

Town of Dartmouth, Massachusetts
Board of Public Works

DRAFT

SUPPLEMENT TO
FACILITY PLAN FOR
ULTIMATE DISPOSAL
ALTERNATIVES
(APPENDIX I)



July, 1988

Fay, Spofford & Thorndike, Inc.
Engineers

Environmental Data Report

SUPPLEMENT TO FACILITY PLAN

Prepared for:

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SUMMARY

Environmental analyses were conducted for the following parameters in support of the request for an expansion of the Town of Dartmouth wastewater treatment plant capacity from 2.0 mgd to 4.2 mgd with ocean discharge. The ocean discharge for the Dartmouth treatment facility is located in Buzzards Bay approximately 3,000 feet south of Salters Point.

- Hydrographics
- Water Quality
- Dispersion Analysis
- Sludge Quality
- Sediment Analyses
- Marine Resources

Analyses reported herein were conducted in keeping with requirements of the Massachusetts Department of Environmental Quality Engineering (DEQE). Such requirements stipulate that existing physical, chemical, and biological conditions be documented at the site of a present and/or alternative outfall, and, that modelling be conducted to determine the level of impact at the outfall location and to make appropriate adjustments in design to avoid adverse water quality degradation.

Hydrographic measurements were conducted utilizing current meters, drogue, and dye tracking techniques. Current meter data indicated higher

current speeds at the surface (also with greater scatter) and tidal velocities decreased with depth. Tidal currents predominate with a variation of approximately 6 cm/s. Dye tracking from the present outfall was found to parallel the shoreline, while remaining offshore, with maximum ebb and flood tide velocities of 58.5 cm/s and 64 cm/s respectively. Drogue tracking at the alternative outfall location resulted in the finding of local anomalies. Deeper local current reversals may be present in that on October 4, 1985 currents travelled in a direction opposite to that of the flood tide direction..

Water quality monitoring was conducted to determine conditions within the Zone of Initial Dilution (ZID), areas downstream of the present outfall, the location of the alternative outfall, and a control station.

Analyses included field determinations of dissolved oxygen, temperature, specific conductance, and pH. Stratified samples were collected for laboratory analyses of nutrients, redox parameters, metals, and pesticides. All analyses indicated water quality conditions within the ZID to be relatively unaffected by the present discharge and no anomalies were found at the other locations. Detailed measurements for dissolved oxygen and salinity were conducted within the ZID to assist in the near field analyses. These investigations resulted in the finding that near field impacts

from the existing 2.0 mgd discharge are limited only to a minor degree to an area within 100 feet of the outfall boil. BOD, suspended solids, nutrients, metals, and pesticide concentrations were found to be extremely low within the ZID and met Class SB water quality criteria.

Analyses were also conducted on the treated effluent quality. Concentrations of residual chlorine were also monitored at the wastewater treatment plant and the transition manhole where the system converts from pressure to gravity flow to the outfall. These analyses indicated a 3 fold reduction of residual chlorine between the treatment plant and the closest point for sampling to the outfall.

Utilizing the above data, detailed plume dispersion modelling of the present outfall and proposed future discharge was conducted. Under the proposed expansion, surface BOD concentrations were computed to be lower than background under a 30 mg/l BOD load. Far field BOD modelling indicated that less than 30 acres at the present outfall location would be impacted by BOD concentrations of approximately 0.03 mg/l. These concentrations are extremely low, are calculable only, and cannot be determined in the field.

Dissolved oxygen deficits were so low that computations conducted at a BOD load one order of magnitude higher (300 mg/l) than proposed (30 mg/l) resulted in a deficit of 0.02 mg/l.

Dispersion analyses at the alternative outfall indicated that while additional dilution and dispersion would be achieved at that location, based on water quality, there is no reason to relocate the outfall. Likewise, there was no reason found to change the configuration of the outfall itself from one port to multiple ports.

In order to evaluate impacts to shellfish beds at both the present and alternative outfall locations, a worse case analysis of coliform bacteria distribution was conducted. Under this scenario, total failure of the treatment plant was simulated, without chlorination, at the proposed expansion flow of 4.2 mgd. Both fecal coliform and total coliform bacteria were analysed. The analyses indicated potential dispersion of fecal coliform and total coliform bacteria from Slocums Neck through Round Hill. The conservativeness of these analyses is illustrated by the excellent operating record of the treatment plant. When the secondary treatment level has failed chlorination still continues. Treatment plant reports indicate that under this condition fecal coliform bacteria concentrations in the effluent were 322/100 ml. Using this value in the model the area of impact was found to be restricted to the immediate area around the outfall. The bacteriological analyses indicated there is no benefit to water quality to be gained by moving to the alternative outfall location.

Analyses were also conducted to determine the quality of sludge from the Dartmouth facility. Data indicate that, overall, the sludge would be categorized as Type III as copper and molybdenum concentrations were found to be above the Type II limits.

Sampling and bulk chemical analyses of marine sediments were also conducted. All sediments were found to be uncontaminated (under the DEQE Classification System) and are Category I. No impacts to the quality of sediment were found as a result of the operation of the present outfall.

Analyses were also conducted to determine the quality of marine resources within the area of the present outfall as well as the alternative outfall. Information on shellfish resources were collected from published data, interviews with the Dartmouth Shellfish Warden; and field sampling via biological dredge, SCUBA, and commercial hydraulic dredge to determine density of shellfish beds. No tissue analyses were conducted. At the present and alternative outfall locations, beds of quahog were found.

The density of the beds is lower at the present outfall than they are at the alternative outfall because of restricted bottom habitat due to rock. Commercial harvesting takes place at the alternative outfall location but is legally prohibited at the present outfall.

Although such a decision would await confirmatory testing after the new treatment plant is operating, it appears that the shellfish closure area around the present outfall could be conditionally open in the future.

The marine benthic community was found to be quite diverse, with polychaete worms being the dominant species.

CONCLUSIONS

As a result of these studies on the Dartmouth wastewater treatment facility and outfall, the following conclusions have been reached:

1. Tidal currents at the present outfall combine with the good effluent quality to yield a minimal impact on the water quality within the ZID. Based on dissolved oxygen and specific conductance measurements, the limit of impact to surface and deeper waters was found to be within 100 feet of the outfall.
2. No impacts to the quality of water within the ZID was found to be attributable to metals or pesticides.
3. Residual chlorine was found to decay three fold between the Dartmouth treatment plant and the closest sampling point to the outfall.
4. An increase of discharge volume from 2.0 to 4.2 mgd was found not to contribute to a measurable impact on BOD or dissolved oxygen. Furthermore, any physical alteration to the configuration of the present outfall via a diffuser was not found to be necessary, nor was it found to be necessary to relocate the outfall to the alternative site in deeper water further into Buzzards Bay.
5. Based on analyses of marine sediments at the present outfall location, an expansion to 4.2 mgd is not expected to result in a

deterioration of sediment quality. Additionally, there is no need for underwater construction which would result in a disturbance of sediments.

6. The shellfish beds in the vicinity of the present outfall are within a shellfish closure area. As such, they cannot be harvested as protection to public health in the event of a treatment plant failure. Therefore, expansion of the discharge volume at the present site will not result in any alteration or impact to existing quahog beds. However, in the location of the alternative outfall, quahog beds are commercially harvested. Should the outfall be relocated to the alternative site, these shellfish beds would be closed to harvesting as a protective measure. Even if the beds closer to the present outfall were to be opened, their replacement value is not at all comparable to that of the beds near the alternative outfall site due to a less than optimal bottom substrate. Based on bacteriological impacts to shellfish, the operational history of the treatment facility, improved design, and shellfish data, a future smaller and conditional closure area around the present outfall may be possible.
7. Marine benthic resources (with the exception of harvestable quantities of shellfish) at either location are not expected to suffer adverse impacts from operation of an expanded outfall,

as dilution and good effluent quality do not produce an adverse impact to water or sediment quality. Although further construction or modification of underwater utilities is considered to be unwarranted, construction of a diffuser and/or alternative outfall would result in a temporary impact to bottom marine resources.

1.0

INTRODUCTION

This report has been prepared for FAY SPOFFORD & THORNDIKE, INC. by JASON M. CORTELL and ASSOCIATES INC. (JMCA). Subconsultants to JMCA included Ocean Surveys, Inc. for hydrographic measurements and Applied Science Associates, Inc. for plume dispersion and coliform bacteria modeling.

The tasks for the oceanographic work was prepared in consultation with Fay, Spofford & Thorndike, Inc. and the Massachusetts Division of Water Pollution Control (DWPC). The scope of work included:

- Review of Existing Data
- Preparation of a field sampling and analysis plan
- Review of the plan with DWPC and make appropriate revisions.
- Conduct hydrographic measurements with current meters, drogues, and dye.
- Conduct benthic macroinvertebrate sampling
- Conduct shellfish sampling
- Conduct water quality monitoring
- Measure residual chlorine
- Conduct bulk sediment analyses
- Conduct plume dispersion modeling
- Conduct coliform bacteria modeling

The sampling stations to be utilized in the study are shown in Figure 1-1. The following tabulation indicates which stations were sampled for each specific area of investigation.

Water quality monitoring - Stations 1, 2,
5, 6, 7, 13, and POTW

Bulk sediment analyses - Stations 1, 2,
3, 7, 10, 11, 13, 14, and 15

Benthic macroinvertebrates - Stations 1, 2,
3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13

Stations 1, 2, 3, 4, 5, and 6 are within the Zone
of Initial Dilution (ZID). Station 7 is the
Alternative outfall location and Station 13 is
the Control.

Data that was reviewed and agencies with whom
contact was made included:

Dartmouth Facilities Plan

Water Quality Management Plan

New Bedford Section 301(h) Waiver
Application

Massachusetts Division of Water
Pollution Control

Massachusetts Office of Coastal
Zone Management

Massachusetts Division of Marine Fisheries
U.S. Environmental Protection Agency
Woods Hole Oceanographic Institution
Southeastern Massachusetts University

2.0

HYDROGRAPHICS

While there were no existing site specific data for tidal currents at the present or alternative outfall locations, hydrographic data from the New Bedford Facilities Plan were found useful and were applied to this project.

Hydrography in the project area was measured through a series of current meter measurements, drogue studies, and dye dispersion tracking. JMCA contracted Ocean Surveys Inc. (OSI) to conduct the current meter measurements and drogue studies. The data resulting from this work was incorporated into the water quality modeling and was also used to compare findings in other parameters such as sediment quality and water quality.

2.1 Current Meter Measurements

An array of current meters was deployed at the location of the proposed alternative outfall. The array consisted of three Endeco Type 105 current meters which were attached to a mooring line at depths of -10ft. (mlw), -25ft. (mlw), and 10 feet off the ocean bottom (total water depth was 40 ft. mlw). The mooring consisted of a 30 inch diameter steel spherical surface buoy, a 44 pound subsurface buoyancy float, a 3/8 inch wire rope mooring line, 700 pound steel anchor, and a 40 pound Danforth anchor. The current meters were deployed for a 30 day period starting on August 26, 1986 and retrieved on September 26, 1986. Retrieval was made just before Hurricane Gloria passed through the area. The data therefore does not contain any unusual events.

August 16 are attributable to the faster wind speed and onshore wind direction. The uneven speeds between observations is attributed to the effect of eddies and other tidal local anomalies as tidal current flow is not laminar.

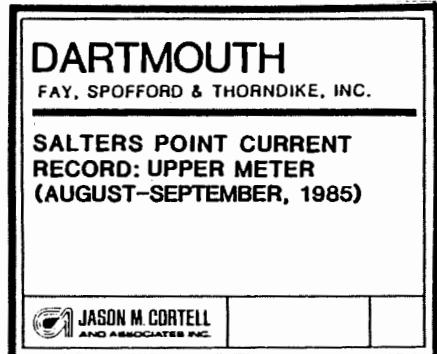
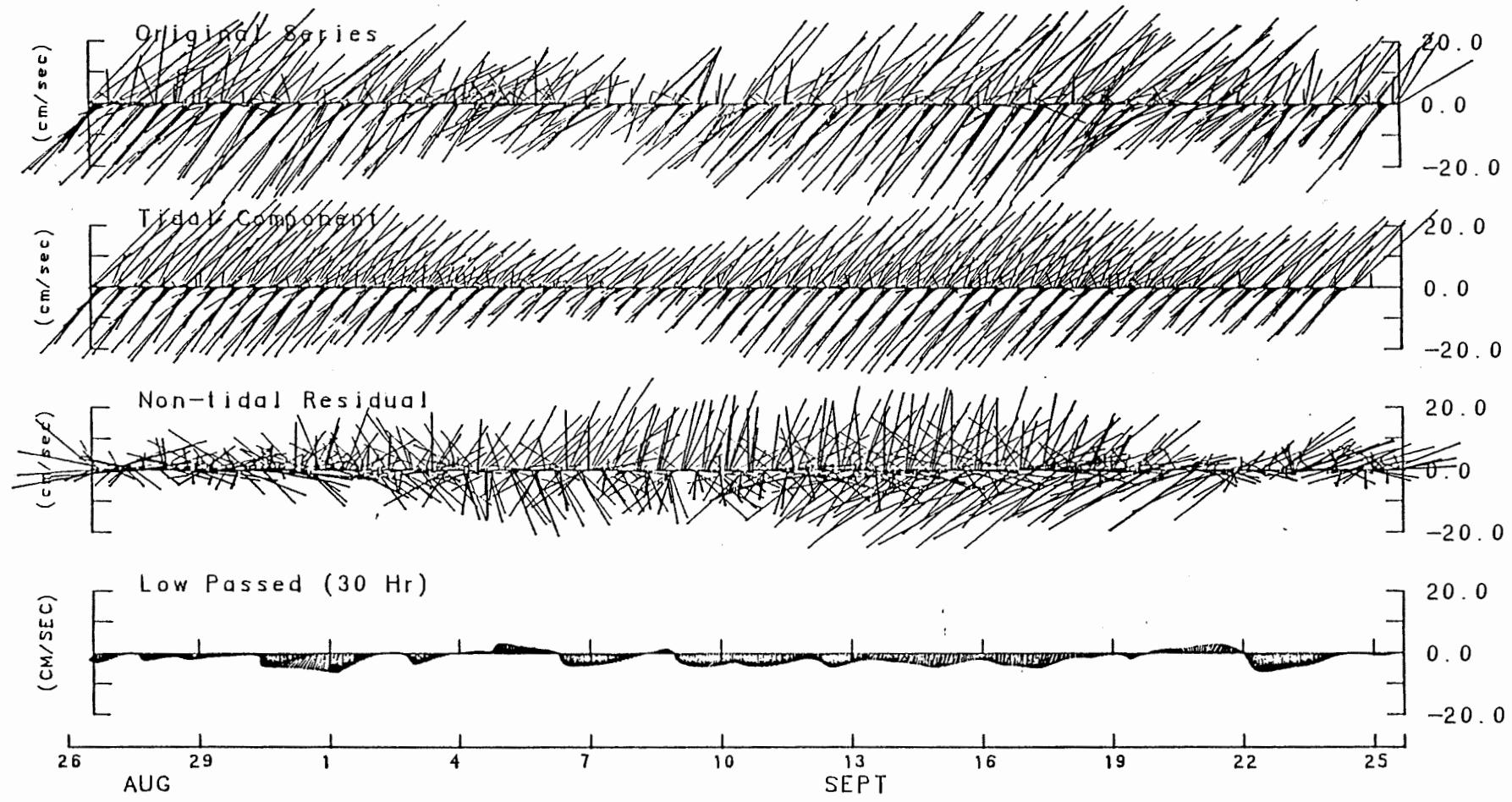


Figure 2-1

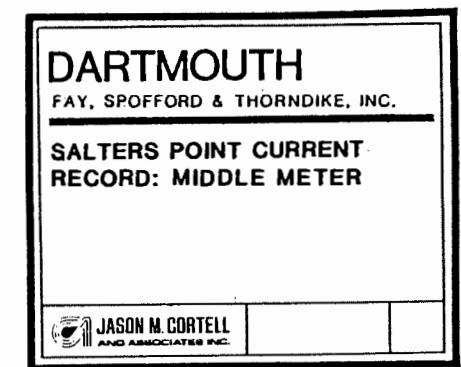
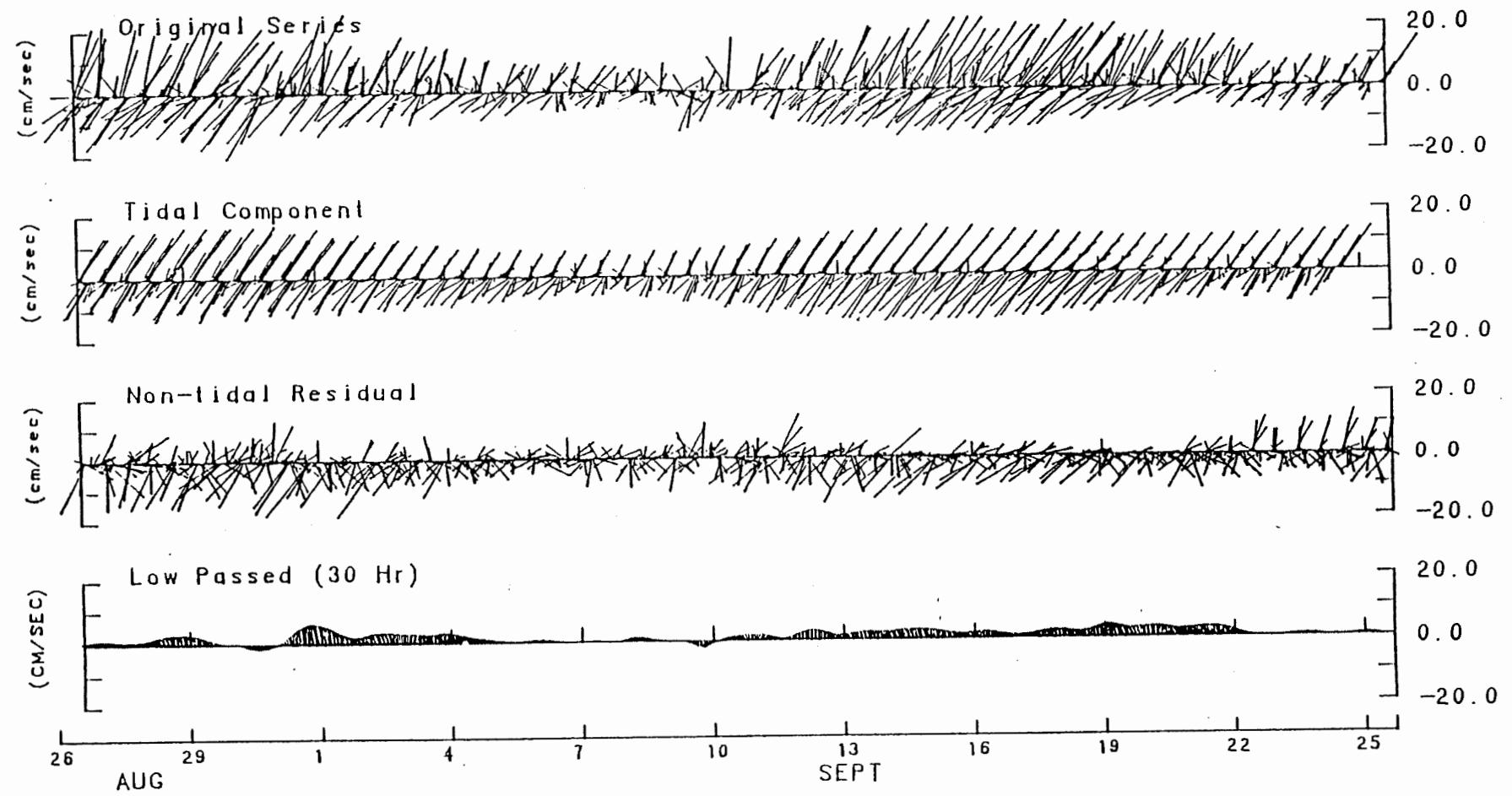


Figure 2-2

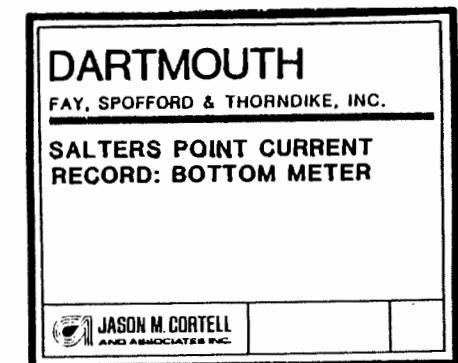
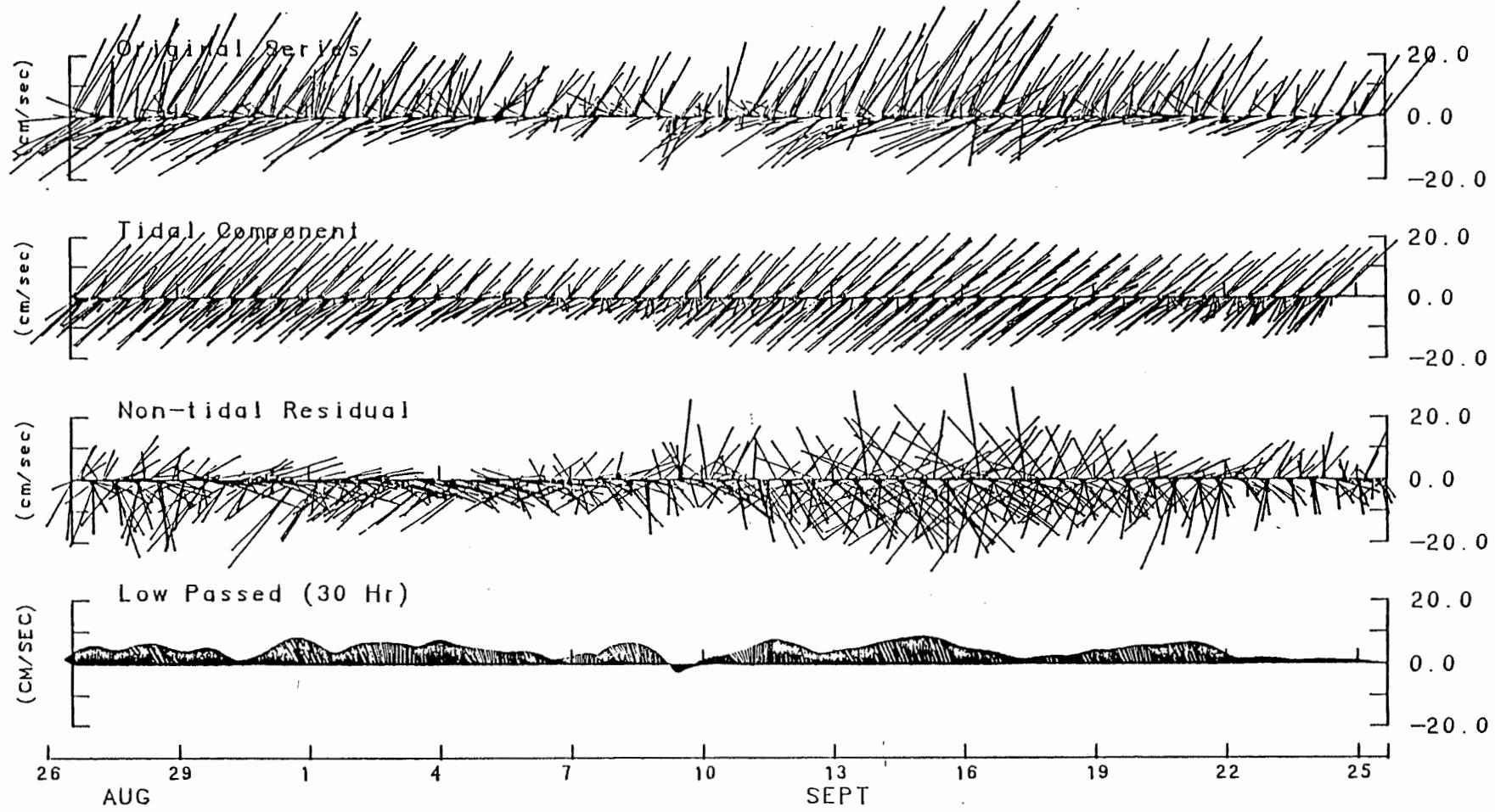


Figure 2-3

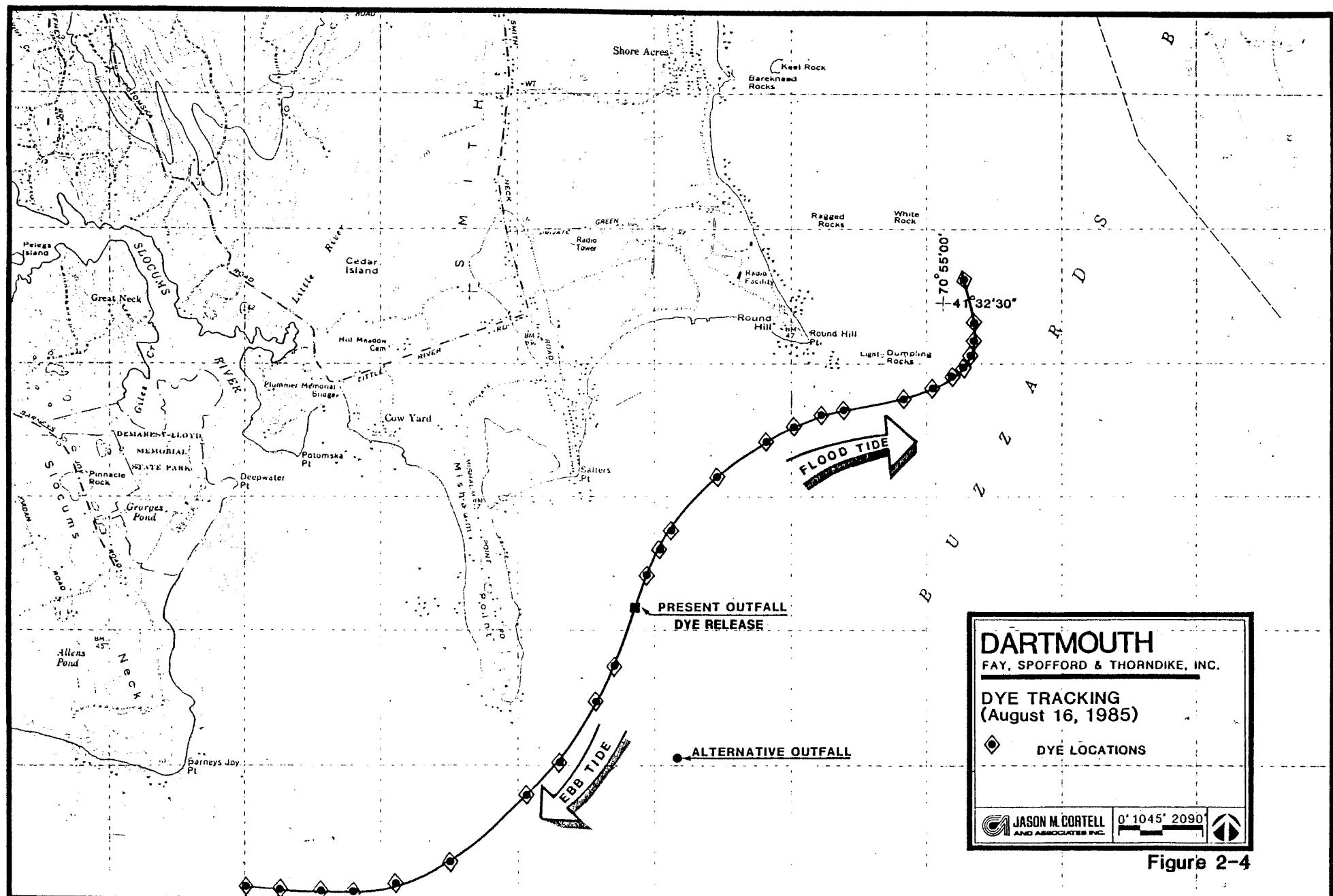
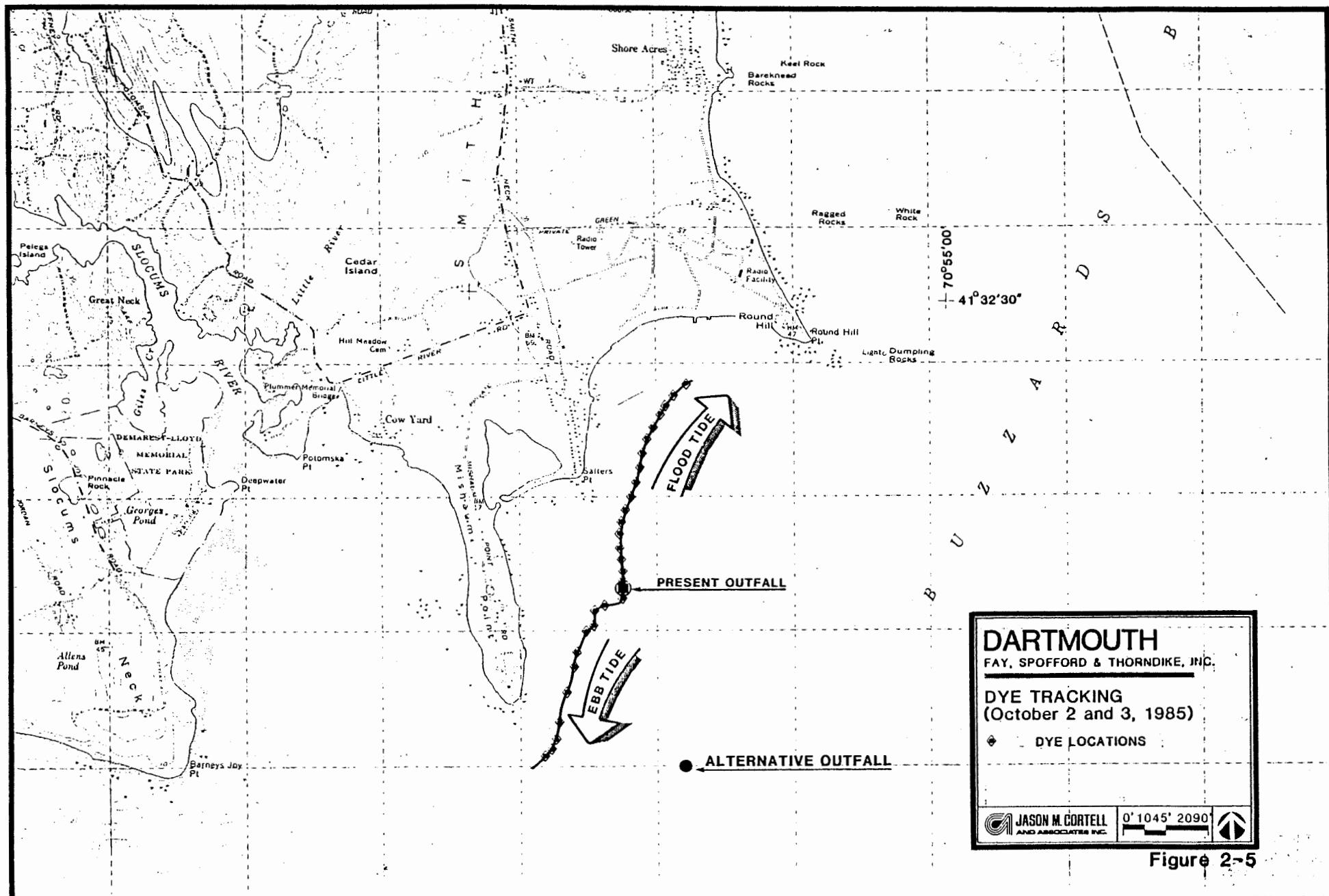


Table 2-I
DARTMOUTH OUTFALL - DYE SPEED
August 16, 1985

Ebb Tide		Flood Tide	
Time	Speed cm/s)	Time	Speed (cm/s)
0835-0905	28.2	1435-1459	24.0
0905-0930	46.1	1459-1508	64.0
0930-0954	50.8	1508-1528	40.6
0954-1005	58.5	1528-1559	29.5
1005-1024	28.5	1559-1608	30.1
1024-1042	32.0	1608-1618	37.3
1042-1059	29.9	1618-1626	29.6
1059-1111	25.4	1626-1637	58.5
1111-1124	36.5	1637-1648	52.3
1124-1139	45.2	1648-1658	20.3
		1658-1707	50.4
		1707-1716	30.1
		1716-1724	33.9
		1724-1732	21.2
		1732-1745	23.4
		1745-1802	33.9

Wind speed: 7.0 knots
 Wind direction: 280 degrees



3.0

WATER QUALITY MONITORING

3.1 General Water Quality Parameters

The wastewater treatment plant routinely conducts effluent analyses for pH, BOD, flow, total suspended solids, chlorine, dissolved oxygen, and fecal coliform bacteria as part of its NPDES discharge permit. Other analyses (such as total dissolved solids, ammonia nitrogen, nitrate nitrogen, total phosphorus, and sulfate) were also necessary to determine the potential need for further treatment should land application be selected over ocean discharge, and, as a further check on overall effluent quality. Four series of samples were collected from the outfall sump at the POTW and analyzed for general parameters. One sample was analyzed for metals and pesticides. The results of these analyses are contained in Table 3-I.

Water quality analyses were also conducted to determine overall water quality in the ZID, downstream areas, a control station, and the alternative outfall site. Specific locations for the sampling are shown on Figure 3-1. Sampling was conducted over a four week period for general water quality parameters and one set of samples were collected for metals and pesticides. Data from the analyses are contained in Tables 3-II through 3-IV. Tide and wind data for each sampling date are provided in Appendix C. The laboratory reports indicate all PCB's (Aroclor 1016, 1042, 1048, 1254, 1260) to be below detection limits.

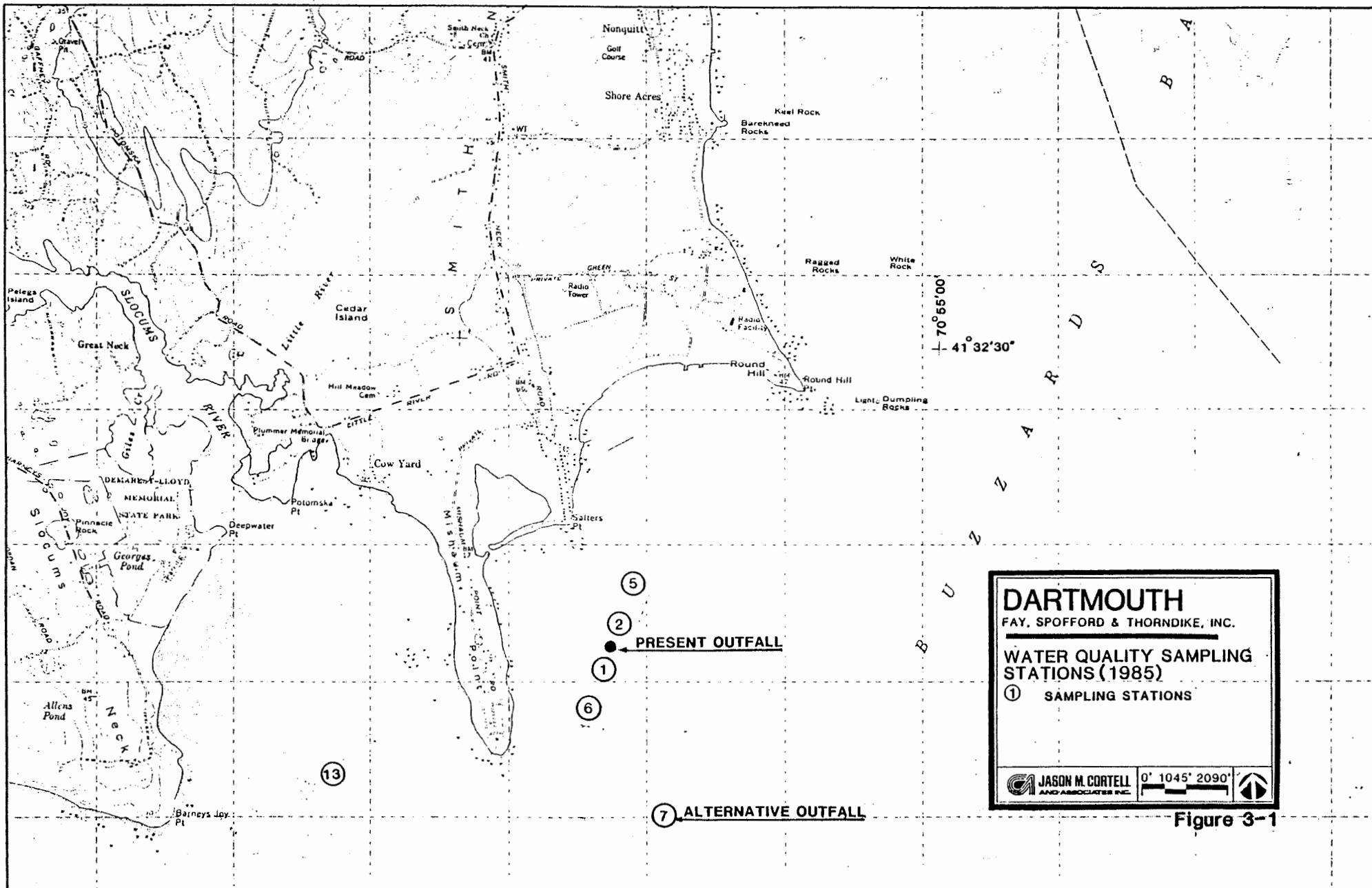


Table 3-I
TREATED EFFLUENT QUALITY

	9/13/85	9/18/85	10/2/85	10/9/85
pH	7.0	7.1	8.3	6.8
Biochemical Oxygen Demand (mg/l)	22.0	50	11	7.5
Total Suspended Solids (mg/l)	7	37	7	7.6
Total Dissolved Solids (mg/l)	280	261	383	301
Ammonia (mg/l)	0.37	8.5	0.12	0.12
Nitrate (mg/l)	13.7	1.4	4.02	12
Phosphorus, Total (mg/l)	0.63	3.7	3.4	2.9
Sulfate (mg/l)	30	42	36	37
Arsenic (mg/l)	---	0.24	---	---
Cadmium (mg/l)	---	<0.02	---	---
Chromium (mg/l)	---	<0.02	---	---
Copper (mg/l)	---	0.16	---	---
Lead (mg/l)	---	<0.10	---	---
Mercury (mg/l)	---	<0.0005	---	---
Nickel (mg/l)	---	<0.02	---	---
Zinc (mg/l)	---	0.08	---	---
Endrin (ug/l)	---	<0.006	---	---
Lindane (ug/l)	---	<0.004	---	---
Methoxychlor (ug/l)	---	<0.011	---	---
Toxaphene (ug/l)	---	<0.24	---	---
2, 4, 5-TP (ug/l)	---	<0.002	---	---
2, 4-D (ug/l)	---	<0.002	---	---
DDT	---	<0.012	---	---
PCB (ug/l)	---	<0.065	---	---

Dissolved oxygen, temperature, and pH concentrations were found to be within Class SB water quality standards. Total suspended solids, however, were found to be consistently above that which would ordinarily be expected averaging an area wide concentration of 33 mg/l with a range of 10 to 70 mg/l. The reason for such concentrations is believed to be suspended bottom sediment, which were clearly visible in the water, and not attributable to the Dartmouth discharge. Even the Control Station was found to have similar concentrations averaging 35 mg/l. On September 13, 1985, BOD concentrations were found to be above those noted at other sample periods. Because this condition was found at all stations to include the Control, it is believed that general turbulence is also the cause.

As monitoring progressed, it became apparent that the original monitoring program was not providing sufficient near field data to facilitate BOD and dilution modelling. Therefore one set of near field analyses for dissolved oxygen and salinity were conducted. These data are contained in Table 3-V. Both the dissolved oxygen and salinity data indicate that any effect of the outfall is dissipated within 100 feet of the boil.

Data on tide and wind on each day of sampling are contained in Table 3-VII.

3.2 Residual Chlorine

Measurements for the presence of residual chlorine were conducted at the wastewater treatment plant (WWTP) outfall sump and at the transition manhole

(the closest sampling location to the outfall). Measurements were conducted over a four day period with four samples being collected each day. The results indicated a three fold reduction of residual chlorine between the treatment plant and the outfall. The average residual chlorine at the transition manhole was 0.54 mg/l with a range of 0.35 to 0.6 mg/l. The data are shown in Table 3-VII.

