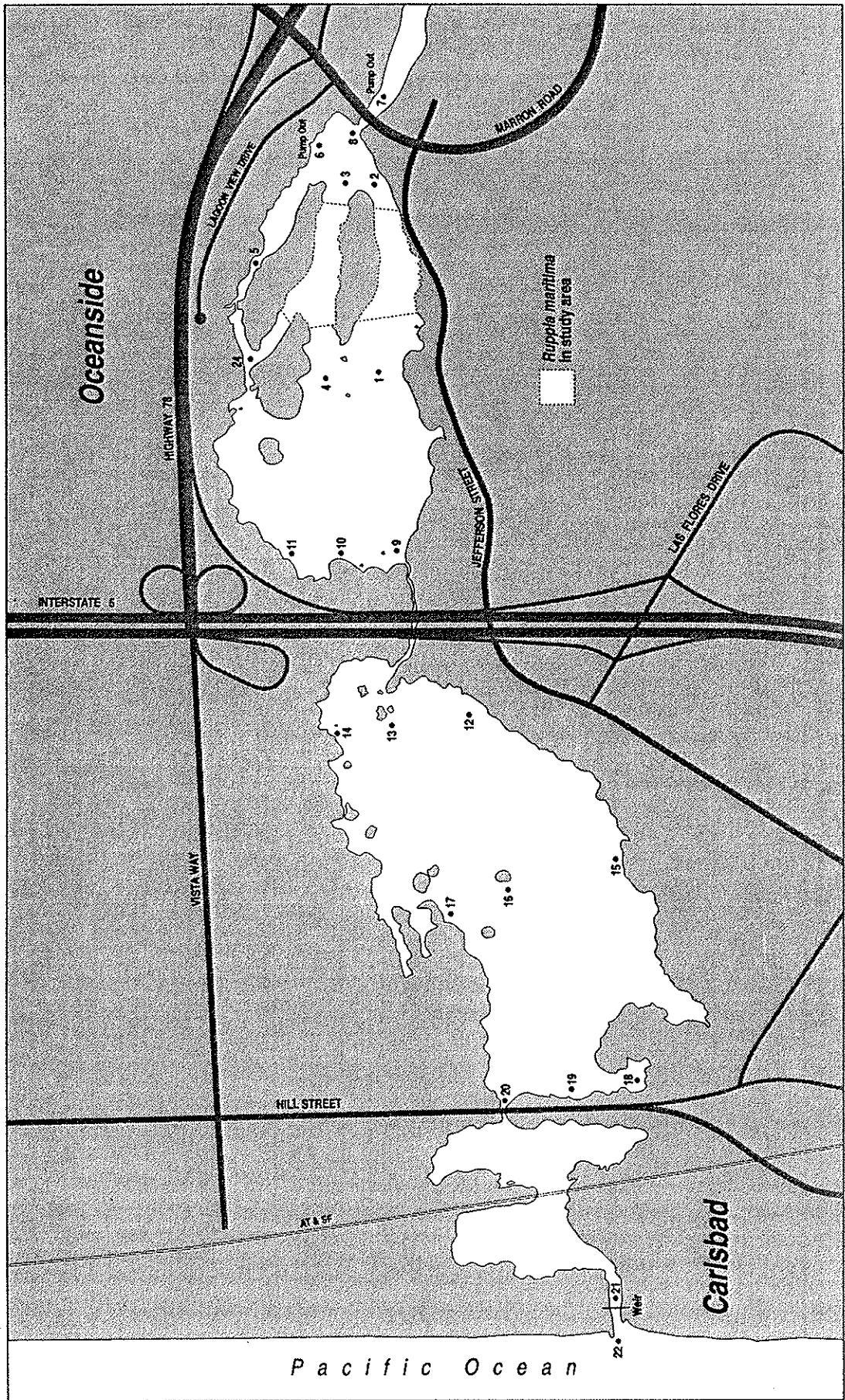
Stations
 August 28, 1994
 0600

Coliforms at Buena Vista Lagoon, 0600, August 28, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	0720	170	160
2	0737	3.0 x 10 ⁵	2.9 x 10 ⁵
3	0740	2.5 x 10 ⁵	2.0 x 10 ⁵
4	0705	120	110
5	0800	2.1 x 10 ⁵	2.0 x 10 ⁵
6	0743	3.2 x 10 ⁵	3.0 x 10 ⁵
7	0750	4.8 x 10 ⁵	4.6 x 10 ⁵
8	0755	6.3 x 10 ⁵	6.0 x 10 ⁵
9	0650	5000	1600
10	0658	100	90
11	0700	200	40
12	0913	2400	20
13	0925	50	<10
14	0930	20	<10
15	0907	20	10
16	0900	20	<10
17	0855	90	80
18	0840	10	10
19	0847	30	30
20	0850	40	10
21	1001	10	<10
22	1006	<10	<10
24	0715	1.3 x 10 ⁵	1.2 x 10 ⁵

Dissolved oxygen at Buena Vista Lagoon, 0600, August 28, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	0720	0.7	5.0
2	0737	3.3	0.0
3	0740	6.5	0.0
4	0705	0.9	4.0
5	0800	2.0	0.0
6	0743	0.7	0.0
7	0750	1.2	0.0
8	0755	9.5	0.0
9	0650	1.0	2.3
10	0658	1.0	2.6
11	0700	0.5	4.2
12A	0913	3.8	12.2
12B	0913	3.8	11.6
12C	0913	3.8	12.8
13	0925	3.7	7.0
14	0930	2.7	1.8
15	0907	4.0	1.9
16	0900	4.0	6.2
17	0855	3.6	0.3
18	0840	2.2	0.0
19	0847	2.5	0.7
20	0850	4.0	0.8
21	1001	2.0	9.0
22	1006	2.0	7.1
24	0715	2.3	0.0



Buena Vista Lagoon

Stations
 August 28, 1994
 1330

Coliforms at Buena Vista Lagoon, 1330, August 28, 1994.
Values are mpn/100ml.

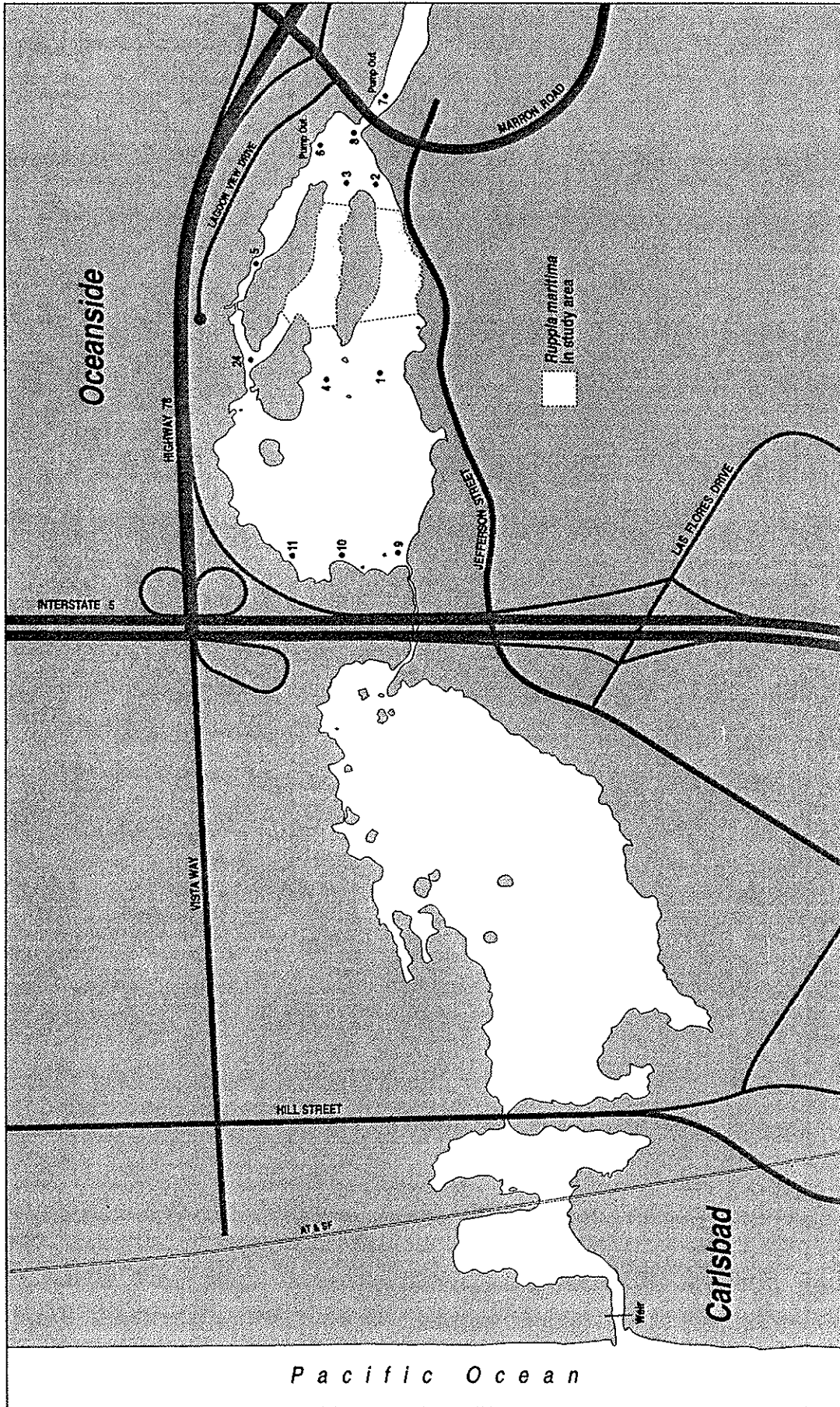
STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	1430	100	100
2	1457	2.3 x 10 ⁵	2.3 x 10 ⁵
3	1500	1.6 x 10 ⁵	1.6 x 10 ⁵
4	1423	10	10
5	1517	1.7 x 10 ⁵	1.7 x 10 ⁵
6	1502	2.1 x 10 ⁵	2.0 x 10 ⁵
7	1506	7.0 x 10 ⁴	6.0 x 10 ⁴
8	1511	1.0 x 10 ⁵	9.0 x 10 ⁴
9	1333	200	200
10	1340	30	30
11	1344	<10	<10
12	1639	10	<10
13	1643	<10	<10
14	1647	<10	<10
15	1633	<10	<10
16	1627	<10	<10
17	1623	20	<10
18	1607	<10	<10
19	1613	10	10
20	1617	10	10
21	1711	<10	<10
22	1718	<10	<10
24	1352	2.0 x 10 ⁴	2.0 x 10 ⁴