Table 3-II

WATER QUALITY MONITORING DATA
September 18, 1985

Parameter Sample Station

	1S	1M	1B	2S	2M	2B	5S	5M	5B	6S	6M	6B	7S	7M	7B	13S	13M	13B
Arsenic (mg/L)	0.30	0.32	0.28	0.29	0.34	0.28	0.29	0.36	0.28	0.34	0.41	0.27	0.33	0.41	0.30	0.42	0.40	0.31
Cadmium (mg/L)	0.10	0.08	0.10	0.11	0.10	0.10	0.08	0.09	0.09	0.10	0.10	0.11	0.10	0.09	0.12	0.08	0.09	0.09
Chromium (mg/L)	0.04	0.05	0.06	0.05	0.05	0.04	0.04	0.03	0.05	0.05	0.06	0.05	0.05	0.06	0.07	0.06	0.05	0.05
Copper (mg/L)	0.11	0.21	0.17	0.11	0.17	0.15	0.10	0.15	0.14	0.10	0.20	0.17	0.09	0.28	0.20	0.09	0.15	0.14
Lead (mg/L)	0.30	0.40	0.45	0.35	0.40	0.40	0.35	0.40	0.45	0.40	0.45	0.30	0.35	0.45	0.35	0.30	0.45	0.35
Mercury (mg/L)										ALL EQUAL	<0.0005							
Nickel (mg/L)	0.47	0.44	0.44	0.52	0.50	0.43	0.43	0.46	0.47	0.45	0.45	0.45	0.34	0.47	0.51	0.44	0.48	0.47
Zinc (mg/L)	0.09	0.15	0.15	0.10	0.16	0.14	0.09	0.18	0.15	0.10	0.17	0.15	0.08	0.20	0.18	0.09	0.14	0.14
DDT (ug/l)										ALL EQUAL	<0.012							
Endrin (ug/l)										ALL EQUAL	<0.006							
Lindane (ug/l)										ALL EQUAL	<0.004							
Methoxychlor (ug/l)										ALL EQUAL	<0.011							
Toxaphene (ug/l)										ALL EQUAL	<0.24							
2, 4-D (ug/l)										ALL EQUAL	<0.002							
2,4,5-TP (Silvex) (ug/l)										ALL EQUAL	<0.002							
PCB (ug/l)										ALL EQUAL	<0.065							

Analysis performed by Arnold Greene Testing Laboratories.

Table 3-III
DARTMOUTH DISSOLVED OXYGEN AND TEMPERATURE DATA

Station 7 (Alternate Outfall)	September 12, 1985			Time 1245
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	20.0	10.2	57,500	7.2
1	19.5	10.2	57,500	
2	19.5	10.3	57,500	
3	19.5	10.3	57,500	
4	19.25	10.3	57,500	
5	19.25	10.3	57,500	
6	19.25	10.0	57,500	
7	19.25	10.0	57,500	
8	19.0	10.0	57,500	6.8
9	19.0	10.0	58,100	
10	19.0	10.0	58,100	
11	19.0	10.0	58,100	
12	19.0	9.8	58,100	
13	19.0	9.8	58,100	
14	19.0	9.8	58,100	
15	19.0	9.8	58,100	
16	19.0	9.7	58,100	7.6

Station 13 (Control)	September 12, 1985			Time 1345
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.75	10.4	51,200	7.7
1	19.75	10.4	52,500	
2	19.25	10.8	52,500	
3	19.25	10.4	53,100	
4	19.0	10.4	51,900	
5	19.0	10.4	51,900	7.7
6	19.0	9.8	52,500	
7	19.0	9.6	53,100	
8	19.0	9.4	53,100	
9	19.0	9.2	53,800	
10	19.0	9.2	53,800	7.7

Table 3-III (Continued)

DARTMOUTH DISSOLVED OXYGEN AND TEMPERATURE DATA

Station 6 (ZID)		September 12, 1985	Time 1550	
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.0	10.2	54,400	7.6
1	19.0	10.4	54,400	
2	19.0	10.0	56,200	
3	19.0	10.0	56,900	
4	19.0	10.0	56,900	
5	19.0	9.8	56,900	7.7
6	19.0	9.8	56,900	
7	19.0	9.8	56,900	
8	19.0	9.8	56,900	
9	19.0	9.8	56,900	
10	19.0	9.8	53,800	
11	19.0	9.7	55,000	
12	19.0	9.7	55,000	7.7

Station 1 (ZID)		September 12, 1985	Time 1620	
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.0	9.8	56,900	6.2
1	19.0	10.0	56,900	
2	9.0	10.0	56,900	
3	19.0	10.0	56,900	
4	19.0	10.0	56,900	
5	19.0	10.0	56,900	6.5
6	19.0	10.0	56,900	
7	19.25	9.8	56,300	
8	19.25	9.6	56,300	
9	19.25	9.6	56,300	7.7

Table 3-III (Continued)
DARTMOUTH DISSOLVED OXYGEN AND TEMPERATURE DATA

Station 2 (ZID)	September 12, 1985			Time 1645
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.0	0.2	58,700	6.5
1	19.0	10.2	58,700	
2	19.0	10.2	58,700	
3	19.0	10.2	58,100	
4	19.0	10.0	58,100	
5	19.0	10.0	58,100	*
6	19.25	10.0	58,100	
7	19.25	10.0	58,100	
8	19.25	10.0	58,100	
9	19.25	10.0	58,100	
10	19.25	10.0	58,100	
11	19.25	10.0	58,100	
12	19.25	10.0	58,100	*

Station 5 (ZID)	September 12, 1985			Time 1715
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.25	10.2	58,100	*
1	19.25	10.2	58,100	
2	19.25	10.2	58,100	
3	19.25	10.2	58,100	
4	19.25	10.2	58,100	
5	19.25	10.2	58,100	*
6	19.25	10.2	58,100	
7	19.25	10.2	58,100	
8	19.25	10.2	58,100	
9	19.25	10.2	58,100	
10	19.25	10.2	58,100	
11	19.25	10.2	58,100	
12	19.25	10.2	58,100	
13	19.25	10.2	58,100	
14	19.25	10.2	57,500	*

* Equipment malfunction

Table 3-III (Continued)
DARTMOUTH DISSOLVED OXYGEN AND TEMPERATURE DATA

Station 7 (Alternate Outfall)	September 17, 1985			Time 1040
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.0	9.6	58,100	6.8
1	19.0	9.6	58,100	
2	18.5	9.6	56,900	
3	18.5	9.6	56,900	
4	18.25	9.6	57,500	
5	18.25	9.6	57,500	
6	18.25	9.4	60,000	
7	18.25	9.4	60,600	
8	18.25	9.4	61,200	6.8
9	18.25	9.4	-	
10	18.25	9.4	-	
11	18.25	9.4	-	
12	18.25	9.4	-	
13	18.25	9.4	-	
14	18.25	9.2	-	
15	18.25	9.2	-	
16	18.25	9.2	-	7.3

Station 13 (Control)	September 17, 1985			Time 1230
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	18.75	9.6	-	7.8
1	18.75	9.6	-	
2	18.75	9.6	-	
3	18.5	9.6	-	
4	18.25	9.6	-	
5	18.25	9.6	-	8.2
6	18.25	9.6	-	
7	18.25	9.6	-	
8	18.25	9.6	-	
9	18.25	9.6	-	
10	18.25	9.6	-	8.2

Table 3-III (Continued)
DARTMOUTH DISSOLVED OXYGEN AND TEMPERATURE DATA

Station 6 (ZID)	September 17, 1985			Time 1450
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	18.5	9.2	54,400	9.1
1	18.5	9.2	54,400	
2	18.5	9.2	54,400	
3	18.5	9.2	54,400	
4	18.5	9.2	54,400	8.6
5	18.5	9.2	54,400	
6	18.5	9.2	54,400	
7	18.5	9.2	54,400	
8	18.5	9.2	54,400	
9	18.5	9.1	54,400	9.1

Station 1 (ZID)	September 17, 1985			Time 1520
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	18.5	9.2	56,900	7.3
1	18.5	9.2	56,900	
2	18.5	9.2	56,900	
3	18.5	9.1	56,900	7.4
4	18.5	8.8	56,900	
5	18.5	8.8	56,900	7.0

Table 3-III (Continued)

DARTMOUTH DISSOLVED OXYGEN AND TEMPERATURE DATA

Station 2 (ZID)	September 17, 1985			Time 1555
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.0	9.8	58,100	7.5
1	19.0	9.8	58,100	
2	18.5	9.8	58,100	
3	18.5	9.8	59,400	
4	18.5	9.8	59,400	
5	18.5	9.6	60,000	7.7
6	18.5	9.0	60,000	
7	18.5	9.6	61,200	
8	18.5	9.6	61,200	
9	18.5	9.6	-	7.8

Station 5 (ZID)	September 17, 1985			Time 1630
Depth (m)	Temp. (°C)	D.O. (mg/l)	Sp. Cond. (umhos/cm)	pH
0	19.0	9.8	59,400	6.6
1	19.0	9.8	59,400	
2	19.0	9.8	59,400	
3	19.0	9.8	59,400	
4	19.0	9.8	59,400	
5	19.0	9.8	59,400	7.2
6	18.75	9.6	60,600	
7	18.75	9.6	60,600	
8	18.75	9.6	60,600	
9	18.75	9.6	-	6.8

Station 2 (ZID)			October 2, 1985			October 6, 1985		
Depth	Temp.	D.O.	Depth	Temp.	D.O.	Depth	Temp.	D.O.
S	20	9.0	S	18	9.2			
M	20	9.3	M	20	9.2			
B	20	9.5	B	18	9.5			

Table 3-V
NEAR FIELD DISSOLVED OXYGEN, AND SPECIFIC CONDUCTANCE MONITORING

Location: Outfall
Date: November 19, 1985
Time: 1350

Depth (meters)	Dissolved Oxygen (mg/l)	Specific Conductance (umhos/cm)
0	9.8	43,000
1	9.8	50,000
2	10.2	50,000
3	10.2	57,000
4	10.2	57,000
5	10.2	57,000
6	10.2	57,000
7	10.2	57,000

Further sampling work stopped due to high wind and water.

Table 3-V (Continued)

Location: Outfall
Date: November 21, 1985
Time: 1130

Depth (meters)	Dissolved Oxygen (mg/l)	Specific Conductance (umhos/cm)
0	9.8	43,000
1	10.2	50,000
2	10.6	49,000
3	10.6	49,000
4	10.6	49,000
5	10.5	49,000
6	10.5	50,000
7	10.5	49,000

Final Effluent Quality Data 11/21/85

Flow:	1.55 mgd
Dissolved Oxygen:	1.4 mg/l
BOD:	18.0 mg/l
Settleable Solids:	0.0 ml/l
pH:	6.6 mg/l
Chlorine Residue:	1.2 mg/l

Table 3-V (Continued)

Location: 30 ft. downstream of outfall
Date: November 21, 1985
Time: 1145

Depth (meters)	Dissolved Oxygen (mg/l)	Specific Conductance (umhos/cm)
0	9.4	43,000
1	9.6	50,000
2	9.8	55,000
3	10.0	58,000
4	10.0	60,000
5	10.2	60,000
6	10.2	61,000
7	10.2	61,000

Location: 50 ft. downstream of outfall
Date: November 21, 1985
Time: 1200

Depth (meters)	Dissolved Oxygen (mg/l)	Specific Conductance (umhos/cm)
0	9.4	48,000
1	9.4	49,000
2	9.8	50,000
3	9.8	55,000
4	9.8	58,000
5	9.8	60,000
6	9.8	60,000
7	9.8	60,000
8	9.8	60,000

Water temperature throughout the water column was 11.5 °C.

Table 3-V (Continued)

Location: 100 ft. downstream of outfall
Date: November 21, 1985
Time: 1220

Depth (meters)	Dissolved Oxygen (mg/l)	Specific Conductance (umhos/cm)
0	9.4	53,000
1	9.6	55,000
2	9.6	58,000
3	9.6	60,000
4	9.8	60,000
5	9.8	60,000
6	9.8	60,000
7	9.8	60,000
8	9.8	60,000

Table 3-VI
TIDE* AND WIND** DATA

September 12, 1985
High tide - 1851 hrs
Wind speed - 8 knots
Wind direction - 228 degrees

September 13, 1985
High tide - 0715 hrs
Wind speed - 9.6 knots
Wind direction - 224 degrees

September 17, 1985
High tide - 1019 hrs
Wind speed - 1.3 knots
Wind direction - 340 degrees

September 18, 1985
High tide - 1109 hrs
Wind speed - 4 knots
Wind direction - 240 degrees

October 4, 1985
High tide - 1154 hrs
Wind speed - 9 knots
Wind direction - 52 degrees

October 6, 1985
High tide - 1339 hrs
Wind speed - 9.6 knots
Wind direction - 290 degrees

November 4, 1985
High tide - 1306 hrs
Wind speed - not available
Wind direction - not available

November 21, 1985
High tide - 1622 hrs
Wind speed - not available
Wind direction - not available

* Eldridge Tide And Pilot Book, 1985.
** New Bedford Airport weather observations.

Table 3-VII
RESIDUAL CHLORINE (mg/l)

Date	Time	WWTP	Transition Manhole
11/20/85	0830	1.5	0.6
	0925	1.4	0.5
	1010	0.8	0.6
	1050	1.1	0.6
11/21/85	0820	2.5	0.6
	0850	1.7	0.5
	0920	1.5	0.6
	0950	1.2	0.6
11/22/85	0830	1.9	0.6
	0900	1.4	0.6
	0930	1.4	0.5
	1000	0.9	0.6
11/23/85	0820	1.5	0.5
	0850	1.9	0.45
	0920	1.8	0.35
	0950	<u>1.5</u>	<u>0.40</u>
Mean		1.5	0.54

4.0

DISPERSION ANALYSIS

Included in this section are descriptions of the circulation and transport dynamics in the area, a description of the outfall, the dilution analysis using a series of numerical models, and, the conclusions reached about the level of impact from BOD and the dissolved oxygen deficit.

4.1 Circulation and Transport Dynamics in Buzzards Bay and the Salters Point Region

Currents in coastal embayments are in general due to a combination of wind, tide, and density forcing. In the lower reaches of Buzzards Bay, which includes the Salters Point area, density forcing is minimal and the currents are associated with three distinct timescales: tidal currents dominate motions from 2 to 24 hours, wind-driven currents dominate motions from 1 to 10 days, and very low-frequency currents due to the interaction of tides with the rapidly varying bathymetry and coastline dominate motions from 10 days to the mean.

To understand the significance and limitations of the current measurements obtained at Salters Point, the present understanding of spatial and temporal variability in Buzzards Bay will be reviewed. First, the physical setting and hydrographic conditions will be described, followed by a discussion of tidal, wind forced and mean circulation in Buzzards Bay. The relationship between these findings and recent measurements near Salters Point will then be described.

4.1.1 Physical Setting

Buzzards Bay may be defined as the body of water extending southwestward from the west end of Cape Cod Canal, opening onto Rhode Island Sound at its mouth, and bounded to the southeast by the Elizabeth Islands (Figure 4-1). The Bay so defined is approximately 40 km long, and varies in width from 10 km near the mouth to a maximum of 20 km at New Bedford. The formation of the Bay occurred during the last ice age (15,000 years ago), and the glacier's retreat is evidenced in the numerous elongate inlets along the northwestern shore, with variations in width comparable to the width of the Bay itself.

Buzzards Bay is quite shallow, with a mean depth from digitized isobaths of 11 m at mean low water (mlw). Depths near the head average 5 to 10 m at mlw and increase seaward to slightly over 20 m at the mouth. Gradations in bathymetry are generally weak over most of the central area of the Bay, but depth profiles of transects across the Bay are typically asymmetric, with shallow water to the northwest. Near the mouth, the bottom topography becomes complex and convoluted, with depths of 20 to 30 m. Offshore to the southwest is Rhode Island Sound (RIS) with more gradually varying depths from 20-40 m. Vineyard Sound, to the southeast, is also generally deeper than Buzzards Bay, with an average depth of 18 m between Woods Hole and Gay Head.

Salters Point is located on the northwestern shore of Buzzards Bay, a small rocky protrusion between Mishauum and Round Hill Points at the tip of Smith

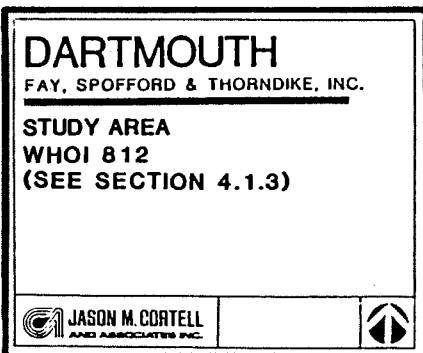
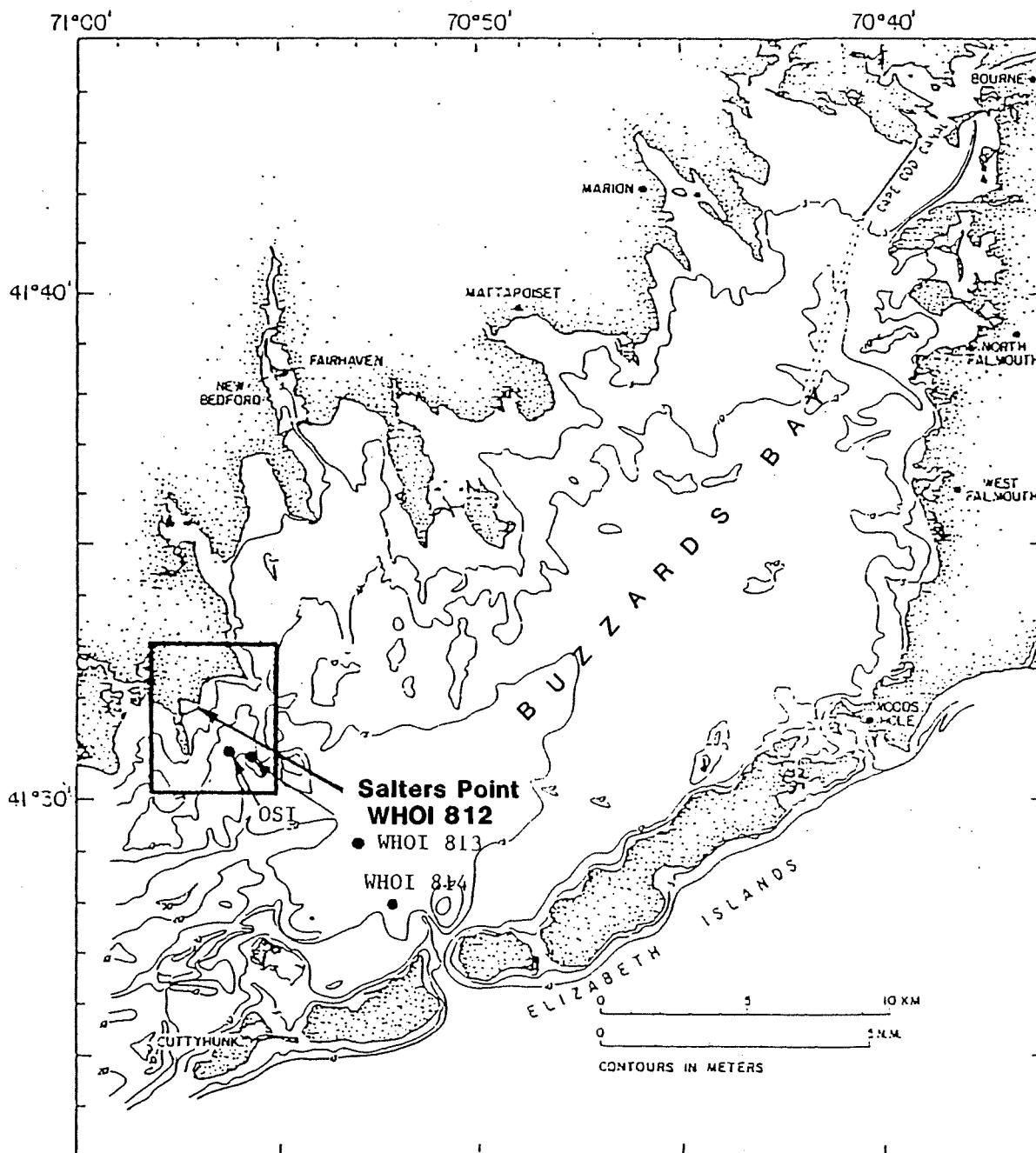


Figure 4-1

Neck (Figure 4-1). A reef extends from the tip of Salters Point for approximately 0.8 km at a water depth of 3 m. Offshore, the water depths in the immediate vicinity range from 8 to 14 m.

4.1.2 Hydrographic Conditions in Buzzards Bay

In many estuaries, hydrographic conditions play a fundamental role in determining the circulation, for the density field may drive thermohaline circulation and substantially alter the structure of forced and free motions. While a detailed description of the hydrography in time and space is difficult due to the complexity of the physical processes and lack of a comprehensive data set, the gross features of the temperature, salinity and density fields in Buzzards Bay are well defined by existing measurements and can be related to freshwater input, the surface heat flux cycle, turbulent mixing and lateral exchange with shelf water.

Buzzards Bay drains approximately 780 km² of land, based on drainage basin data for the northwest side of the Bay (Wandle and Morgan, 1984) and contours of groundwater elevation from Cape Cod (Guswa and LeBlanc, 1981). Most of the inflow enters along the northwestern side with a concentration at the head of the Bay, where the Wankinko, Agawam and Weweantic Rivers discharge. Using drainage area and stream gauge information from the Westport River near the mouth of the Bay, an estimate of the total mean inflow to the Bay is given by Signell

(1987) as $15.4 \pm 3.9 \text{ m}^3 \text{ s}^{-1}$. For comparison, Delaware Bay has only twice the volume of Buzzards Bay but has roughly 400 times as much freshwater input (Bumpus, 1973).

Salinity in Buzzards Bay generally ranges from 30-32 ppt with an annual variation of less than 1 ppt. Water temperature in the Bay follows the surface heat flux, which becomes positive in March and negative in October. Minimum temperatures around 0°C are found in February and the maximum temperatures around 20°C are found in August. Horizontal temperature gradients are small except in summer, when $4-5^\circ\text{C}$ difference between head and mouth are found due to the relatively smaller heat capacity of the shallower water.

The gravitational circulation driven by horizontal density gradients in Buzzards Bay has been examined by Signell (1987) using data from recent hydrographic cruises (Rosenfeld et al, 1984). With a simple theoretical model, it was estimated that along-bay density gradients give rise to large scale estuarine circulation of 1 cm s^{-1} or less, except in the immediate vicinity of river mouths.

Vertical stratification can develop during the spring and summer which can alter the structure of forced wind and tidal response. The Bay is well mixed October through February when the heat flux is negative and the water column is unstable. In March the heat flux becomes positive, and combined with increased freshwater input, stratification may develop. In summer, the freshwater input has decreased, and vertical stratification is due

primarily to surface heat flux. In September, the surface begins to cool, overturning takes place, and by late October most of the region is well mixed in the vertical. In the August 1982 and May 1983 surveys, (Rosenfeld et al, 1984) mid-bay stations (in water depths of 10-15 m) typically showed top-to-bottom density differences of $0.5\sigma_t$ units, while October 1982 and January 1983 top-to-bottom vertical differences were less than $0.5\sigma_t$ units.

In summary, although horizontal gradients in the density field do not play an important role in driving the large scale circulation in Buzzards Bay, vertical density gradients can exist from April to September which alter the response of the Bay to wind and tidal forces.

4.1.3 Tidal Currents in Buzzards Bay

Tides along the U.S. East Coast are dominated by the lunar semi-diurnal component M_2 (12.42 hrs) due to response characteristics of the North Atlantic (Platzman, 1975) and the near resonance in the Gulf of Maine (Garrett, 1972). The local effect of the tide generating force over the shelf is small. Thus tides in this region can be modeled as the response to boundary forcing at the shelf break by the open ocean tides. Likewise, the tides in Buzzards Bay can be modeled as the response to boundary forcing at the bay mouth by shelf tides. Buzzards Bay is a semi-enclosed basin, and the tidal response can be modeled as the sum of an incoming wave and an outgoing wave due to reflection at the head of the Bay, both of which

are progressively damped by frictional effects (Redfield, 1953). The degree to which a semi-enclosed basin deviates from a standing wave response is determined by the frictional dissipation of the basin. With no friction, the tide arrives simultaneously over the entire Bay and currents are 90° out of phase with elevation so that slack current occurs at high and low waters. When frictional effects are present, the tide arrives later at the head than at the mouth, and slack current occurs after high and low waters.

In Buzzards Bay, the mean range in tidal elevation increases from 92 cm at the mouth to 110 cm at the head. Frictional dissipation causes the tide at the head of the Bay to arrive 20 minutes after the mouth, and causes slack water to arrive approximately 1 hour after high and low tides at the Bay mouth. Mean tidal current amplitudes (M_2) range from near 40 cm s^{-1} at the mouth to 10 cm s^{-1} near the head.

Temporal variation of Buzzards Bay tides are due to changes in the astronomical forcing and changes in the dynamical response of the Bay and the adjoining shelf. In the lower reaches of the Bay, recent current meter data exist that allow this tidal variation to be quantified. From August 1984 to January 1985, current meters were deployed by the Woods Hole Oceanographic Institution (WHOI) at three surface moorings on a transect from Round Hill Point to Quicks Hole (Figure 4-1). Each of the moorings had EG&G VMCM current meters at 5 and 10 m depths. The bay was well mixed vertically in October, so the data span both stratified and well

mixed conditions. The measurements revealed that at a given level in the water column the maximum difference in the tidal current was 10% between the stratified and well mixed conditions. These differences are masked, however, by the larger fluctuations in the strength of the tide caused by astronomical effects. In Buzzards Bay, the moon's perigee/apogee cycle of 27.6 days, represented by the magnitude of the N_2 component, is as important as the spring/neap cycle of 14.8 days, represented by the magnitude of the S_2 component. Harmonic analysis shows, that averaged over the Bay, the ratio N_2/M_2 for both tidal currents and elevation is 0.25, and is equal to the S_2/M_2 ratio. Since each effect represents a 25% fluctuation in tidal strength, over any given 7 months there will be periods of several days when the tides are up to 50% weaker than normal, and periods when the tides will be up to 50% stronger than normal.

The spatial variation in Buzzards Bay tidal currents is chiefly due to the coastline geometry and bathymetry of the Bay. In general, because the tides in the Bay are almost a standing wave, the current amplitude decreases linearly from the mouth to the head. Near the shallow northwestern side of the Bay, velocities are reduced except in the vicinity of headlands such as West Island, Round Hill and Micham Point, where the flow is locally accelerated (Haight, 1938).

4.1.4 Wind Forcing Currents in Buzzards Bay

Winds along the Mid-Atlantic Bight (a coastline concavity which forms a large open bay) are generally northwesterly in winter and southwesterly in summer (Saunders, 1977). Climatological wind data from

Otis Air Force Base located 15 km inland from eastern shore of Buzzards Bay on Cape Cod show this seasonal pattern clearly, the southwesterly tendency in summer augmented substantially by the local sea breeze (Figure 4-2 and Table 4-I). It can also be seen that strong wind events in excess of 33 knots (17.8 m s^{-1}) occur principally November through May from the northwest quadrant. Table 4-I shows that the frequency of thunderstorms (and severe winds) is greatest in summer and fall, however, corresponding to the migration of tropical storms northward along the Eastern Seaboard. The average monthly wind strength varies by 30% over the year, with weaker average winds of 9 knots (4.9 m s^{-1}) in summer and fall, and stronger average winds of 11-12 knots ($6.0\text{-}6.5 \text{ m s}^{-1}$) in winter and spring. Wind measurements from Otis Air Force Base, the New Bedford hurricane barrier and the Buzzards Bay light tower have been shown to be well correlated, which suggests that wind from any of these locations gives an adequate representation of wind over the entire bay (Signell, 1987).

Wind driven circulation in coastal embayments can be both locally and remotely forced. In Chesapeake Bay and Narragansett Bay, significant currents are generated by fluctuations in average bay level which in turn are generated by wind driven transport on and off the shelf. In Buzzards Bay, the geometry causes non-local effects to be insignificant compared to the effects of the local wind (Signell, 1987).

When the local wind acts over the surface of the Bay, it initially drives water downwind, establishing an adverse pressure gradient. Since

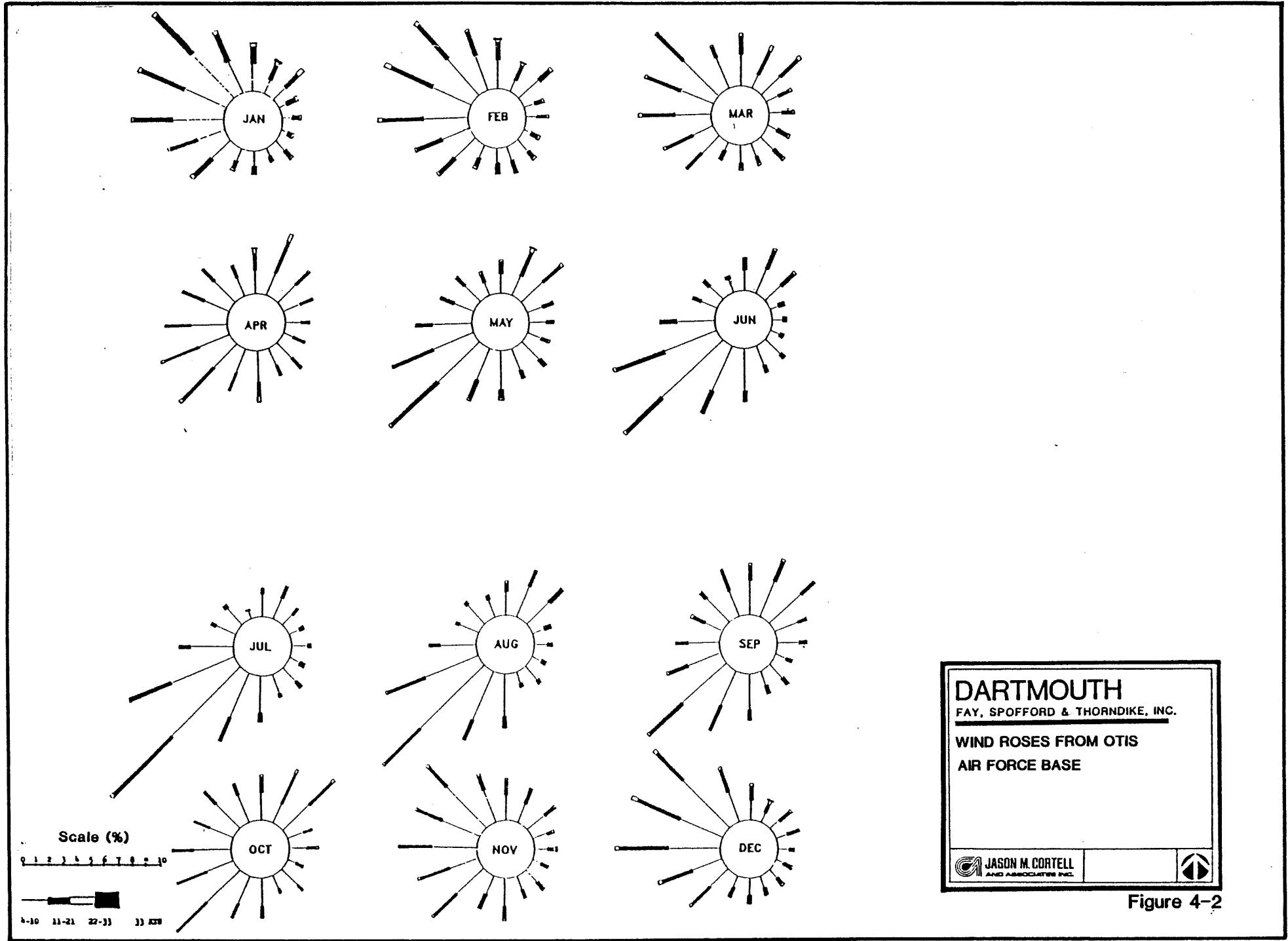


Figure 4-2

Table 4-I
CLIMATOLOGICAL DATA FROM OTIS AFB, MASSACHUSETTS

Location: 41° 39' N, 70° 31' W
Duration of Record: 1948 - 1971

	Prevailing Wind Direction (direction from)	Average Speed (cm/sec)	Mean Days Thunderstorms
JAN	NW	565.9	-
FEB	NW	565.9	-
MAR	NW	617.3	-
APR	SW	565.9	1
MAY	SW	514.4	3
JUN	SW	514.4	2
JUL	SW	463.0	3
AUG	SW	463.0	3
SEP	SW	463.0	1
OCT	SW	617.3	1
NOV	NW	565.9	-
DEC	NW	617.3	-
YEAR	WSW	565.9	14

the natural period of the Bay is approximately two hours, while the period of wind forcing is several days, the pressure gradient adjusts rapidly and a quasi-equilibrium balance is quickly established between surface stress, pressure gradient, and dissipative frictional forces. The data from the WHOI transect showed the wind driven currents were polarized in the along-bay direction although the major axis of wind variability was nearly north/south. This indicated the across-bay response was not very efficient, and subsequent analysis focussed only on more efficient along-bay current response.

It was found that the along-bay currents at 5 m depth in the deeper parts of the section were uncorrelated with the along-bay wind, while currents at 10 m depth were negatively correlated. This downwind surface flow, upwind bottom flow is required to satisfy mass conservation when the cross-sectional depth is nearly constant. If depth varies considerably over the cross-section, however, then in the shallow water near the sides of the basin, surface stress balances bottom stress, the response is downwind at all depths and the downwind transport generated is returned in the deeper parts of the section where the integrated pressure gradient balances the surface stress. The precise structure of the response depends on the magnitude of bottom friction and on the nature of the vertical mixing. With simple parameterizations of the bottom boundary layer and vertical mixing, this model has been shown to approximate the wind response in the WHOI transect (Signell, 1987).

For a 10 m/s wind, the downwind surface current near the shore was 10-20 cm/s, or 1-2% of the wind speed. According to this simple model of local wind driving, the predicted currents are an effective mechanism for transport and mixing. A northeasterly wind event of 10 m/s would drive currents along the northwestern shore, within about 3 km of the coast, with an average velocity of 10 cm/s. If the wind lasted for 3 days, this would result in a displacement of 25 km, sufficient to transport water from New Bedford out of the Bay into Rhode Island Sound, assuming the response is similar to the WHOI transect along this section. From a mixing point of view, the same wind results in a transport of 2400 m³/s in and out of the bay, enough to exchange roughly 15% of the Bay volume over the three days.

In summary, winds are primarily from the southwest in summer, along the axis of the Bay, while in winter the winds are primarily from the northwest, across the axis of the Bay. Strong wind events generally occur from November to May from the northeast, severe winds associated with tropical storms can occur from June to November. Along-bay winds are expected to drive currents downwind at all depths in the shallow regions near the coast. In deeper water, there will be an upwind return flow at depth to satisfy mass conservation. With rapidly varying cross-sectional depth, moderate wind events of 10 m/s can have a significant influence on the exchange of Bay water with the shelf.

4.1.5 Mean Circulation in Buzzards Bay

One of the most striking features in lower Buzzards Bay is the constancy of the low frequency circulation. Tidal current meter time series filtered to remove the tides show a strong mean component that is modulated at two weeks and one month (Signell, 1987). This mean circulation is due to the interaction of the energetic tidal currents with the coastline and bathymetric features in the region through nonlinear advective processes. Around headlands, the mean circulation consists of strong offshore flow at the headland tip, and a gyre on either side. These features are clearly seen in Figure 4-3, the mean circulation in lower Buzzards Bay obtained from a depth-averaged nonlinear tidal model (Signell, 1987). The predicted structure of the mean circulation is consistent with measurements, but the severe undersampling of the moored current meters illustrates the difficulty in resolving tidal mean circulation with conventional techniques when tidal flow interacts with rapidly varying topography and coastline features. Typical scales for the residual features in lower Buzzards Bay are 1-4 km, approximately the same range as the tidal excursion, and typical amplitudes are 1-5 cm s⁻¹.

It should be emphasized that the mean circulation obtained from a numerical model at fixed grid points or from current meters (the Eulerian mean current) does not indicate the direction or magnitude of net material transport (the Lagrangian mean) when the structure of the Eulerian mean varies significantly over the length of the tidal

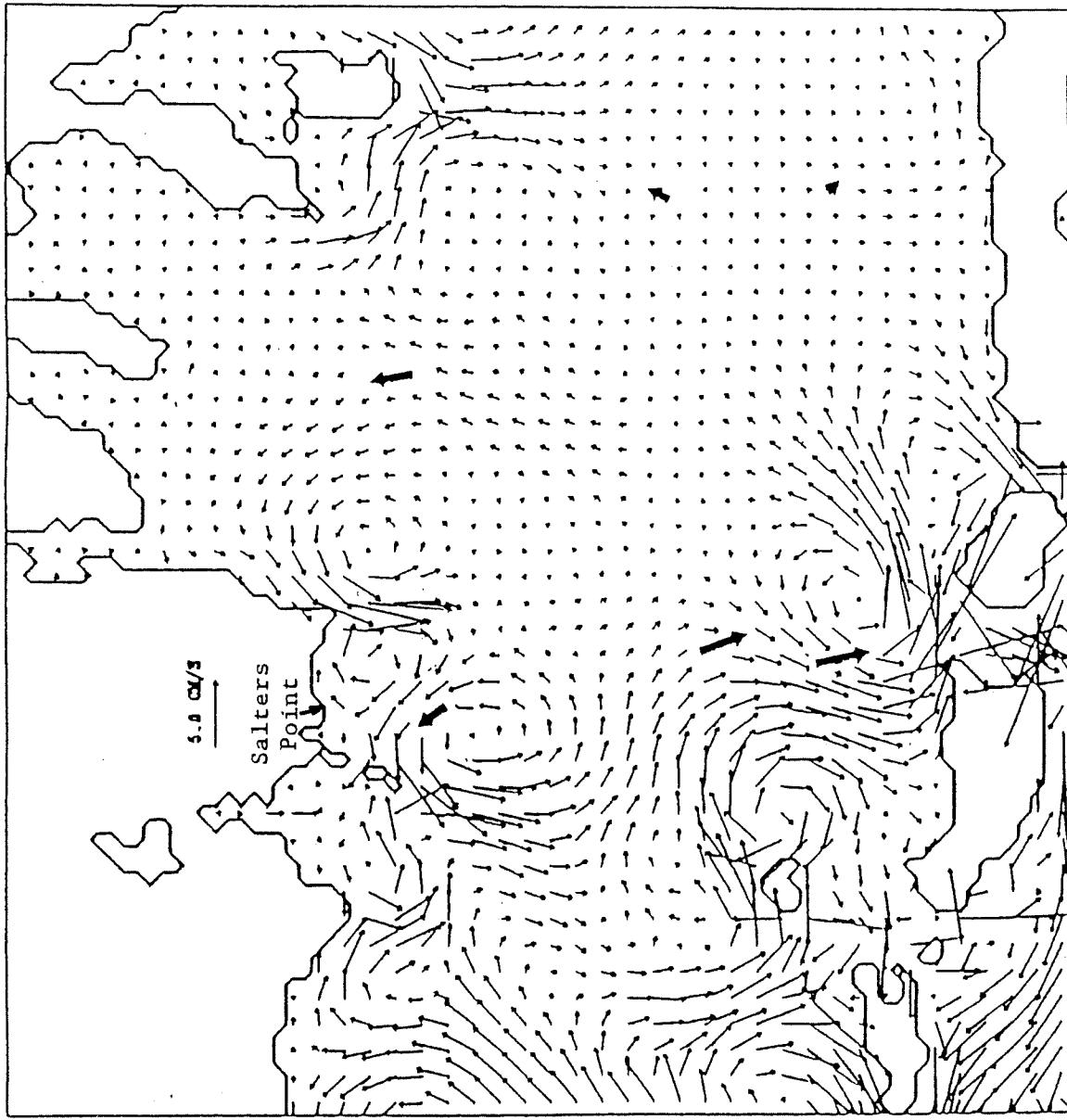
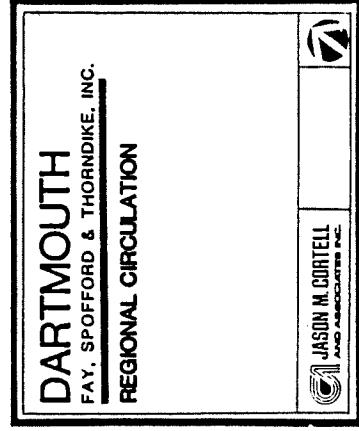


Figure 4-3.

excursion. In this case, the net displacement of a particle carried on the oscillatory tide depends on the characteristics of the tidal flow over the entire tidal excursion, and bears no resemblance to the Eulerian residual flow at the point of release. In fact, the residual eddy field becomes effectively a large scale turbulent mixing mechanism that tends to effectively diffuse material (Zimmerman, 1981) rather than advecting it along Eulerian streamlines. For lower Buzzards Bay, it has been suggested that mixing induced by nonlinear tidal effects is as important as exchange due to wind forcing (Signell, 1987).

4.1.6 Current Measurements at Salters Point

In order to obtain flow measurements in the Salters Point region, a single taut-wire mooring with three Endeco 105 current meters was deployed by Ocean Surveys, Inc. (under contract to JASON M. CORTELL and ASSOCIATES INC.) 1.9 km SSE of Salters Point (the proposed alternate outfall site) from August 26 to September 25, 1985. The water depth at the mooring was 12.5 m at MLW and nominal instrument depths were 3.0, 6.2, and 10.0 m above bottom (Table 4-II). Wind time series measurements were obtained during the deployment from the Buzzards Bay Light Tower, located approximately 17 km to the SSW of Salters Point near the mouth of Buzzards Bay ($41^{\circ}37.44'N$, $70^{\circ}54.48'W$). For these purposes a better data set is available from this source than Otis Air Force Base.

The hourly time series of wind and current vectors are shown in Figure 4-4. As expected, the current records are dominated by the semi-diurnal tide

Table 4-II
SUMMARY OF THE CURRENT METER DEPLOYMENT

Location:	41°30' 15.6" N 70°56' 18.5" W
Start Time:	1400 EST August 26, 1985
End Time:	1600 EST September 25, 1985
Bottom Depth (MLW):	40.7 ft.
Current Meter Distances from Bottom:	
Top:	32.7 ft.
Middle:	20.4 ft.
Bottom:	10.0 ft.

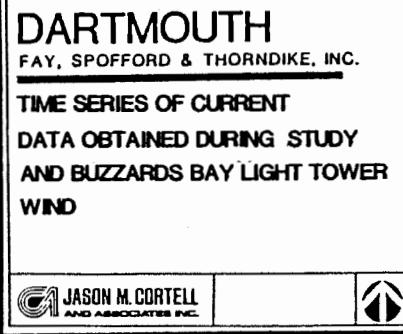
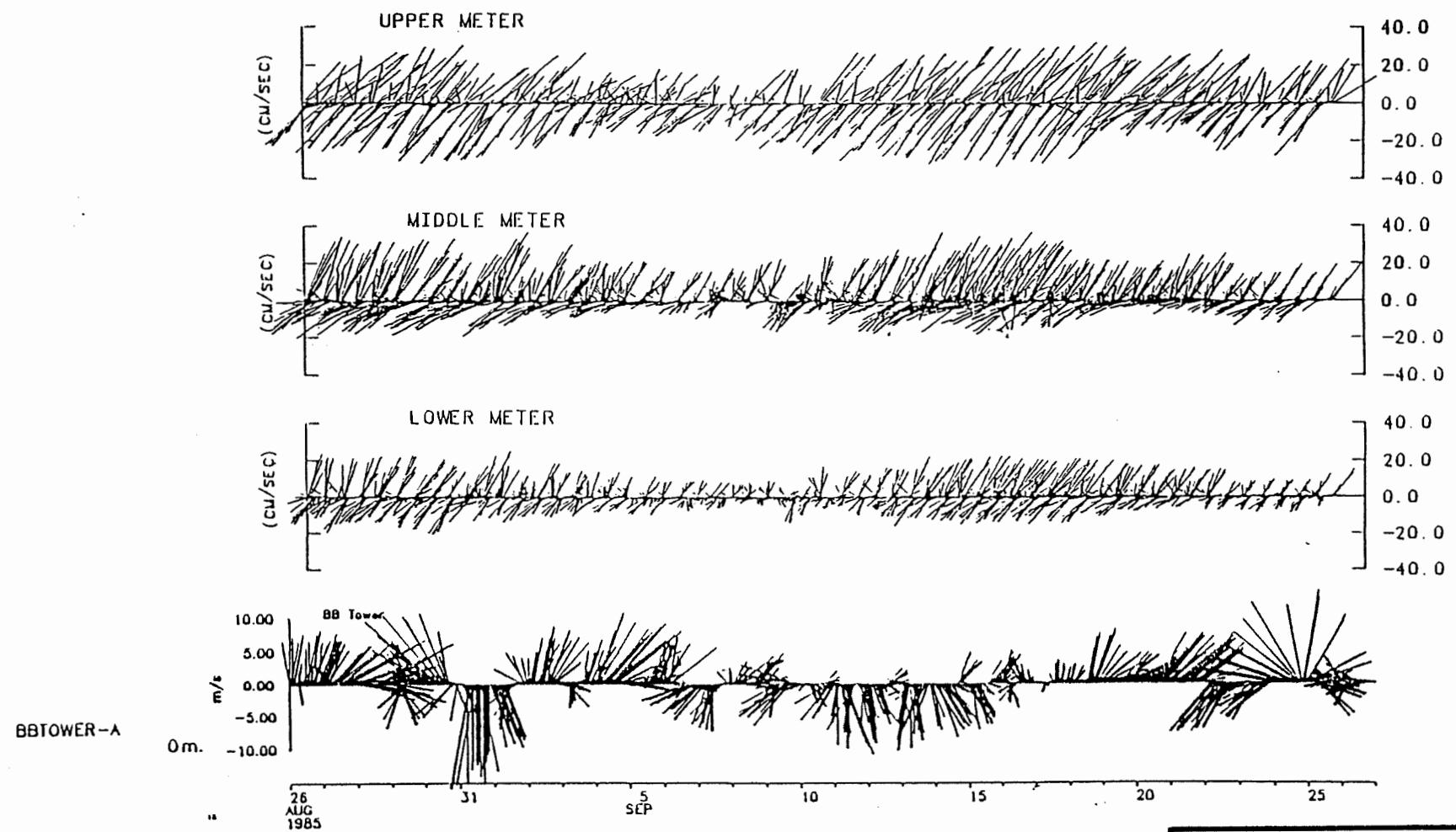


Figure 4-4

which fluctuates in magnitude from approximately 10-30 cm/s at the surface and decreases to 5-15 cm/s at the lower instrument. The tidal flow basically follows the local along-bay axis, but it is evident that at the middle and lower instruments the flood tide is stronger, while the ebb tide is weaker and has a significant landward component. The vector time series of wind is dominated by 2-8 day events with typical amplitudes of 10 m/s. Much of the variability appears in the north/south direction.

The mean currents from the Salters Point mooring are shown in Figure 4-5 along with the means obtained from the WHOI transect mooring 812. The mean at the upper instrument is in the down-bay direction, while at the middle and lower instruments the mean is directed toward shore. The magnitude of the mean wind is not significantly different from zero, and therefore must be dismissed as a possible forcing mechanism for the mean current.

4.1.7 Tidal Currents at Salters Point

Further information about the tides was obtained by performing a least squares harmonic analysis to the 30 day records (Foreman, 1977). Results for the major constituents are compared to Station 812 from the WHOI transect (located 1.1 km to the SE, see Figure 4-5) in Table 4-III. For both stations, the tidal signal is dominated by the semi-diurnal constituents M2, S2, and N2 and the first harmonic of M2, M4. Diurnal tides are an order of magnitude smaller

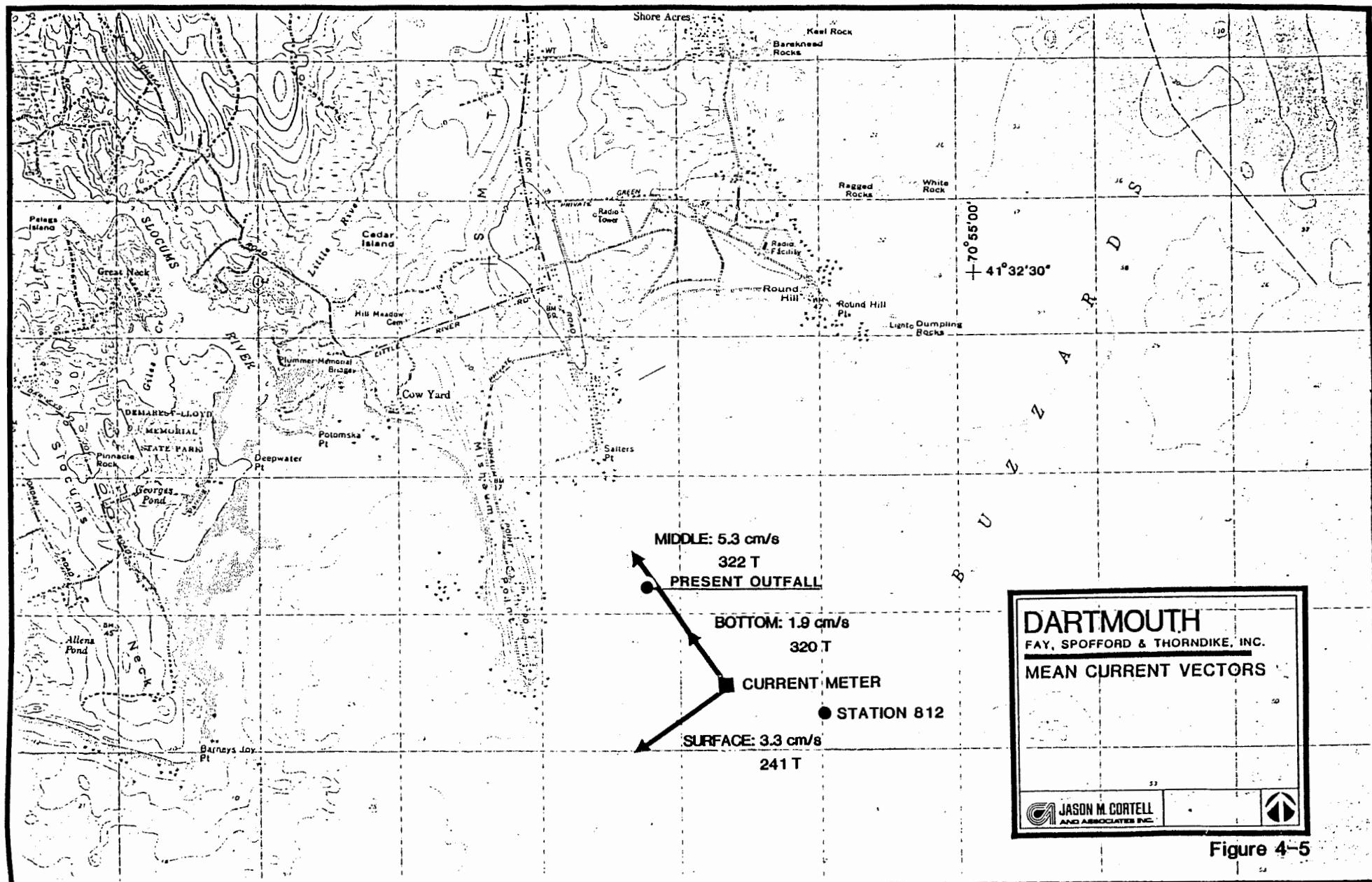


Figure 4-5

Table 4-III

**SUMMARY OF DOMINANT TIDAL CURRENT CONSTITUENTS
AT SALTERS POINT AND WHOI 812 STATIONS**

		Salters Point			WHOI 812	
		41° 30.24 N	70° 56.28 W	Water Depth: 12.5 m	41° 31.80 N	70° 55.70 W
		26 Aug 85 - 25 Sep 85			Water Depth: 15.4 m	
		Instrument Depths			Instrument Depths	
		2.5 m (10 mab)	6.3 m (6.2 mab)	9.5 m (3.0 mab)	5.0 m (10.4 mab)	10.0 m (5.4 mab)
mean	spd cm/s	3.3	5.3	1.9	2.0	3.0
	dir deg T	241.0	322.0	320.0	318.0	326.0
M2	maj cm/s	25.9	19.4	12.0	25.7	22.1
	min cm/s	-2.4	1.6	1.8	-0.4	0.9
	inc deg T	45.3	49.3	38.1	39.9	36.2
	pha deg G	294.0	291.0	285.9	296.4	296.1
S2	maj cm/s	4.3	3.5	2.3	6.1	4.2
	min cm/s	-1.0	-0.7	-0.5	-0.1	-0.1
	inc deg T	32.5	43.3	36.8	40.7	38.2
	pha deg G	288.4	287.9	294.7	306.4	312.5
N2	maj cm/s	5.7	3.9	3.6	7.2	6.1
	min cm/s	-0.3	-0.4	-0.2	0.1	0.3
	inc deg T	42.2	52.9	46.9	40.7	38.0
	pha deg G	269.6	268.4	265.6	271.0	268.3
M4	maj cm/s	6.4	5.9	4.4	6.4	5.9
	min cm/s	0.4	-1.0	0.5	0.3	0.1
	inc deg T	53.5	51.8	41.4	35.0	35.9
	pha deg G	296.1	306.4	302.4	312.5	309.3
K1	maj cm/s	2.5	2.5	2.0	1.8	2.0
	min cm/s	-0.3	-0.9	-0.1	-0.1	-0.1
	inc deg T	45.1	39.4	37.7	37.7	22.9
	pha deg G	85.2	65.7	82.6	82.6	101.2

than M2. Consistent with measurements elsewhere in the Bay, the N2 current is comparable to the S2 current. Thus while the average tidal strength at the upper instrument is 26 cm/s, apogean-neap tides will be up to 40% weaker at 16 cm/s and perigean-spring tides will be up to 40% stronger at 36 cm/s.

The average tidal current conditions can be obtained by combining M2 and its harmonics M4, M6, and M8. The resulting currents at each instrument are listed in Table 4-IV for each half lunar hour (0 lunar hours is the moon's passage over Greenwich). From the table, it can be seen that the harmonics create asymmetry in the flow: a weaker ebb of longer duration is followed by a stronger flood of shorter duration. The table also shows that the maximum ebb arrives sooner at the lower instrument and veers counterclockwise relative to the current at the middle instruments, consistent with simple rotational boundary layer theory (e.g., Tee, 1979). The observed 50% reduction in speed between the upper and lower instruments is too much shear to be explained by vertical structure models for homogeneous conditions, however, suggesting the presence of stratification. It is expected that during the winter well-mixed conditions that the vertical tidal structure at Salters Point would show a decreased shear and phase lag between the upper and lower instruments, resulting in differences of approximately 10% in the tidal ellipse parameters.

Table 4-IV
 AVERAGE TIDAL CURRENTS AT THE UPPER, MIDDLE AND
 LOWER SALTERS POINT INSTRUMENTS OVER THE
 SEMI-DIURNAL TIDAL CYCLE (12 LUNAR HOURS)

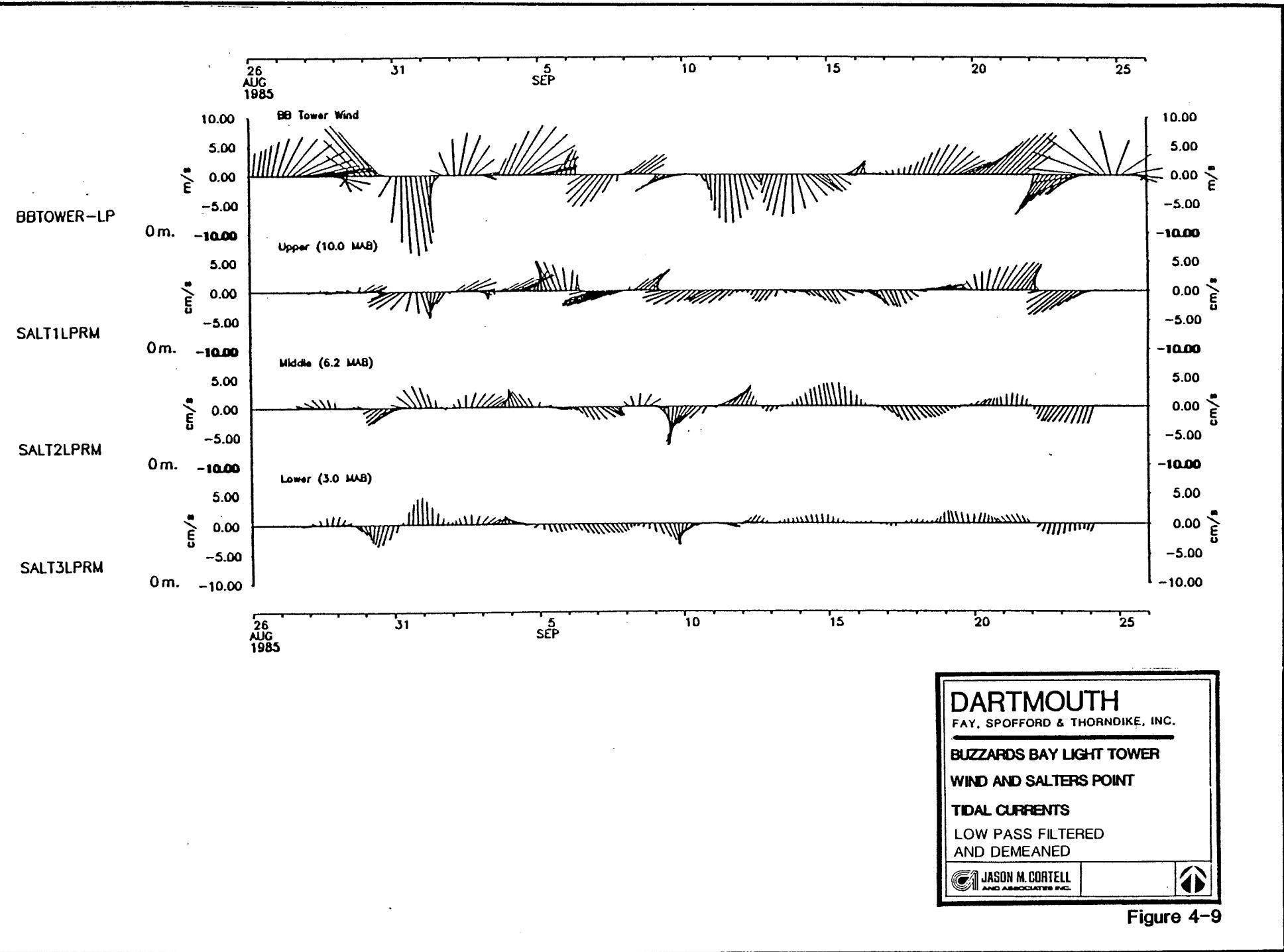
Lunar Hour	Upper		Middle		Lower	
	Speed (cm/s)	Direction (°T)	Speed (cm/s)	Direction (°T)	Speed (cm/s)	Direction (°T)
0.0	11.8	56.7	9.7	54.8	5.5	20.8
0.5	0.2	96.7	0.6	33.0	3.2	285.9
1.0	9.1	229.5	7.8	242.9	7.7	235.5
1.5	15.1	224.2	13.7	241.2	10.9	235.5
2.0	19.0	219.4	17.1	237.7	12.0	226.5
2.5	22.0	218.0	18.8	233.2	12.2	217.9
3.0	24.6	220.1	19.7	229.8	12.1	212.6
4.0	24.9	226.2	18.1	230.0	10.9	214.4
4.5	21.2	227.5	15.0	230.6	8.8	216.2
5.0	15.9	228.6	10.6	227.7	5.7	213.0
5.5	10.5	232.3	6.2	215.3	2.7	190.2
6.0	6.3	244.6	3.4	181.6	2.0	121.1
7.0	2.9	324.5	3.1	102.7	2.7	82.0
7.5	4.6	14.0	3.9	79.4	2.7	70.1
8.0	8.3	32.0	5.8	64.5	3.4	54.9
8.5	13.1	36.6	8.9	55.4	5.3	45.0
9.0	18.9	38.4	13.1	49.0	8.1	40.1
10.0	30.2	45.5	22.1	43.5	14.0	37.1
10.5	32.7	50.0	24.2	44.6	15.3	37.3
11.0	30.5	53.7	22.9	47.6	14.4	37.3
11.5	23.0	56.0	17.8	51.4	10.9	34.9

4.1.8 Wind Driven Currents at Salters Point

While power spectra of currents are dominated by energy in the tidal bands, there are significant contributions in the longer period range from 2-10 days, the synoptic weather band (Figures 4-6, 4-7, and 4-8). This is consistent with current spectra obtained from the similarly located WHOI instruments in 1984 (Signell, 1987).

To remove the tidal signal, the wind and current time series were low-pass filtered with a half-power point at 33 hours. Since the mean current was determined not to be the result of the mean wind, the means were also removed before analysis. These low-passed demeaned winds and currents are shown in Figure 4-9. From the vector time series, it is apparent that subtle changes in the wind direction have a marked influence on the wind-driven current response. When the wind blows from the north to northeast as on September 22-24, the response is downwind at all instruments. When the wind shifts from north to northeast, the lower two instruments display an upwind response, as on August 31 and September 11. This response may be explained simply in terms of the basin geometry.

When the wind blows along the Bay from the northeast, the proposed outfall site, at 12.5 m water depth, is shallow compared to the average depth of the cross-section. Thus the wind drives a downwind response at all instruments, and the downwind transport is returned in the deeper central part of the Bay. When the wind blows



across the Bay from the northeast, however, the water driven offshore by the surface wind stress must be returned at depth, thus creating an upwind transport at the middle and lower instruments. This same argument explains the observed downwind response at all levels to the southwest wind, and the downwind surface/upwind bottom response to southeast winds.

To quantify the response to wind, the complex correlation between the low-passed currents and winds was calculated. The only instrument significantly correlated at the 95% significance level was the upper instrument, which showed a response of 3.7 cm s^{-1} per 10.0 m s^{-1} of wind rotated 12° to the right of the wind. It is reasonable that the middle and lower instruments were uncorrelated due to the fluctuating upwind/downwind nature of their response.

4.1.9 Mean Circulation at Salters Point

The mean circulation at the Salters Point moorings can not be explained by the mean wind, as the mean wind is not significantly different from zero. Thus the forcing must be due to density driving or rectification of tidal currents. As previously mentioned, observed gradients in Buzzards Bay have been too weak to support mean currents above 1 cm/s magnitude. In addition, the proximity of the mooring to two prominent headlands, Round Hill and Mishauum Point, suggests that tidal rectification should be important. Indeed, Figure 4-3 shows that the depth-averaged numerical tidal model predicts

an onshore flow at Salters Point as the result of tidal rectification around Round Hill and Mishauum Points. The residual current magnitude and direction from the middle and lower instruments were consistent with the numerical prediction: they also agree reasonable well with the means obtained from the WHOI mooring 812. The cause for the down-bay mean at the surface mooring is not clear. No reliable hydrographic information exists for the period, so local density driving cannot be ruled out simply on the basis of historical hydrographic measurements. It is also possible that three-dimensional tidal rectification effects are present.

4.1.10 Conclusion

The circulation of Buzzards Bay and the Salters Point region has been reviewed to determine whether the measurements made in August through October, 1985, at the outfall site near Salters Point, were representative of conditions throughout the year. Since Salters Point is located in Buzzards Bay, the circulation there is directly related to circulation in Buzzards Bay proper.

An analysis of hydrographic conditions shows that while vertical stratification may occur in the Bay and, specifically at Salters Point, from April to September, 1985 the impact would be to modulate the primary flow induced by other mechanisms, particularly the tides. From both the Salters Point current meter measurements and those by WHOI for longer periods, the tides, and particularly the M_2 , is the predominant driving mechanism in the

Bay. The largest temporal variation in the tides, up to 50% of the mean M_2 component, is due to astronomical effects of the moon's perigee/apogee cycle of 27.6 days and the spring/neap cycle of 14.8 days. The strength of various tidal constituents is similar between the currents measured at Salters Point and those measured further offshore in Buzzards Bay for longer times supporting the contention that there is little spatial variability.

The winds also induce flow in Buzzards Bay and the Salters Point area. In general, they drive water downwind, towards the northeast in summer along the axis of the bay and towards the southeast in winter across the axis of the bay. Spectral analysis in the 2-10 day weather band of the currents measured at Salters Point are consistent with spectra from other current meters, thus supporting this conclusion.

The mean circulation at Salters Point is also consistent with the WHOI measurements at a nearby location. Tidal rectification due to the proximity of the two prominent headlands, Round Hill and Mishauum Point, suggests an onshore flow at Salters Point which is seen at both the middle and lower current meters. The cause of mean offshore flow at the surface meter is unknown.

4.2 Description of The Outfall

The present outfall is located approximately 900 m (3,000 ft) south-southeast of Salters Point and 800 m (2,600 ft) east of the Mishauum Point peninsula.

The outfall structure consists of a 0.6 m (2 ft) pipe, raised to an angle of 45 degrees from the horizontal, with a single outlet port at its culmination. The outlet port is surrounded by stone riprap, approximately 2.8 m (9 ft) in the direction of flow and to either side and 2.4 m (8 ft) behind. The port is elevated 0.3 m (1 ft) above the existing bottom and submerged 6 m (20 ft) below mean sea level.

Over the year from July, 1985 through June, 1986 the monthly median of the total daily flowrate was 0.072 m³/s (1.64 mgd), as recorded in the monthly reports of the wastewater treatment plant. The maximum total daily flowrate recorded was 0.238 m/s (5.44 mgd). From the flowrates given above, the average exit velocity of the effluent is approximately 0.25 m/s (0.81 ft/s) with a maximum of 0.82 m/s (2.68 ft/s).

The concentration of BOD in the effluent, also for the year from July 1985 through June 1986, had a range of 8 mg/l to 70 mg/l. The yearly average of the monthly minimums was 15.4 mg/l and monthly maximums was 27.7 mg/l. In addition, the yearlong average of monthly averages yielded a concentration of 21.1 mg/l.

The dissolved oxygen content of the effluent ranged from a low monthly average concentration of 1.0 mg/l to a high of 3.0 mg/l, with an average of 2.0 mg/l.

4.3 Dilution Analysis

The approach used in examining the wastewater effluent distribution was to determine the dilution as the discharge mixes with ambient seawater at various locations in the plume. When the effluent is ejected from the underwater outfall, it is assumed that its quality is the same as when it left the treatment facility. The effluent forms a buoyant plume; owing to the difference in salinity and temperature relative to the ambient receiving water, and rises toward the surface, growing in size and decreasing in concentration. The size of the plume and concentration of the effluent in the plume are dependent on a number of parameters which will be discussed below. This plume growth occurs in the near field which is usually defined as the volume of water close to the outfall where the dynamics of the outfall predominate over the dynamics of the receiving water. The near field analysis consists of predicting the dilution and location of the plume of waste water as it exits from the outfall port until it reaches either the water surface or an equilibrium depth.

Various approaches to this analysis can be taken, but the more accurate and complete methods use computerized numerical models. Once the plume has reached the surface or an equilibrium height, the near field analysis is no longer appropriate. It is at this point, when the plume has lost its momentum, that the far field analysis is begun. Any further dilution is accomplished by advection and diffusion in the receiving waters. The effluent concentration is then tracked until it becomes negligible.

4.3.1 Near Field Analysis

The model chosen for the near field analysis of the Salters Point outfall is UMERGE (Schuldt et al, 1985). The model calculates the dynamics of multiple adjacent plumes in a stratified flowing ambient environment. Developmental stages of the model have been reported at various times (Winiarski and Frick, 1976 and 1978; Frick, 1981, 1984). The EPA now recommends UMERGE as one of five initial dilution models for use in water quality assessment in connection with discharges to a marine environment.

The model is a two-dimensional Lagrangian analysis of a continuous plume. It predicts the trajectory and dilution of a single plume element as it develops by entraining ambient water. The plume is considered to have a circular cross-section everywhere and an element is, in general, a section of a bent cone. Following Frick (1981) the basic conservation equations solved in UMERGE can be written as follows:

Horizontal Momentum

$$\frac{dmu}{dt} = u_o \frac{dm}{dt} \quad (1)$$

Vertical Momentum

$$\frac{dmw}{dt} = m \frac{\rho_0 - \rho}{\rho} g \quad (2)$$

Energy

$$\frac{dmT}{dt} = T_0 \frac{dm}{dt} \quad (3)$$

Salt

$$\frac{dmS}{dt} = S_0 \frac{dm}{dt} \quad (4)$$

Continuity

$$\frac{dm}{dt} = 2\pi \rho_0 b h v_e + \rho_0 A u_0 \quad (5)$$

Where:

- m = element mass (kg)
- u = element horizontal velocity ($m \cdot s^{-1}$)
- u_0 = ambient horizontal velocity ($m \cdot s^{-1}$)
- w = element vertical velocity ($m \cdot s^{-1}$)
- ρ = element density ($kg \cdot m^{-3}$)
- ρ_0 = ambient density ($kg \cdot m^{-3}$)
- S = element salinity ($g \cdot kg^{-1}$)
- S_0 = ambient salinity ($g \cdot kg^{-1}$)
- T = element temperature ($^{\circ}C$)
- T_0 = ambient temperature ($^{\circ}C$)
- b = element radius (m)
- h = element length (m)

v_e = entrainment velocity ($\text{m}\cdot\text{s}^{-1}$)

g = gravity ($\text{m}\cdot\text{s}^{-2}$)

A = projected area of element normal to current (m^2)

Assumptions inherent in the model include:

- Fluid is incompressible.
- Ambient conditions vary over the vertical but are steady and are largely undisturbed by the presence of the plume.
- All fluid impinging on the projected area of the plume is entrained.
- Adjacent plumes do not change any plume element properties except for plume radius.
- An empirical equation of state relates density to salinity and temperature.
- The model calculates average plume properties.
- The initial plume velocity is assumed to be perpendicular to the ambient current.
- Specific heat is considered to be constant over the range of temperatures observed in the system.
- There is no port to port variation in effluent characteristics.

Two mechanisms for entrainment are considered in UMERGE. They are forced and aspiration entrainment, and are considered additive quantities based on superimposed flow fields. Forced entrainment is due to the impingement of current on the plume. This form of entrainment reduces to zero in the absence of an ambient current. Aspiration entrainment is calculated as a product of the plume surface area and its shear velocity and occurs regardless of the presence of an ambient current. The flow field created by the aspiration entrainment is radial and directed inward, towards the center of the plume.

The relative magnitudes of forced and aspiration entrainment vary greatly as ambient current increases. At zero ambient current, entrainment is due solely to aspiration but is rapidly dominated by impingement as ambient current increases. The interdependence of these two mechanisms is of particular importance at low ambient velocities where their respective contributions are comparable. In order to represent this interdependence, the calculated flow fields of the aspiration and the forced entrainment are superimposed and the total entrainment may then be pictured as fluid flowing through a single, larger projected area. This method is better than simply adding the two entrainment values or choosing the larger of the two.

The superposition of the two flow fields is reflected in the calculation of the projected area, A, and the entrainment velocity, v_e , which appear in the continuity equation. The continuity

equation simply states that the rate of change of the plume element mass is strictly determined by entrainment.

The model calculation cycle starts with either specified initial conditions at the diffuser port or values from a previous timestep. The continuity equation is first used to estimate the additional entrained mass. The first term on the right hand side of Equation 5 defines the increase in aspirated mass while the second term defines the mass flowing into the projected element area. Conservation of horizontal momentum (Equation 1) is then used to calculate the new time horizontal velocity. This velocity is the weighted average horizontal velocity of both the plume element mass and the entrained mass. The reason for this can be seen from the horizontal momentum equation which states that the rate of change of the horizontal momentum is equal to the ambient velocity multiplied by the entrained mass, and would consequently be zero in the absence of entrainment. Another way to view this is to state that the plume horizontal momentum is constant except for the momentum carried by the entrained mass. The new time temperature and salinity (Equations 3 and 4) are also determined as weighted averages in a manner similar to the horizontal momentum.

An equation of state provides new time density, which in turn is used to estimate the new vertical velocity through conservation of vertical momentum (Equation 2), again as a weighted average. The new position of the plume element is then calculated

along with the new radius and length. The new radius is calculated from the new total mass, the plume density and the element length. The new element length is calculated from the difference between the velocity of element leading face and that of element trailing face and the old element length. A check is made to see if adjacent plumes are overlapping and, if so, the plume volume is adjusted so that element mass is distributed away from the line of ports.

The solution is considered to be constant in time describing a continuous, flowing plume. The equations are integrated in time only to determine the plume location, relative to the output port. Computations cease when the plume either breaks the surface or attains a stagnant equilibrium below the surface and will rise no more. No surface effects are included in the analysis.

Model input is required to describe both the ambient environment and the outfall characteristics. Figure 4-10 illustrates the parameters in relation to a typical plume release. The environmental parameters include ambient current, temperature and salinity or density. The quantities are entered in the form of a profile in the vertical, making the analysis of a wide variety of ambient conditions possible. The stratification parameter thus emerges as a function of environmental conditions rather than a single hypothetical input parameter. The outfall parameters include port angle, diameter, spacing, depth, and number of ports in addition to the effluent volume flowrate, temperature and salinity or density.

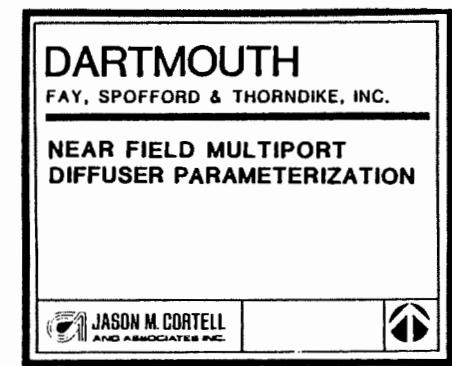
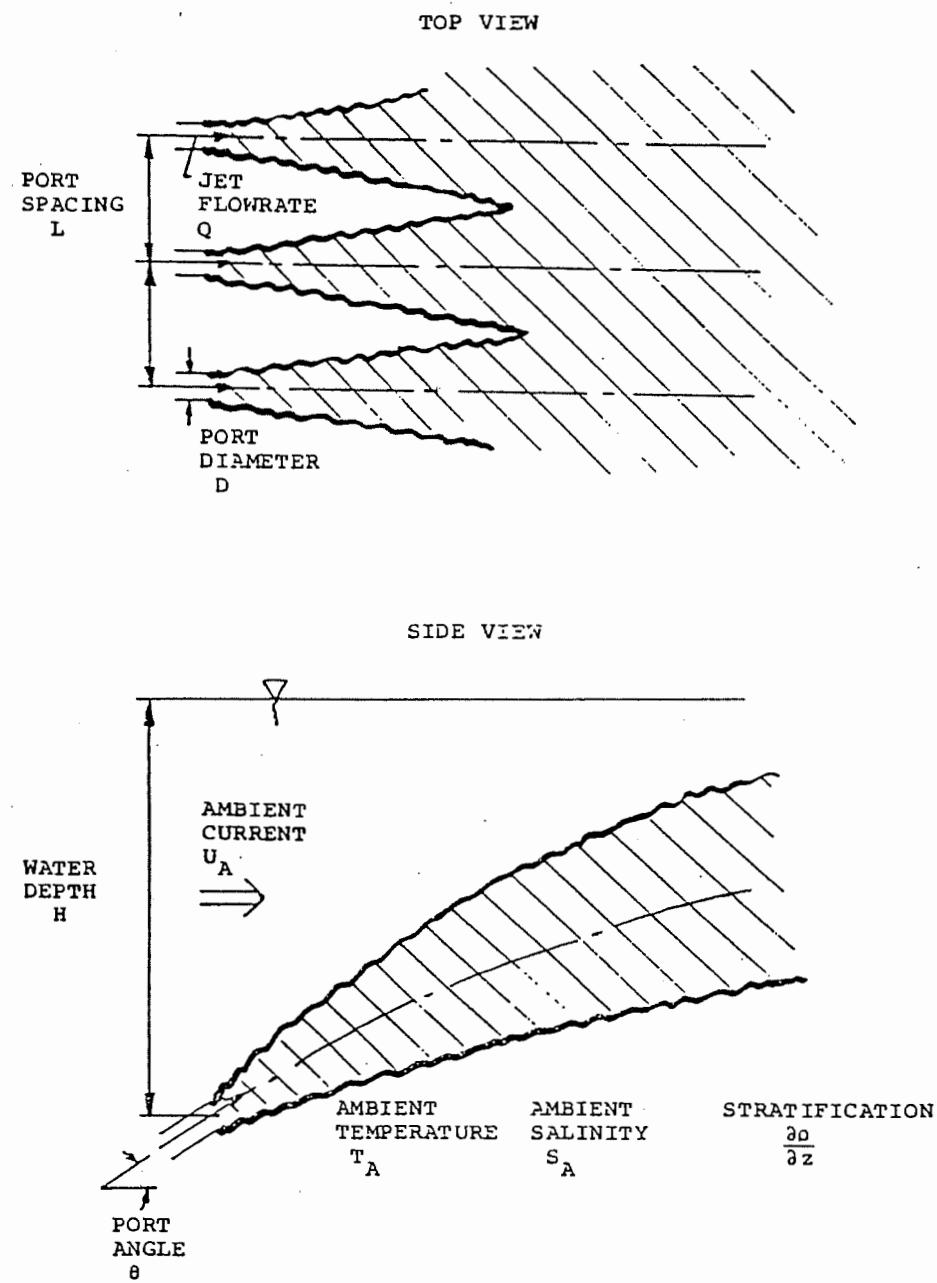


Figure 4-10

A parametric analysis varying both the environmental and outfall parameters was undertaken, both in conjunction with the present design and possible future design modifications. A listing of the base or mean condition and the range for the parameters is shown in Table 4-V. A description of each follows.

Ambient Current: Both the direct current measurements (Camp Dresser & McKee, Inc. 1983; U.S. Coast and Geodetic Survey, 1971) including measurements made by Ocean Surveys Inc. for this study and computer model studies (Beauchamp and Spaulding 1979) indicate tidal current speeds in the area varying between zero and 0.6 m/s (2 ft/s) with a general flow toward the northeast on flood and southwest on ebb. The effect of ambient current on a plume is to deflect it downstream, thereby increasing its effective length and allowing more time for dilution before surfacing. For this reason, a worst case of zero flow was used as the base case.

Ambient Temperature: Data from the region (Camp Dresser & McKee, Inc. 1983; Rosenfeld et al, 1984; Driscoll, 1975) including measurements made by JMCA for this study indicate variation of the ambient water temperature, in the vicinity of the outfall, from approximately 0°C (32°F) to 24°C (75.2°F) with a mean of 11.29°C (52.3°F). The mean temperature was used as the base condition.

Table 4-V
BASE CONDITION AND RANGE OF
NEAR FIELD PLUME MODEL PARAMETERS

<u>VARIABLE</u>	<u>BASE CONDITION</u>	<u>RANGE</u>
AMBIENT CURRENT U_A	0.0 m/s (0.0 ft/s)	0 - 0.6 m/s (0 - 2.6 ft/s)
AMBIENT TEMPERATURE T_A	11.29°C (52.3°F)	0 - 25°C (32 - 77°F)
AMBIENT SALINITY S_A	31.2 ppt	26-32 ppt
STRATIFICATION $\Delta \rho / \Delta Z$	0.0 kg/m ³ /m (0.0 slug/ft ³ /ft)	0.0 - -0.5 kg/m ³ /m (0.0 - -0.3 x 10 ⁻³ slug/ft ³ /ft)
JET AMBIENT TEMPERATURE T	15.3°C (59.5°F)	11/1 - 19.4°C (52 - 67°F)
JET FLOW Q	0.184 m ³ /s (4.2 mgd)	0.088 - 0.469 m ³ /s (2 - 10.7 mgd)
PORT ANGLE	45°	-
WATER DEPTH	6. m (20 ft)	-
PORT DIAMETER	0.6 m (2. ft)	-

Ambient Salinity: Data from the region, (Rosenfeld et al, 1984; Driscoll, 1975) including measurements made by JMCA for this study, show variation in salinity from approximately 29.5 ppt to 32.9 ppt with a mean of 31.2 ppt. The mean salinity was used as the base condition.

Ambient Stratification: Data from the region (Rosenfeld et al, 1984), including measurements made by JMCA for this study, show that for certain times a maximum stratification of approximately $-0.5 \text{ kg/m}^3/\text{m}$ ($-0.3 \times 10^{-3} \text{ slug/ft}^3/\text{ft}$) exists with the pycnocline at 4 m (13 ft) below the surface. Since the water is usually well mixed at this location, a base value of no stratification was used.

Port Angle: The orientation of the outfall ports relative to the horizontal can be important since the port imparts a direction to the momentum of the jet. Thus, buoyant jets pointing straight up (90°) will reach the surface more quickly than jets initially pointing horizontally (0°). A port angle of 0° is not usually implemented since the jet can potentially scour and resuspend sediments from the bottom. The present outfall consists of a single port at an angle of 45° from the horizontal. An angle of 45° was therefore chosen as the base condition.

Number of Ports: The number of ports along with the port diameter determine the port exit velocity. The port exit velocity is one of

the critical parameters in the use of UMERGE for dilution analyses. Since UMERGE assumes an equal volumetric flow rate through each port, the exit velocity is strictly dependent on the number of ports and port diameter once the volume flux has been specified. The base condition is the present outfall design of one port.

Port Diameter: The port diameter is the other factor controlling the flow out of the port. As stated above, the port diameter, in conjunction with the number of ports and the volumetric flow rate, strictly determines all port exit velocities. A base condition of 0.6 m (2 ft), the present size, was used.

Port Spacing: For a multiple port analysis the distance between adjacent ports can be important in the merging zone where adjacent plumes entrain each other thus reducing the dilution. The optimum spacing would be such that merging occurs only when the plume reaches the surface. This parameter is ignored in the single port analysis presented here.

Port Depth: The depth of water from the discharge port to the surface strongly affects the dilution, where the deeper the water the higher the dilution. The effective water depth of the present outfall is 6 m (20 ft).

Effluent Temperature: From the wastewater treatment plant monthly reports, effluent temperature varies from 10°C (51°F) to 20°C

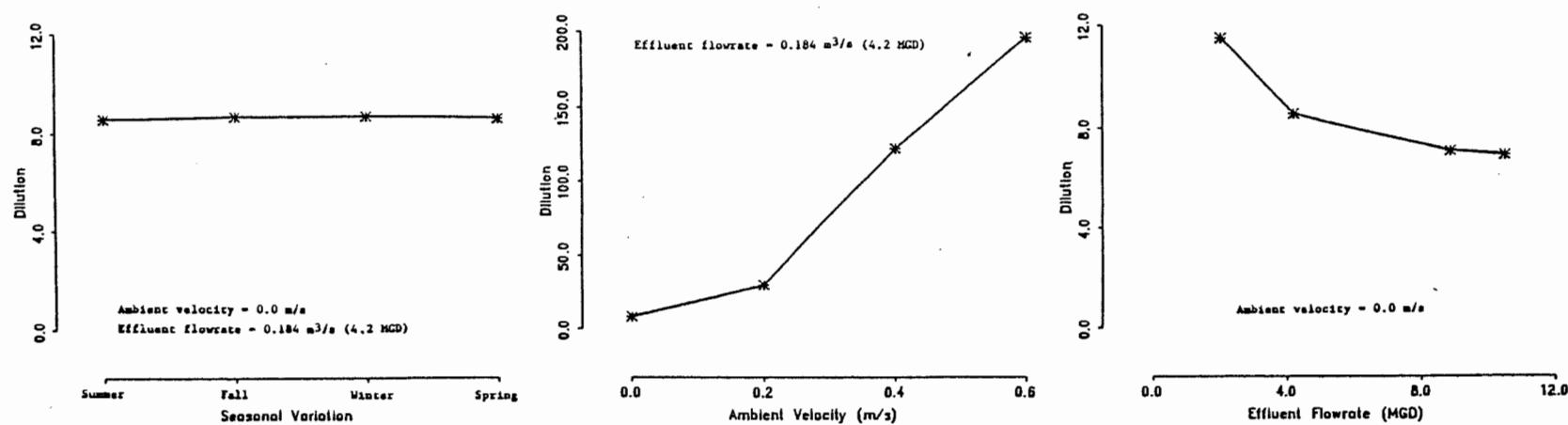
(68°F) depending on the season. The yearly average temperature of 15.3°C (59.5°F) was used as the base condition.