Dissolved oxygen at Buena Vista Lagoon, 1330, August 28, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1430	0.8	15.6
2	1457	3.0	0
3	1500	4.0	0
4	1423	1.0	15.7
5	1517	2.0	0
6	1502	7.0	0
7	1506	1.0	0
8	1511	11.0	0
9	1333	1.0	7.3
10	1340	0.8	9.2
11	1344	0.8	12.6
12	1639	3.0	15.5
13	1643	3.0	15.3
14	1647	3.5	11.4
15	1633	4.0	12.0
16	1627	3.5	12.2
17	1623	3.0	11.0
18	1607	2.0	10.7
19	1613	2.5	10.3
20	1617	4.5	5.8
21	1711	2.0	11.8
22	1718	--	6.9
24A	1352	2.0	2.7
24B	1352	2.0	3.1
24C	1352	2.0	1.9

**Surface temperature and salinity at Buena Vista Lagoon,
1330, August 28, 1994.**

STATION	TEMPERATURE (°C)	SALINITY (‰)
1	30	3
2	29	2
3	30	2
4	31	3
5	25	1
6	30	2
7	28	2
8	29	1
9	29	3
10	29	3
11	30	3
12	29	2.5
13	28	3
14	29	3
15	29	2.5
16	31	3
17	28	2
18	27	2
19	26	2
20	27	2
21	28	4
22	25	35
24	31	2



Buena Vista Lagoon

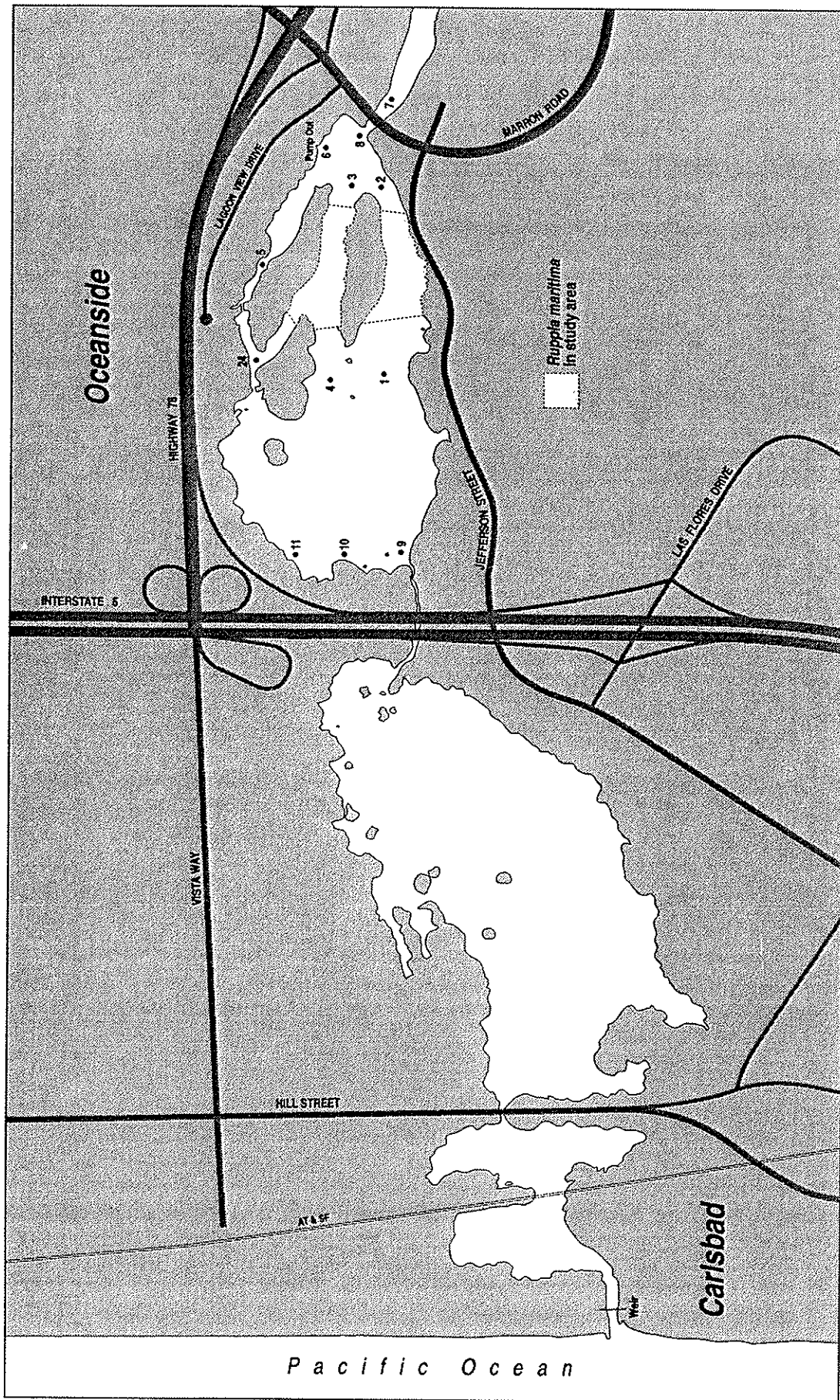
Stations
 August 29, 1994
 1500

Coliforms at Buena Vista Lagoon, 1500, August 29, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	1522	100	10
2	1531	9×10^4	9000
3	1532	9×10^4	8000
4	1520	100	10
5	1537	1.7×10^5	8000
6	1534	5×10^4	5000
7	1544	1.5×10^5	2000
8 Surface	1551	9×10^4	5000
8 Midwater	1551	1.8×10^5	8000
8 Bottom	1551	2.0×10^5	1.7×10^5
9	1500	1000	100
10	1505	<100	<10
11	1508	<100	10
24	1514	4×10^4	3000

Dissolved oxygen at Buena Vista Lagoon, 1500, August 29, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1522	1.0	18.1
2	1531	3.5	2.7
3	1532	4.5	4.4
4	1520	1.2	22.1
5A	1537	2.0	0
5B	1537	2.0	0
5C	1537	2.0	0
6	1534	6.5	0.3
7	1544	1.3	0.2
8 Surface	1551	9.0	1.7
8 Midwater	1551	9.0	0
8 Bottom	1551	9.0	0
9	1500	1.0	6.7
10	1505	1.0	14.6
11	1508	0.7	13.7
24	1514	2.0	11.9