Effluent Flowrate: The upgrade design flowrate for the system is 0.184 m³/sec (4.2 mgd). Flow rates varying between 0.0876 m³/s (2 mgd) (present flowrate) and 0.469 m³/s (10.7 mgd) were also assessed for comparison, using the upgrade design flow rate as the base condition.

For each of the parameters the UMERGE model was run to predict the effluent plume dilution upon reaching the surface. One parameter was varied over its range while the others were held at the base condition. The results are plotted in Figure 4-11. The effluent plume dilution presented is the average plume dilution when the plume reaches the surface. Each set of port characteristics was analyzed to determine its individual effect on effluent plume dilution under base conditions.

For the variation of the environmental parameters, vertical property profiles for temperature and salinity from the data of Rosenfeld et al (1984), corresponding to the four seasons, were employed.

The first and most important parameter varied is the ambient current. All other parameters were held at the base condition. At zero velocity, or slack water conditions, the plume dilution upon reaching the surface is 8.52. As the ambient



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NEAR FIELD MODEL
PREDICTIONS OF
DILUTION vs. AMBIENT AND
EFFLUENT PARAMETERS

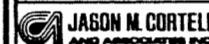


Figure 4-11

current velocity increases, the available water for dilution increases, which results in a rapid increase in the total plume dilution as shown in Figure 4-11. At the maximum observed current of 0.6 m/s (2 ft/s) the dilution reaches 197.

This procedure was repeated for each of the four seasonal variations in ambient conditions. The seasonal variation of dilution for the case of zero ambient velocity is presented in Figure 4-11, where its relative insignificance becomes apparent.

The stratification effects are therefore much less dramatic than the ambient current. Stratified conditions can impede or trap a buoyant plume as it rises to the surface. Under the conditions measured near the site, however, the stratification is insufficient to substantially decrease the dilution due to the large density difference between the plume and the ambient water.

The effects of salinity variation in the ambient waters are minimal in comparison to that of the salinity difference between the effluent and the ambient. Since the effluent is composed primarily of fresh water, the salinity is effectively negligible and the density is therefore approximately that of fresh water. This density difference and consequent buoyant forces, in conjunction with the vertical component of the initial exit momentum, are the vertical driving forces in the plume analysis. When the vertical momentum from the initial exit velocity becomes negligible, buoyancy is the only vertical driving force. Although temperature differences contribute

to the density difference, the effects are an order of magnitude smaller than those of the salinity, over the range under consideration.

The results of varying the discharge port flowrate are also shown in Figure 4-11. It can be seen that the proposed increase in the flow rate from 0.0876 m³/s (2.0 mgd) to 0.184 m³/s (4.2 mgd) corresponds to a decrease in initial plume dilution from 11.53 to 8.58. For higher flow rates the dilution is approximately 7.

In general the effluent plume dilution was 8 or greater, which for an output loading of 30 mg/l BOD₅ becomes 3.75 mg/l or less in the initial dilution stage. With this relatively small near field loading, additional far field dilution factors of 4 would bring the BOD₅ concentration down to less than 1 mg/l, which is less than background values of BOD found in the area and in similar estuarine situations, (Camp, Dresser and McKee, Inc., 1983; Metcalf and Eddy, 1984).

An assumed worst case analysis for fecal coliform bacteria (FC) is total failure of the wastewater treatment facility resulting in effluent concentrations equal to influent values of 10⁷ MPN/100 ml at a flow rate of 0.184 m³/s (4.2 mgd). With a near field dilution of 8 or greater the FC concentration becomes 1.25 x 10⁶ MPN/100 ml or less. Far field dilutions of 500 would be required to reach the FC upper limit for SC waters of 2,500 MPN/100 ml. Under the assumption that the total coliforms (TC) are 100 times more concentrated than FC's in the effluent, a far field dilution of 5.43 x 10⁵ is required to reach the TC upper limit for SA waters of 230 MPN/100 ml. The alternative

outfall location with a dilution of 19, would reduce the near field concentrations only marginally more than the present site.

4.3.2 Far Field Analysis

The purpose of the far field analysis is to estimate the ultimate mixing zone size for the treatment plant effluent. Both biochemical oxygen demand (BOD) and coliform bacteria were analysed as the water quality indicators. For BOD no distinction is made between that exerted by carbonaceous matter and that exerted by nitrogenous matter. This analysis includes the advection, diffusion, and decay of the BOD in the treatment plant effluent as well as the subsequent dissolved oxygen (DO) depletion due to the addition of the BOD into the ambient waters. The coliform analysis includes the advection, diffusion, and decay of the material in the ambient water.

A computer model system was utilized, in this case that described by Isaji and Spaulding (1978), and Coastal Resources Center (1977). The model system consists of a hydrodynamic model and a pollutant transport model. The vertically averaged conservation laws for water mass, momentum, and pollutant mass are solved by a finite element technique at each nodal point on a triangular grid as shown in Figure 4-12. The models are integrated over a series of timesteps to simulate a typical tidal cycle. Following Isaji and Spaulding (1978) the conservation of momentum components are:

$$\frac{\delta U}{\delta t} + U \frac{\delta U}{\delta x} + V \frac{\delta U}{\delta y} = fV - g \frac{\delta h}{\delta x} - \tau_{Bx}$$

$$\frac{\delta V}{\delta t} + U \frac{\delta V}{\delta x} + V \frac{\delta V}{\delta y} = -fU - g \frac{\delta h}{\delta y} - \tau_{By}$$

and the continuity equation is

$$\frac{\delta h}{\delta t} + \frac{\delta UH}{\delta x} + \frac{\delta VH}{\delta y} = 0$$

where

- h = surface elevation measured from mean sea level,
 d = local depth,
 H = total depth = $d + h$,
 U = x component of water velocity averaged over the total depth,
 V = y component of water velocity averaged over the total depth,
 f = Coriolis parameter = $2 \cdot \Omega \cdot \sin(\theta)$, in which
= angular rotation rate = $7.272 \times 10^{-5} \text{ s}^{-1}$
= latitude,
 g = gravitational acceleration,
and
- $$\tau_{Bx} = \frac{g U (U^2 + V^2)^{1/2}}{C_z^2 H}$$
- $$\tau_{By} = \frac{g V (U^2 + V^2)^{1/2}}{C_z^2 H}$$

in which

C_z = Chezy relation = $H^{1/6}/M$

M = Manning friction factor

At open boundaries the tidal elevation is prescribed while at land boundaries the normal component of velocity is zero. The assumptions implicit in the hydrodynamic model are:

1. Velocities are depth averaged.
2. Water is incompressible.
3. Density is uniform.

4. Viscosity in the water column is negligible.
5. Bottom stresses can be parameterized by a quadratic law.
6. Hydrostatic approximation is valid.

The tides, and specifically the M2 tide, are the predominant driving mechanisms inducing circulation in the Bay. The other mechanisms, including winds and density gradients, are smaller in magnitude relative to the tidal velocities (Spaulding and Gordon, 1982; Beauchamp, 1978).

The tidal model of Southern New England Bight, including Buzzards Bay, presented by Spaulding and Gordon (1982) compared quite favorably with available field observations (U.S. Coast and Geodetic Survey, 1977; Haight, 1936). The present hydrodynamic model was thus driven by tidal elevations at the east, south, and west boundaries taken from the results of Spaulding and Gordon. The model predicted tidal current roses are shown in Figure 4-13 and are consistent with available field observations. The tidal roses show current speed and direction for every two hours over the M2 tidal cycle. In many cases the roses degenerate to a straight line indicating a rectilinear flood and ebb condition. At the outfall site, the flow is toward the north northeast on flood and south southwest on ebb tide. A typical tidal cycle of data is then utilized in a repeated manner to drive the pollutant transport model.

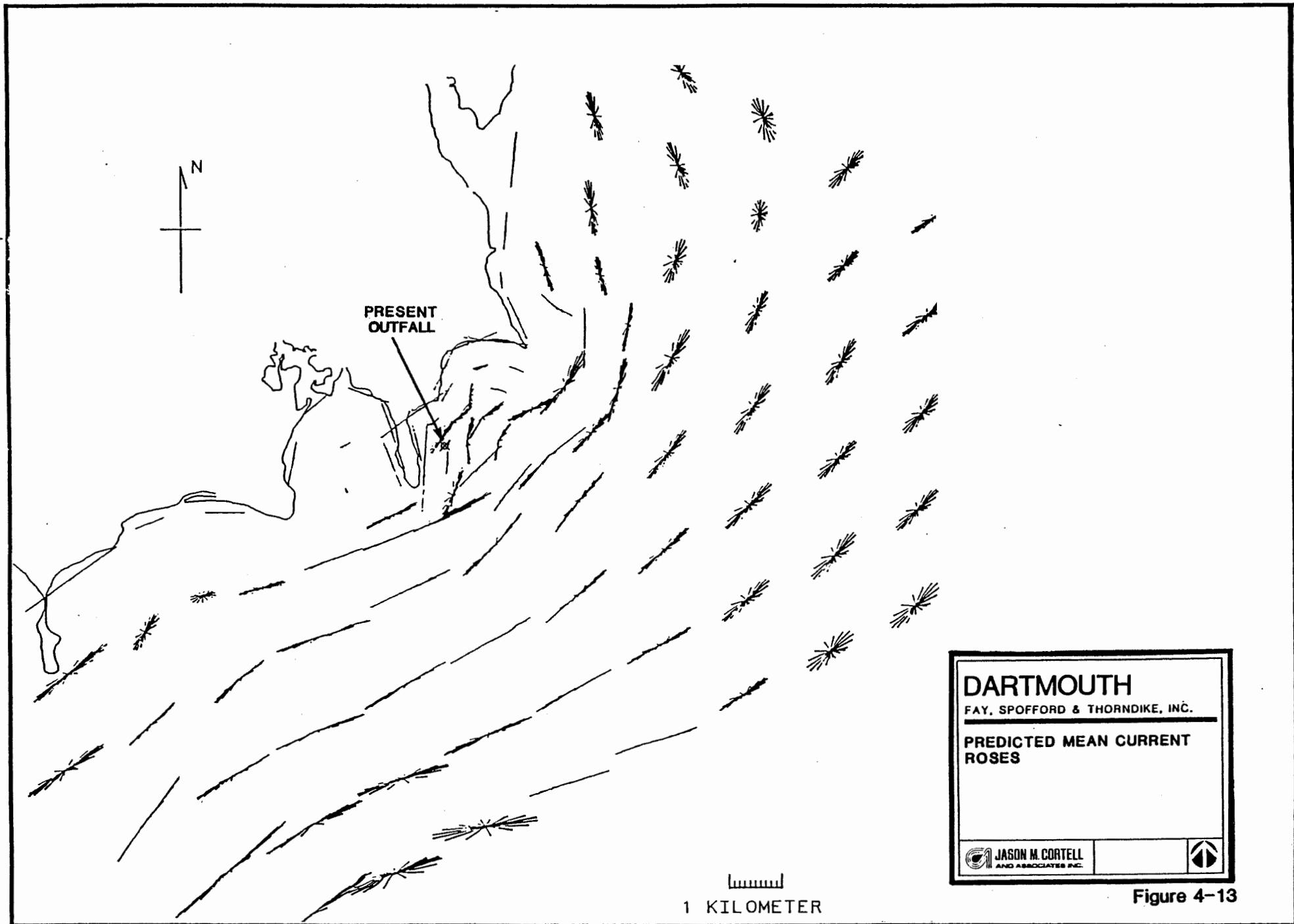


Figure 4-13

Alternatively, for coliforms with first order decay, C becomes the coliform concentration, either fecal or total, and $S = -KC$, where K is the decay rate.

At open boundaries, zero concentration gradients are specified on outflow and zero concentration is specified on inflow while at land boundaries, zero concentration gradients in the normal direction are specified. Assumptions include the following:

1. The calculated concentration is averaged over a mixed water layer thickness that is specified apriori.
2. The density change either in the ambient or due to the inclusion of the constituent is negligible.
3. All constituent diffusivities are included in the diffusion coefficient.
4. The initial dissolved oxygen deficit is zero.

The inputs required for the pollutant transport model, besides the tidal hydrodynamics, are the horizontal diffusion rate, the mixing depth, the BOD oxidation rate, the DO reaeration rate, the BOD settling rate, and the coliform decay rate. Using an empirical formulation based on water depth and tidal velocity (Harleman, 1966),

$$D = \frac{1.86 g^{1/2} (U^2 + V^2)^{1/2}}{C_z} H$$

a value of $2 \text{ m}^2/\text{s}$ ($22 \text{ ft}^2/\text{s}$) was calculated for the diffusion coefficient. This value was halved as a conservative estimate, so a value of $D = 1 \text{ m}^2/\text{s}$ was employed for all simulations.

The mixing depth is the effective depth of water over which the pollutant can mix vertically and is usually taken as the water column depth or depth to the pycnocline. The pycnocline, when present, is typically 4 m (13 ft) in the vicinity of Salters Point (Rosenfeld et al, 1984). Assuming that the mixing depth extends only to the pycnocline is a conservative assumption that ignores the smaller but finite rate of effluent mixing across this density gradient. It should be emphasized that the water column in the area is usually well mixed and, even in the summer when stratification may occur, it is normally quite modest. A value of 3 m (10 ft) for the mixing depth was employed as a conservative estimate.

From the literature (Environmental Protection Agency, 1985; Nemerow, 1985; Spaulding et al, 1974) experimentally determined values of the BOD oxidation rate, K_1 , ranging from 0.06 to 0.25, (in units of day $^{-1}$) were reported. The oxidation rate, K_1 , of the BOD analysis, is also the rate at which the oxygen demand is exerted in the DO analysis. Therefore, larger values of K_1 increase the rate of oxygen demand in the DO analysis but decrease the values of residual BOD (from the BOD analysis) on which it acts. A value of 0.1 day $^{-1}$ for K_1 was selected as typical of estuarine situations.

The reaeration rate, K_2 , is a ratio of a mass transfer coefficient, K_1 , to the local depth of the estuary, H ,

$$K_2 = K_1/H$$

It can be seen from the equation of conservation of mass that the reaeration, or the depth averaged flux of dissolved oxygen across the water surface, is the product of K_2 and the DO deficit concentration. From the application of O'Connor et al, (1981) to the New York Bight a value of 1 m/day (3 ft/day) for the mass transfer coefficient was chosen. Although many complicated empirical correlations are available for the calculation of the reaeration coefficient, most involve factors such as wind speed and molecular diffusivity. It is felt that for the tidal analysis at hand the given transfer coefficient is sufficient.

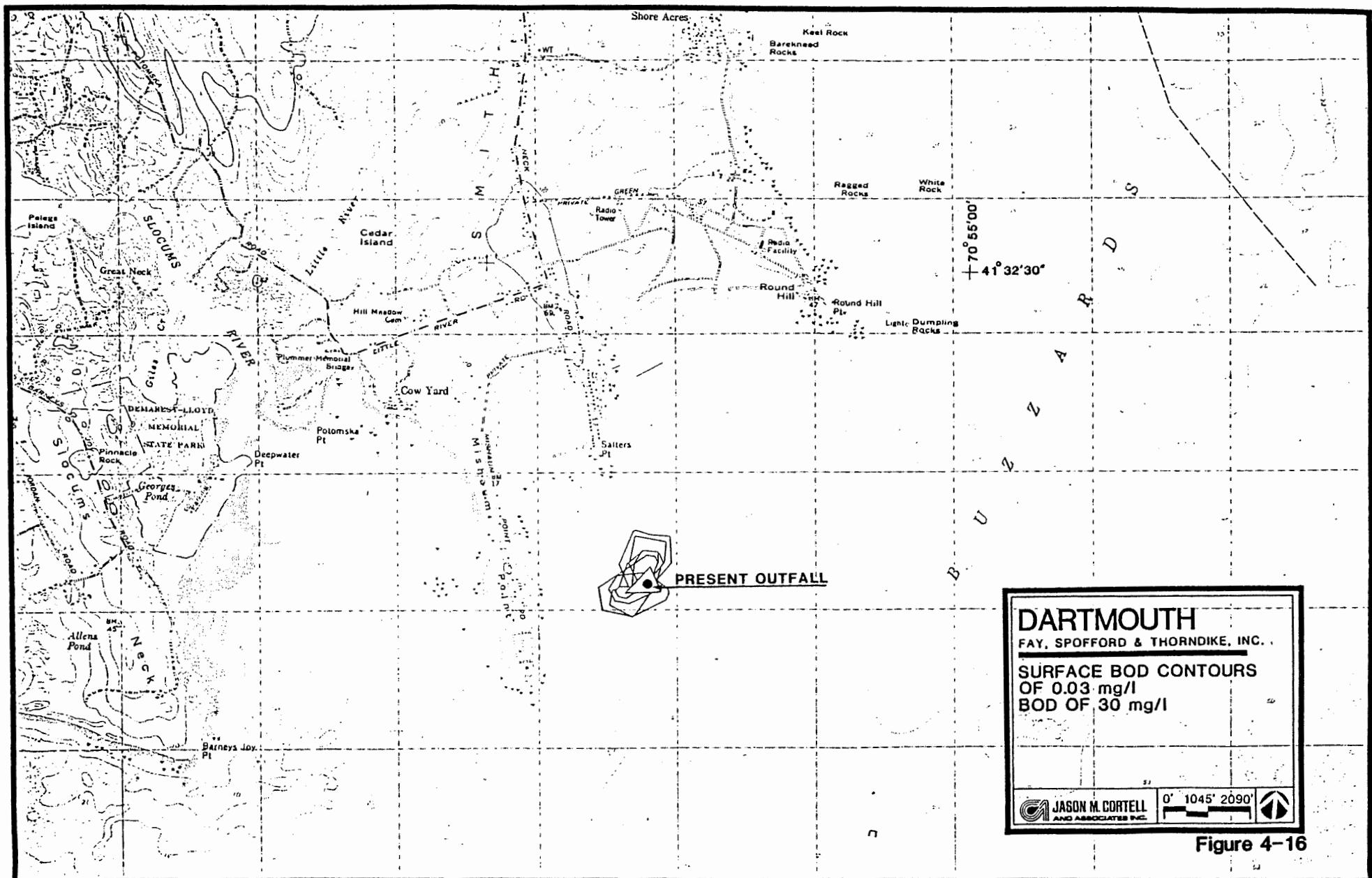
For the settling rate, K_3 , in the BOD equation a value of zero was selected, for a worst case of no settling. The value for coliform decay rate will be discussed later in this section.

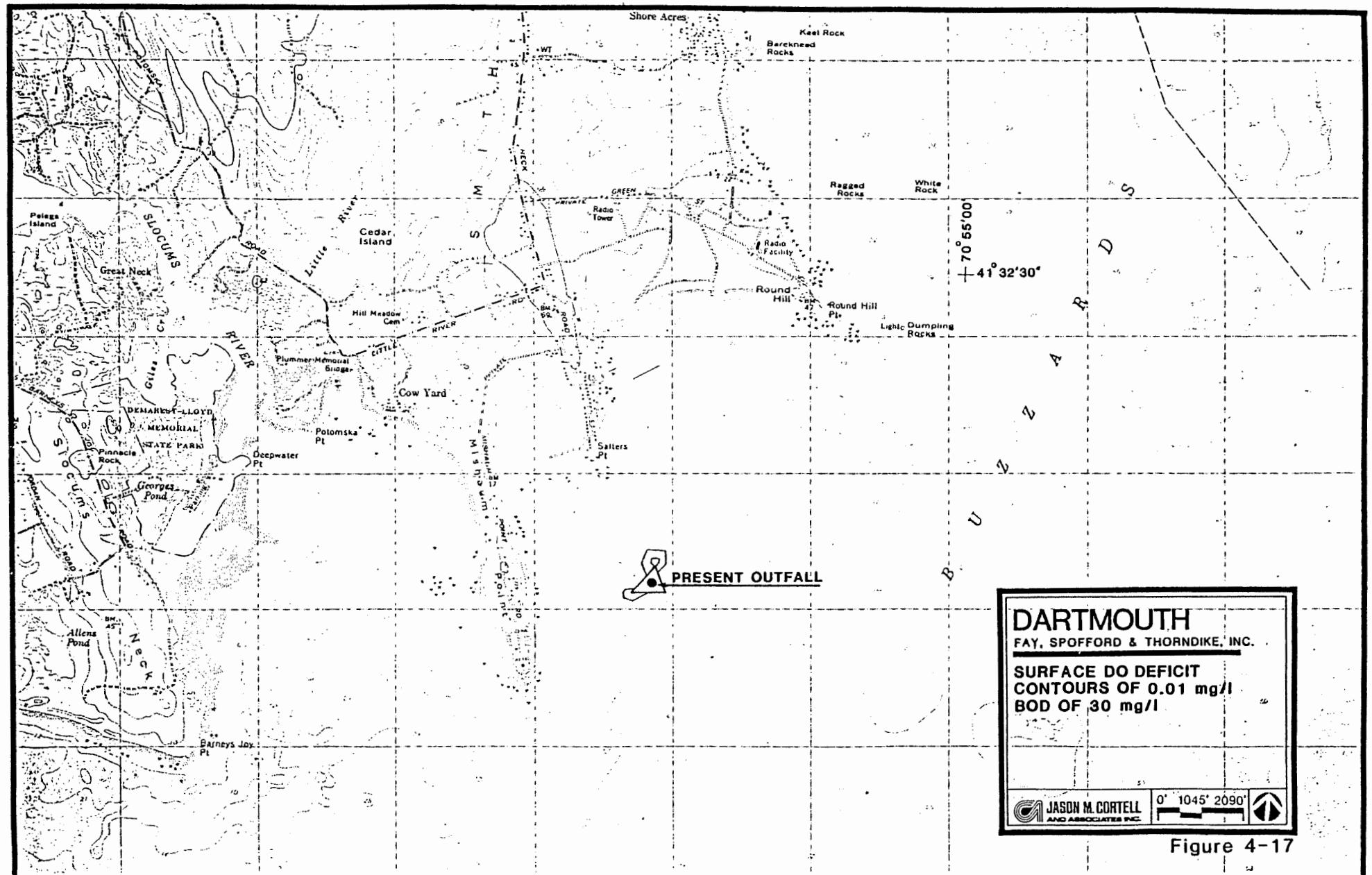
The pollutant transport model was run for two BOD cases. The first case monitored the transport, diffusion, dispersion and decay of the BOD added to the environment as a direct result of the effluent input. The second case monitored the DO deficit created by 1) the transport, diffusion and dispersion of the effluent DO deficit and 2) the BOD exertion applied by the superposition of the spatial BOD concentration, over a typical tidal cycle, as calculated in the first case. For both cases the source strength was maintained as a

constant with a maximum flow rate of $0.184 \text{ m}^3/\text{sec}$ (4.2 mgd), corresponding to that of the proposed upgrade. The effluent BOD concentration used in the simulation was the design, average daily load of 30 mg/l. For the effluent DO deficit loading an average daily DO deficit of 8 mg/l was derived from a yearly average ambient saturation DO value of 9 mg/l and a conservative effluent DO value of 1 mg/l (from the monthly reports of the wastewater treatment plant).

The results for the BOD effluent simulation are shown in Figure 4-16. The contours display the extent of the 0.03 mg/l concentration limit (representing 1,000 to 1 dilution) at approximately 2 hour intervals over one tidal cycle. Surface area coverage of the contours shown, range from a maximum of $112,000 \text{ m}^2$ (27.66 acres) to a minimum of $19,500 \text{ m}^2$ (4.82 acres). The triangular shape of some of the contours is due to the finite element discretization. The marker at the center of the triangle corresponds to the location of the outfall and the effluent input location for the model. Concentrations greater than 0.05 mg/l are all contained within the input element.

The results of the DO analysis are shown in Figures 4-17 and 4-18. In Figure 4-17, the contours represent the extent of the area of a dissolved oxygen depletion of 0.01 mg/l, due to the effluent DO depression as well as the effluent BOD-DO reaction. Note that the BOD concentrations obtained in the previous BOD analysis were used in the BOD-DO exertion here. Dissolved oxygen





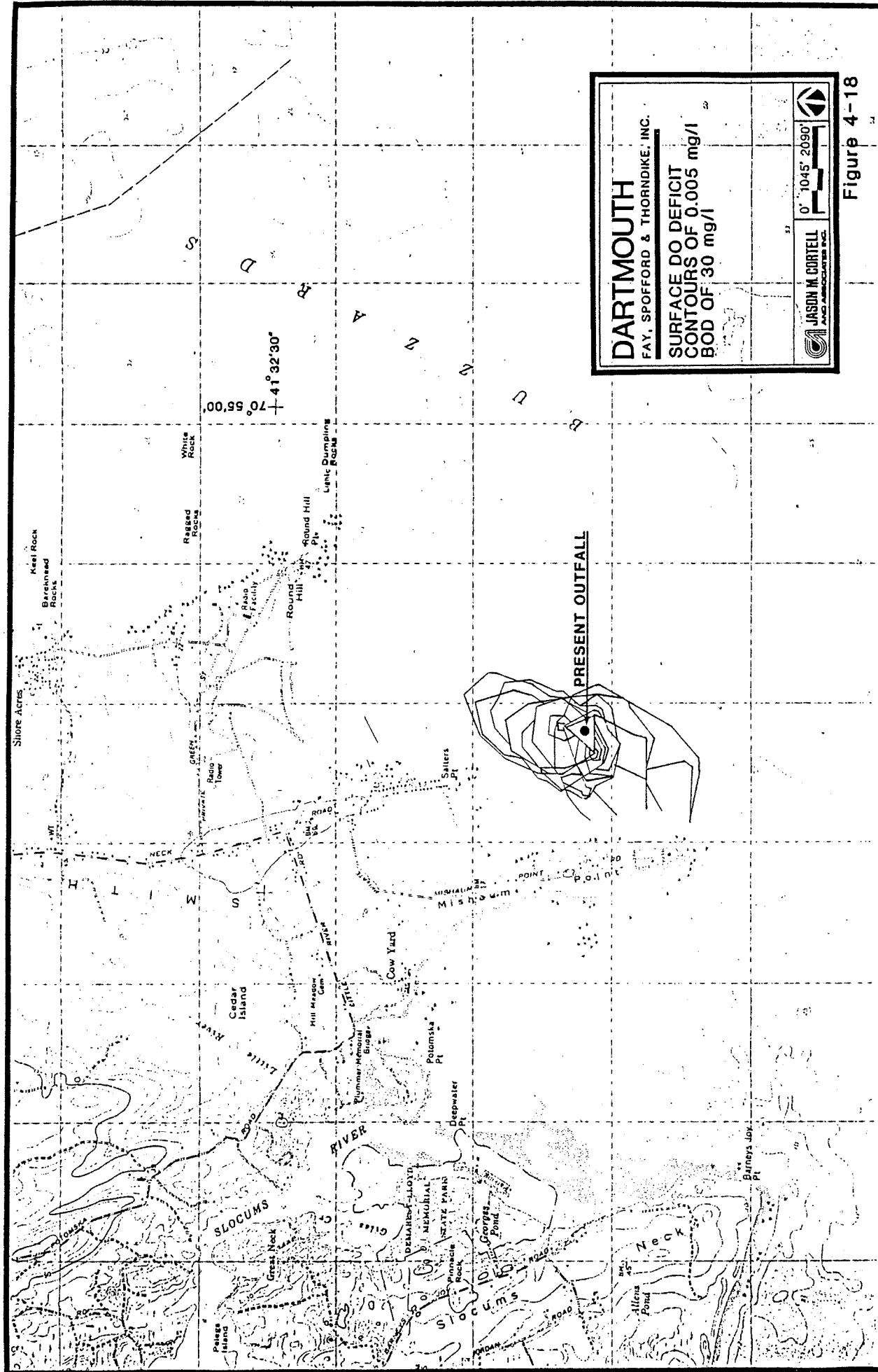
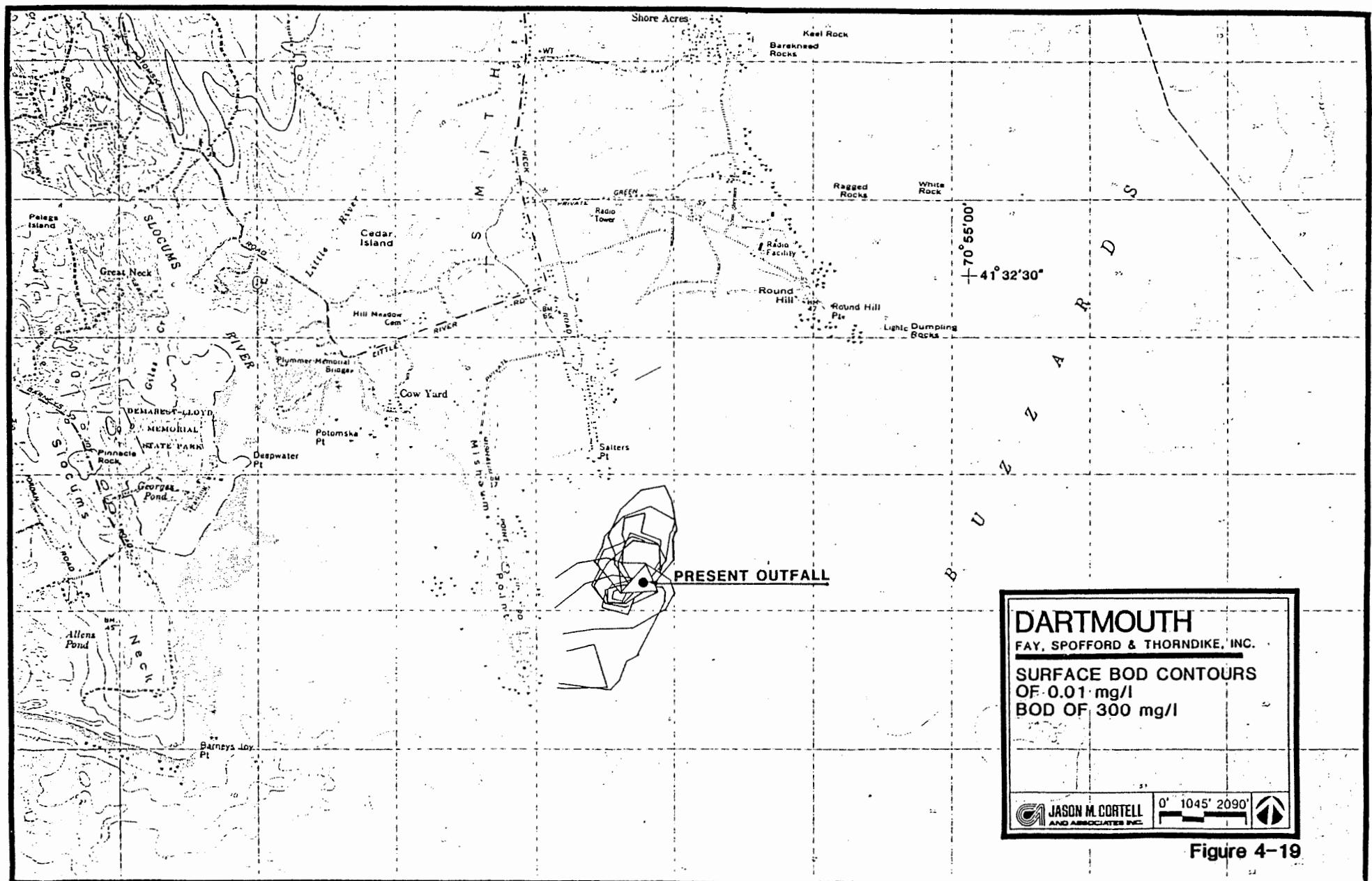


Figure 4-18



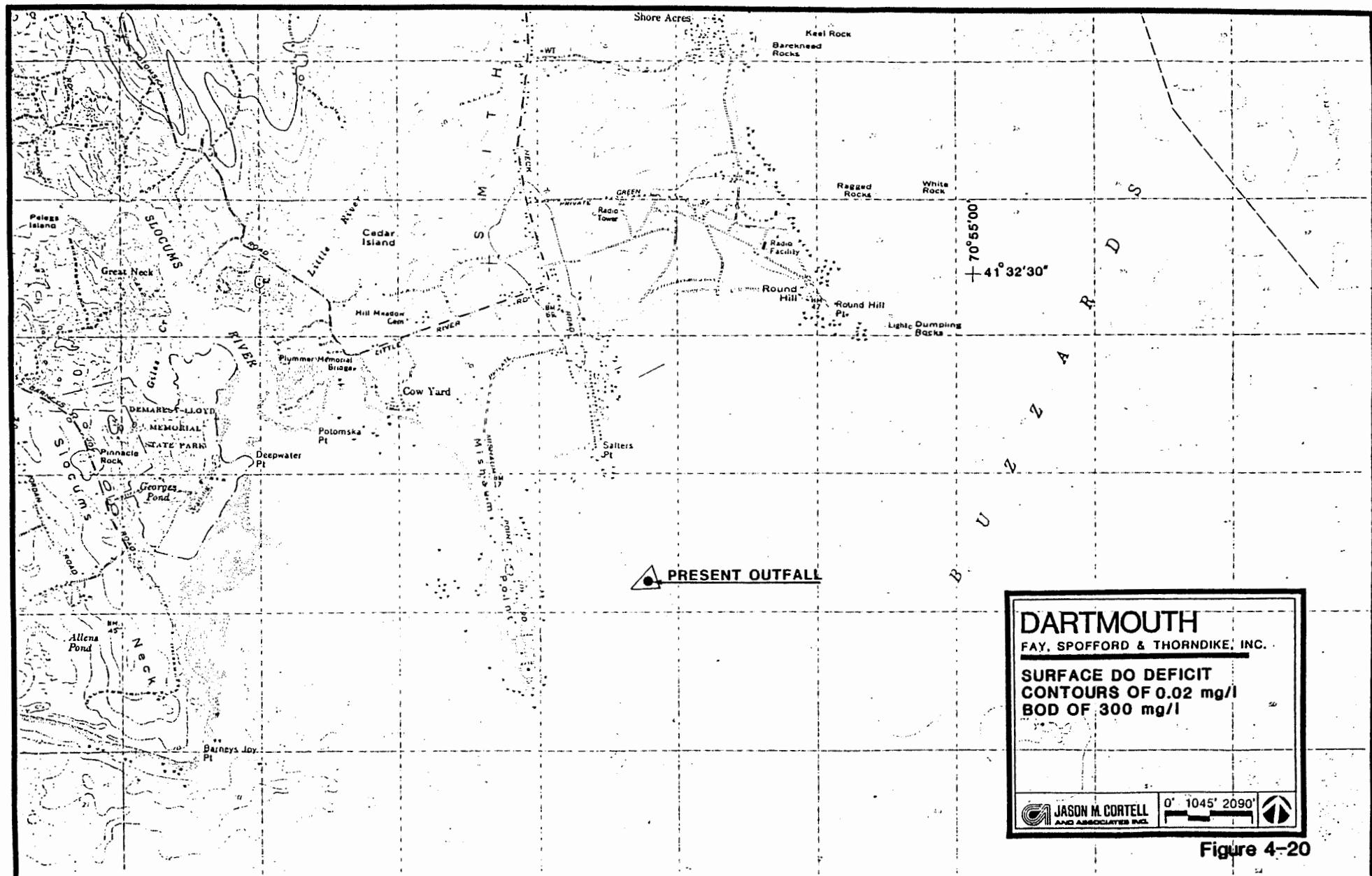


Figure 4-20

values are still relatively small. It can be seen from Figure 4-20 that concentrations greater than 0.02 mg/l are contained within the input element where a substantial portion of the depression is attributable to the oxygen depleted effluent. Again, for a saturation dissolved oxygen value of 10 mg/l the contour limits depicted in Figures 4-19 and 4-20 correspond to 0.1% and 0.2% depletion of DO, respectively.

An investigation of coliform distribution was also carried out. Both fecal coliform (FC) and total coliform (TC) bacteria were examined. A worse case analysis was assumed where total failure of the plant occurred under design flow conditions of 0.184 m³/s (4.2 MGD). Assuming that effluent concentrations were equal to influent concentrations resulted in values of 10⁷ MPN/100 ml for FC and 10⁹ MPN/100 ml for TC. For both coliforms a range of decay rates were investigated: 0, 1, 3, 8 day⁻¹. The 3 day⁻¹ was chosen by the Massachusetts Department of Environmental Quality Engineering (DEQE) as the typical dieoff condition.