Buena Vista Lagoon

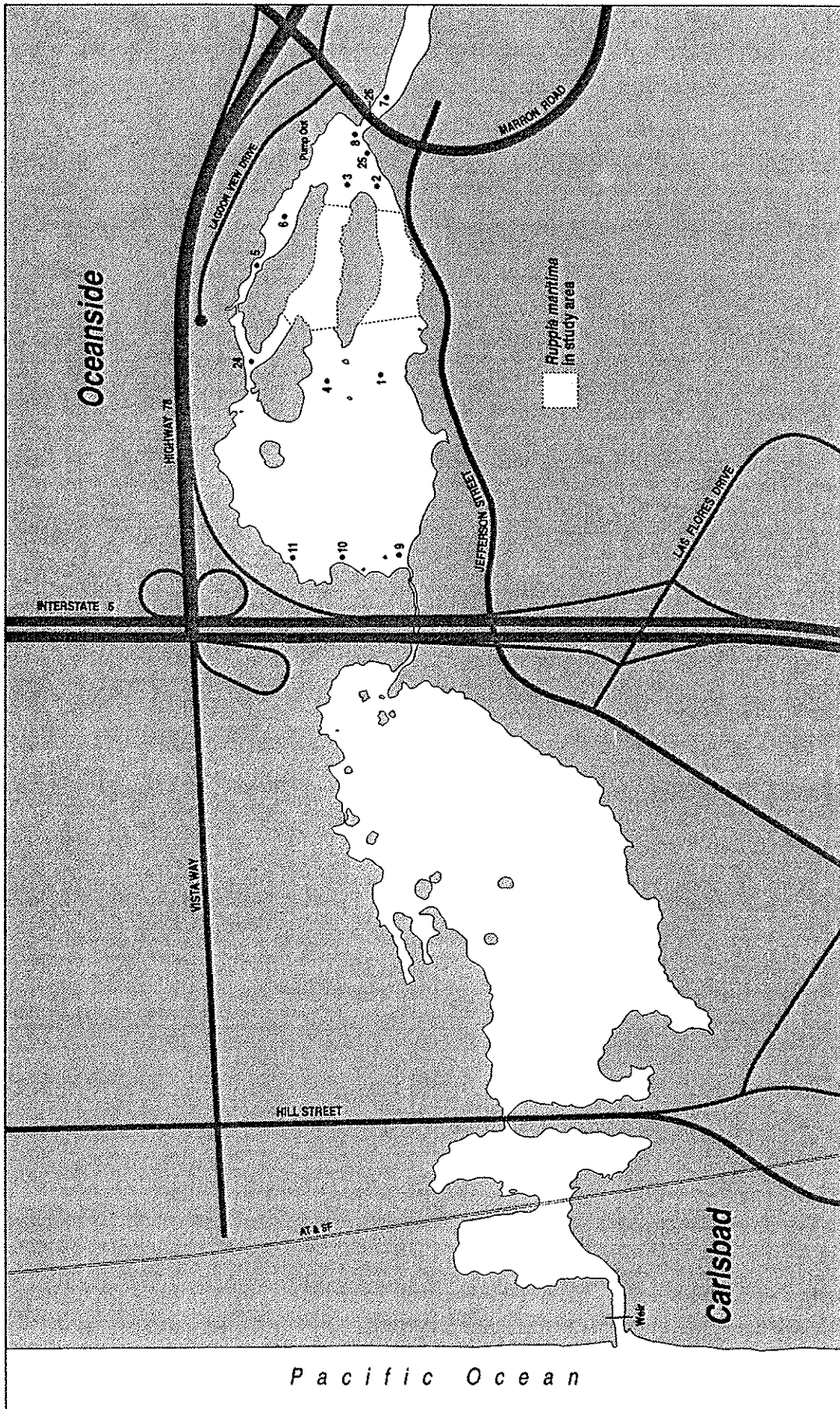
Stations
 August 30, 1994
 0600

Coliforms at Buena Vista Lagoon, 0600, August 30, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	0653	800	190
2	0659	1.0 x 10 ⁵	6000
3	0701	1.0 x 10 ⁵	7800
4	0649	1000	280
5	0708	1.1 x 10 ⁵	7500
6	0702	1.0 x 10 ⁵	9600
7	0714	1.8 x 10 ⁵	2200
8	0716	1.2 x 10 ⁵	1.2 x 10 ⁴
9	0630	200	60
10	0634	100	40
11	0637	650	140
24	0644	1.7 x 10 ⁴	1500

Dissolved oxygen at Buena Vista Lagoon, 0600, August 30, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	0653	0.8	5.2
2	0659	3.5	0
3	0701	5.0	0
4	0649	1.0	2.9
5A	0708	2.0	0
5B	0708	2.0	0
5C	0708	2.0	0
6	0702	6.0	0
7	0714	1.3	0
8	0716	9.0	0
9	0630	0.8	3.7
10	0634	1.0	4.1
11	0637	0.6	2.9
24	0644	2.2	0



Buena Vista Lagoon

Stations
 August 30, 1994
 1330

Coliforms at Buena Vista Lagoon, 1330, August 30, 1994.
Values are mpn/100ml.

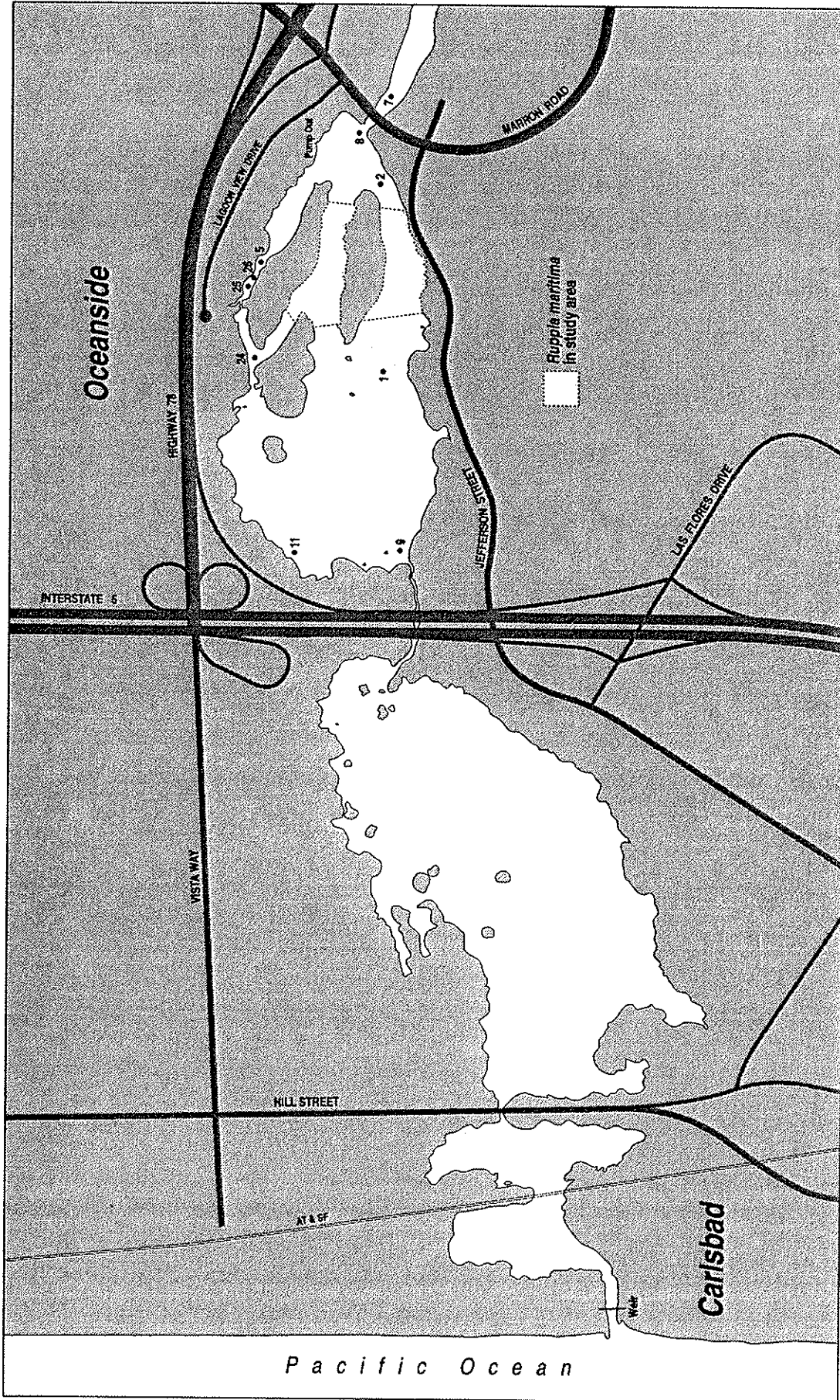
STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
1	1424	100	70
2	1437	9.0 x 10 ⁴	3500
3	1439	8.0 x 10 ⁴	5400
4	1421	1000	10
5	1449	4.6 x 10 ⁴	5300
6	1451	9.0 x 10 ⁴	4000
7	1458	1.0 x 10 ⁵	1800
8	1502	4.5 x 10 ⁴	2500
9	1350	200	70
10	1359	100	20
11	1402	<10	<10
24	1410	4500	2500
25	1442	7.0 x 10 ⁴	5000
26	1504	8.2 x 10 ⁴	6500

Dissolved oxygen at Buena Vista Lagoon, 1330, August 30, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1424	0.8	14.8
2	1437	4.0	3.5
3	1439	5.0	2.7
4	1421	1.0	15.7
5	1449	1.0	0
6	1451	2.7	2.5
7	1458	1.2	4.6
8	1502	9.0	9.0
9A	1350	0.8	6.9
9B	1350	0.8	7.0
9C	1350	0.8	7.1
10	1359	1.0	14.8
11	1402	0.7	17.0
24	1410	4.0	11.7
25	1442	3.0	4.0
26	1504	1.5	3.9

**Surface temperature and salinity at Buena Vista Lagoon,
1330, August 30, 1994.**

STATION	TEMPERATURE (° C)	SALINITY (‰)
1	25	3
2	24	2
3	24	2
4	25	2.5
5	23	2
6	21	2
7	23	2
8	25	2
9	24	3.5
10	25	3.5
11	26	3.5
24	24	2.5