The results for the FC simulation with no decay are shown in Figure 4-21. Contours of 70, 700, 1,000, and 10,000 MPN/100 ml were plotted. These contours represent the maximum coverage over a tidal cycle. Along the shore from Round Hill Point in the northeast direction to the west side of Mishauum Point in the southwest direction concentrations

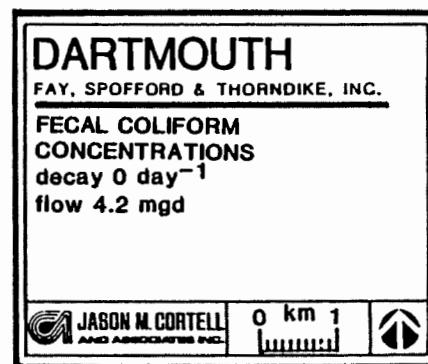
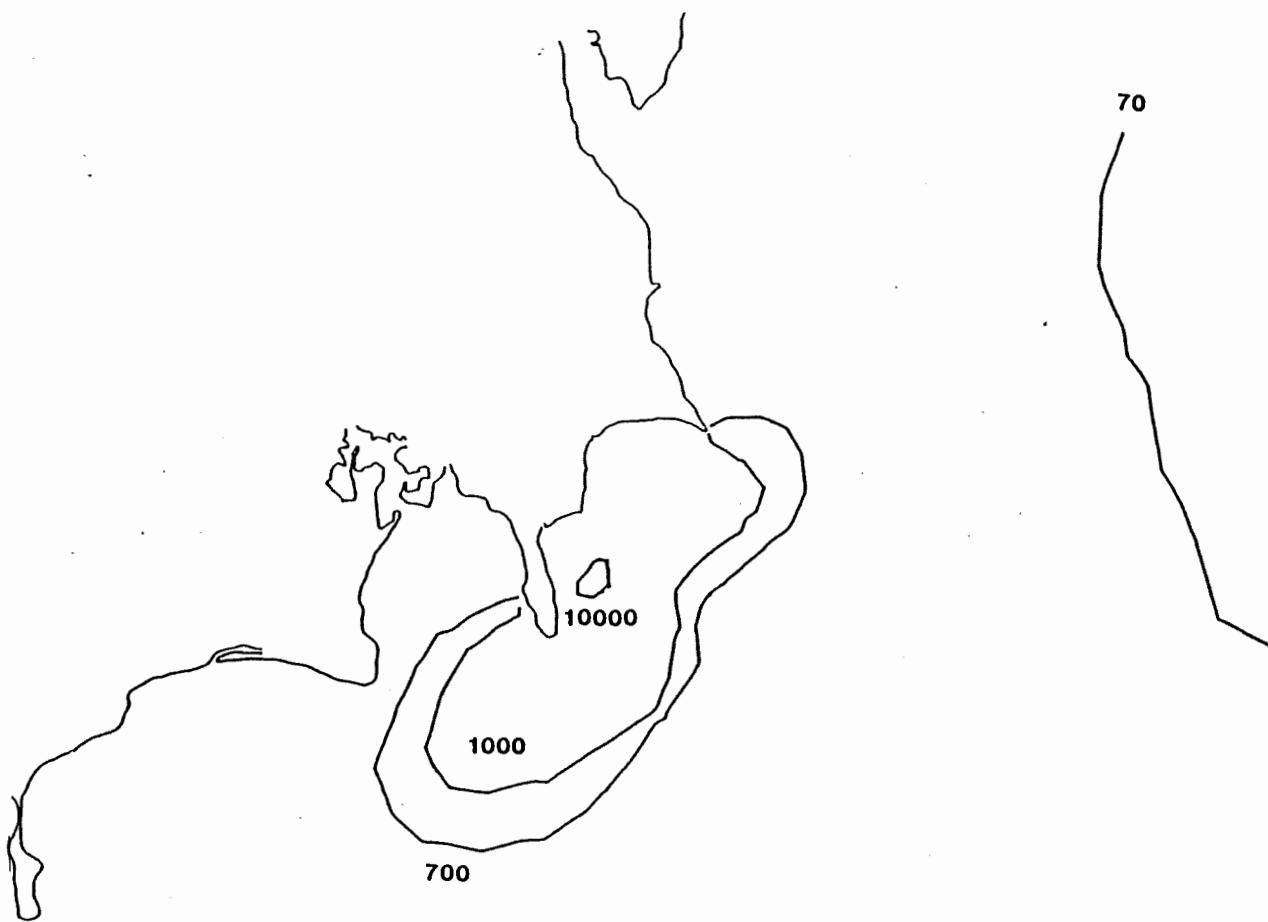
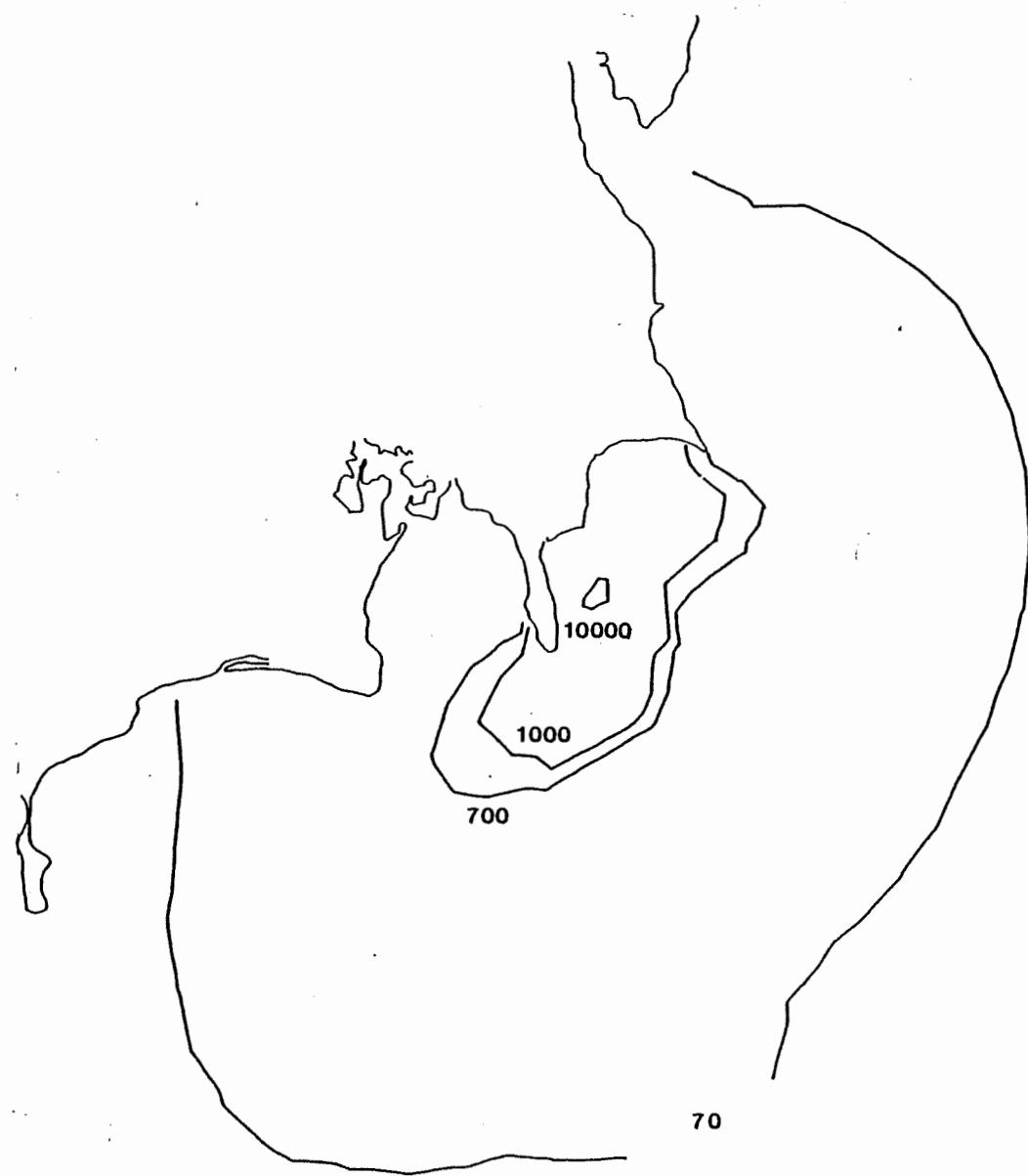


Figure 4-21

exceed the DEQE mean limit for FC in SC waters which is 100 MPN/100 ml. Standards are violated for this situation since the area is classified as SA. Figures 4-22 through 4-24 show simulation results for decay rates of 1, 3, and 8 day⁻¹, respectively. The 1,000 MPN/100 ml contracts slightly for each larger decay rate but even for the 8 day⁻¹ case (Figure 4-24) approximately 2 km (1.2 mi) of shoreline is impacted at this level. To determine the variation over a tidal cycle the 70 MPN/100 ml contour was plotted at two hour intervals as shown in Figure 4-25. The numbers indicate hours after high tide and reveal that the furthest southwestern extent of the coverage occurs 3 hours after high tide and the furthest northeastern extent occurs between 9 and 11 hours after high tide. The area from Round Hill Point to the western side of Mishauum Point is always located in an area above 70 MPN/100 ml.

The results for FC can be scaled up for TC by a factor of 100 (10^7 MPN/100 ml for FC = 10^9 MPN/100 ml for TC) (Environmental Protection Agency, Design Manual. Onsite Wastewater Treatment and Disposal Systems, 1980). These results are shown in Figures 4-26 through 4-29 for decay rates of 0, 1, 3, and 8 day⁻¹, respectively. The contours have been plotted for 9 values from 2×10^4 to 10^6 MPN/100 ml to show the structure of the distribution. The DEQE TC standards for SA waters are a mean of 70 MPN/100 ml and an upper 10% limit of 230 MPN/100 ml. For SB waters they are a mean of 700 MPN/100 ml and an upper 20% limit of 1,000 MPN/100 ml are clearly exceeded along the coast for all decay rates.



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**FECAL COLIFORM
CONCENTRATIONS**
decay 1 day^{-1}
flow 4.2 mgd

JASON M. CORTELL
AND ASSOCIATES INC.

0 km 1
[Scale bar]



Figure 4-22

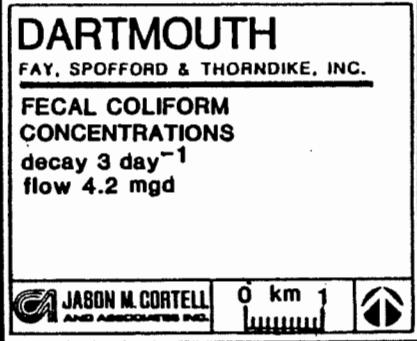
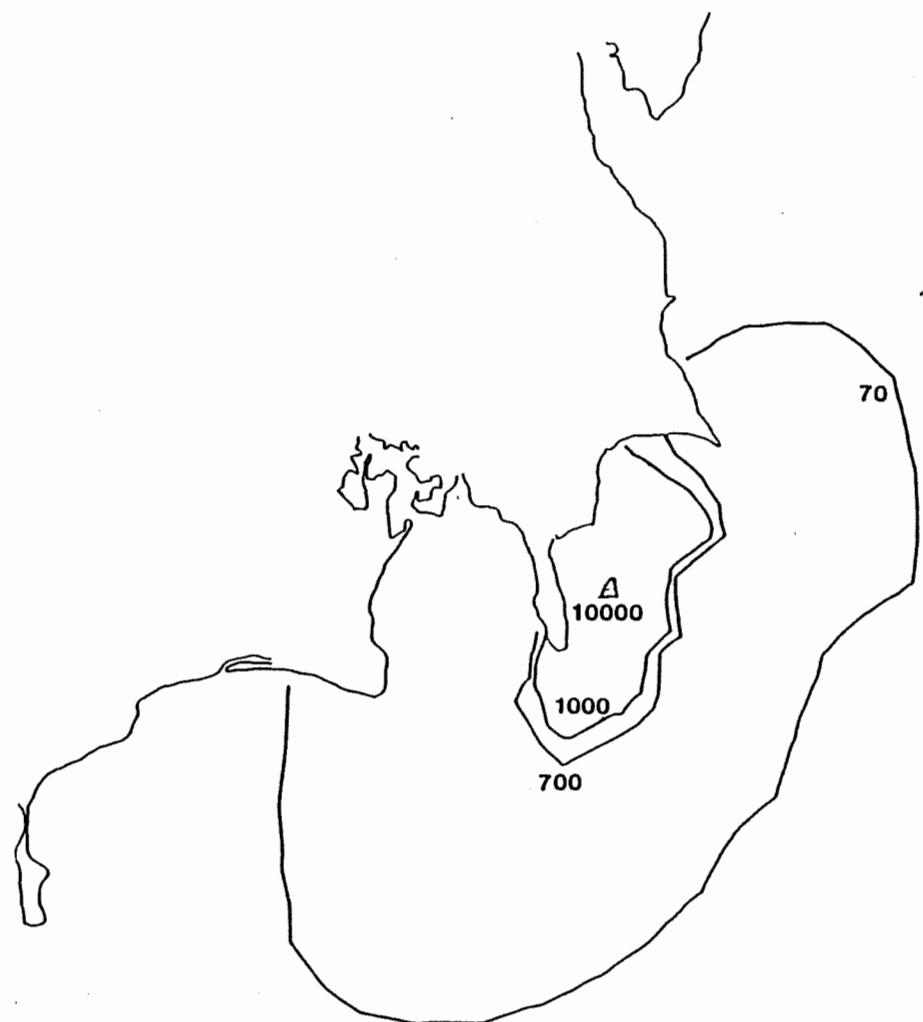


Figure 4-23

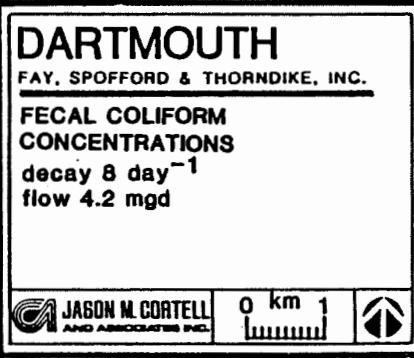
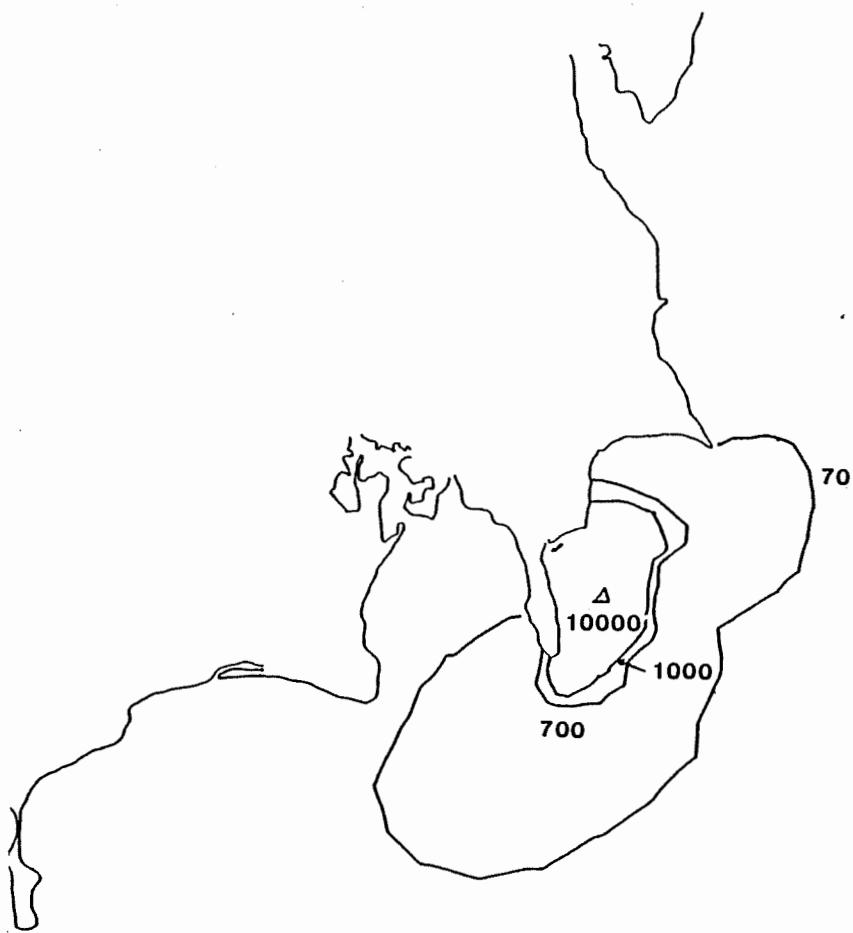


Figure 4-24



DARTMOUTH
FAY, SPOFFORD & THORNDIKE, INC.

**FECAL COLIFORM
CONCENTRATIONS OF
70 MPN/100 ml
contours hours after high tide**

 JASON M. CORTELL
AND ASSOCIATES INC.

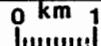
0 km




Figure 4-25

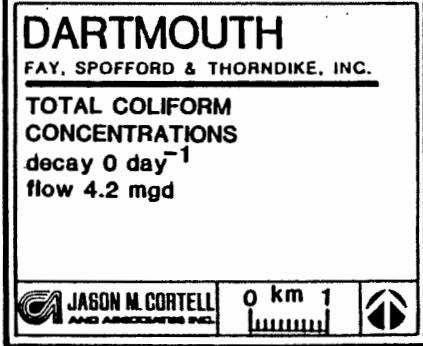
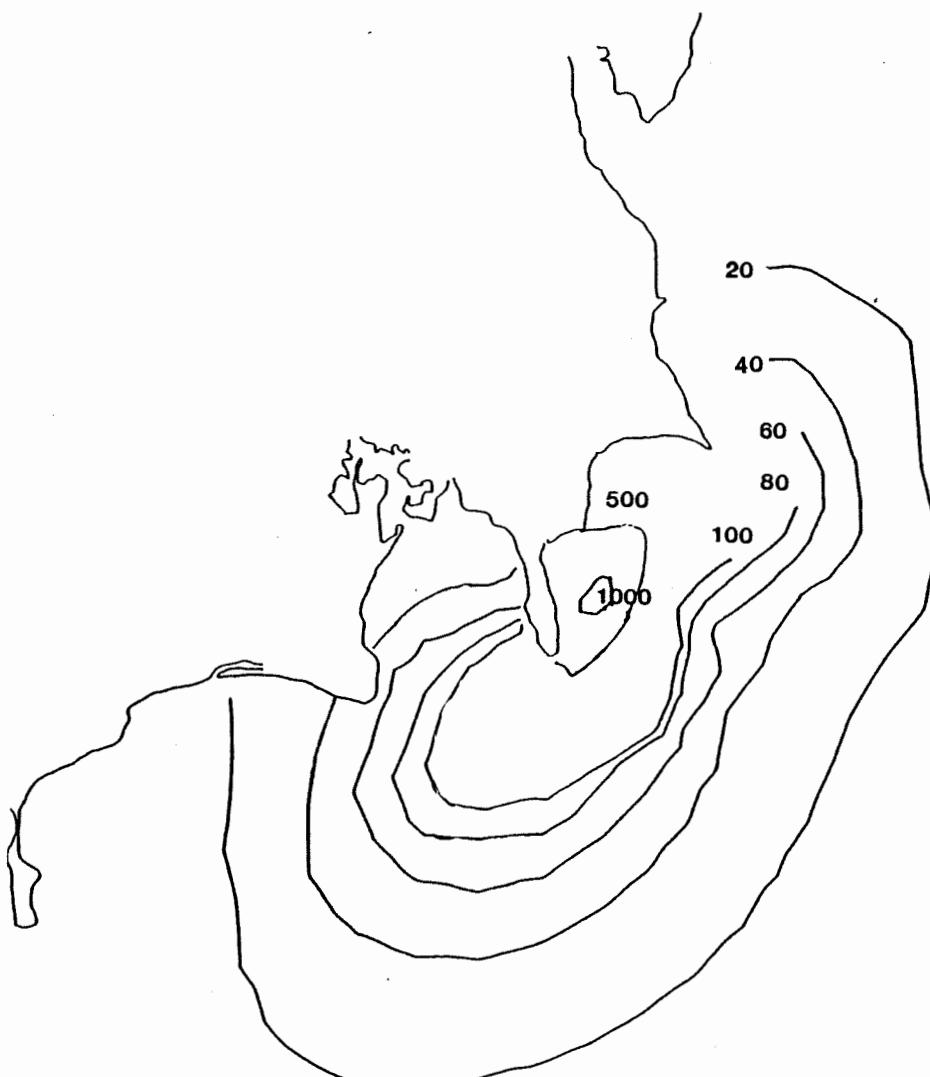


Figure 4-26

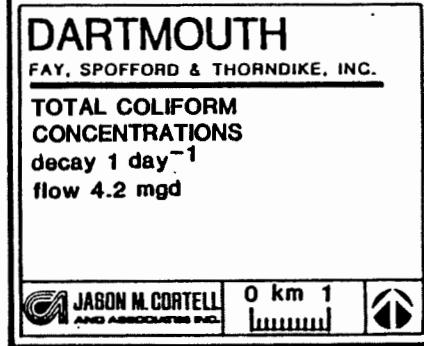
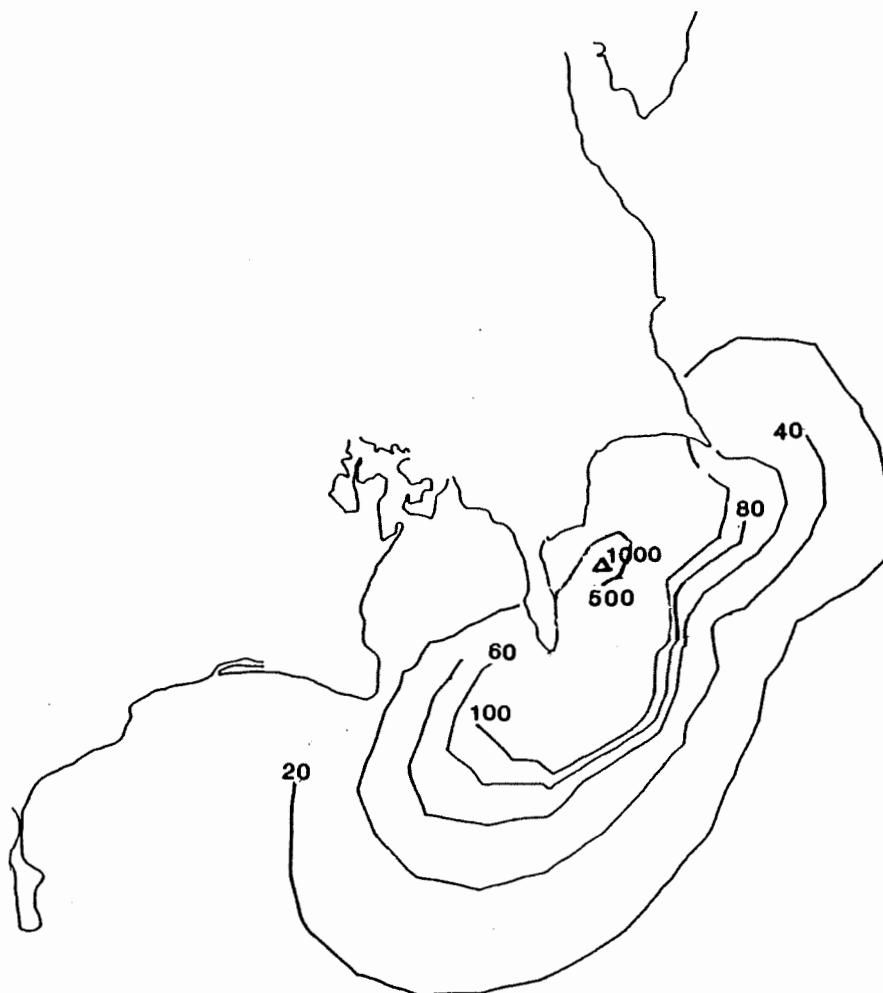
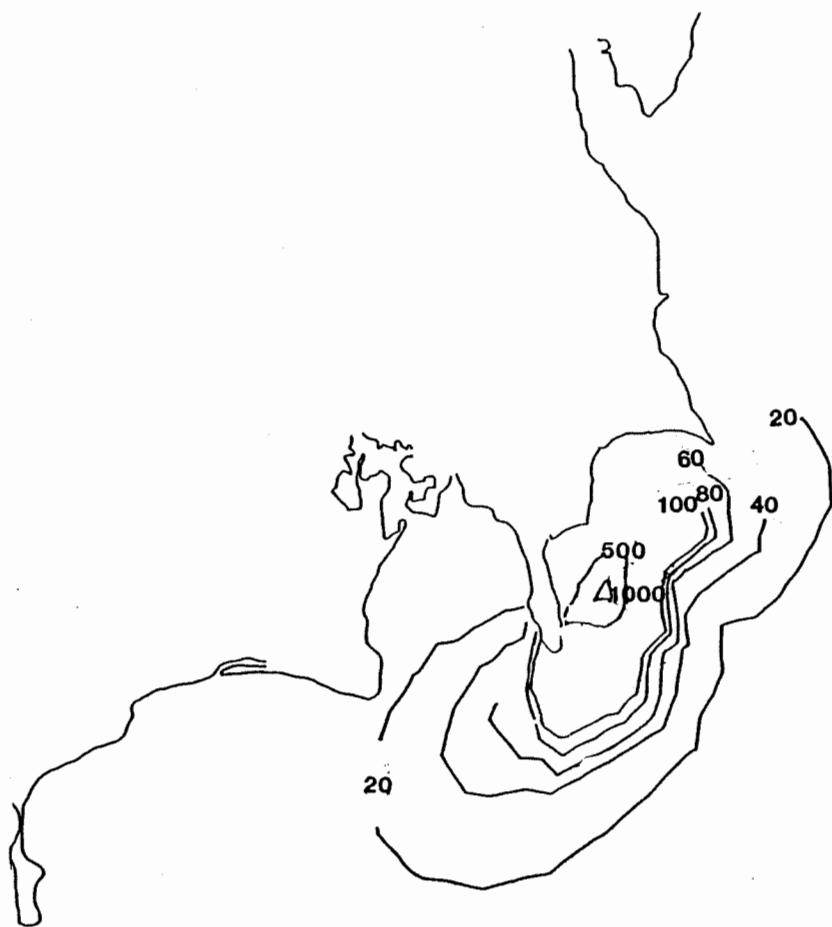


Figure 4-27



DARTMOUTH
FAY, SPOFFORD & THORNDIKE, INC.

**TOTAL COLIFORM
CONCENTRATIONS**
decay 3 day⁻¹
flow 4.2 mgd

JASON M. CORTELL
AND ASSOCIATES INC.

0 km 1
[Scale bar]



Figure 4-28

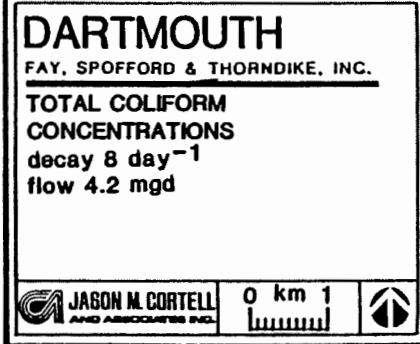


Figure 4-29

These conditions have been modeled under the very conservative assumption that total failure of the treatment plant (to include loss of chlorination) would take place.

Operating data indicate that during 1987 the average fecal coliform bacteria concentration was 65 MPN/100 ml. Additionally, the last time the facility was on primary treatment level, the fecal coliform bacteria were 322/100 ml because chlorination continued. Multiplying these concentrations by 100 to convert to total coliform bacteria and then dividing by the source loading used in the modelling (10^9 MPN/100), scale down factors of 10^{-6} and 10^{-5} are derived.

4.4 Conclusions

Tidally induced currents predominate in the circulation and transport dynamics of the waters off Salters Point. At the present outfall site, flood tide currents are generally in the north-northeast direction and ebb tide currents toward the south-southwest. Observations also indicate that, in general, the waters are well mixed in the vicinity of the outfall. The single port outfall pipe is inclined 45 degrees from the horizontal which will yield a greater dilution than a vertical pipe at the same depth, while minimizing bottom scouring. The computer study of the wastewater effluent indicated a maximum near field BOD concentration of 3.8 mg/l from a source concentration of 30 mg/l and a flow rate of 0.184 m /sec (4.2 mgd). For the same effluent loading and flow rate, the far field analysis predicted a maximum surface area coverage of 14,000 m² (3.5 acres) for dilutions of 500 to 1 and less,

corresponding to BOD concentrations of 0.06 mg/l and greater. A maximum surface area coverage of 112,000 m³ (27.66 acres) is expected for dilutions of 1000 to 1 or less, corresponding to BOD concentrations of 0.03 mg/l or greater. Both of these areas are quite small in relation to the area of the waters off Salters Point, as are the BOD concentrations that mark their farthest extent.

The far field analysis also predicted a maximum DO depression of less than 0.01 mg/l, outside the initial dilution zone in the near field, as a result of an effluent BOD concentration of 30 mg/l and a 0.184 m³/sec (4.2 mgd) flow rate. The resulting DO depression is quite small and within the expected daily range of DO fluctuation for estuarine waters.

For the order of magnitude impact study the BOD dilution contours of 500 to 1 and 1000 to 1 and their respective surface areas given above may be interpreted as corresponding to concentrations of 0.6 mg/l and 0.3 mg/l respectively. The resulting DO depression associated with the 300 mg/l effluent loading was greater but did not reflect the linear increase found with the BOD. DO depressions greater than 0.02 mg/l were not found outside the initial dilution zone in the near field, where the depleted effluent is itself quite important. This DO depression is again within the expected daily range of DO fluctuation in estuaries.

The coliform analysis proceeded with the unlikely loading based on total failure of the treatment plant, including loss of chlorination. Under this scenario the coast from Round Hill Point to Misham Point always exceeds 70 MPN/100 ml for FC. Total

coliforms (TC), being 100 times the FC levels, exhibit the same distribution at increased concentrations. The DEQE standards for both SA and SB waters are exceeded along the coast under the loading used. If loadings based on actual plant effluent concentrations are used the results are reduced by 10^5 to 10^6 thus staying well within the DEQE SA standards at the coast.

5.0

SLUDGE QUALITY

Samples of sludge were collected and analyzed in keeping with Regulations for the Application of Sludge and Septage (310 CMR 32.00). A sample of the filter cake was collected at hourly intervals by treatment plant personnel, composited, and submitted to JMCA for analysis. Results of the analyses are contained in Table 5-I.

Table 5-1

**Arnold Greene
Testing Laboratories**



East Natick Industrial Park
8 Huron Drive • Natick, MA 01760
(617) 235-7330, 653-5950
Telex 948459 GREENELAB NTIK

Nondestructive • Chemical • Pollution • Metallurgical
Inspection • Evaluation • Analysis
Research • Development



Branch Laboratories:
Springfield, Mass. 01109 Auburn, Mass. 01501
(413) 734-8548 (617) 832-5500

CONAM INSPECTION A UNIT OF O'NEILL CORP.
California, Texas, Illinois, Pennsylvania, Minnesota, Ohio

TO: JASON M. CORTELL & ASSOC.	DATE: 11/4 /85	MATERIAL: SLUDGE
244 2ND AVE.	JOB NO. 70378-1	BOOK NO. 174-25 SM
WALTHAM, MA 02154	LAB NO. 3333	SPECIFICATIONS:
ATTN:	ORDER NO. 0599	
SAMPLE ID: 1 SLUDGE	DATE REC'D: 10/2/85	
Ammonia (mg/kg)	6,100	
Boron (mg/kg)	41	
Cadmium (mg/kg)	6.9	
Chromium (mg/kg)	48	
Copper (mg/kg)	1290	
Lead (mg/kg)	95	
Mercury (mg/kg)	3.3	
Molybdenum (mg/kg)	17	
Nickel (mg/kg)	3.4	
Nitrate (mg/kg)	124	
pH	10.8	
Phosphate, Total (mg/kg)	1430	
Potassium (mg/kg)	1500	
Zinc (mg/kg)	404	
Total Kjeldahl-Nitrogen (%)	10.2	
Solids (%)	14.1	

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4TH DAY OF NOVEMBER 1985
ARNOLD GREENE TESTING LABORATORIES
DIVISION OF CONAM INSPECTION

Jeffrey Coelho
Jeffrey Coelho, Lead Chemist

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Table 5-1 (cont.)



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CONAM INSPECTION *agent of O'Dwyer*
California, Texas, Illinois, Pennsylvania, Minnesota, Ohio



TO: JASON M CORTELL & ASSOC

DATE 11/5 /85

MATERIAL: SLUDGE

244 2ND AVENUE

JOB NO. 70378-1

BOOK NO. 167-39 6C

WALTHAM MA 02154

LAB NO. 3333

SPECIFICATIONS:

ATTN:

ORDER NO. 0599

SAMPLE ID: 1 Sludge sample

DATE REC'D: 10/2/85

PURPOSE: To determine the concentration of PCB, pesticides and herbicides in the sludge sample submitted for analysis.

PROCEDURE: PCB and pesticides - Approximately 30g of sample was soxhlet extracted with methylene chloride. The extract was exchanged to hexane, submitted to alumina clean-up and analyzed by GC/ECD.

Herbicides - Approximately 30g of sample was soxhlet extracted with methylene chloride. The extract was exchanged to methanol, submitted to esterification and analyzed by GC/ECD.

EPA Method 608 - EPA/CE -81-1

RESULTS: Sludge: Dartmouth wastewater treatment facility
Pesticides:

Lindane (ug/g) <0.00053

Endrin (ug/g) <0.0013

Methoxychlor (ug/g) <0.0043

Toxaphene (ug/g) <4.09

Herbicides:

2,4 - D (ug/g) <0.0031

2,4,5 - T,P (Silvex) (ug/g) <0.053

PCB (ug/g) <0.090

COMMENT: Date extracted: Pesticide - 10/24/85 Herbicide - 10/28/85
Date analyzed: PCB + Pesticide - 10/26/85 Herbicide - 11/2/85
Results calculated on a dry weight basis.

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John O'Neill

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6.0

SEDIMENT ANALYSES

The quality of sediment in the project area was determined through a review of existing information as well as site specific sampling and analyses. Data reviewed included the 201 Facilities Plan for the New Bedford wastewater treatment plant, the U.S. EPA data for New Bedford Harbor, sediment data from the U.S. Army Corps of Engineers, and published information from Woods Hole Oceanographic Institution. None of these data sources, however, contain information near the project site.

Site specific sampling and analysis was conducted after confirming the sediment sampling locations with DEQE. Samples were collected during October, 1986 at the locations illustrated on Figure 6-1. Samples were collected with a Ponar Grab, packaged, and placed under refrigeration for delivery to the laboratory. Chemical and physical analysis of the sediments were conducted in accordance with the procedures presented in:

1. Ecological Evaluation of Proposed Discharge of Dredge or Fill Material into Navigable Water. Ecological Effects Laboratory U.S. Army Corps of Engineers, Vicksburg, MI. 1977.
2. Methods for the Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, Washington, D.C.

Results of the analysis are presented in Table 6-I. Sample Stations 1, 2, 3 were selected to provide an evaluation of sediment conditions

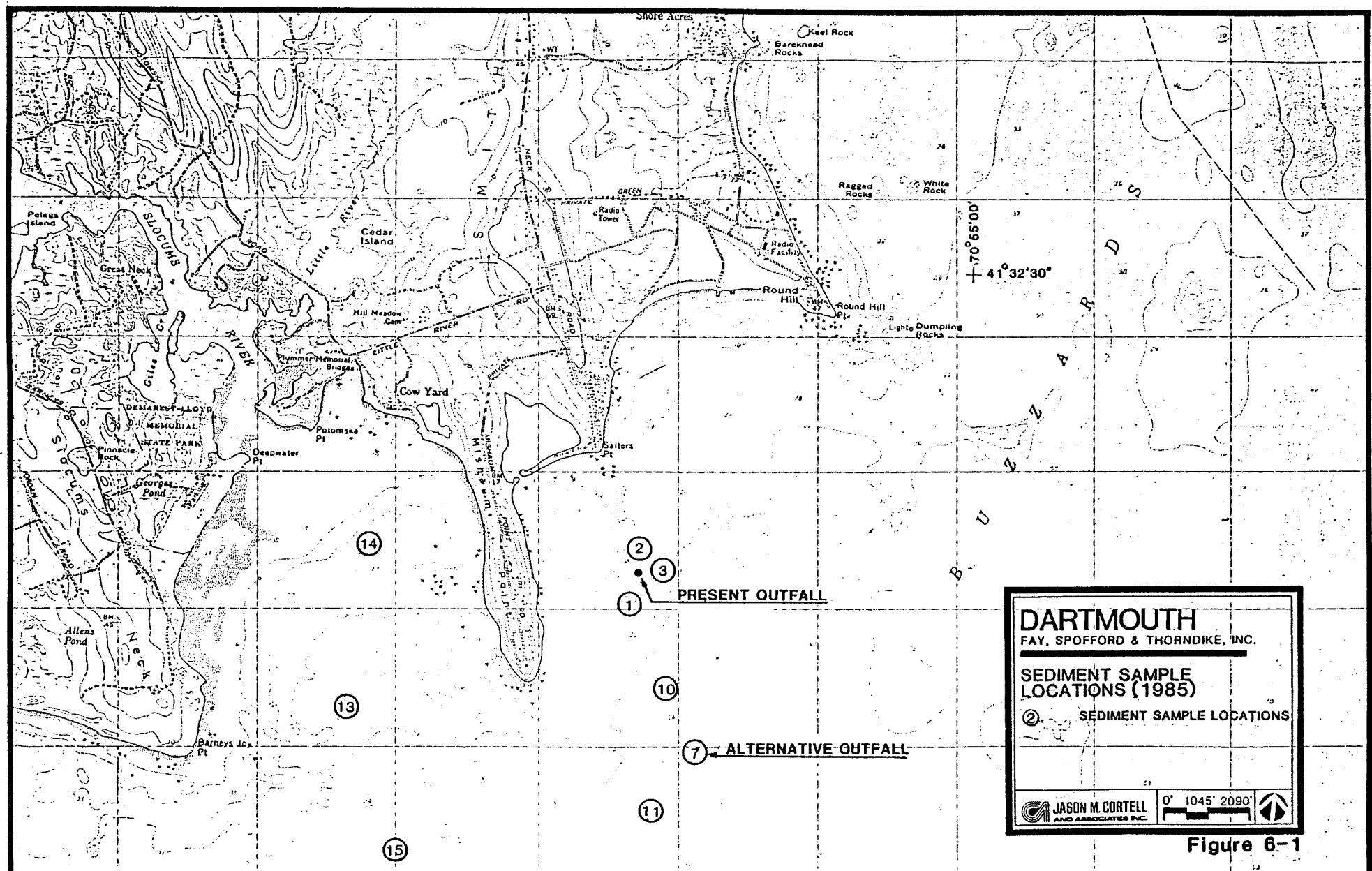


Table 6-1



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CONAM INSPECTION A UNIT OF DOLCORP
California, Texas, Illinois, Pennsylvania, Minnesota, Ohio

TO: JASON M. CORTELL & ASSOC.	DATE: 11/6 /85	MATERIAL: SEDIMENTS					
244 2ND AVE.	JOB NO. 71331-1	BOOK NO. 176-17 RPA/AJP					
WALTHAM, MA 02154	LAB NO. 3422	SPECIFICATIONS:					
ATTN:	ORDER NO.0600						
SAMPLE ID: 7 SEDIMENTS	DATE REC'D: 10/22/85						
	#2	#7	#10	#11	#13	#14	#15
Arsenic (mg/kg)	8.6	1.8	8.6	1.3	8.4	7.5	12
Cadmium (mg/kg)	<0.77	<0.79	<0.70	<0.60	<0.72	0.69	0.75
Chromium (mg/kg)	17	4.8	9.1	2.7	17	12	7.5
Copper (mg/kg)	8.1	2.8	4.9	2.4	6.5	3.8	7.2
Lead (mg/kg)	9.6	4.0	8.8	4.5	11	6.9	12.4
Mercury (mg/kg)	<0.004	<0.004	<0.004	<0.003	<0.004	<0.003	<0.002
Nickel (mg/kg)	5.8	2.8	5.6	3	7.6	5.2	8.7
Zinc (mg/kg)	28	16	26	12	30	19	40
I Solid	66	76	73	76	68	68	68

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Jeffrey Coelho, Lead Chemist

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CONAM INSPECTION A SUBSIDIARY OF O'Donnell
California, Texas, Illinois, Pennsylvania, Minnesota, Ohio

TO: JASON M. CORTELL & ASSOC.	DATE 11/6 /85	MATERIAL: SEDIMENT
244 2ND AVENUE	JOB NO. 7133I-2	BOOK NO. 181-2 SC
WALTHAM, MA 02154	LAB NO. 3422	SPECIFICATIONS:
ORDER NO. 0600	SAMPLE ID: 7 SEDIMENT	DATE REC'D: 10/22/85

PURPOSE: To determine the concentration of PCB, Pesticides and Herbicides in the sediment samples submitted for analysis.

PROCEDURE: PCB and Pesticides - Approximately 30g of sample was soxhlet extracted with Methylene Chloride. The extract was exchanged to Hexane, submitted to Alumina and Copper Clean-up, and analyzed by GC/ECD.

Herbicides - Approximately 30g of sample was acidified and soxhlet extracted with Methylene Chloride.

The extract was exchanged to Methanol, submitted to Esterification and Copper Clean-up, and analyzed by GC/ECD.

EPA Method 60B

EPA/CE-81-1

RESULTS: (ug/g)	STATION #2	STATION #7	STATION #10	STATION #11	STATION #13	STATION #14	STATION #18
-----------------	------------	------------	-------------	-------------	-------------	-------------	-------------

Pesticides:

Lindane	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Endrin	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Methoxychlor	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040
Toxaphene	<0.120	<0.120	<0.120	<0.120	<0.120	<0.120	<0.120

Herbicides:

2,4-D	<0.0090	<0.0090	<0.0090	<0.0090	<0.0090	<0.0090	<0.0090
2,4,5-TP (Silvex)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

PCB	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
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John Quill

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close to the outfall. Stations 7, 10 and 11 were selected to assess sediment quality along the potential alternate outfall line as dredging may be necessary for outfall construction. Samples 13, 14 and 18 were the controls.

Sediment quality data are compared with the marine sediment classification system used by DEQE. Category I sediments are considered uncontaminated and clean while Category III sediments are potentially degrading. Category II materials are felt to be of questionable quality. The system is used in evaluating the suitability of sediments for ocean disposal. The classification system is presented in Table 6-II.

Overall, all sediments were found to be uncontaminated and well within the Category I limits for all parameters. Unfortunately rock and a very hard bottom at Stations 1 and 3 precluded sample collection and a comparison of these stations with themselves is not possible. While there is a wide range in arsenic concentrations (1.3 mg/kg - 8.6 mg/kg), the arsenic concentrations at the outfall were not found to be any higher than sediment from either the alternate outfall site or the control locations. Cadmium at the present outfall was below detection limits. Chromium at the present outfall was found to be elevated in comparison to all other sample stations except Control Station 13 with which the concentrations were identical. Copper concentrations near the outfall were also found to be elevated in comparison to the other sediment sample sites. Sediment concentrations for lead were variable between all sites and actually highest at Control Station 15. Mercury was below detection limits.

Variation was evident in sediment nickel concentrations and highest at Control Station 18. Zinc concentrations were also variable with the highest levels found in sediment from Control Station 18. The percent solids were found to be reasonably represented of typical marine sediments.

No detectable concentrations of lindane, endrin, methoxychlor, toxaphene; 2,4-D; 2,4,5-TP; or PCB's were found.

Grain size analyses were also conducted on each sediment sample. A summary of the grain size is contained in Table 6-III. Figures 6-2 through 6-8 present actual data for each location. The majority of the sediments were found to be coarser than typical marine muds ranging from gravel/sand to fine sand. The presence of gravel/sand to fine sand at Station 15 clearly indicates a higher energy zone. Similarly for Station 2 near the present outfall also indicates strong water currents.