Buena Vista Lagoon

Stations
August 31, 1994
1330

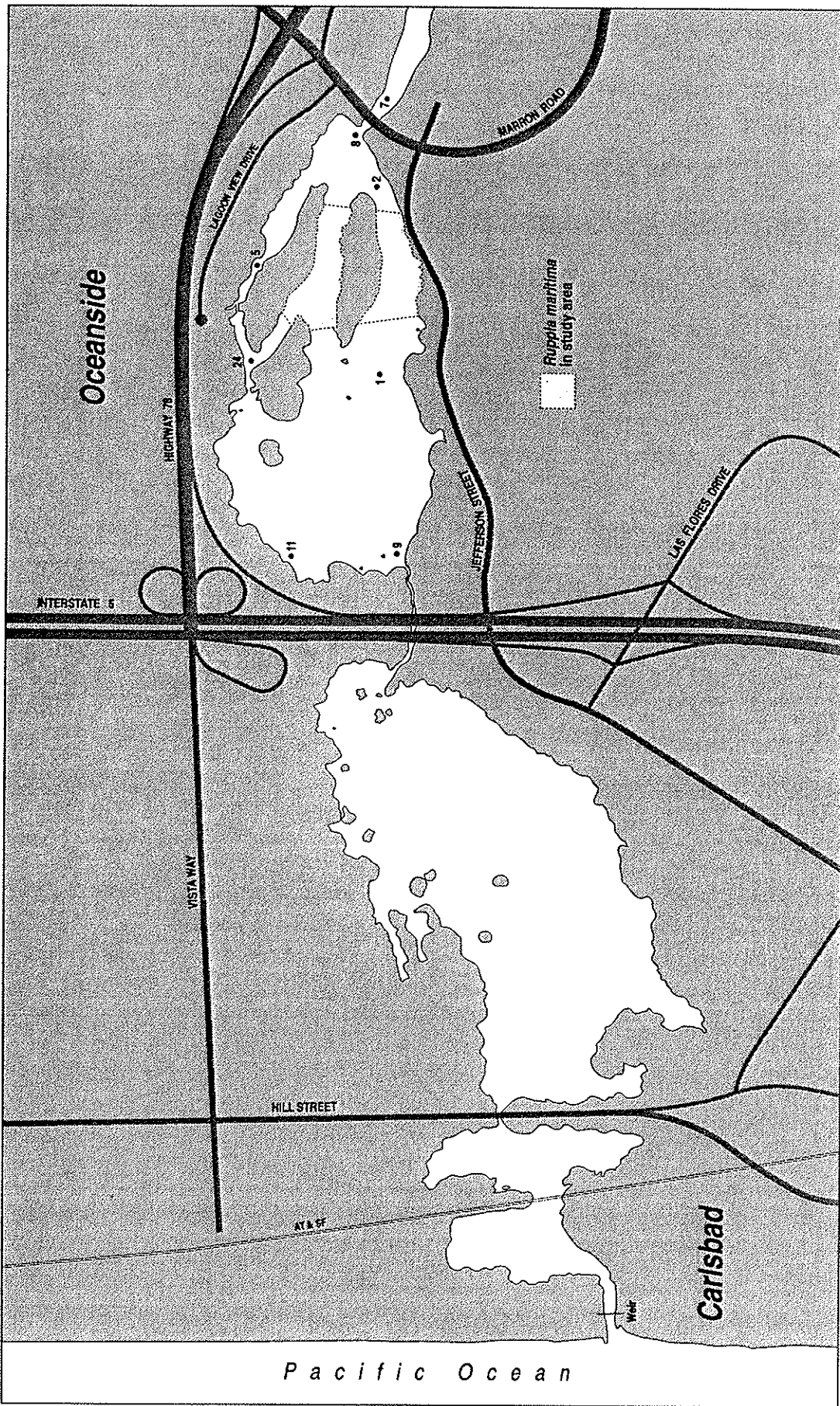
Coliforms at Buena Vista Lagoon, 1330, August 31, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
2	1432	1.7×10^4	1400
5	1438	1.7×10^4	1850
7	1448	8000	700
8 Surface	1455	1.9×10^4	1400
8 Bottom	1455	5.3×10^4 *	2.0×10^4
24	1415	200	170

* Milky white turbidity, with solvent odor.

Dissolved oxygen at Buena Vista Lagoon, 1330, August 31, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1424	0.8	12.4
2	1432	6.0	5.9
5	1438	2.0	10.5
7A	1448	1.2	7.5
7B	1448	1.2	11.7
7C	1448	1.2	7.1
8 Surface	1455	11.0	8.4
8 Bottom	1455	11.0	0
9	1357	0.8	11.5
11	1409	0.6	18.1
24	1415	2.0	13.5
25	1440	2.0	3.9
26	1443	2.0	9.3



Buena Vista Lagoon

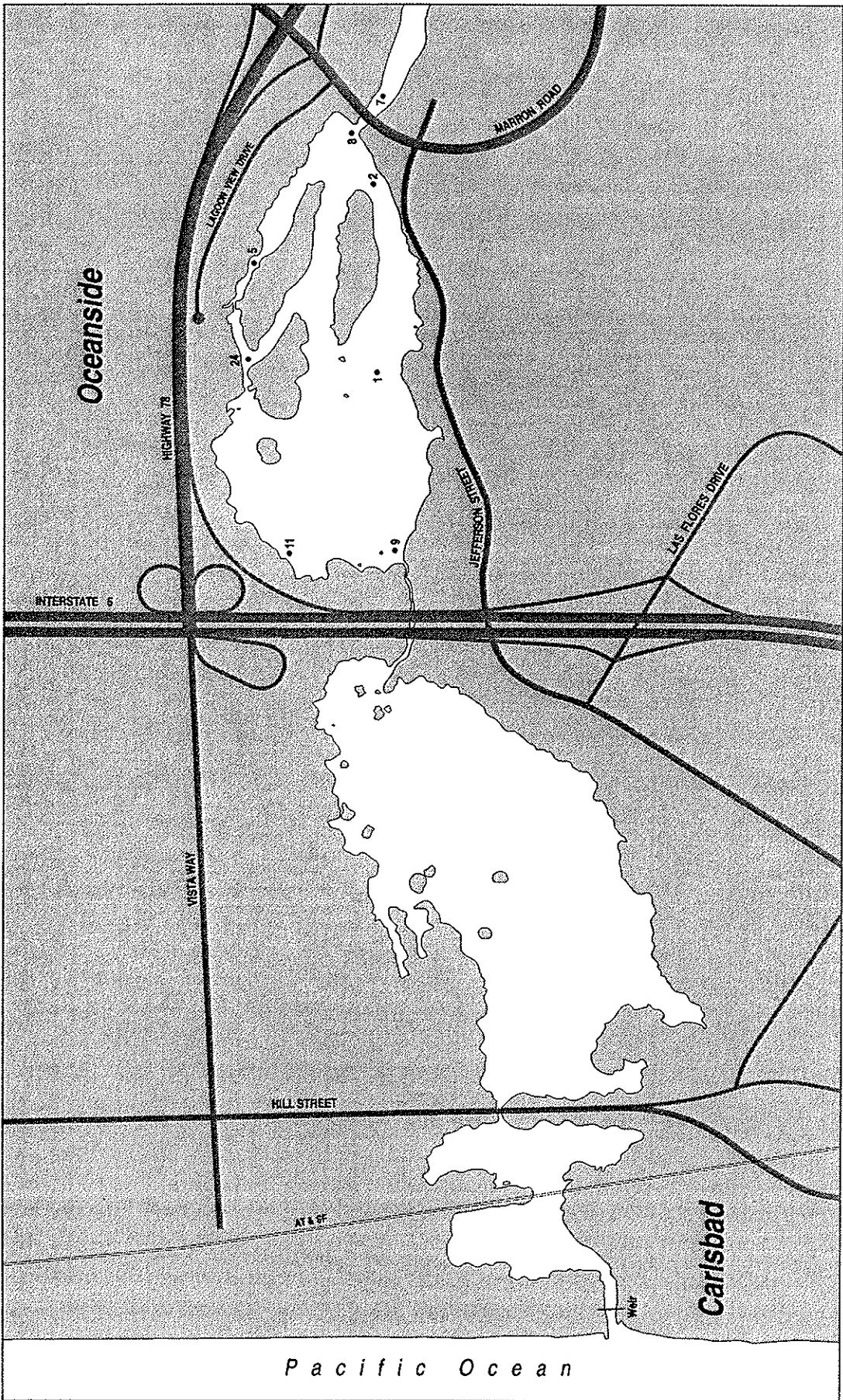
Stations
 September 1, 1994
 1330

Coliforms at Buena Vista Lagoon, 1330, September 1, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
2 Surface	1421	4000	6000
2 Bottom	1421	1.5 x 10 ⁴	1700
5	1429	4000	700
7	1435	7000	1100
8 Surface	1440	3500	400
8 Midwater	1440	7000	1000
8 Bottom	1440	7500	3000
24	1401	100	90