Table 6-III
SEDIMENT GRAIN SIZE

Station Number	Percent of Sample		
	25	50	75
2		CMFS	S/C
7		CMS	FS
10		CMS	FS
11		CMS	FS
13		FS	S/C
14		FS	S/C
15	G/S	FS	S/C

Legend:

G/S	Gravel/sand
CMS	Course, medium sand
CMFS	Course, medium fine sand
FS .	Fine sand
S/C	Silt or clay

GRADATION TESTS

BORING NO. 2
SAMPLE NO. 1
DEPTH 1
TECH. PEC
REVIEWER L7202

DARTMOUTH PROJECT

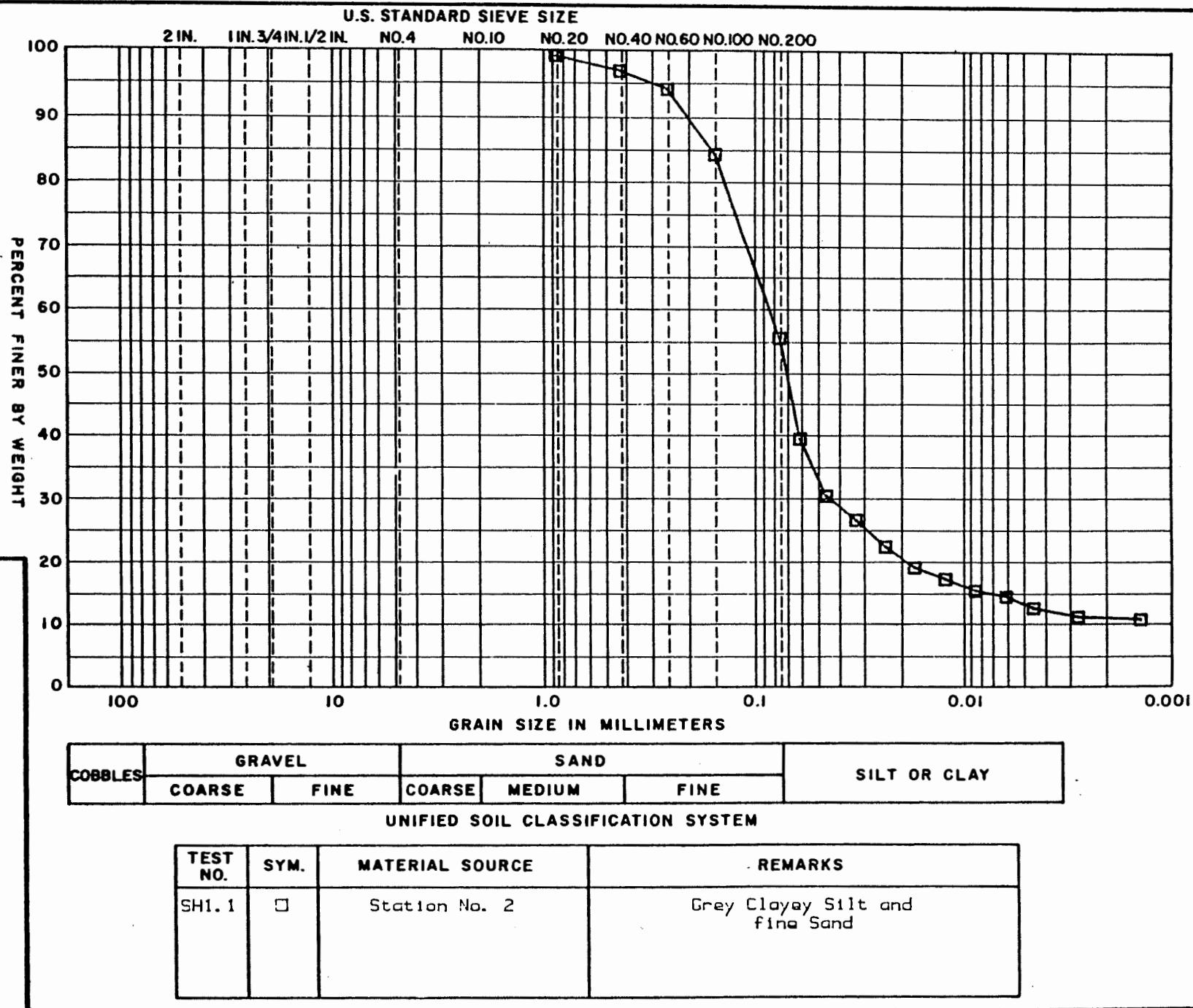
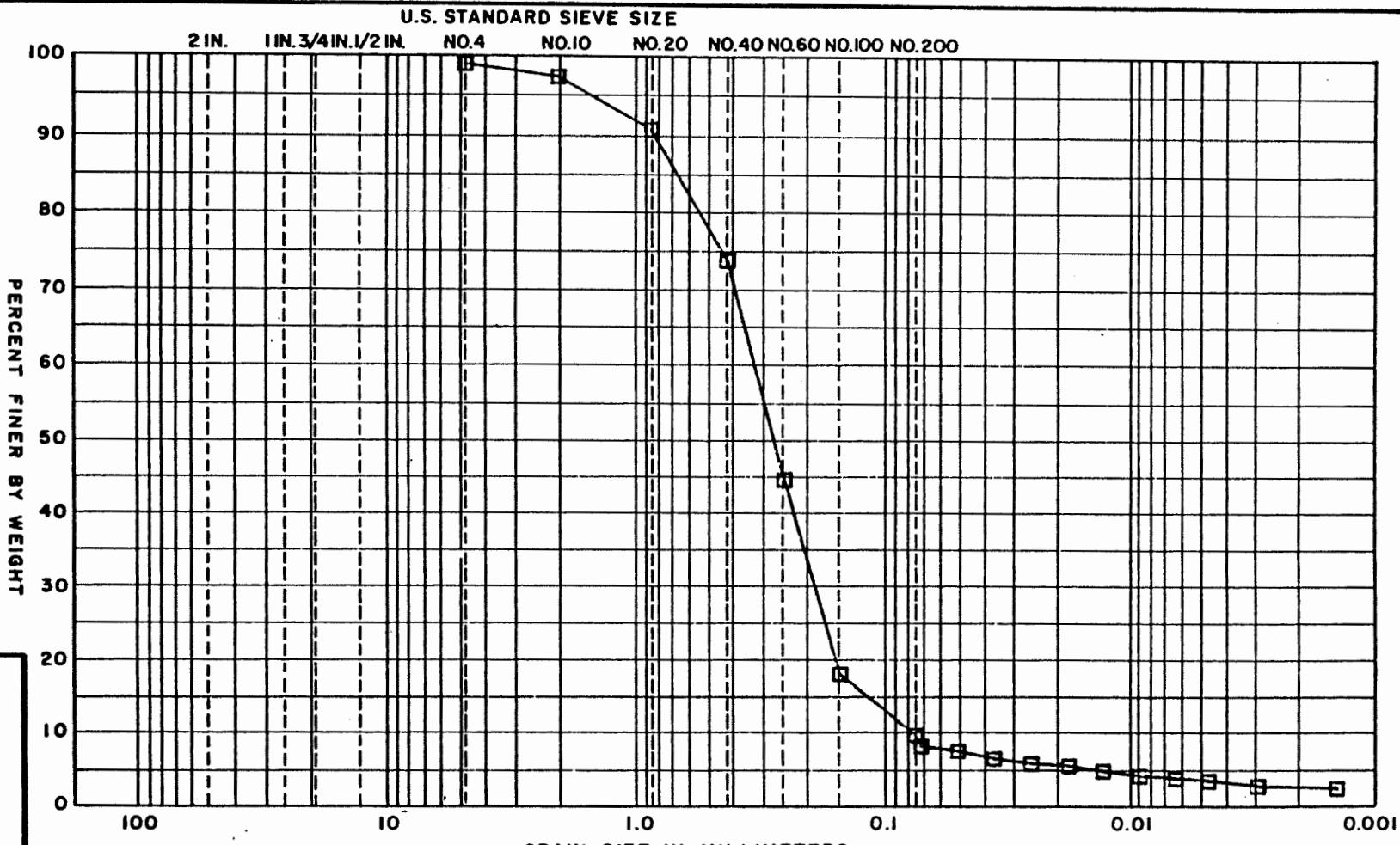


Figure 6-2

GRADATION TESTS

BORING NO.	7
SAMPLE NO.	2
DEPTH	
TECH.	
REVIEWER	P.F.C.

DARTMOUTH PROJECT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

UNIFIED SOIL CLASSIFICATION SYSTEM

TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
SH2.1	□	Station No. 7	Yellow Grey f-m Sand, trace (+) Silt

Figure 6-3

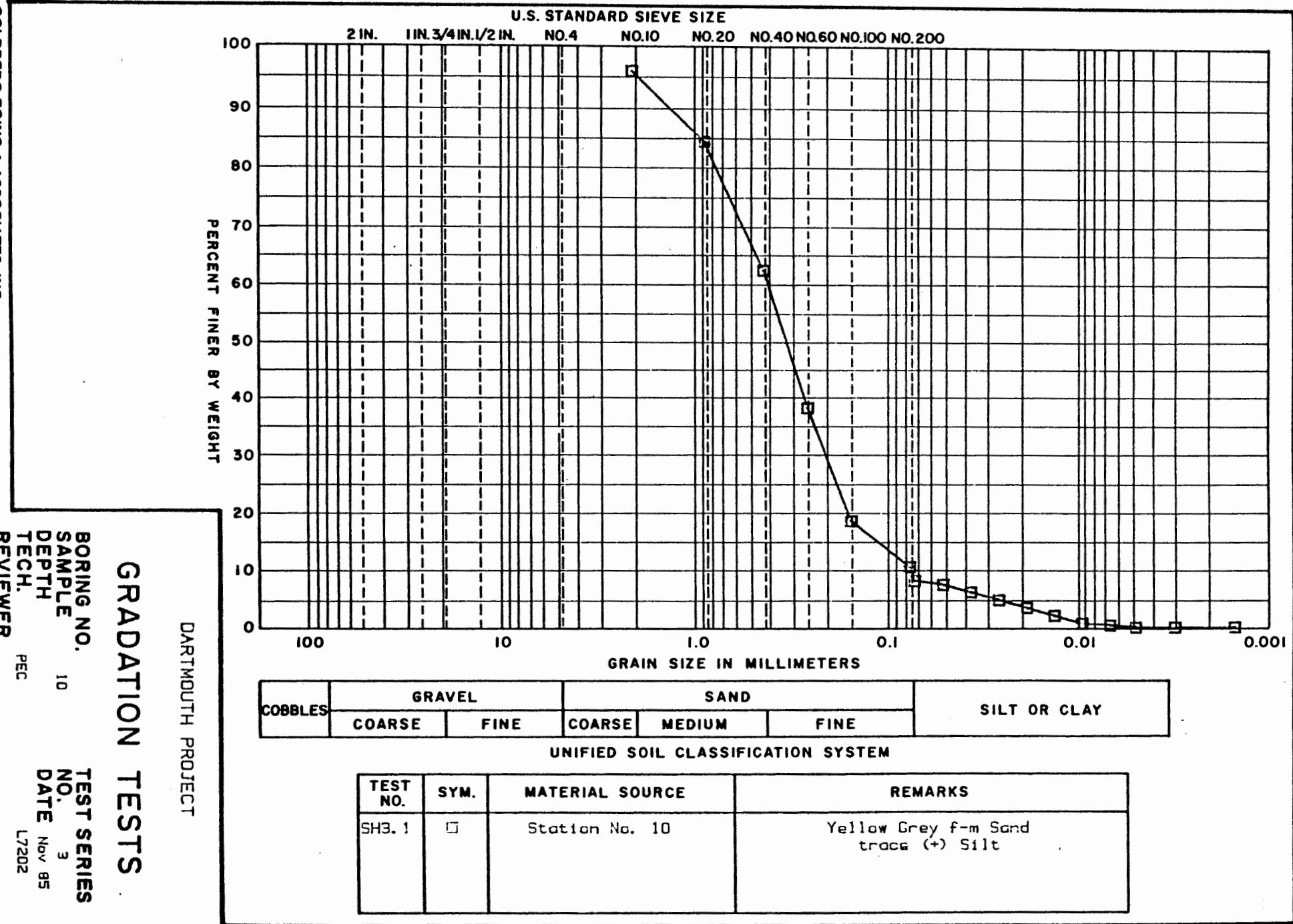
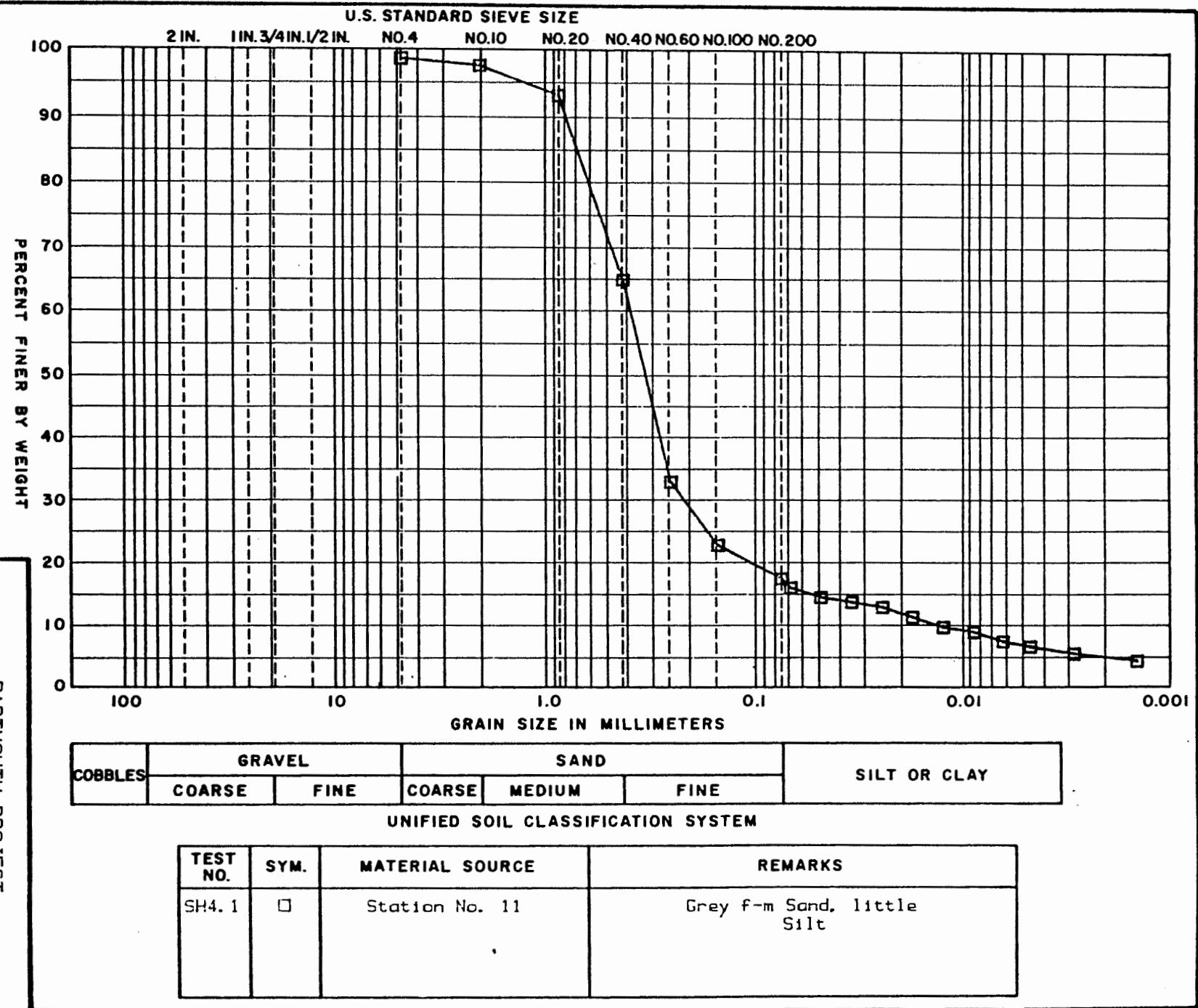
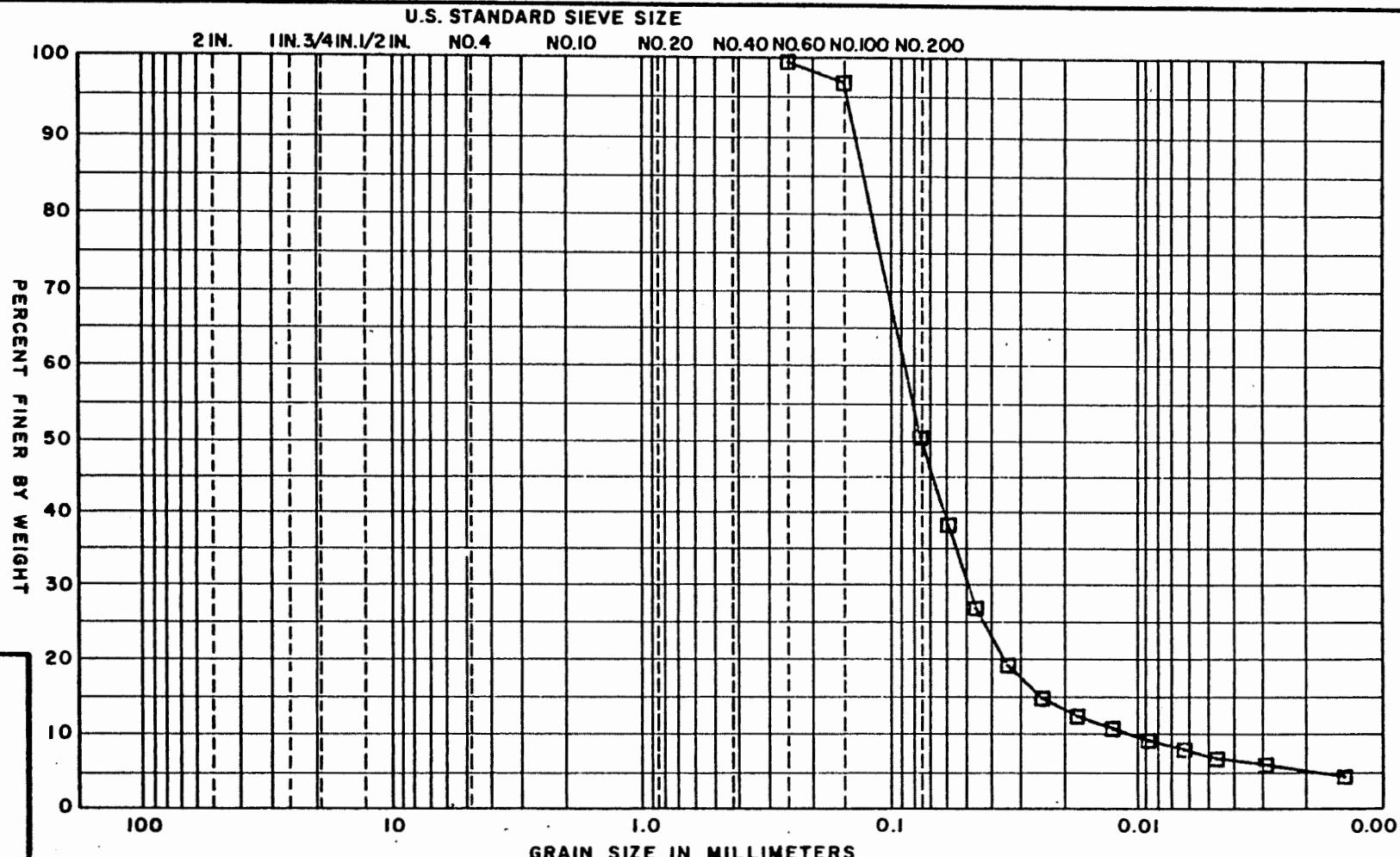


Figure 6-4





COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

UNIFIED SOIL CLASSIFICATION SYSTEM

TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
SH5. 1	<input type="checkbox"/>	Station No. 13	Grey Silt and fine Sand

GRADATION TESTS

DARTMOUTH PROJECT

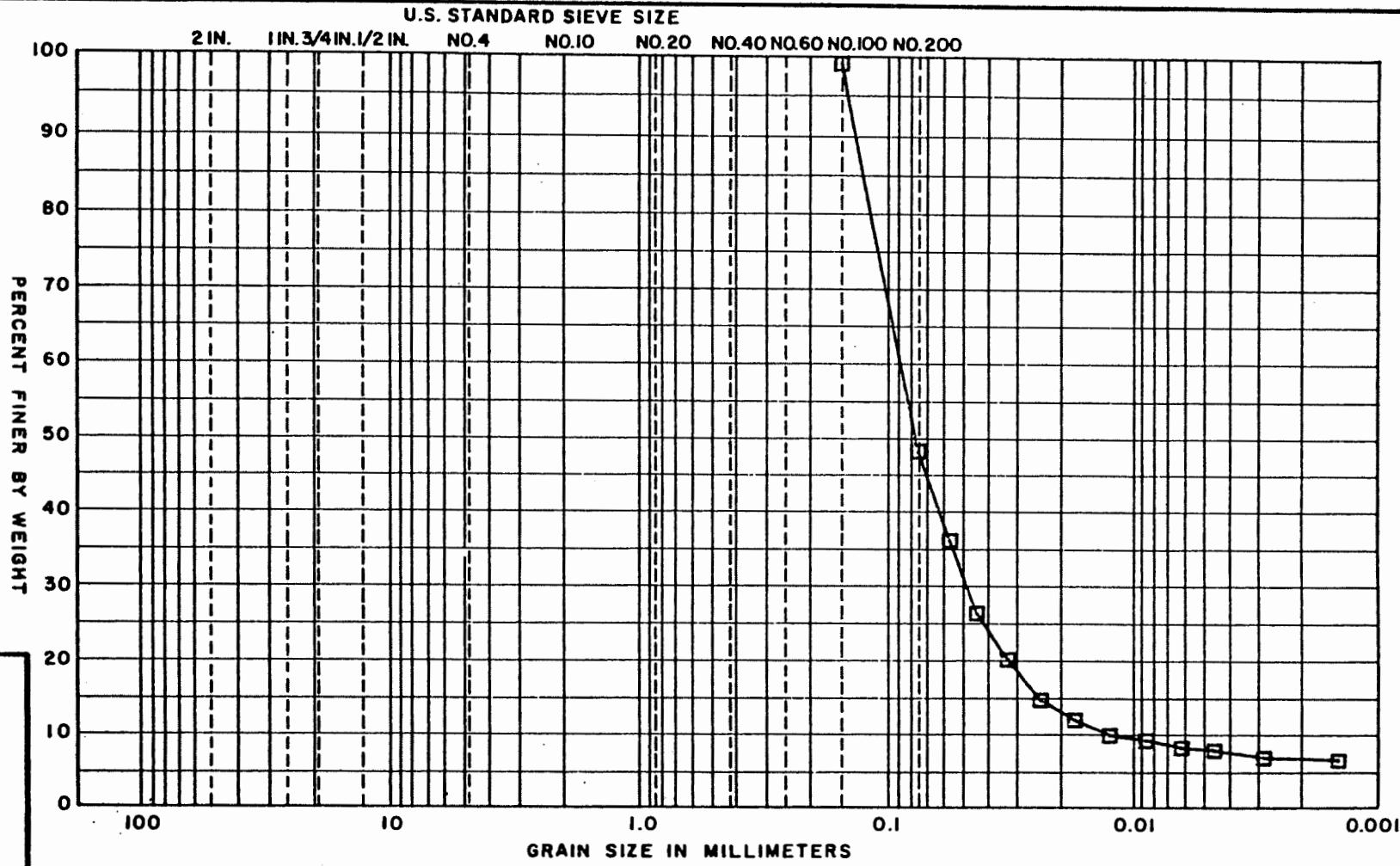
BORING NO. 13 **TEST SERIES**
SAMPLE 5 **NO.** 5
DEPTH **DATE** Nov 85
TECH. PEC **L7202**

**GOLDBERG-ZUINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS**

GRADATION TESTS

BORING NO. 14 TEST SERIES NO. 6
 SAMPLE 5 DATE Nov 85
 DEPTH 10' TECH. L7202
 REVIEWER PEC

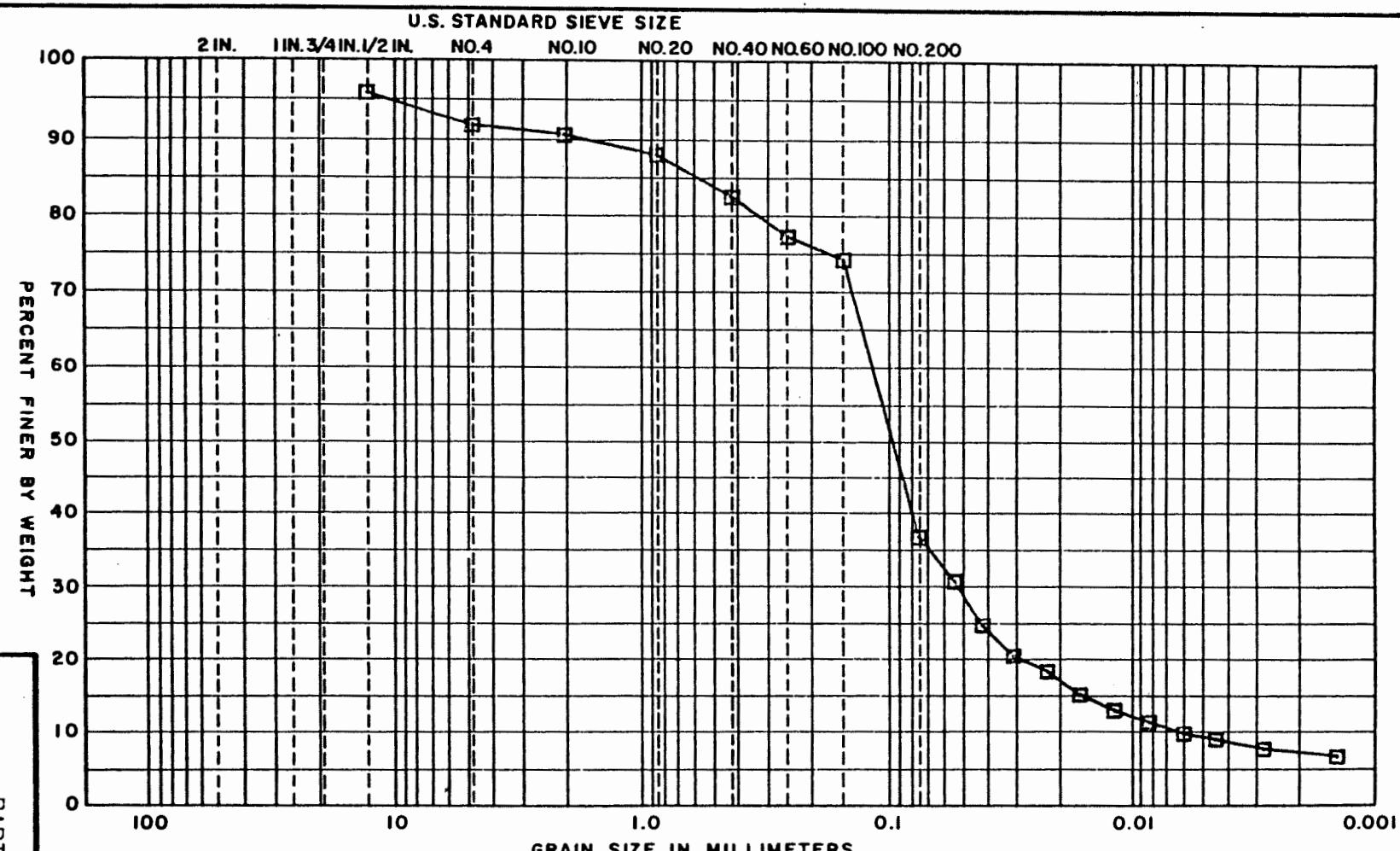
DARTMOUTH PROJECT



COBBLES	GRAVEL			SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

UNIFIED SOIL CLASSIFICATION SYSTEM

TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
SH6. 1	□	Station No. 14	Grey fine Sand and Silt



COBBLES	GRAVEL			SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

UNIFIED SOIL CLASSIFICATION SYSTEM

TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
SH7. 1	□	Station No. 18	Grey f-m Sand and Clayey Silt, trace fine Gravel

DARTMOUTH PROJECT

GOLDBERG,ZOINO & ASSOCIATES, INC.

GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GRADATION TESTS

BORING NO.	18
SAMPLE NO.	7
DEPTH	
TECH.	PEC
REVIEWER	

TEST SERIES

TEST NO.	7
DATE	Nov 85
LAB NO.	L7202

Figure 6-8

7.0

MARINE RESOURCES

Investigations to determine the nature of marine resources in the area of the present outfall and alternative outfall included a search for existing data from federal, state, and local sources to include universities and other institutions followed by sampling and analyses for the presence of benthic macroinvertebrates and shellfish. The search for site specific information did not reveal any data, however.

7.1 Benthic Macroinvertebrates

Sampling for benthic macroinvertebrates (marine life that lives on or in the sea bottom) was conducted with a Biological Dredge and Ponar Dredge.

A Biological Dredge with a 1.25 square foot opening (1.5' x 0.8') was towed at the transects illustrated on Figure 7-1. The dredge was towed for approximately 1,000 feet at each transect. Materials recovered from each tow are reported in Table 7-I.

Bottom samples were also collected for the determination of the benthic macroinvertebrate community. Samples were collected from locations shown in Figure 7-2 using a 0.049 square meter Ponar dredge. Triplicate samples were collected from each station, sieved in the field, and composited. Sampling was started on August 28, 1985 and completed by mid September, 1985.

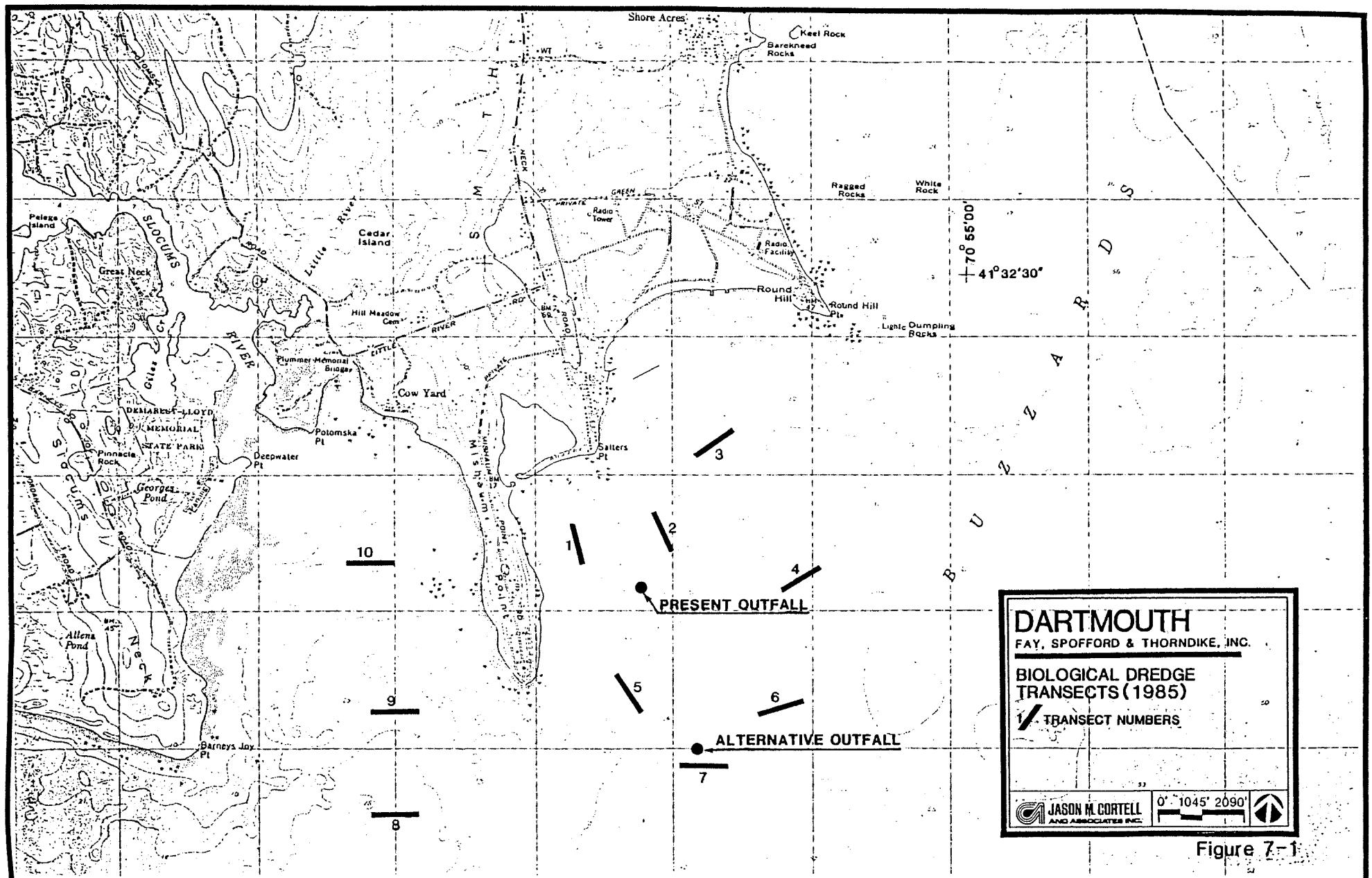


Table 7-I

Species Recovered In The Biological Dredge
November 21, 1985

Common Name	Scientific Name
Transect 1	
Rockweed	<u>Fucus</u> sp.
Kelp	<u>Laminaria</u> sp
Hermit crab - 2	<u>Pagurus longicarpus</u>
Green crab - 2	<u>Carcinus maenas</u>
Starfish - 8	<u>Asterias forbesi</u>
Transect 2	
Rockweed	<u>Fucus</u> sp
Sponge	<u>Cliona</u> sp
Quahog shells (many)	<u>Mercenaria mercenaria</u>
Hermit crab	<u>Pagurus longicarpus</u>
Transect 3	
Rockweed	<u>Fucus</u> sp
Sponge	<u>Cliona</u> sp
Rock crab - 1	<u>Cancer irroratus</u>
Starfish - 1	<u>Asterias forbesi</u>
Transect 4	
Rockweed	<u>Fucus</u> sp
Kelp	<u>Laminaria</u> sp
Seaworm	<u>Nereis</u> sp
Quahog - 4 live	<u>Mercenaria mercenaria</u>
Hermit crab - 2	<u>Pagurus longicarpus</u>
Starfish - 1	<u>Asterias forbesi</u>
Transect 5	
Rockweed	<u>Fucus</u> sp
Razor clam - 2	<u>Ensis directus</u>
Green crab - 2	<u>Carcinus maenas</u>
Starfish - 1	<u>Asterias forbesi</u>
Transect 6	
Rockweed	<u>Fucus</u> sp
Sponge	<u>Cliona</u> sp
Hermit crab - 15	<u>Pagurus longicarpus</u>
Starfish - 1	<u>Asterias forbesi</u>

Table 7-I (Continued)

Transect 7

Rockweed	<u>Fucus</u> sp
Sponge	<u>Cliona</u> sp
Quahog - 7 live	<u>Mercenaria mercenaria</u>
Quahog many shells	
Hermit crab - 1	<u>Pagurus longicarpus</u>
Green crab - 2	<u>Carcinus maenas</u>
Sea urchin - 1	<u>Strongylocentrotus</u> <u>drobanchiensis</u>

Transect 8

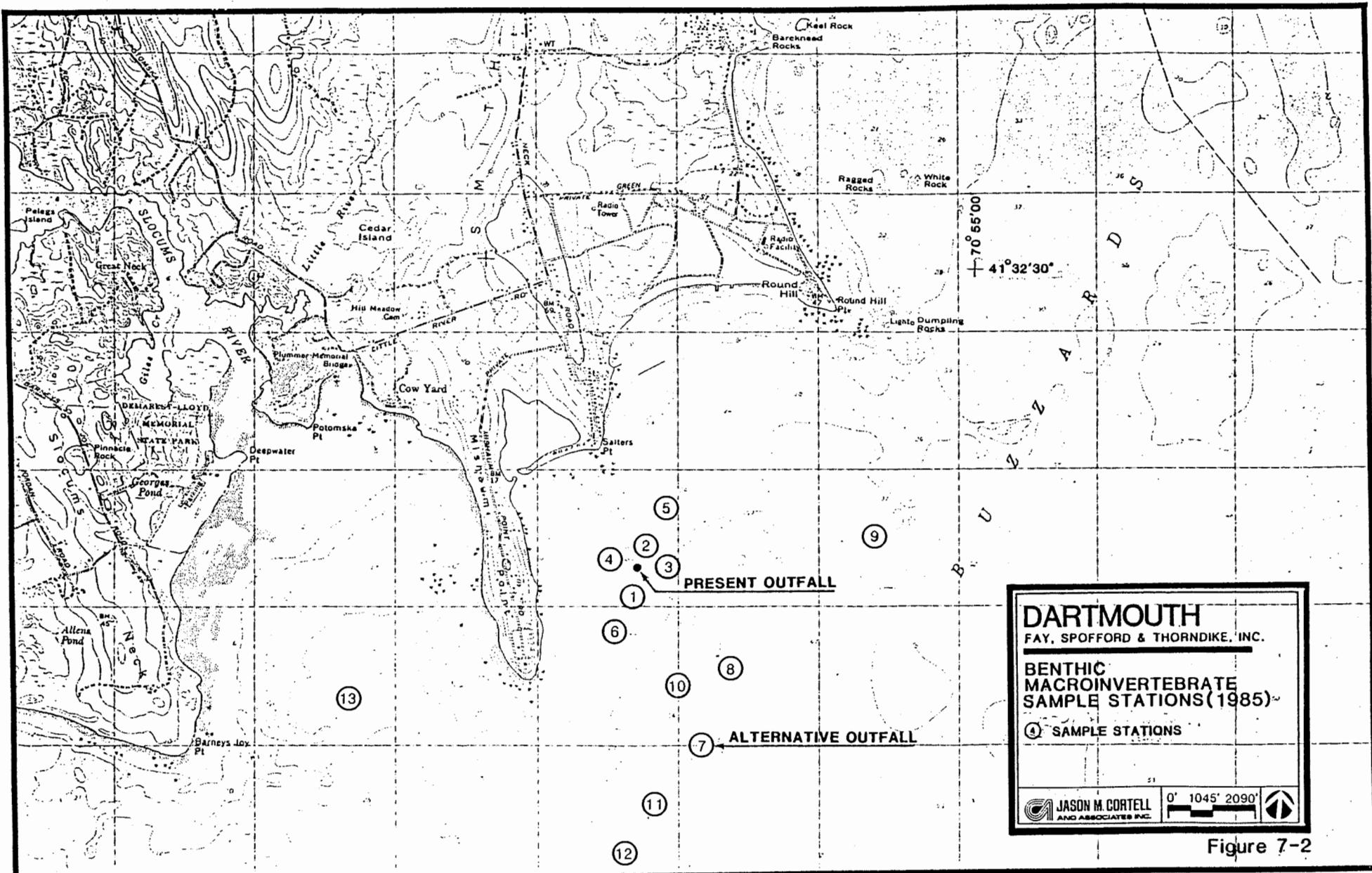
Rockweed	<u>Fucus</u> sp
Sponge	<u>Cliona</u> sp

Transect 9

Rockweed	<u>Fucus</u> sp
Eelgrass	<u>Zostera marina</u>
Sponge	<u>Cliona</u> sp
Hermit crab	<u>Pagurus longicarpus</u>
Green crab - 1	<u>Carcinus maenas</u>

Transect 10

Rockweed	<u>Fucus</u> sp
Sponge	<u>Cliona</u> sp
Quahog shells	<u>Mercenaria mercenaria</u>



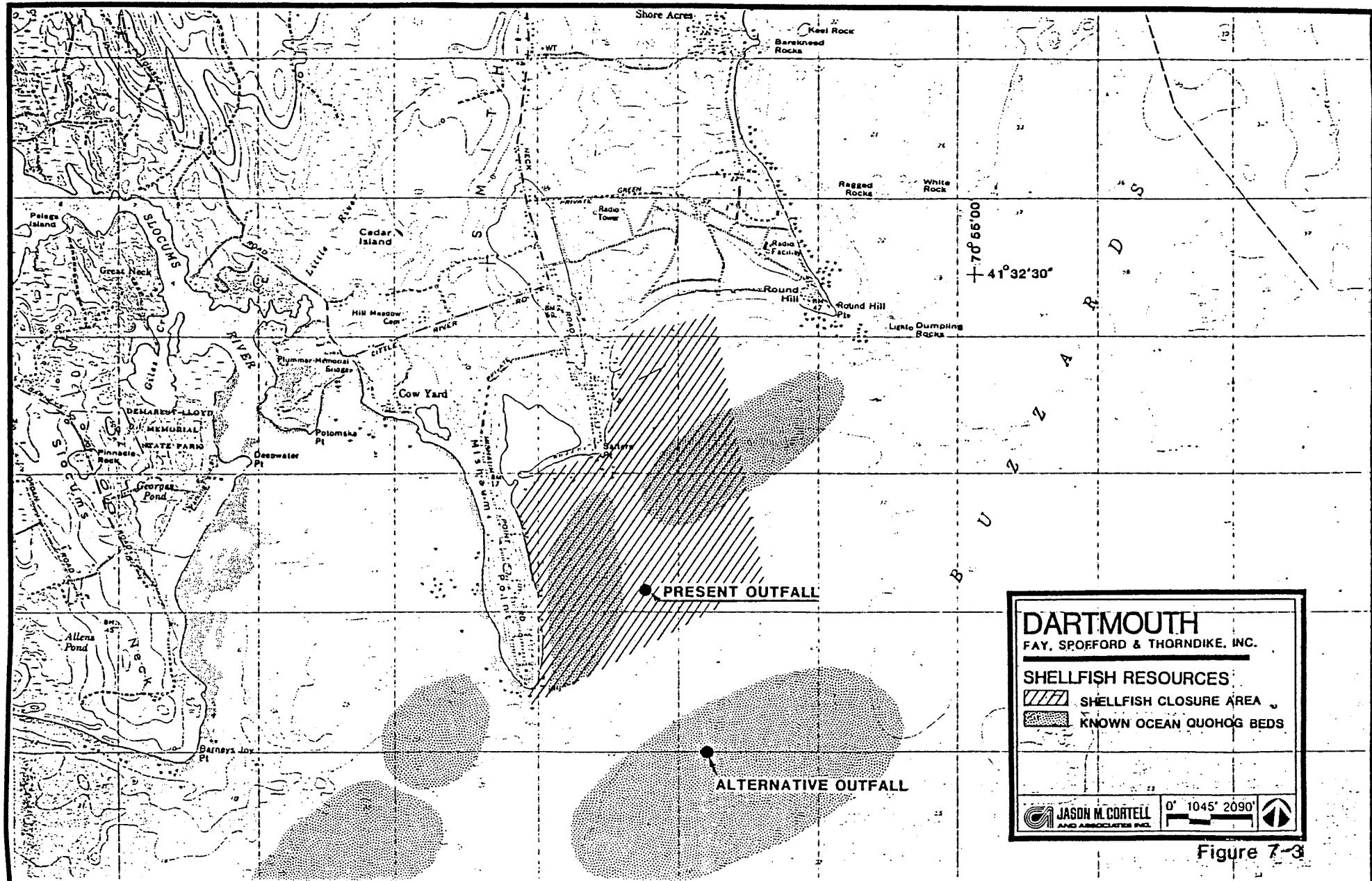


Figure 7-3

efforts with the Ponar dredge showed the bottom to be hard and rocky. SCUBA inspections did not reveal the presence of quahog to the west of the present outfall although this is a factor of the dive location as later sampling along the coast of Mishauum Point revealed the presence of quahog. A significantly rocky bottom was found to prevail approximately 1,000 feet south-southeast of the present outfall in the direction of the alternative outfall site. After that point the bottom softened and dense concentrations of quahog were found with an average of 6 shellfish per square foot. The Division of Marine Fisheries considers any area with more than one shellfish per square foot as a commercial resource.