Dissolved oxygen at Buena Vista Lagoon, 1330, September 1, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1413	0.8	13.3
2 Surface A	1421	4.0	9.5
2 Surface B	1421	4.0	9.5
2 Bottom	1421	4.0	6.1
5	1429	2.0	14.2
7	1435	1.3	8.2
8 Surface	1440	11.0	15.6
8 Midwater	1440	11.0	0.3
8 Bottom	1440	11.0	0.0
9	1352	1.0	12.6
11	1356	0.8	16.8
24	1401	2.0	15.5

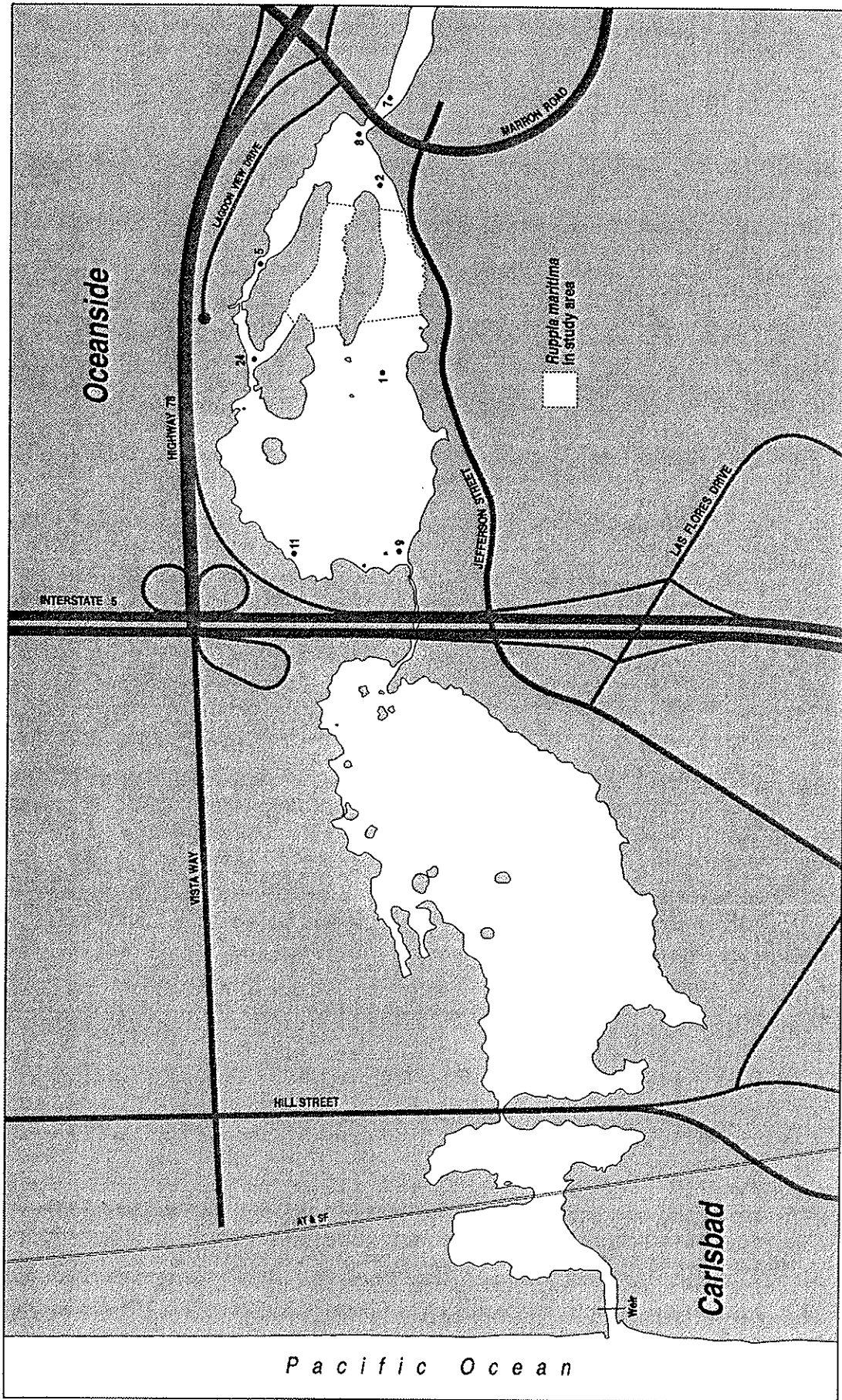


Buena Vista Lagoon

Stations
September 2, 1994
0630

Dissolved oxygen at Buena Vista Lagoon, 0630, September 2, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	0657	0.7	4.1
2	0702	6.0	5.3
5	0706	2.0	4.9
7	0713	1.3	0.4
8 Surface A	0717	11.6	5.9
8 Surface B	0717	11.6	5.9
8 Midwater	0717	11.6	5.5
8 Bottom	0717	11.6	0
9	0635	0.8	5.5
11	0640	0.6	4.6
24	0647	2.0	4.5



Buena Vista Lagoon

Stations
 September 2, 1994
 1315

Coliforms at Buena Vista Lagoon, 1315, September 2, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
2	1350	1000	200
5	1355	2500	380
7	1400	3.0×10^4	600
8 Surface	1407	2000	400
8 Midwater	1407	3000	600
8 Bottom	1407	7500	2000
24	1329	200	200

Dissolved oxygen at Buena Vista Lagoon, 1315, September 2, 1994.

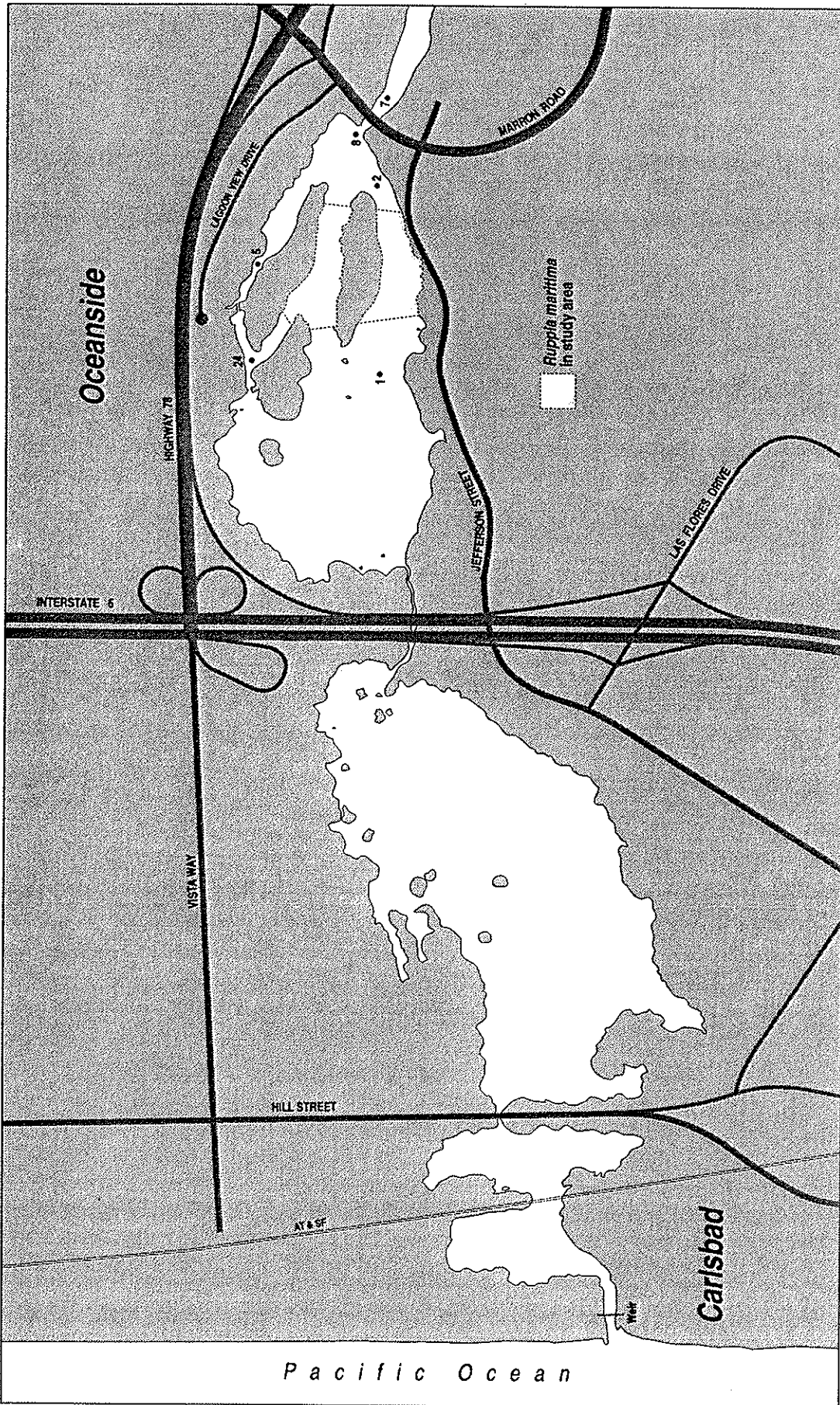
STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1339	0.7	13.7
2	1350	4.0	16.0
5	1355	2.0	17.8
7	1400	1.3	10.0
8 Surface	1407	11.5	21.8
8 Midwater	1407	11.5	0
8 Bottom	1407	11.5	0
9	1318	0.8	12.9
11	1323	0.8	13.0
24A	1329	2.0	15.5
24B	1329	2.0	16.1

**Surface temperature and salinity at Buena Vista Lagoon,
1315, September 2, 1994.**

STATION	TEMPERATURE (°C)	SALINITY (‰)
1	26	3
2	24	2
5	24	2
7	23	2
8	25	2
9	26	3
11	24	3
24	24	2

Biochemical oxygen demand (BOD), chlorophyll-a, and Total Kjeldahl Nitrogen (TKN) at Buena Vista Lagoon, 1315, September 2, 1994.

STATION	TIME	BOD (mg/l)	CHLOROPHYLL-a (mg/m³)	TKN (mg/l)
1	1339	12	18	3.1
2	1350	14	269	3.0
5	1355	15	282	4.1
7	1400	9	121	2.4
8 Surface	1407	13	299	2.8
8 Midwater	1407	14	160	3.9
8 Bottom	1407	200	29	4.3
9	1318	7	27	4.5
11	1323	7	22	0.1
24A	1329	14	254	4.0
24B	1329	14	203	3.1



Buena Vista Lagoon

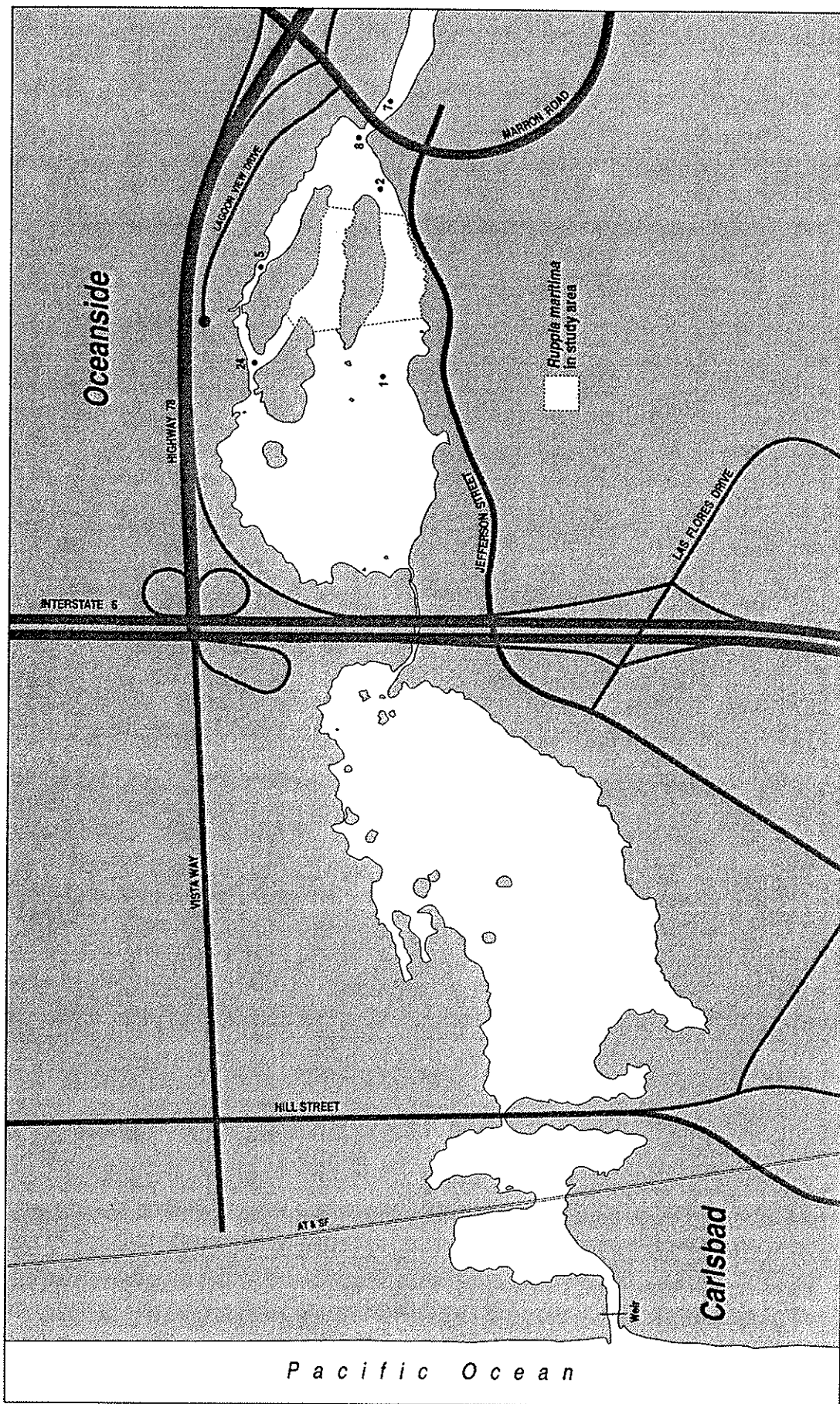
Stations
 September 4, 1994
 1330

Coliforms at Buena Vista Lagoon, 1330, September 4, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
2	1417	800	110
5	1421	500	200
7	1428	3.8×10^4	280
8 Surface	1429	900	150
8 Midwater	1429	7000	500
8 Bottom	1429	1.1×10^4	300
24	1402	100	100

Dissolved oxygen at Buena Vista Lagoon, 1330, September 4, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1410	0.8	12.8
2	1417	3.5	22.9
5	1421	2.0	21.2
7	1428	1.3	14.8
8 Midwater	1429	11.0	5.2
8 Bottom	1429	11.0	0
24	1402	1.6	21.2



Buena Vista Lagoon

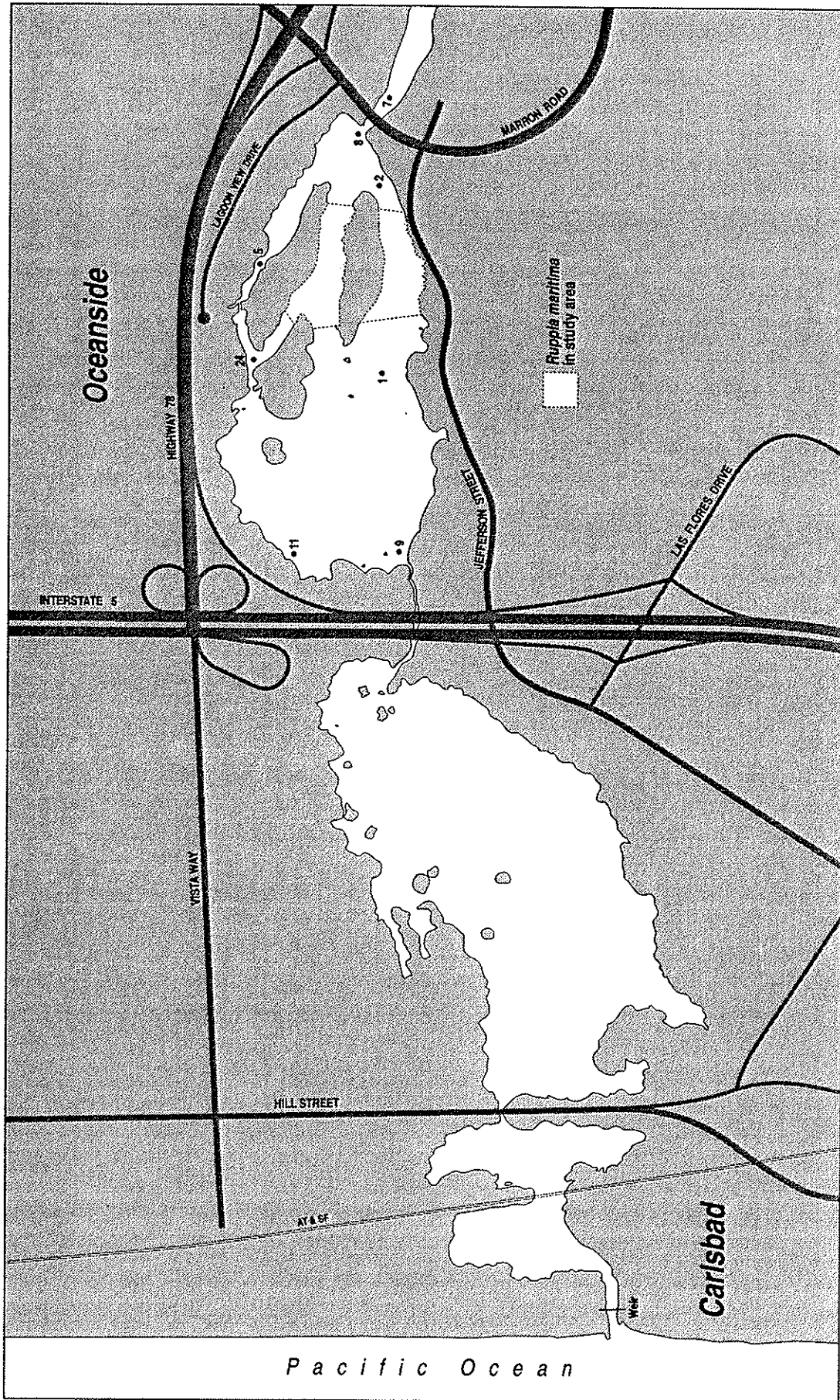
Stations
 September 6, 1994
 1330

Coliforms at Buena Vista Lagoon, 1330, September 6, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
2	1423	300	100
5	1426	1000	100
7	1430	2.3×10^4	300
8 Surface	1436	1000	40
8 Midwater	1436	1800	210
8 Bottom	1436	1700	190
24	1408	200	160