Confirmation of the location of the beds illustrated in Figure 7-3 was conducted through the sampling for benthic macroinvertebrates with a Ponar dredge and towing of a biological dredge at selected transects shown on Figure 7-1.

Based on the above findings, additional work tasks were developed, reviewed with DEQE, the Division of Marine Fisheries, and the Town of Dartmouth. These resulted in additional field sampling and coliform modelling. The purpose of this work was not only to better delineate the shellfish resources, but, to protect the resource from further deterioration.

It also resulted in design changes in the treatment plant that may, in the future, result in a conditional shellfish closure which would allow restricted commercial harvesting closer to the outfall.

In June, 1987 sampling was conducted to determine density utilizing a commercial hydraulic dredge. Sampling locations are illustrated in Figure 7-4 and the work was supervised by two personnel from the Division of Marine Fisheries. Two passes were made with the dredge and the retrieved shellfish were graded and counted. The results were significant with numerous quahog found at all locations. Good shellfish stocks were found at the majority of locations with physical bottom features (rock, ledge) being the restricting factor. While tissue analyses were not conducted, reports from the Division of Marine Fisheries indicated good tissue quality.

Computer modelling for fecal and total coliform bacteria was then undertaken and the results have been reported in Section 4.3 of this report.

There are several pertinent points that have been reached as a result of the coliform modelling. The first is that there is no benefit to be gained, from a water quality standpoint, by moving the present outfall. In fact, movement to the alternative outfall site would result in a major loss of shellfishing revenues because of the required closure line even though the quality of the effluent would have no adverse impact to the shellfish.

The second is that in considering the excellent operating history of the Dartmouth treatment facility, the area impacted by bacteria is very small (less than 10 acres) even while the facility is on primary treatment with disinfection. Under

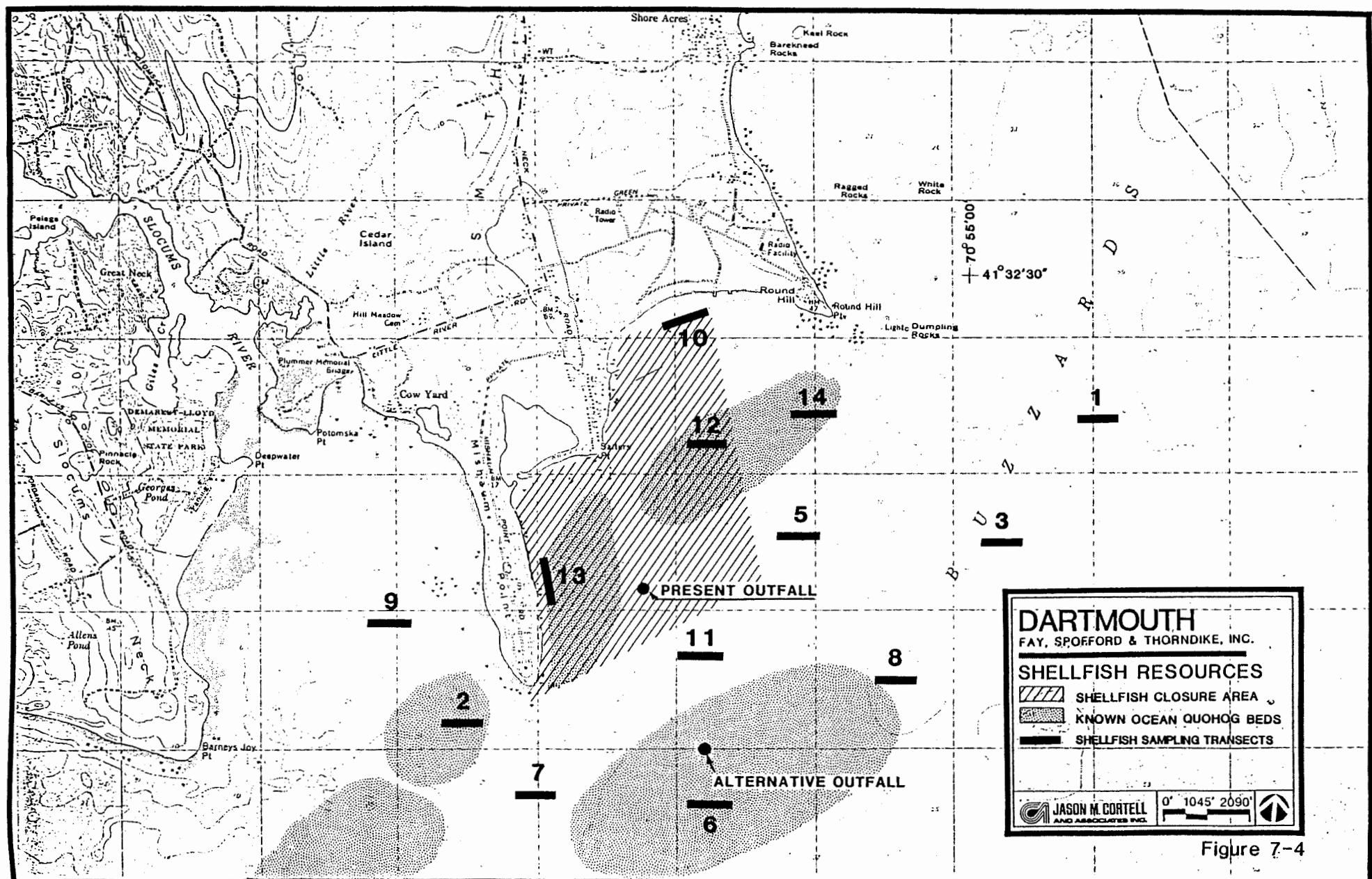


Figure 7-4

such operational conditions, treatment plant records indicate an effluent fecal coliform bacteria concentration of 322/100 ml. The results of the extremely conservative bacteriological modelling reported in Section 4.3, have been scaled down to illustrate the probable area of impact and the results are shown in Figures 7-5 and 7-6.

The last point is that through improved design (to meet Class I reliability criteria), the size of the present shellfish closure may be reduced and/or modified to a conditional closure. A conditional closure means that the area is only open to specific designated shellfishermen who can be readily notified in the event of an upset at the treatment plant.

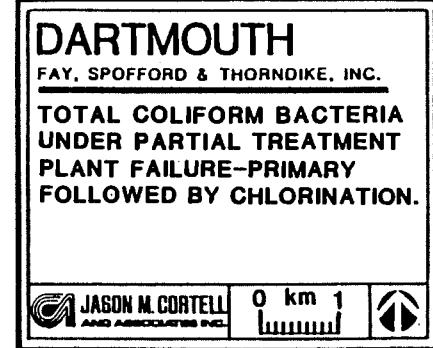
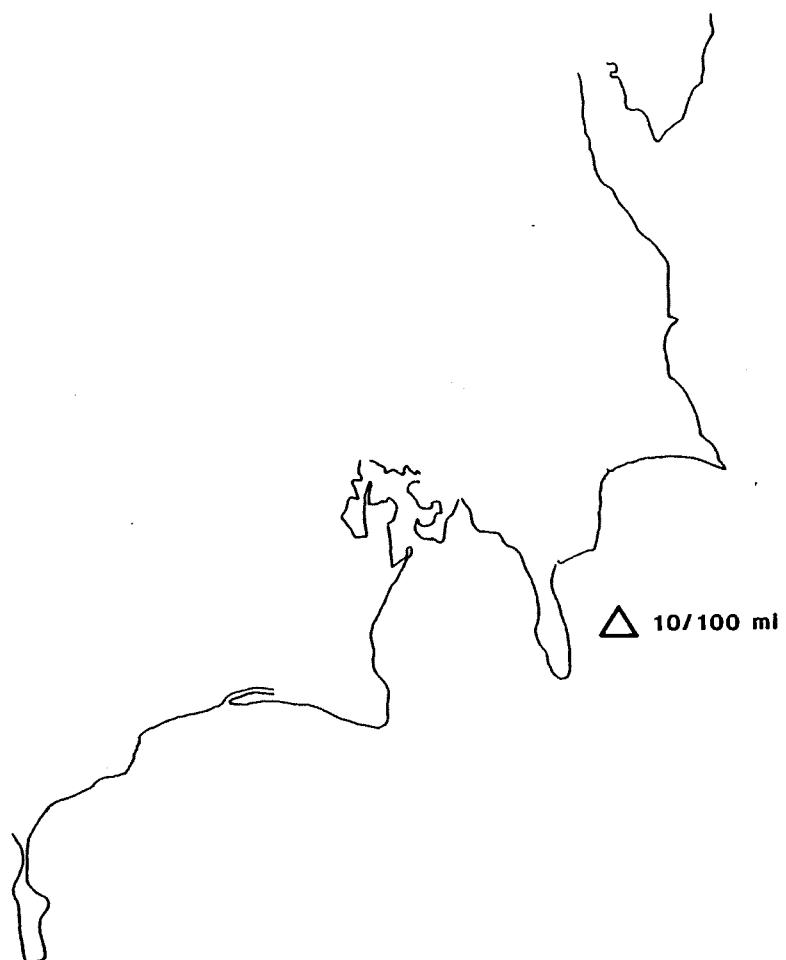


Figure 7-6

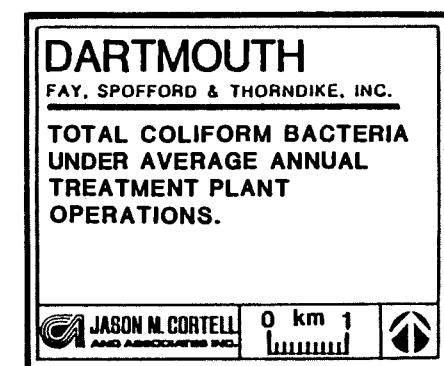
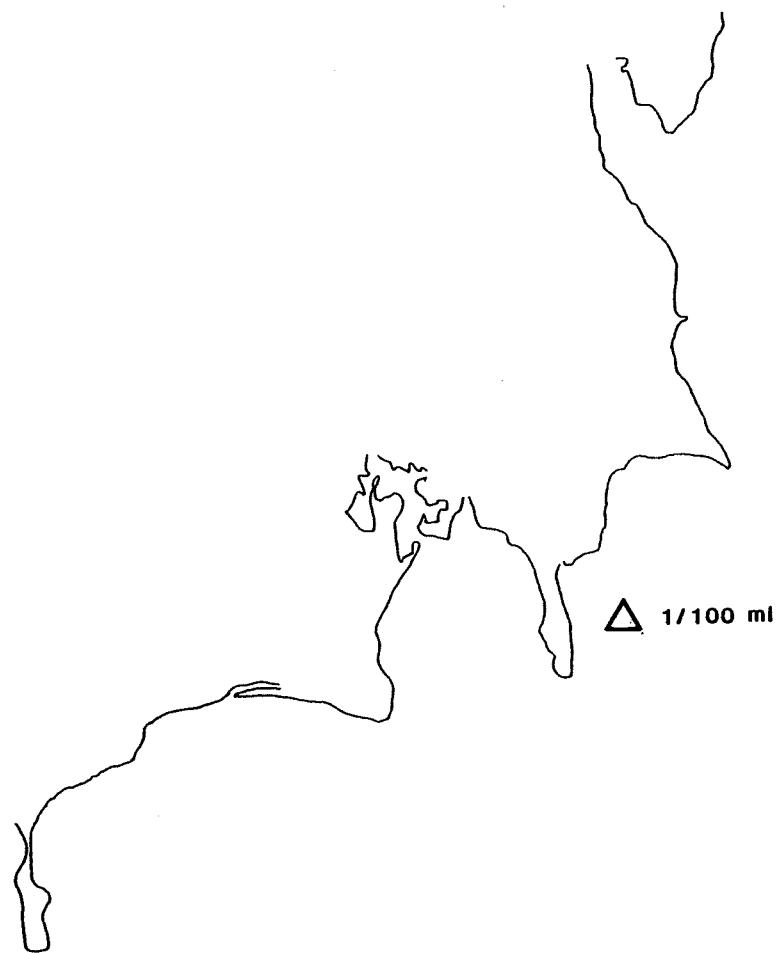


Figure 7-5

8.0

REFERENCES

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Appendix A

CURRENT SPEED AND DIRECTION DATA

00	CC	EEEEE	AA	NN	NN		
0000	CCCC	EEEEE	AAAA	NNN	NN		
00	00	CC	EE	AA	AA	NNN	NN
00	00	CC	EEEE	AA	AA	NNNNNN	
00	00	CC	EEEE	AAAAAA	NN	NNN	
00	00	CC	EE	AAAAAA	NN	NNN	
0000	CCCC	EEEEE	AA	AA	NN	NNN	
00	CCC	EEEEE	AA	AA	NN	NN	

SSSSS	UU	UU	RRRRR	VV	VV	EEEEE	YY	YY	SSSSS
SSSSSS	UU	UU	RRRRRR	VV	VV	EEEEE	YY	YY	SSSSSS
SS	UU	UU	RR RRR	VV	VV	EE	YY	YY	SS
SSS	UU	UU	RRRRR	VVVVVV	VVVVVV	EEEEE	YYYY	YYYY	SSS
SSS	UU	UU	RRRR	VVVV	VVVV	EEEEE	YY	YY	SSS
SS	UU	UU	RRRR	VVVV	VVVV	EE	YY	YY	SS
SSSSSS	UUUU	RR RR	VV	VV	VV	EEEEE	YY	YY	SSSSSS
SSSSS	UU	RR RR	VV	VV	VV	EEEEE	YY	YY	SSSSS

CURRENT SPEED AND DIRECTION

LOWER METER

SALTERS POINT, MA

FOR: JASON M. CORTELL
JOB NO.: 85ES079DATE OF SURVEY: 26 AUG-25 SEP 85
DATE PRINTED: 16 OCT 1985

(50)

CURRENT DATA
LOWER METER
SALTERS POINT, MA

26 AUG 1985

27 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
1400	0.42	21.	25	0000	0.03	2.	146
1430	0.49	25.	20	0030	0.03	1.	88
1500	0.43	22.	16	0100	0.05	3.	39
1530	0.43	22.	21	0130	0.15	8.	39
1600	0.40	21.	29	0200	0.25	13.	16
1630	0.20	10.	31	0230	0.41	21.	5
1700	0.17	9.	269	0300	0.43	22.	6
1730	0.28	14.	255	0330	0.43	22.	12
1800	0.28	15.	237	0400	0.37	19.	8
1830	0.36	18.	216	0430	0.33	17.	0
1900	0.37	19.	222	0500	0.23	12.	298
1930	0.34	17.	228	0530	0.32	16.	277
2000	0.25	13.	217	0600	0.33	17.	239
2030	0.26	13.	217	0630	0.31	16.	232
2100	0.25	13.	226	0700	0.27	14.	216
2130	0.13	7.	227	0730	0.29	15.	220
2200	0.13	7.	216	0800	0.25	13.	222
2230	0.08	4.	195	0830	0.20	10.	211
2300	0.06	3.	189	0900	0.26	13.	215
2330	0.03	1.	186	0930	0.28	14.	233
				1000	0.19	10.	232
				1030	0.09	4.	243
				1100	0.05	3.	285
				1130	0.08	4.	7
				1200	0.13	7.	15
				1230	0.14	7.	23
				1300	0.12	6.	12
				1330	0.18	9.	323
				1400	0.20	10.	323
				1430	0.19	10.	325
				1500	0.20	10.	320
				1530	0.35	18.	0
				1600	0.42	22.	15
				1630	0.41	21.	20
				1700	0.32	16.	20
				1730	0.16	8.	9
				1800	0.39	20.	257
				1830	0.43	22.	244
				1900	0.44	22.	217
				1930	0.45	23.	212
				2000	0.37	19.	216
				2030	0.34	17.	209
				2100	0.29	15.	221
				2130	0.27	14.	234
				2200	0.23	12.	236
				2230	0.13	7.	240
				2300	0.05	2.	265
				2330	0.03	2.	266

CURRENT DATA
LOWER METER
SALTERS POINT, MA

28 AUG 1985

29 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.01	1.	272	0000	0.04	2.	105
0030	0.01	1.	290	0030	0.04	2.	88
0100	0.05	3.	35	0100	0.09	4.	67
0130	0.13	7.	35	0130	0.09	5.	65
0200	0.17	9.	39	0200	0.10	5.	57
0230	0.23	12.	41	0230	0.18	9.	46
0300	0.33	17.	38	0300	0.23	12.	44
0330	0.45	23.	20	0330	0.31	16.	35
0400	0.39	20.	13	0400	0.40	21.	35
0430	0.50	25.	27	0430	0.43	22.	24
0500	0.37	19.	29	0500	0.48	25.	23
0530	0.22	12.	20	0530	0.48	25.	26
0600	0.08	4.	284	0600	0.34	17.	35
0630	0.31	16.	262	0630	0.08	4.	31
0700	0.31	16.	242	0700	0.16	8.	294
0730	0.33	17.	231	0730	0.20	10.	280
0800	0.37	19.	226	0800	0.26	13.	256
0830	0.40	21.	227	0830	0.24	12.	240
0900	0.33	17.	218	0900	0.26	13.	230
0930	0.35	18.	224	0930	0.32	16.	227
1000	0.30	15.	239	1000	0.38	19.	225
1030	0.21	11.	241	1030	0.41	21.	230
1100	0.08	4.	249	1100	0.27	14.	236
1130	0.01	0.	282	1130	0.20	10.	219
1200	0.05	3.	37	1200	0.17	9.	220
1230	0.16	8.	44	1230	0.06	3.	194
1300	0.16	8.	37	1300	0.04	2.	77
1330	0.18	9.	9	1330	0.12	6.	77
1400	0.20	11.	32	1400	0.14	7.	76
1430	0.24	12.	35	1430	0.16	8.	69
1500	0.24	12.	29	1500	0.18	9.	58
1530	0.30	15.	19	1530	0.23	12.	58
1600	0.37	19.	26	1600	0.28	14.	51
1630	0.47	24.	30	1630	0.30	15.	34
1700	0.48	25.	29	1700	0.53	27.	40
1730	0.39	20.	33	1730	0.50	26.	42
1800	0.24	12.	29	1800	0.45	23.	43
1830	0.06	3.	338	1830	0.35	18.	46
1900	0.19	10.	274	1900	0.20	10.	60
1930	0.33	17.	242	1930	0.05	3.	244
2000	0.38	19.	237	2000	0.25	13.	257
2030	0.41	21.	230	2030	0.33	17.	234
2100	0.36	19.	228	2100	0.36	18.	221
2130	0.28	14.	220	2130	0.39	20.	215
2200	0.28	14.	225	2200	0.37	19.	220
2230	0.20	10.	230	2230	0.35	18.	219
2300	0.11	6.	237	2300	0.35	18.	228
2330	0.05	3.	229	2330	0.36	18.	230

CURRENT DATA
LOWER METER
SALTERS POINT, MA

30 AUG 1985

31 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)
0000	0.29	15.	228	0000	0.39	20.	221
0030	0.14	7.	218	0030	0.32	17.	238
0100	0.07	4.	207	0100	0.15	8.	251
0130	0.02	1.	191	0130	0.04	2.	296
0200	0.01	1.	158	0200	0.03	2.	328
0230	0.04	2.	68	0230	0.06	3.	52
0300	0.06	3.	54	0300	0.08	4.	54
0330	0.13	7.	46	0330	0.08	4.	48
0400	0.26	13.	42	0400	0.12	6.	36
0430	0.32	17.	37	0430	0.16	8.	32
0500	0.41	21.	39	0500	0.16	8.	18
0530	0.44	22.	36	0530	0.18	9.	41
0600	0.43	22.	39	0600	0.26	14.	43
0630	0.38	20.	42	0630	0.30	15.	29
0700	0.27	14.	35	0700	0.40	21.	33
0730	0.13	6.	43	0730	0.46	24.	39
0800	0.10	5.	280	0800	0.30	16.	39
0830	0.23	12.	246	0830	0.12	6.	44
0900	0.32	16.	227	0900	0.14	7.	291
0930	0.37	19.	221	0930	0.23	12.	269
1000	0.43	22.	217	1000	0.21	11.	264
1030	0.41	21.	216	1030	0.16	8.	244
1100	0.36	19.	217	1100	0.35	18.	224
1130	0.34	18.	219	1130	0.39	20.	238
1200	0.30	15.	225	1200	0.25	13.	251
1230	0.23	12.	225	1230	0.15	8.	281
1300	0.15	8.	230	1300	0.09	5.	301
1330	0.05	3.	238	1330	0.08	4.	316
1400	0.03	2.	278	1400	0.10	5.	2
1430	0.02	1.	295	1430	0.07	4.	13
1500	0.03	2.	31	1500	0.08	4.	14
1530	0.08	4.	41	1530	0.09	5.	9
1600	0.15	8.	43	1600	0.06	3.	16
1630	0.20	10.	38	1630	0.09	5.	17
1700	0.28	14.	37	1700	0.19	10.	30
1730	0.31	16.	36	1730	0.30	15.	26
1800	0.32	17.	33	1800	0.46	24.	18
1830	0.31	16.	31	1830	0.53	27.	32
1900	0.22	11.	23	1900	0.57	29.	30
1930	0.13	7.	9	1930	0.45	23.	31
2000	0.09	4.	300	2000	0.26	13.	28
2030	0.15	8.	247	2030	0.13	7.	297
2100	0.22	12.	215	2100	0.18	9.	276
2130	0.27	14.	212	2130	0.26	13.	266
2200	0.32	17.	206	2200	0.17	9.	269
2230	0.42	21.	207	2230	0.14	7.	239
2300	0.46	24.	212	2300	0.16	8.	227
2330	0.49	25.	218	2330	0.21	11.	211

CURRENT DATA
LOWER METER
SALTERS POINT, MA

1 SEP 1985

2 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.31	16.	218	0000	0.34	18.	222
0030	0.35	18.	253	0030	0.29	15.	216
0100	0.24	12.	266	0100	0.29	15.	225
0130	0.10	5.	284	0130	0.19	10.	238
0200	0.08	4.	299	0200	0.09	5.	266
0230	0.11	6.	19	0230	0.05	3.	21
0300	0.17	9.	21	0300	0.11	6.	35
0330	0.20	10.	21	0330	0.12	6.	20
0400	0.22	11.	24	0400	0.07	4.	22
0430	0.21	11.	20	0430	0.07	4.	16
0500	0.22	11.	10	0500	0.08	4.	358
0530	0.28	14.	20	0530	0.11	6.	352
0600	0.29	15.	16	0600	0.18	9.	1
0630	0.34	18.	7	0630	0.26	13.	33
0700	0.33	17.	5	0700	0.36	18.	35
0730	0.35	18.	13	0730	0.41	21.	28
0800	0.35	18.	31	0800	0.31	16.	28
0830	0.25	13.	28	0830	0.43	22.	32
0900	0.12	6.	301	0900	0.40	21.	31
0930	0.17	9.	288	0930	0.18	9.	31
1000	0.26	13.	273	1000	0.11	6.	302
1030	0.24	12.	243	1030	0.24	12.	283
1100	0.30	15.	221	1100	0.22	11.	256
1130	0.21	11.	210	1130	0.21	11.	241
1200	0.20	10.	215	1200	0.27	14.	224
1230	0.18	9.	223	1230	0.34	17.	235
1300	0.10	5.	235	1300	0.31	16.	230
1330	0.02	1.	288	1330	0.21	11.	217
1400	0.04	2.	27	1400	0.17	9.	229
1430	0.04	2.	54	1430	0.10	5.	229
1500	0.08	4.	67	1500	0.02	1.	223
1530	0.13	6.	65	1530	0.07	4.	69
1600	0.14	7.	70	1600	0.10	5.	55
1630	0.16	8.	69	1630	0.14	7.	33
1700	0.16	8.	61	1700	0.10	5.	26
1730	0.15	8.	41	1730	0.14	7.	3
1800	0.19	10.	21	1800	0.08	4.	325
1830	0.16	8.	14	1830	0.21	11.	356
1900	0.25	13.	25	1900	0.24	12..	2
1930	0.25	13.	21	1930	0.19	10..	3
2000	0.22	11.	19	2000	0.31	16..	32
2030	0.21	11.	17	2030	0.32	16..	30
2100	0.17	9.	5	2100	0.29	15..	23
2130	0.12	6.	308	2130	0.18	9..	13
2200	0.12	6.	292	2200	0.11	5..	5
2230	0.23	12.	257	2230	0.12	6..	304
2300	0.28	14.	233	2300	0.11	6..	282
2330	0.35	18.	222	2330	0.22	11..	241

CURRENT DATA
LOWER METER
SALTERS POINT, MA

3 SEP 1985

4 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)
0000	0.25	13.	229	0000	0.16	8.	264
0030	0.26	13.	221	0030	0.20	10.	236
0100	0.23	12.	210	0100	0.23	12.	235
0130	0.18	9.	203	0130	0.29	15.	234
0200	0.12	6.	209	0200	0.23	12.	239
0230	0.05	2.	219	0230	0.12	6.	232
0300	0.03	2.	34	0300	0.12	6.	239
0330	0.11	6.	48	0330	0.12	6.	273
0400	0.19	10.	57	0400	0.02	1.	360
0430	0.20	10.	55	0430	0.03	1.	10
0500	0.14	7.	49	0500	0.06	3.	30
0530	0.13	7.	43	0530	0.12	6.	33
0600	0.11	6.	37	0600	0.09	5.	8
0630	0.14	7.	33	0630	0.12	6.	329
0700	0.29	15.	37	0700	0.13	7.	340
0730	0.29	15.	31	0730	0.16	8.	6
0800	0.30	16.	20	0800	0.23	12.	19
0830	0.28	14.	17	0830	0.32	16.	27
0900	0.26	13.	34	0900	0.22	11.	17
0930	0.24	12.	40	0930	0.19	10.	1
1000	0.13	6.	24	1000	0.13	7.	332
1030	0.08	4.	297	1030	0.14	7.	336
1100	0.14	7.	281	1100	0.16	8.	320
1130	0.19	10.	264	1130	0.17	9.	296
1200	0.21	11.	245	1200	0.18	9.	273
1230	0.23	12.	235	1230	0.17	9.	264
1300	0.18	9.	223	1300	0.21	11.	234
1330	0.18	9.	214	1330	0.24	12.	229
1400	0.21	11.	204	1400	0.28	14.	235
1430	0.12	6.	212	1430	0.27	14.	245
1500	0.06	3.	190	1500	0.19	10.	238
1530	0.02	1.	33	1530	0.11	5.	242
1600	0.04	2.	39	1600	0.04	2.	299
1630	0.08	4.	48	1630	0.03	1.	19
1700	0.08	4.	22	1700	0.04	2.	22
1730	0.07	3.	35	1730	0.08	4.	41
1800	0.04	2.	17	1800	0.06	3.	57
1830	0.07	3.	1	1830	0.02	1.	45
1900	0.10	5.	359	1900	0.01	0.	37
1930	0.19	10.	360	1930	0.03	2.	355
2000	0.23	12.	23	2000	0.06	3.	357
2030	0.28	14.	22	2030	0.14	7.	14
2100	0.29	15.	18	2100	0.21	11.	20
2130	0.30	15.	16	2130	0.23	12.	17
2200	0.27	14.	13	2200	0.20	10.	11
2230	0.13	7.	5	2230	0.14	7.	3
2300	0.11	6.	318	2300	0.11	6.	335
2330	0.18	9.	286	2330	0.15	8.	312

CURRENT DATA
LOWER METER
SALTERS POINT, MA

5 SEP 1985

6 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.16	8.	286	0000	0.10	5.	330
0030	0.22	12.	245	0030	0.10	5.	312
0100	0.20	10.	232	0100	0.23	12.	273
0130	0.27	14.	239	0130	0.09	5.	243
0200	0.20	10.	246	0200	0.21	11.	230
0230	0.13	7.	242	0230	0.24	13.	225
0300	0.10	5.	203	0300	0.19	10.	231
0330	0.11	5.	203	0330	0.11	5.	225
0400	0.06	3.	150	0400	0.03	1.	212
0430	0.07	3.	109	0430	0.01	1.	229
0500	0.10	5.	86	0500	0.03	1.	56
0530	0.11	5.	81	0530	0.09	5.	65
0600	0.08	4.	85	0600	0.08	4.	71
0630	0.04	2.	69	0630	0.06	3.	78
0700	0.04	2.	75	0700	0.03	1.	83
0730	0.01	1.	85	0730	0.03	2.	64
0800	0.03	2.	8	0800	0.03	2.	62
0830	0.09	5.	33	0830	0.07	3.	51
0900	0.20	10.	52	0900	0.09	5.	42
0930	0.19	10.	50	0930	0.14	7.	37
1000	0.24	12.	44	1000	0.21	11.	43
1030	0.25	13.	28	1030	0.23	12.	43
1100	0.19	10.	24	1100	0.21	11.	34
1130	0.13	7.	15	1130	0.18	9.	25
1200	0.08	4.	324	1200	0.12	6.	11
1230	0.10	5.	302	1230	0.09	5.	3
1300	0.25	13.	243	1300	0.06	3.	299
1330	0.27	14.	231	1330	0.11	6.	245
1400	0.25	13.	227	1400	0.17	9.	248
1430	0.21	11.	229	1430	0.16	8.	244
1500	0.13	6.	221	1500	0.13	7.	220
1530	0.09	5.	193	1530	0.12	6.	208
1600	0.05	3.	177	1600	0.11	6.	177
1630	0.06	3.	138	1630	0.13	7.	173
1700	0.05	3.	112	1700	0.12	6.	160
1730	0.05	3.	101	1730	0.12	6.	156
1800	0.07	3.	121	1800	0.11	6.	162
1830	0.02	1.	172	1830	0.09	5.	185
1900	0.06	3.	212	1900	0.11	6.	197
1930	0.04	2.	228	1930	0.14	7.	201
2000	0.01	1.	243	2000	0.09	4.	197
2030	0.01	0.	287	2030	0.04	2.	151
2100	0.04	2.	11	2100	0.04	2.	89
2130	0.13	7.	19	2130	0.09	5.	40
2200	0.16	8.	21	2200	0.12	6.	37
2230	0.18	9.	16	2230	0.19	10.	36
2300	0.20	10.	28	2300	0.19	10.	21
2330	0.16	8.	5	2330	0.11	6.	12

CURRENT DATA
LOWER METER
SALTERS POINT, MA

7 SEP 1985

8 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.08	4.	323	0000	0.12	6.	11
0030	0.10	5.	307	0030	0.13	7.	1
0100	0.12	6.	268	0100	0.16	8.	292
0130	0.14	7.	251	0130	0.16	8.	270
0200	0.14	7.	240	0200	0.11	6.	271
0230	0.11	6.	229	0230	0.14	7.	276
0300	0.06	3.	223	0300	0.10	5.	273
0330	0.07	4.	201	0330	0.04	2.	268
0400	0.04	2.	158	0400	0.05	3.	282
0430	0.04	2.	160	0430	0.02	1.	299
0500	0.03	2.	146	0500	0.03	1.	221
0530	0.04	2.	90	0530	0.06	3.	228
0600	0.06	3.	53	0600	0.03	2.	245
0630	0.14	7.	48	0630	0.04	2.	303
0700	0.21	11.	42	0700	0.02	1.	10
0730	0.17	9.	43	0730	0.05	2.	44
0800	0.14	7.	43	0800	0.09	5.	40
0830	0.04	2.	23	0830	0.10	5.	44
0900	0.06	3.	310	0900	0.08	4.	39
0930	0.03	1.	306	0930	0.10	5.	44
1000	0.06	3.	303	1000	0.06	3.	42
1030	0.04	2.	43	1030	0.05	3.	41
1100	0.12	6.	47	1100	0.12	6.	44
1130	0.19	10.	44	1130	0.11	6.	38
1200	0.22	11.	44	1200	0.14	7.	11
1230	0.17	9.	42	1230	0.16	8.	356
1300	0.13	7.	296	1300	0.13	7.	332
1330	0.10	5.	234	1330	0.13	6.	303
1400	0.16	8.	239	1400	0.18	9.	274
1430	0.18	9.	225	1430	0.19	10.	261
1500	0.14	7.	224	1500	0.16	8.	248
1530	0.11	6.	196	1530	0.16	8.	248
1600	0.06	3.	160	1600	0.13	7.	258
1630	0.08	4.	156	1630	0.05	3.	241
1700	0.10	5.	202	1700	0.06	3.	179
1730	0.12	6.	200	1730	0.09	4.	164
1800	0.09	5.	202	1800	0.09	5.	151
1830	0.10	5.	195	1830	0.06	3.	157
1900	0.08	4.	195	1900	0.07	3.	153
1930	0.05	3.	204	1930	0.07	4.	156
2000	0.07	4.	209	2000	0.08	4.	185
2030	0.05	3.	204	2030	0.04	2.	209
2100	0.02	1.	180	2100	0.04	2.	237
2130	0.04	2.	78	2130	0.05	3.	201
2200	0.12	6.	55	2200	0.05	3.	199
2230	0.18	9.	52	2230	0.02	1.	216
2300	0.19	10.	44	2300	0.02	1.	46
2330	0.17	9.	36	2330	0.04	2.	41

CURRENT DATA
LOWER METER
SALTERS POINT, MA

9 SEP 1985

10 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.11	6.	27	0000	0.03	2.	30
0030	0.18	9.	25	0030	0.06	3.	33
0100	0.18	9.	6	0100	0.13	7.	33
0130	0.18	9.	354	0130	0.12	6.	36
0200	0.15	8.	318	0200	0.14	7.	31
0230	0.15	8.	308	0230	0.09	5.	13
0300	0.16	8.	267	0300	0.08	4.	291
0330	0.15	8.	256	0330	0.16	8.	285
0400	0.18	9.	248	0400	0.11	6.	265
0430	0.02	1.	250	0430	0.10	5.	243
0500	0.04	2.	286	0500	0.10	5.	240
0530	0.05	3.	282	0530	0.12	6.	249
0600	0.04	2.	213	0600	0.12	6.	218
0630	0.05	3.	151	0630	0.12	6.	216
0700	0.09	5.	155	0700	0.22	11.	208
0730	0.13	7.	141	0730	0.21	11.	216
0800	0.15	7.	113	0800	0.21	11.	226
0830	0.18	9.	106	0830	0.18	9.	237
0900	0.17	9.	109	0900	0.06	3.	248
0930	0.16	8.	103	0930	0.00	0.	287
1000	0.17	9.	114	1000	0.03	2.	3
1030	0.08	4.	136	1030	0.05	3.	3
1100	0.06	3.	283	1100	0.08	4.	359
1130	0.04	2.	288	1130	0.07	4.	323
1200	0.02	1.	302	1200	0.05	3.	359
1230	0.13	6.	335	1230	0.08	4.	323
1300	0.16	8.	61	1300	0.14	7.	11
1330	0.11	6.	50	1330	0.27	14.	17
1400	0.12	6.	327	1400	0.33	17.	5
1430	0.11	6.	312	1430	0.24	12.	336
1500	0.16	8.	277	1500	0.26	13.	326
1530	0.16	8.	261	1530	0.17	9.	284
1600	0.08	4.	242	1600	0.19	10.	250
1630	0.04	2.	226	1630	0.14	7.	249
1700	0.07	4.	148	1700	0.14	7.	226
1730	0.09	4.	151	1730	0.12	6.	245
1800	0.07	4.	171	1800	0.07	4.	260
1830	0.09	5.	195	1830	0.01	0.	286
1900	0.23	12.	190	1900	0.03	2.	116
1930	0.28	14.	192	1930	0.09	5.	140
2000	0.27	14.	203	2000	0.14	7.	214
2030	0.21	11.	207	2030	0.14	7.	208
2100	0.12	6.	207	2100	0.13	7.	211
2130	0.02	1.	185	2130	0.12	6.	208
2200	0.02	1.	136	2200	0.09	4.	193
2230	0.03	2.	129	2230	0.04	2.	159
2300	0.02	1.	142	2300	0.06	3.	68
2330	0.02	1.	329	2330	0.13	7.	76

CURRENT DATA
LOWER METER
SALTERS POINT, MA

21 SEP 1985

22 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)
0000	0.31	16.	24	0000	0.31	16.	36
0030	0.15	8.	6	0030	0.32	17.	31
0100	0.18	9.	326	0100	0.22	12.	23
0130	0.26	14.	263	0130	0.12	6.	310
0200	0.27	14.	250	0200	0.17	9.	296
0230	0.26	13.	242	0230	0.19	10.	262
0300	0.27	14.	241	0300	0.16	8.	249
0330	0.25	13.	246	0330	0.14	7.	242
0400	0.13	7.	240	0400	0.12	6.	230
0430	0.14	7.	221	0430	0.12	6.	229
0500	0.13	7.	256	0500	0.14	7.	232
0530	0.07	4.	279	0530	0.17	9.	220
0600	0.01	0.	307	0600	0.15	8.	227
0630	0.01	0.	21	0630	0.12	6.	268
0700	0.04	2.	32	0700	0.02	1.	291
0730	0.05	2.	31	0730	0.00	0.	6
0800	0.08	4.	331	0800	0.04	2.	18
0830	0.05	3.	338	0830	0.03	2.	18
0900	0.08	4.	340	0900	0.03	1.	10
0930	0.12	6.	355	0930	0.00	0.	11
1000	0.15	8.	9	1000	0.01	0.	8
1030	0.18	9.	23	1030	0.00	0.	8
1100	0.24	12.	30	1100	0.05	3.	37
1130	0.33	17.	32	1130	0.11	6.	39
1200	0.34	18.	35	1200	0.12	6.	40
1230	0.32	17.	33	1230	0.15	8.	28
1300	0.19	10.	18	1300	0.19	10.	46
1330	0.11	6.	324	1330	0.18	9.	27
1400	0.19	10.	294	1400	0.08	4.	12
1430	0.25	13.	268	1430	0.08	4.	310
1500	0.23	12.	243	1500	0.12	6.	248
1530	0.22	11.	239	1530	0.16	8.	232
1600	0.25	13.	243	1600	0.14	7.	225
1630	0.17	9.	246	1630	0.17	9.	225
1700	0.11	6.	240	1700	0.13	7.	222
1730	0.08	4.	248	1730	0.16	8.	223
1800	0.09	5.	247	1800	0.22	11.	230
1830	0.06	3.	248	1830	0.20	10.	247
1900	0.06	3.	254	1900	0.13	7.	253
1930	0.04	2.	260	1930	0.09	5.	251
2000	0.05	3.	270	2000	0.07	4.	238
2030	0.05	3.	268	2030	0.07	4.	240
2100	0.01	0.	303	2100	0.05	2.	251
2130	0.06	3.	39	2130	0.01	1.	273
2200	0.11	6.	40	2200	0.03	1.	49
2230	0.16	8.	12	2230	0.05	3.	56
2300	0.24	13.	17	2300	0.13	6.	53
2330	0.33	17.	25	2330	0.14	7.	46

(A)

CURRENT DATA
LOWER METER
SALTERS POINT, MA

23 SEP 1985

24 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.15	8.	37	0000	0.08	4.	38
0030	0.16	8.	31	0030	0.12	6.	26
0100	0.20	10.	36	0100	0.07	4.	43
0130	0.17	9.	23	0130	0.15	8.	35
0200	0.09	5.	8	0200	0.17	9.	34
0230	0.07	3.	306	0230	0.21	11.	36
0300	0.09	4.	283	0300	0.18	9.	20
0330	0.11	6.	256	0330	0.10	5.	5
0400	0.11	6.	220	0400	0.10	5.	300
0430	0.11	5.	221	0430	0.11	6.	288
0500	0.16	8.	230	0500	0.15	8.	226
0530	0.14	7.	223	0530	0.16	8.	214
0600	0.17	9.	216	0600	0.18	9.	219
0630	0.15	8.	219	0630	0.13	7.	225
0700	0.22	11.	239	0700	0.12	6.	221
0730	0.12	6.	249	0730	0.13	7.	215
0800	0.02	1.	288	0800	0.13	7.	234
0830	0.01	0.	315	0830	0.13	7.	242
0900	0.02	1.	30	0900	0.15	7.	252
0930	0.04	2.	42	0930	0.15	8.	254
1000	0.04	2.	49	1000	0.08	4.	269
1030	0.00	0.	64	1030	0.07	4.	280
1100	0.00	0.	64	1100	0.04	2.	299
1130	0.04	2.	47	1130	0.01	0.	320
1200	0.11	6.	42	1200	0.03	1.	13
1230	0.15	8.	42	1230	0.06	3.	41
1300	0.17	9.	35	1300	0.08	4.	50
1330	0.18	9.	36	1330	0.13	7.	50
1400	0.22	11.	33	1400	0.14	7.	34
1430	0.18	9.	23	1430	0.17	9.	34
1500	0.11	6.	0	1500	0.21	11.	35
1530	0.08	4.	309	1530	0.17	9.	29
1600	0.13	7.	277	1600	0.12	6.	18
1630	0.13	6.	243	1630	0.09	5.	323
1700	0.14	7.	228	1700	0.06	3.	292
1730	0.14	7.	223	1730	0.15	7.	257
1800	0.11	6.	219	1800	0.16	8.	234
1830	0.14	7.	213	1830	0.17	9.	224
1900	0.22	11.	221	1900	0.19	10.	225
1930	0.27	14.	239	1930	0.20	10.	225
2000	0.17	9.	244	2000	0.23	12.	225
2030	0.09	5.	259	2030	0.19	10.	218
2100	0.04	2.	286	2100	0.21	11.	237
2130	0.02	1.	14	2130	0.16	8.	233
2200	0.04	2.	37	2200	0.11	6.	240
2230	0.05	2.	34	2230	0.07	3.	243
2300	0.05	2.	31	2300	0.03	1.	256
2330	0.05	3.	20	2330	0.00	0.	303