Dissolved oxygen at Buena Vista Lagoon, 1330, September 6, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1415	0.8	13.8
2	1423	3.5	8.9
5	1426	2.0	8.4
7	1430	1.2	8.7
8 Surface	1436	13.0	8.4
8 Midwater	1436	13.0	7.3
8 Bottom	1436	13.0	0
24A	1408	2.2	4.2
24B	1408	2.2	4.5



Buena Vista Lagoon

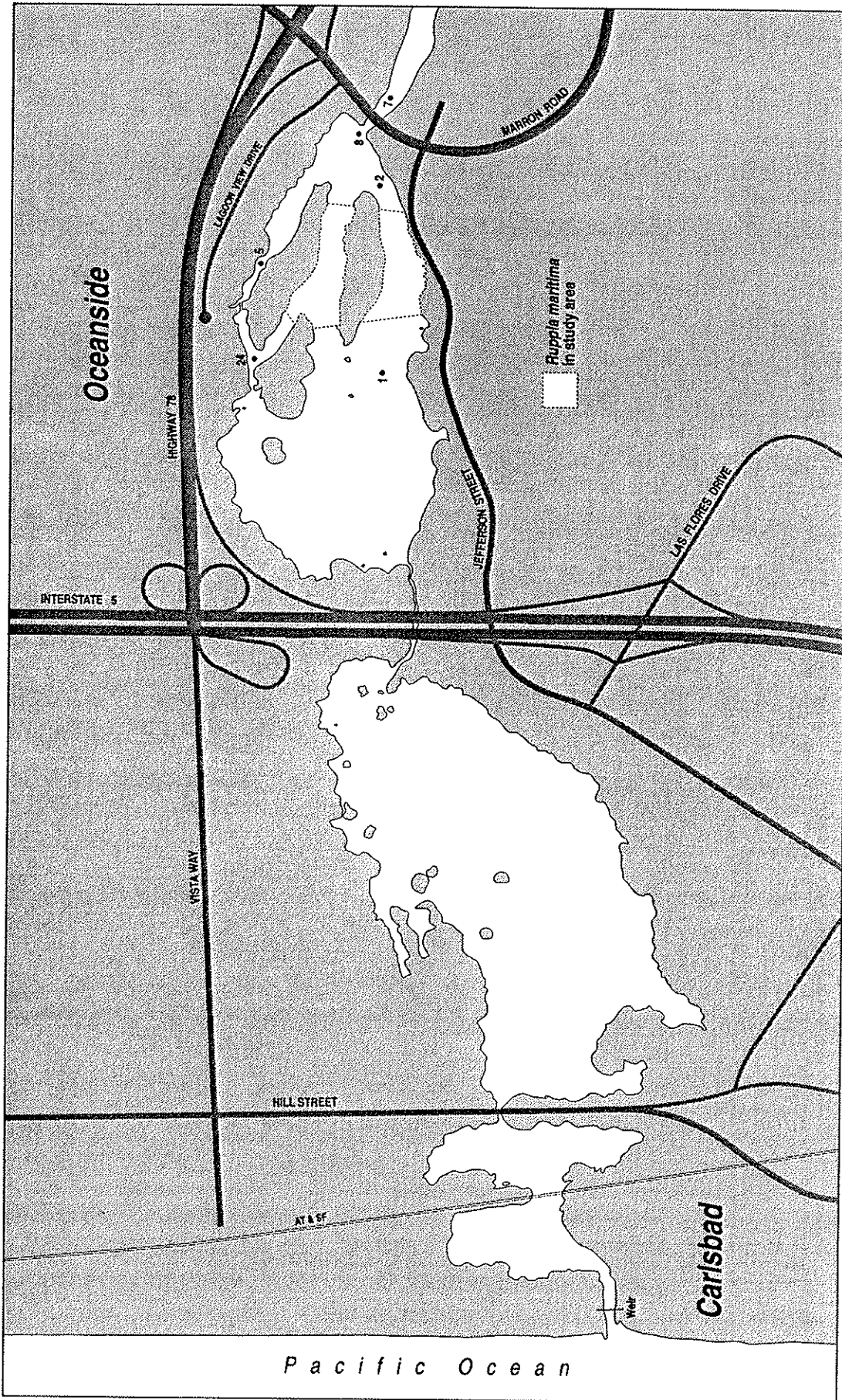
Stations
September 8, 1994
1330

Coliforms at Buena Vista Lagoon, 1330, September 8, 1994.
Values are mpn/100ml.

STATION	TIME	TOTAL COLIFORMS	FECAL COLIFORMS
2	1410	300	80
5	1414	400	290
7	1422	9000	400
8 Surface	1431	200	90
8 Midwater	1431	4100	230
8 Bottom	1431	<100	20
24	1355	100	100

Dissolved oxygen at Buena Vista Lagoon, 1330, September 8, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1400	0.9	12.6
2A	1410	6.4	12.9
2B	1410	6.4	12.2
5	1414	2.9	11.6
7	1422	1.3	9.2
8 Surface	1431	11.5	13.2
8 Midwater	1431	11.5	2.5
8 Bottom	1431	11.5	0
9	1340	1.0	7.4
11	1345	0.8	12.3
24	1355	2.2	7.9

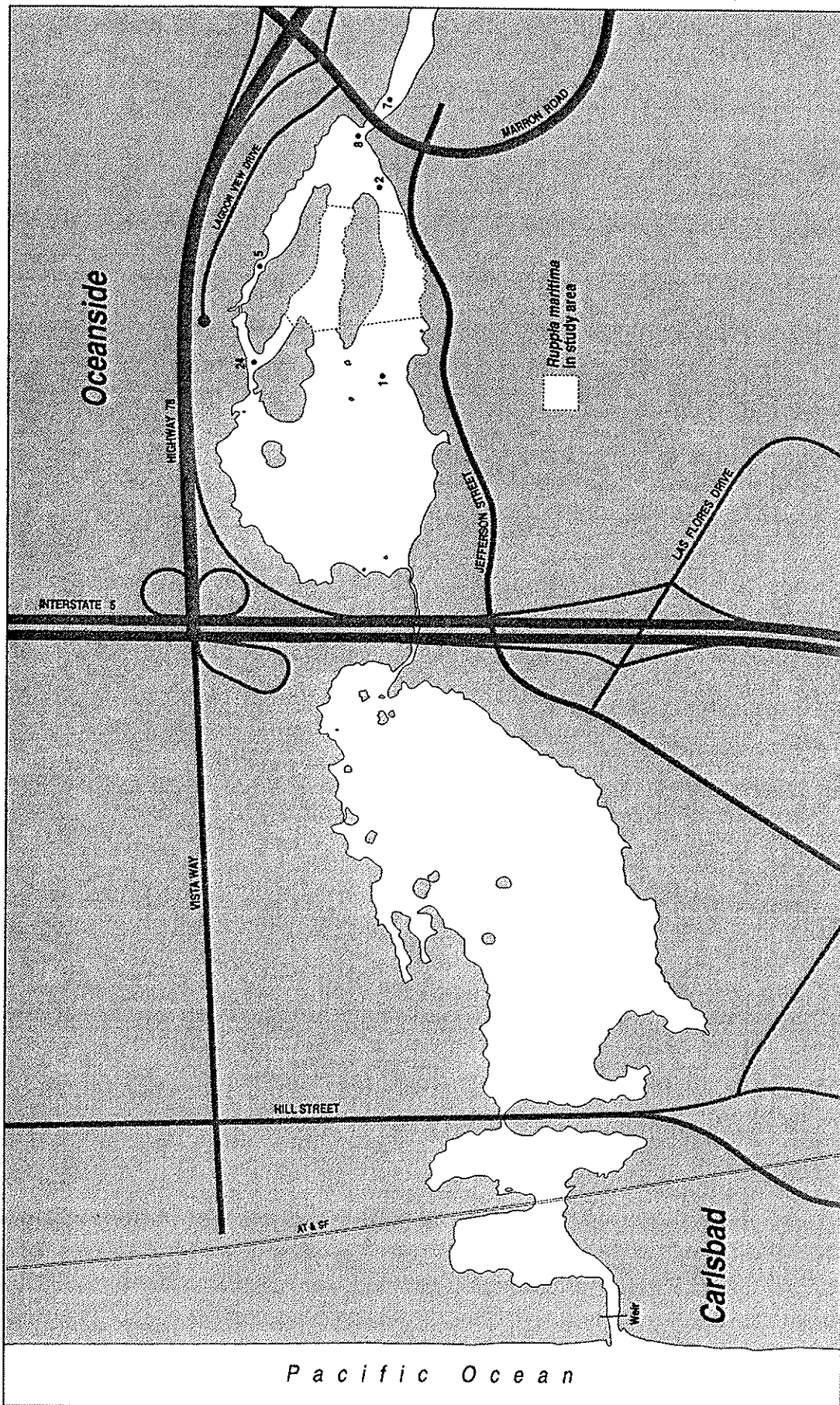


Buena Vista Lagoon

Stations
 September 12, 1994
 1330

Dissolved oxygen at Buena Vista Lagoon, 1330, September 12, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1A	1352	0.9	12.7
1B	1352	0.9	12.8
2	1400	7.3	8.4
5	1406	2.3	9.8
7	1413	1.3	8.8
8 Surface	1420	12.0	9.5
8 Midwater	1420	12.0	4.1
8 Bottom	1420	12.0	0
24	1343	2.5	5.7



Buena Vista Lagoon

Stations
 September 16, 1994
 1415

Dissolved oxygen at Buena Vista Lagoon, 1415, September 16, 1994.

STATION	TIME	DEPTH (ft.)	DISSOLVED OXYGEN (mg/l)
1	1421	0.6	13.0
2	1425	5.6	17.3
5A	1432	2.0	14.8
5B	1432	2.0	13.4
7	1440	1.2	11.8
8 Surface	1442	12.7	15.2
8 Midwater	1442	12.7	0.03
8 Bottom	1442	12.7	0
24	1415	1.8	10.9

PRELIMINARY

EMERGENCY ENVIRONMENTAL RESPONSE
SUMMARY REPORT
APRIL 2007 BUENA VISTA FORCE MAIN RUPTURE
BUENA VISTA LAGOON, CARLSBAD, CA

Prepared for:

City of Vista
600 Eucalyptus Avenue
Vista, CA 92084

and

City of Carlsbad
1635 Faraday Avenue
Carlsbad, CA 92008

Prepared by:

Merkel & Associates, Inc.
5434 Ruffin Road
San Diego, CA 92123
Phone: (858) 560-5465
Fax: (858) 560-7779

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete as of the dates referenced. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.



Keith Merkel, Principal Consultant

April 23, 2007

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Preliminary
Emergency Environmental Response Summary Report
April 2007 Buena Vista Force Main Rupture
Buena Vista Lagoon, Carlsbad, CA

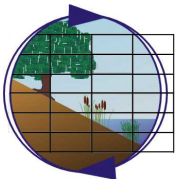
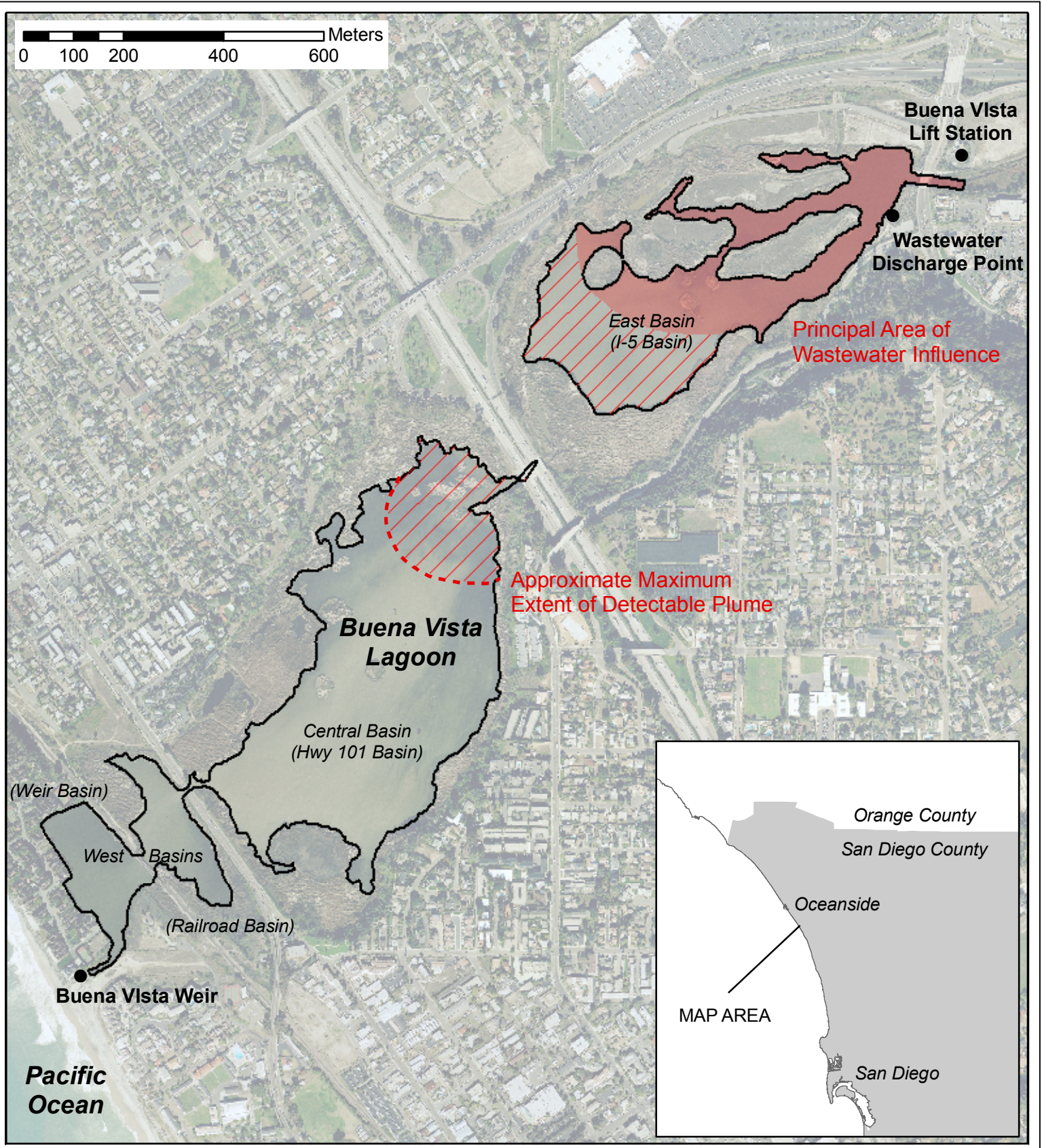
April 2007

INTRODUCTION

Buena Vista Lagoon is located in northern San Diego County on the border between the cities of Oceanside and Carlsbad (Figure 1). The lagoon, more aptly described as a shallow coastal lake, is an approximately 200-acre freshwater system, separated from the Pacific Ocean by an aging weir structure. As such, there is no tidal exchange within the lagoon. The principal hydrologic influence in Buena Vista Lagoon is the inflow of Buena Vista Creek at the easternmost end of the system. The creek is a perennial stream that predominantly drains an urban watershed. Several storm drains discharge to the lagoon along its perimeter. Hydrologic structures at roadway and railroad infrastructure, and the weir at the downstream end of the lagoon, divide the lagoon into four basins. The division into basins has been made even more distinct by the expansion of freshwater marsh over the past two decades that now forms a considerable barrier to water flow and aquatic resource interchange between basins. The basins are generally described by each of the controlling hydrologic features. The eastern basin is termed the I-5 basin, the central basin is termed the Highway 101 basin, the next most westerly basin is termed the railroad basin, and the final basin in the lagoon is termed the weir basin (Figure 1).

Between Saturday, March 31 and approximately 1300 hours on Tuesday, April 3, 2007, a rupture in the 24-inch ductile iron Buena Vista Force Main discharged approximately 7.329 million gallons of untreated sewage into Buena Vista Lagoon near the eastern end of the lagoon. The spill resulted in a primary discharge located at a wildlife viewing area on the south shore of the lagoon approximately 250 feet southwest of the Jefferson Street Bridge. In order to make line repairs, the Buena Vista Lift Station located immediately east of Jefferson Street adjacent to Buena Vista Creek, was shut down and allowed to flood with sewage. After the 1 million gallon containment basin surrounding the pump station filled, the levee around the station overtopped allowing a secondary release into the lagoon while repairs were being made. This discharge was also to the pooled area of the lagoon approximately 130 feet upstream of the Jefferson Street Bridge. The discharge of sewage principally influenced the eastern portions of the I-5 basin and showed some infiltration of the central (Highway 101) basin. Bacteriological testing evidence indicates that the plume did not reach Highway 101 or further downstream areas.

Repairs were made to the force main and the spill was stopped at 1300 hours on April 3, 2007.



Incident Area Map
Buena Vista Sewer Force Main Discharge
April 2007

Figure 1