CURRENT DATA
LOWER METER
SALTERS POINT, MA

25 SEP 1985

TIME SPEED SPEED DIRECTION

(EST)	(KTS)	(CM/S)	(DEG. TRUE)
0000	0.00	0.	4
0030	0.03	2.	15
0100	0.07	4.	32
0130	0.13	7.	32
0200	0.18	9.	28
0230	0.24	13.	37
0300	0.29	15.	34
0330	0.24	12.	33
0400	0.15	8.	27
0430	0.16	8.	12
0500	0.10	5.	314
0530	0.19	10.	294
0600	0.14	7.	270
0630	0.13	7.	257
0700	0.06	3.	234
0730	0.07	4.	209
0800	0.07	3.	175
0830	0.11	5.	205
0900	0.12	6.	210
0930	0.10	5.	241
1000	0.10	5.	242
1030	0.03	1.	248
1100	0.01	0.	250
1130	0.04	2.	67
1200	0.10	5.	61
1230	0.10	5.	59
1300	0.10	5.	55
1330	0.15	8.	44
1400	0.15	8.	38
1430	0.21	11.	45
1500	0.21	11.	40
1530	0.33	17.	41
1600	0.36	19.	36

(21)

CURRENT DATA
LOWER METER
SALTERS POINT, MA

***** END OF DATA *****

2109 RECORDS TYPED

	GOOD	BAD
IR	1445	0
PD	1445	0

1445 RECORDS WRITTEN TO TAPE FILE

00	CC	EEEEEE	AA	NN	NN		
0000	CCCC	EEEEEE	AAAAA	NNN	NN		
00	00	CC	EE	AA	AA	NNN	NN
00	00	CC	EEEE	AA	AA	NNNNNN	
00	00	CC	EEEE	AAAAAA	NN	NNN	
00	00	CC	EE	AAAAAA	NN	NNN	
0000	CCCC	EEEEEE	AA	AA	NN	NNN	
00	CCC	EEEEEE	AA	AA	NN	NN	

SSSSS	UU	UU	RRRRR	VV	VV	EEEEEE	YY	YY	SSSSS
SSSSS	UU	UU	RRRRRR	VV	VV	EEEEEE	YY	YY	SSSSS
SS	UU	UU	RR RRR	VV	VV	EE	YY	YY	SS
SSS	UU	UU	RRRRR	VVVVVV	VVVVVV	EEFE	YYYY	SSS	
SSS	UU	UU	RRRR	VVVV	VVVV	EEEE	YY	SSS	
SS	UU	UU	RRRR	VVVV	VVVV	EE	YY	SS	
SSSSS	UUUU	UUUU	RR RR	VV	VV	EEEEEE	YY	SSSSS	
SSSSS	UU	UU	RR RR	VV	VV	EEEEEE	YY	SSSSS	

CURRENT SPEED AND DIRECTION

MIDDLE METER

SALTERS POINT, MA

FOR: JASON M. CORTELL
JOB NO.: 85E6079DATE OF SURVEY: 26 AUG-25 SEP 85
DATE PRINTED: 15 OCT 1985

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

26 AUG 1985

27 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
1400	0.55	28.	25	0000	0.01	1.	242
1430	0.70	36.	28	0030	0.00	0.	247
1500	0.68	35.	31	0100	0.04	2.	18
1530	0.63	32.	30	0130	0.24	12.	30
1600	0.47	24.	34	0200	0.37	19.	22
1630	0.25	13.	38	0230	0.71	36.	18
1700	0.14	7.	277	0300	0.69	36.	25
1730	0.29	15.	264	0330	0.69	36.	32
1800	0.37	19.	266	0400	0.56	29.	33
1830	0.38	19.	248	0430	0.45	23.	31
1900	0.49	25.	237	0500	0.21	11.	26
1930	0.51	26.	235	0530	0.32	16.	304
2000	0.57	29.	232	0600	0.35	18.	291
2030	0.44	23.	230	0630	0.39	20.	264
2100	0.48	25.	244	0700	0.40	20.	244
2130	0.33	17.	245	0730	0.39	20.	236
2200	0.32	16.	244	0800	0.44	23.	238
2230	0.27	14.	244	0830	0.49	25.	240
2300	0.16	8.	232	0900	0.47	24.	241
2330	0.09	5.	230	0930	0.43	22.	249
				1000	0.43	22.	244
				1030	0.18	9.	251
				1100	0.12	6.	281
				1130	0.09	5.	302
				1200	0.20	10.	3
				1230	0.26	13.	18
				1300	0.35	18.	1
				1330	0.28	14.	2
				1400	0.30	16.	1
				1430	0.39	20.	9
				1500	0.47	24.	19
				1530	0.56	29.	27
				1600	0.69	36.	34
				1630	0.61	32.	30
				1700	0.49	25.	26
				1730	0.21	11.	19
				1800	0.30	15.	279
				1830	0.45	23.	273
				1900	0.48	25.	247
				1930	0.59	31.	233
				2000	0.66	34.	234
				2030	0.60	31.	235
				2100	0.48	25.	234
				2130	0.39	20.	236
				2200	0.39	20.	241
				2230	0.25	13.	248
				2300	0.14	7.	252
				2330	0.09	5.	255

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

28 AUG 1985

29 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.03	1.	256	0000	0.20	10.	228
0030	0.00	0.	285	0030	0.01	1.	217
0100	0.06	3.	9	0100	0.01	1.	216
0130	0.17	9.	11	0130	0.00	0.	42
0200	0.22	11.	6	0200	0.09	5.	37
0230	0.27	14.	12	0230	0.20	10.	31
0300	0.53	27.	24	0300	0.33	17.	29
0330	0.65	34.	21	0330	0.52	27.	24
0400	0.66	34.	22	0400	0.63	32.	22
0430	0.71	37.	32	0430	0.66	34.	26
0500	0.53	27.	35	0500	0.71	37.	27
0530	0.31	16.	32	0530	0.73	37.	31
0600	0.07	3.	22	0600	0.43	22.	37
0630	0.32	16.	266	0630	0.14	7.	32
0700	0.43	22.	255	0700	0.14	7.	280
0730	0.47	24.	253	0730	0.30	15.	283
0800	0.49	25.	252	0800	0.33	17.	265
0830	0.59	30.	243	0830	0.34	18.	253
0900	0.62	32.	235	0900	0.44	23.	242
0930	0.54	28.	243	0930	0.45	23.	241
1000	0.41	21.	251	1000	0.59	31.	235
1030	0.39	20.	253	1030	0.66	34.	249
1100	0.29	15.	263	1100	0.40	21.	248
1130	0.18	9.	280	1130	0.47	24.	233
1200	0.12	6.	302	1200	0.41	21.	243
1230	0.19	10.	10	1230	0.22	11.	243
1300	0.28	14.	18	1300	0.07	3.	251
1330	0.22	11.	8	1330	0.04	2.	34
1400	0.35	18.	8	1400	0.13	7.	48
1430	0.40	21.	19	1430	0.15	8.	48
1500	0.45	23.	14	1500	0.22	11.	44
1530	0.45	23.	25	1530	0.33	17.	44
1600	0.59	31.	33	1600	0.48	25.	40
1630	0.63	32.	29	1630	0.55	28.	33
1700	0.63	32.	33	1700	0.79	41.	36
1730	0.56	29.	34	1730	0.67	34.	38
1800	0.39	20.	35	1800	0.60	31.	41
1830	0.15	8.	39	1830	0.48	25.	61
1900	0.15	8.	329	1900	0.27	14.	71
1930	0.38	20.	252	1930	0.06	3.	110
2000	0.42	22.	247	2000	0.31	16.	279
2030	0.47	24.	241	2030	0.46	24.	268
2100	0.49	25.	229	2100	0.53	27.	260
2130	0.54	28.	234	2130	0.65	33.	253
2200	0.48	25.	240	2200	0.57	30.	254
2230	0.33	17.	244	2230	0.51	26.	251
2300	0.26	14.	247	2300	0.51	26.	261
2330	0.32	17.	242	2330	0.50	26.	268

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

30 AUG 1985

31 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.48	25.	276	0000	0.64	33.	256
0030	0.30	16.	270	0030	0.55	28.	268
0100	0.18	9.	264	0100	0.27	14.	280
0130	0.18	9.	274	0130	0.11	6.	301
0200	0.04	2.	301	0200	0.12	6.	310
0230	0.03	1.	19	0230	0.05	3.	311
0300	0.01	0.	32	0300	0.05	3.	315
0330	0.23	12.	36	0330	0.13	7.	7
0400	0.38	20.	38	0400	0.13	7.	12
0430	0.46	24.	37	0430	0.22	11.	20
0500	0.54	28.	35	0500	0.22	11.	15
0530	0.61	32.	36	0530	0.27	14.	38
0600	0.55	29.	37	0600	0.34	18.	42
0630	0.55	29.	38	0630	0.47	24.	32
0700	0.41	21.	36	0700	0.61	31.	36
0730	0.22	11.	45	0730	0.59	31.	40
0800	0.07	4.	285	0800	0.46	24.	42
0830	0.29	15.	267	0830	0.12	6.	47
0900	0.45	23.	247	0900	0.17	8.	281
0930	0.52	27.	242	0930	0.44	23.	257
1000	0.60	31.	244	1000	0.54	28.	242
1030	0.50	26.	240	1030	0.64	33.	242
1100	0.51	26.	238	1100	0.66	34.	248
1130	0.50	26.	243	1130	0.80	41.	253
1200	0.45	23.	251	1200	0.45	23.	257
1230	0.33	17.	249	1230	0.30	15.	267
1300	0.24	13.	245	1300	0.19	10.	281
1330	0.10	5.	252	1330	0.17	9.	291
1400	0.02	1.	265	1400	0.13	7.	306
1430	0.01	1.	2	1430	0.07	4.	304
1500	0.05	3.	24	1500	0.03	2.	317
1530	0.15	8.	32	1530	0.11	5.	313
1600	0.21	11.	36	1600	0.03	1.	13
1630	0.29	15.	34	1630	0.15	8.	16
1700	0.38	20.	31	1700	0.25	13.	28
1730	0.43	22.	33	1730	0.42	22.	31
1800	0.48	25.	34	1800	0.75	39.	31
1830	0.46	23.	33	1830	0.88	45.	35
1900	0.38	19.	35	1900	0.74	38.	33
1930	0.25	13.	21	1930	0.60	31.	39
2000	0.12	6.	315	2000	0.37	19.	44
2030	0.18	9.	260	2030	0.13	7.	307
2100	0.33	17.	236	2100	0.27	14.	263
2130	0.49	25.	234	2130	0.41	21.	262
2200	0.48	25.	234	2200	0.39	20.	255
2230	0.62	32.	240	2230	0.39	20.	252
2300	0.73	38.	241	2300	0.42	22.	247
2330	0.75	38.	247	2330	0.55	28.	249

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

5 SEP 1985

6 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.20	10.	283	0000	0.21	11.	4
0030	0.24	12.	255	0030	0.22	11.	331
0100	0.30	15.	244	0100	0.22	11.	292
0130	0.38	20.	254	0130	0.26	13.	277
0200	0.34	17.	260	0200	0.36	19.	263
0230	0.26	13.	256	0230	0.40	21.	265
0300	0.34	18.	251	0300	0.32	17.	266
0330	0.23	12.	250	0330	0.24	12.	256
0400	0.10	5.	243	0400	0.07	4.	251
0430	0.00	0.	229	0430	0.00	0.	255
0500	0.06	3.	66	0500	0.02	1.	28
0530	0.18	9.	60	0530	0.04	2.	28
0600	0.21	11.	63	0600	0.08	4.	47
0630	0.15	8.	49	0630	0.08	4.	63
0700	0.15	8.	47	0700	0.03	2.	76
0730	0.15	8.	50	0730	0.00	0.	73
0800	0.20	10.	49	0800	0.01	1.	61
0830	0.26	13.	52	0830	0.09	5.	42
0900	0.38	19.	52	0900	0.21	11.	41
0930	0.46	24.	48	0930	0.29	15.	43
1000	0.46	23.	45	1000	0.37	19.	45
1030	0.43	22.	35	1030	0.41	21.	41
1100	0.30	16.	31	1100	0.37	19.	36
1130	0.24	13.	25	1130	0.37	19.	34
1200	0.11	6.	11	1200	0.25	13.	26
1230	0.17	9.	299	1230	0.15	7.	17
1300	0.40	20.	272	1300	0.05	3.	295
1330	0.43	22.	264	1330	0.16	8.	267
1400	0.49	25.	259	1400	0.27	14.	261
1430	0.40	21.	259	1430	0.26	13.	259
1500	0.26	14.	260	1500	0.28	15.	244
1530	0.21	11.	248	1530	0.24	13.	248
1600	0.10	5.	247	1600	0.21	11.	231
1630	0.03	2.	243	1630	0.20	10.	231
1700	0.00	0.	227	1700	0.19	10.	239
1730	0.00	0.	220	1730	0.13	6.	236
1800	0.00	0.	226	1800	0.11	5.	235
1830	0.02	1.	251	1830	0.17	9.	227
1900	0.02	1.	254	1900	0.07	3.	232
1930	0.00	0.	248	1930	0.14	7.	209
2000	0.00	0.	242	2000	0.09	5.	204
2030	0.01	0.	220	2030	0.05	2.	208
2100	0.05	3.	204	2100	0.01	0.	211
2130	0.21	11.	33	2130	0.10	5.	22
2200	0.32	16.	27	2200	0.20	10.	34
2230	0.35	18.	28	2230	0.36	19.	32
2300	0.36	18.	24	2300	0.33	17.	32
2330	0.28	15.	14	2330	0.23	12.	31

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

7 SEP 1985

8 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.08	4.	18	0000	0.34	18.	25
0030	0.09	4.	324	0030	0.25	13.	11
0100	0.11	6.	293	0100	0.16	8.	323
0130	0.14	7.	284	0130	0.23	12.	312
0200	0.17	9.	281	0200	0.34	17.	296
0230	0.23	12.	270	0230	0.31	16.	299
0300	0.25	13.	261	0300	0.30	15.	297
0330	0.17	9.	254	0330	0.23	12.	285
0400	0.13	7.	257	0400	0.25	13.	274
0430	0.03	2.	253	0430	0.34	17.	281
0500	0.04	2.	248	0500	0.27	14.	287
0530	0.00	0.	243	0530	0.24	12.	283
0600	0.03	1.	220	0600	0.24	12.	278
0630	0.13	7.	65	0630	0.18	9.	275
0700	0.23	12.	49	0700	0.09	5.	295
0730	0.20	10.	39	0730	0.03	1.	321
0800	0.17	8.	39	0800	0.06	3.	5
0830	0.12	6.	26	0830	0.11	6.	17
0900	0.12	6.	4	0900	0.12	6.	41
0930	0.15	7.	8	0930	0.14	7.	40
1000	0.21	11.	15	1000	0.12	6.	42
1030	0.19	10.	46	1030	0.15	8.	39
1100	0.35	18.	39	1100	0.26	13.	24
1130	0.37	19.	38	1130	0.33	17.	28
1200	0.41	21.	33	1200	0.46	24.	30
1230	0.35	18.	30	1230	0.48	25.	31
1300	0.23	12.	35	1300	0.41	21.	21
1330	0.09	5.	37	1330	0.36	18.	14
1400	0.06	3.	32	1400	0.23	12.	323
1430	0.19	10.	244	1430	0.22	11.	304
1500	0.24	12.	249	1500	0.19	10.	296
1530	0.30	16.	233	1530	0.16	8.	286
1600	0.20	10.	233	1600	0.20	10.	285
1630	0.22	11.	230	1630	0.09	5.	256
1700	0.22	11.	227	1700	0.06	3.	244
1730	0.22	11.	218	1730	0.09	4.	242
1800	0.18	9.	225	1800	0.09	5.	247
1830	0.12	6.	235	1830	0.06	3.	251
1900	0.18	9.	271	1900	0.02	1.	247
1930	0.16	8.	272	1930	0.13	7.	249
2000	0.14	7.	265	2000	0.16	8.	241
2030	0.08	4.	259	2030	0.08	4.	243
2100	0.00	0.	246	2100	0.16	8.	244
2130	0.03	2.	245	2130	0.12	6.	242
2200	0.12	6.	49	2200	0.01	0.	246
2230	0.25	13.	47	2230	0.03	1.	241
2300	0.32	16.	37	2300	0.03	2.	242
2330	0.32	16.	34	2330	0.11	5.	21

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

9 SEP 1985

10 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.26	13.	28	0000	0.04	2.	306
0030	0.30	16.	33	0030	0.11	6.	9
0100	0.43	22.	29	0100	0.16	8.	24
0130	0.46	24.	19	0130	0.23	12.	31
0200	0.17	9.	8	0200	0.24	12.	31
0230	0.23	12.	341	0230	0.28	15.	15
0300	0.19	10.	316	0300	0.08	4.	14
0330	0.17	9.	320	0330	0.05	3.	294
0400	0.16	8.	308	0400	0.16	8.	268
0430	0.13	6.	297	0430	0.18	9.	256
0500	0.07	4.	293	0500	0.24	12.	241
0530	0.06	3.	279	0530	0.24	12.	235
0600	0.05	3.	248	0600	0.28	14.	233
0630	0.04	2.	233	0630	0.33	17.	230
0700	0.10	5.	213	0700	0.45	23.	229
0730	0.11	6.	192	0730	0.38	19.	235
0800	0.10	5.	195	0800	0.41	21.	241
0830	0.10	5.	192	0830	0.36	18.	246
0900	0.10	5.	193	0900	0.19	10.	251
0930	0.05	2.	192	0930	0.12	6.	269
1000	0.07	3.	189	1000	0.13	7.	294
1030	0.07	4.	193	1030	0.17	9.	291
1100	0.08	4.	192	1100	0.09	5.	4
1130	0.02	1.	189	1130	0.08	4.	7
1200	0.11	6.	191	1200	0.07	4.	11
1230	0.22	11.	194	1230	0.18	9.	7
1300	0.26	14.	203	1300	0.31	16.	19
1330	0.29	15.	45	1330	0.45	23.	21
1400	0.19	10.	38	1400	0.49	25.	16
1430	0.02	1.	44	1430	0.47	24.	8
1500	0.19	10.	42	1500	0.32	16.	2
1530	0.22	11.	293	1530	0.22	11.	301
1600	0.20	10.	288	1600	0.22	11.	287
1630	0.13	7.	273	1630	0.19	10.	284
1700	0.11	6.	254	1700	0.13	7.	253
1730	0.11	5.	252	1730	0.17	9.	245
1800	0.15	8.	248	1800	0.19	10.	245
1830	0.25	13.	240	1830	0.10	5.	253
1900	0.37	19.	209	1900	0.28	14.	242
1930	0.39	20.	220	1930	0.10	5.	245
2000	0.43	22.	230	2000	0.18	9.	241
2030	0.32	17.	238	2030	0.26	13.	239
2100	0.25	13.	234	2100	0.26	14.	242
2130	0.13	7.	247	2130	0.26	13.	240
2200	0.05	3.	259	2200	0.15	8.	235
2230	0.07	3.	250	2230	0.07	4.	232
2300	0.10	5.	256	2300	0.05	2.	203
2330	0.08	4.	296	2330	0.08	4.	189

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CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

11 SEP 1985

12 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.06	3.	190	0000	0.15	8.	31
0030	0.13	7.	191	0030	0.20	10.	22
0100	0.17	9.	55	0100	0.24	13.	27
0130	0.15	8.	39	0130	0.28	15.	25
0200	0.27	14.	37	0200	0.34	17.	29
0230	0.34	19.	37	0230	0.43	22.	22
0300	0.55	28.	36	0300	0.54	28.	30
0330	0.52	27.	32	0330	0.60	31.	26
0400	0.38	20.	27	0400	0.52	27.	29
0430	0.21	11.	16	0430	0.40	20.	28
0500	0.11	6.	326	0500	0.26	13.	16
0530	0.25	13.	316	0530	0.25	13.	303
0600	0.17	9.	305	0600	0.33	17.	287
0630	0.14	7.	290	0630	0.26	14.	280
0700	0.18	9.	273	0700	0.24	12.	262
0730	0.19	10.	277	0730	0.22	11.	261
0800	0.21	11.	285	0800	0.25	13.	242
0830	0.23	12.	280	0830	0.36	18.	248
0900	0.19	10.	277	0900	0.28	14.	248
0930	0.12	6.	289	0930	0.31	16.	247
1000	0.07	4.	309	1000	0.24	12.	243
1030	0.03	2.	17	1030	0.15	8.	246
1100	0.09	4.	26	1100	0.06	3.	267
1130	0.15	8.	35	1130	0.00	0.	312
1200	0.23	12.	38	1200	0.04	2.	10
1230	0.28	15.	37	1230	0.10	5.	27
1300	0.22	11.	29	1300	0.20	10.	34
1330	0.31	16.	22	1330	0.27	14.	32
1400	0.45	23.	37	1400	0.32	17.	24
1430	0.48	25.	35	1430	0.40	21.	26
1500	0.51	26.	30	1500	0.46	23.	24
1530	0.58	30.	36	1530	0.50	26.	23
1600	0.52	27.	36	1600	0.53	27.	30
1630	0.39	20.	34	1630	0.60	31.	37
1700	0.16	8.	21	1700	0.44	23.	40
1730	0.06	3.	12	1730	0.20	10.	38
1800	0.26	13.	286	1800	0.06	3.	17
1830	0.30	15.	265	1830	0.30	15.	273
1900	0.28	14.	259	1900	0.39	20.	262
1930	0.39	20.	241	1930	0.41	21.	241
2000	0.29	15.	252	2000	0.45	23.	226
2030	0.40	21.	251	2030	0.41	21.	221
2100	0.44	23.	237	2100	0.53	27.	233
2130	0.26	14.	240	2130	0.51	26.	238
2200	0.15	7.	255	2200	0.43	22.	243
2230	0.11	5.	277	2230	0.39	20.	245
2300	0.04	2.	15	2300	0.28	14.	243
2330	0.10	5.	19	2330	0.13	6.	235

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

13 SEP 1985

14 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.02	1.	262	0000	0.18	9.	271
0030	0.01	1.	275	0030	0.14	7.	285
0100	0.01	0.	290	0100	0.12	6.	305
0130	0.00	0.	290	0130	0.00	0.	307
0200	0.13	7.	26	0200	0.13	7.	304
0230	0.31	16.	31	0230	0.25	13.	18
0300	0.43	22.	30	0300	0.38	20.	30
0330	0.57	29.	28	0330	0.48	25.	27
0400	0.63	32.	26	0400	0.63	33.	26
0430	0.79	41.	27	0430	0.68	35.	27
0500	0.63	32.	28	0500	0.77	40.	30
0530	0.45	23.	23	0530	0.74	38.	38
0600	0.22	11.	10	0600	0.48	25.	45
0630	0.26	13.	294	0630	0.21	11.	54
0700	0.37	19.	262	0700	0.13	7.	61
0730	0.41	21.	238	0730	0.34	17.	283
0800	0.42	22.	237	0800	0.41	21.	253
0830	0.46	24.	238	0830	0.42	22.	254
0900	0.50	26.	233	0900	0.47	24.	252
0930	0.56	29.	233	0930	0.54	28.	252
1000	0.48	25.	246	1000	0.51	26.	246
1030	0.34	18.	239	1030	0.57	29.	251
1100	0.19	10.	234	1100	0.46	24.	257
1130	0.09	5.	245	1130	0.32	16.	259
1200	0.03	2.	281	1200	0.18	9.	253
1230	0.10	5.	15	1230	0.05	3.	288
1300	0.18	9.	23	1300	0.13	7.	23
1330	0.18	9.	26	1330	0.24	12.	27
1400	0.26	13.	32	1400	0.26	14.	27
1430	0.32	16.	20	1430	0.23	12.	18
1500	0.40	21.	26	1500	0.27	14.	9
1530	0.52	27.	31	1530	0.42	22.	14
1600	0.62	32.	32	1600	0.48	25.	19
1630	0.65	33.	35	1630	0.64	33.	30
1700	0.65	33.	38	1700	0.73	38.	37
1730	0.63	32.	39	1730	0.68	35.	37
1800	0.38	19.	38	1800	0.72	37.	38
1830	0.06	3.	68	1830	0.56	29.	43
1900	0.24	12.	208	1900	0.18	9.	67
1930	0.41	21.	253	1930	0.16	8.	144
2000	0.49	25.	238	2000	0.41	21.	274
2030	0.52	27.	242	2030	0.57	29.	235
2100	0.52	27.	242	2100	0.54	28.	263
2130	0.43	22.	241	2130	0.55	28.	255
2200	0.43	22.	252	2200	0.53	27.	252
2230	0.43	22.	252	2230	0.59	30.	263
2300	0.33	17.	251	2300	0.53	27.	267
2330	0.35	18.	252	2330	0.47	24.	267

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

15 SEP 1985

16 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)
0000	0.38	20.	271	0000	0.52	27.	255
0030	0.18	9.	275	0030	0.45	23.	258
0100	0.15	8.	297	0100	0.34	17.	261
0130	0.12	6.	320	0130	0.19	10.	260
0200	0.13	7.	5	0200	0.11	6.	270
0230	0.21	11.	14	0230	0.02	1.	277
0300	0.25	13.	24	0300	0.13	7.	21
0330	0.39	20.	30	0330	0.22	11.	26
0400	0.46	24.	28	0400	0.27	14.	22
0430	0.53	27.	28	0430	0.43	22.	19
0500	0.76	39.	30	0500	0.56	29.	24
0530	0.68	35.	36	0530	0.63	33.	32
0600	0.91	47.	39	0600	0.70	36.	33
0630	0.68	35.	47	0630	0.76	39.	38
0700	0.41	21.	58	0700	0.81	42.	40
0730	0.21	11.	110	0730	0.65	33.	45
0800	0.24	12.	264	0800	0.43	22.	68
0830	0.44	22.	278	0830	0.17	9.	106
0900	0.53	27.	270	0900	0.32	16.	190
0930	0.61	31.	261	0930	0.51	26.	249
1000	0.61	31.	256	1000	0.59	30.	244
1030	0.55	28.	259	1030	0.59	30.	237
1100	0.57	30.	267	1100	0.59	30.	233
1130	0.62	32.	259	1130	0.66	34.	244
1200	0.32	17.	269	1200	0.57	29.	249
1230	0.46	24.	274	1230	0.49	25.	244
1300	0.23	12.	281	1300	0.41	21.	246
1330	0.09	5.	319	1330	0.37	19.	255
1400	0.17	9.	22	1400	0.21	11.	268
1430	0.22	11.	22	1430	0.14	7.	281
1500	0.22	11.	23	1500	0.10	5.	300
1530	0.28	15.	25	1530	0.11	6.	11
1600	0.40	21.	23	1600	0.15	8.	38
1630	0.56	29.	32	1630	0.30	15.	37
1700	0.68	35.	36	1700	0.44	23.	28
1730	0.67	35.	37	1730	0.64	33.	31
1800	0.81	42.	41	1800	0.68	35.	32
1830	0.79	41.	41	1830	0.66	34.	33
1900	0.50	26.	47	1900	0.66	34.	33
1930	0.39	20.	69	1930	0.69	35.	39
2000	0.18	9.	111	2000	0.39	20.	58
2030	0.30	16.	161	2030	0.26	14.	79
2100	0.40	21.	272	2100	0.15	7.	103
2130	0.55	28.	262	2130	0.30	16.	255
2200	0.58	30.	248	2200	0.44	23.	258
2230	0.67	35.	250	2230	0.52	27.	233
2300	0.59	30.	245	2300	0.51	26.	232
2330	0.55	28.	260	2330	0.48	25.	232

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CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

17 SEP 1985

18 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.51	26.	233	0000	0.39	20.	232
0030	0.05	3.	236	0030	0.42	22.	229
0100	0.26	13.	240	0100	0.40	21.	237
0130	0.28	14.	245	0130	0.39	20.	240
0200	0.22	11.	247	0200	0.30	16.	240
0230	0.13	7.	253	0230	0.19	10.	240
0300	0.10	5.	289	0300	0.07	4.	246
0330	0.03	2.	16	0330	0.07	4.	16
0400	0.00	0.	27	0400	0.11	6.	26
0430	0.18	9.	29	0430	0.13	7.	29
0500	0.22	12.	27	0500	0.13	7.	28
0530	0.28	14.	28	0530	0.13	7.	3
0600	0.35	18.	31	0600	0.16	8.	12
0630	0.43	22.	29	0630	0.29	15.	22
0700	0.46	24.	34	0700	0.33	17.	33
0730	0.52	27.	37	0730	0.50	26.	33
0800	0.49	25.	44	0800	0.51	26.	34
0830	0.33	17.	55	0830	0.51	26.	34
0900	0.17	9.	69	0900	0.41	21.	36
0930	0.14	7.	137	0930	0.31	16.	59
1000	0.28	14.	186	1000	0.09	5.	65
1030	0.49	25.	245	1030	0.12	6.	124
1100	0.41	21.	235	1100	0.25	13.	260
1130	0.42	22.	233	1130	0.35	18.	243
1200	0.39	20.	233	1200	0.44	23.	236
1230	0.37	19.	241	1230	0.38	20.	234
1300	0.37	19.	241	1300	0.48	25.	234
1330	0.37	19.	245	1330	0.49	25.	235
1400	0.31	16.	250	1400	0.38	19.	247
1430	0.22	11.	258	1430	0.30	15.	236
1500	0.07	3.	263	1500	0.17	9.	233
1530	0.02	1.	279	1530	0.14	7.	248
1600	0.04	2.	294	1600	0.07	4.	257
1630	0.07	4.	14	1630	0.01	1.	300
1700	0.10	5.	18	1700	0.03	1.	13
1730	0.20	10.	24	1730	0.07	4.	15
1800	0.28	15.	31	1800	0.10	5.	20
1830	0.37	19.	27	1830	0.15	8.	25
1900	0.49	25.	34	1900	0.26	13.	25
1930	0.51	26.	30	1930	0.35	18.	26
2000	0.48	25.	39	2000	0.42	22.	31
2030	0.44	23.	40	2030	0.46	24.	38
2100	0.30	15.	49	2100	0.51	26.	36
2130	0.15	8.	74	2130	0.43	22.	37
2200	0.09	5.	94	2200	0.35	18.	38
2230	0.20	10.	131	2230	0.19	10.	40
2300	0.31	16.	248	2300	0.03	2.	39
2330	0.40	21.	231	2330	0.20	10.	271

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

21 SEP 1985

22 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.38	19.	29	0000	0.45	23.	38
0030	0.20	10.	18	0030	0.47	24.	36
0100	0.22	11.	318	0100	0.31	16.	35
0130	0.29	15.	283	0130	0.19	10.	20
0200	0.34	17.	278	0200	0.25	13.	305
0230	0.38	19.	267	0230	0.26	14.	278
0300	0.39	20.	262	0300	0.30	16.	261
0330	0.39	20.	264	0330	0.28	15.	267
0400	0.36	18.	259	0400	0.13	7.	251
0430	0.31	16.	243	0430	0.25	13.	250
0500	0.23	12.	264	0500	0.28	15.	249
0530	0.18	9.	281	0530	0.28	14.	243
0600	0.07	4.	294	0600	0.28	14.	265
0630	0.05	3.	323	0630	0.20	10.	278
0700	0.06	3.	5	0700	0.09	5.	263
0730	0.07	4.	18	0730	0.00	0.	258
0800	0.10	5.	13	0800	0.00	0.	267
0830	0.08	4.	16	0830	0.04	2.	267
0900	0.16	8.	9	0900	0.00	0.	273
0930	0.22	12.	19	0930	0.01	0.	270
1000	0.34	17.	30	1000	0.02	1.	271
1030	0.36	19.	39	1030	0.00	0.	270
1100	0.44	23.	30	1100	0.04	2.	273
1130	0.47	24.	38	1130	0.17	9.	28
1200	0.63	32.	38	1200	0.25	13.	34
1230	0.47	24.	37	1230	0.28	15.	36
1300	0.28	14.	28	1300	0.32	16.	46
1330	0.14	7.	15	1330	0.33	17.	34
1400	0.24	12.	302	1400	0.17	9.	20
1430	0.31	16.	280	1430	0.10	5.	332
1500	0.35	18.	273	1500	0.20	10.	259
1530	0.39	20.	261	1530	0.28	14.	252
1600	0.39	20.	262	1600	0.31	16.	248
1630	0.37	19.	260	1630	0.31	16.	247
1700	0.33	17.	255	1700	0.27	14.	247
1730	0.25	13.	249	1730	0.33	17.	246
1800	0.19	10.	250	1800	0.31	16.	258
1830	0.13	7.	263	1830	0.40	21.	274
1900	0.07	3.	270	1900	0.25	13.	264
1930	0.08	4.	273	1930	0.21	11.	257
2000	0.08	4.	270	2000	0.21	11.	258
2030	0.12	6.	272	2030	0.15	8.	260
2100	0.06	3.	278	2100	0.19	10.	263
2130	0.09	5.	11	2130	0.08	4.	273
2200	0.18	9.	17	2200	0.02	1.	276
2230	0.33	17.	23	2230	0.13	7.	34
2300	0.44	23.	26	2300	0.17	9.	41
2330	0.48	24.	34	2330	0.24	12.	28

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

23 SEP 1985

24 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.27	14.	28	0000	0.08	4.	22
0030	0.29	15.	32	0030	0.13	7.	31
0100	0.35	18.	35	0100	0.19	10.	35
0130	0.28	14.	30	0130	0.27	14.	34
0200	0.15	7.	13	0200	0.38	20.	30
0230	0.07	3.	332	0230	0.45	23.	32
0300	0.14	7.	303	0300	0.31	16.	28
0330	0.17	9.	256	0330	0.18	9.	20
0400	0.20	10.	248	0400	0.11	6.	289
0430	0.16	8.	245	0430	0.16	8.	261
0500	0.30	16.	254	0500	0.22	12.	225
0530	0.33	17.	246	0530	0.30	15.	228
0600	0.37	19.	251	0600	0.31	16.	230
0630	0.41	21.	247	0630	0.25	13.	239
0700	0.37	19.	251	0700	0.27	14.	240
0730	0.25	13.	268	0730	0.21	11.	234
0800	0.12	6.	257	0800	0.30	16.	250
0830	0.06	3.	251	0830	0.21	11.	260
0900	0.00	0.	251	0900	0.29	15.	262
0930	0.07	4.	265	0930	0.25	13.	270
1000	0.02	1.	284	1000	0.24	12.	264
1030	0.02	1.	314	1030	0.08	4.	261
1100	0.00	0.	311	1100	0.11	6.	277
1130	0.07	4.	321	1130	0.06	3.	289
1200	0.20	10.	32	1200	0.00	0.	6
1230	0.24	13.	33	1230	0.09	5.	31
1300	0.33	17.	31	1300	0.22	11.	41
1330	0.32	16.	37	1330	0.29	15.	37
1400	0.35	18.	35	1400	0.32	17.	37
1430	0.32	16.	27	1430	0.31	16.	33
1500	0.19	10.	8	1500	0.35	18.	36
1530	0.17	9.	310	1530	0.25	13.	35
1600	0.12	6.	273	1600	0.22	12.	26
1630	0.20	10.	250	1630	0.13	7.	14
1700	0.21	11.	242	1700	0.08	4.	296
1730	0.33	17.	232	1730	0.21	11.	250
1800	0.30	16.	238	1800	0.22	11.	242
1830	0.41	21.	245	1830	0.32	16.	242
1900	0.44	23.	235	1900	0.31	16.	235
1930	0.47	24.	250	1930	0.29	15.	234
2000	0.30	16.	251	2000	0.38	19.	231
2030	0.19	10.	242	2030	0.36	18.	233
2100	0.16	8.	239	2100	0.34	17.	252
2130	0.00	0.	246	2130	0.23	12.	234
2200	0.03	2.	242	2200	0.19	10.	238
2230	0.04	2.	5	2230	0.11	6.	235
2300	0.02	1.	10	2300	0.03	2.	250
2330	0.07	4.	11	2330	0.00	0.	290

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

25 SEP 1985

TIME SPEED SPEED DIRECTION

(EST)	(KTS)	(CM/S)	(DEG. TRUE)
0000	0.01	1.	318
0030	0.05	2.	24
0100	0.16	8.	30
0130	0.22	11.	32
0200	0.30	15.	31
0230	0.39	20.	33
0300	0.45	23.	33
0330	0.16	8.	36
0400	0.00	0.	28
0430	0.02	1.	19
0500	0.06	3.	308
0530	0.12	6.	284
0600	0.09	5.	276
0630	0.13	7.	268
0700	0.22	11.	238
0730	0.10	5.	241
0800	0.04	2.	247
0830	0.06	3.	246
0900	0.10	5.	251
0930	0.07	4.	250
1000	0.06	3.	253
1030	0.00	0.	250
1100	0.00	0.	251
1130	0.00	0.	13
1200	0.02	1.	29
1230	0.08	4.	36
1300	0.12	6.	33
1330	0.10	5.	26
1400	0.16	8.	29
1430	0.28	15.	38
1500	0.32	17.	41
1530	0.41	21.	40
1600	0.50	26.	39

CURRENT DATA
MIDDLE METER
SALTERS POINT, MA

***** END OF DATA *****

2108 RECORDS TYPED

	GOOD	BAD
IR	1445	0
PD	1445	0
T1	-- STOP	

00	CC	EEEEEE	AA	NN	NN					
0000	CCCC	EEEEEE	AAAA	NNN	NN					
00	00	CC	EE	AA	AA					
00	00	CC	EEEE	AA	AA					
00	00	CC	EEEE	AAAAAA	NN	NN				
00	00	CC	EE	AAAAAA	NN	NN				
0000	CCCC	EEEEEE	AA	AA	NN	NN				
00	CCC	EEEEEE	AA	AA	NN	NN				
SSSSS	UU	UU	RRRRR	VV	VV	EEEEEE	YY	YY	SSSSS	
SSSSSS	UU	UU	RRRRRR	VV	VV	EEEEEE	YY	YY	SSSSSS	
SS	UU	UU	RR	RRR	VV	VV	EE	YY	YY	SS
SSS	UU	UU	RRRRR	VVVVVV	VVVVVV	EEEE	YYYY	YYYY	SSS	
SSS	UU	UU	RRRR	VVVV	VVVV	EEEE	YY	YY	SSS	
SS	UU	UU	RRRR	VVVV	VVVV	EE	YY	YY	SS	
SSSSSS	UUUU	UUUU	RR	RR	VV	VV	EEEEEE	YY	YY	SSSSSS
SSSSS	UU	UU	RR	RR	VV	VV	EEEEEE	YY	YY	SSSSS

CURRENT SPEED AND DIRECTION

UPPER METER

SALTERS POINT, MA

FOR: JASON M. CORTELL
JOB NO.: 85ES079DATE OF SURVEY: 26 AUG-25 SEP 85
DATE PRINTED: 16 OCT 1985

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CURRENT DATA
UPPER METER
SALTERS POINT, MA

26 AUG 1985

27 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
1400	0.59	30.	44	0000	0.19	10.	248
1430	0.85	44.	58	0030	0.15	7.	249
1500	0.76	39.	55	0100	0.21	11.	357
1530	0.70	36.	56	0130	0.26	13.	8
1600	0.34	17.	94	0200	0.49	25.	36
1630	0.12	6.	341	0230	0.87	45.	55
1700	0.17	9.	220	0300	0.95	49.	57
1730	0.27	14.	221	0330	0.81	42.	63
1800	0.40	20.	218	0400	0.68	35.	68
1830	0.49	25.	220	0430	0.41	21.	62
1900	0.37	19.	218	0500	0.11	6.	303
1930	0.46	24.	215	0530	0.06	3.	252
2000	0.60	31.	224	0600	0.21	11.	253
2030	0.63	33.	231	0630	0.39	20.	225
2100	0.66	34.	230	0700	0.32	17.	232
2130	0.54	28.	228	0730	0.38	19.	223
2200	0.62	32.	229	0800	0.37	19.	217
2230	0.37	19.	231	0830	0.37	19.	219
2300	0.37	19.	235	0900	0.36	19.	219
2330	0.29	15.	237	0930	0.37	19.	229
				1000	0.45	23.	226
				1030	0.33	17.	222
				1100	0.12	6.	228
				1130	0.03	1.	279
				1200	0.05	3.	503
				1230	0.12	6.	306
				1300	0.30	16.	13
				1330	0.34	18.	37
				1400	0.46	24.	47
				1430	0.47	24.	51
				1500	0.70	36.	59
				1530	0.77	40.	61
				1600	0.83	43.	54
				1630	0.64	33.	52
				1700	0.34	18.	56
				1730	0.02	1.	248
				1800	0.29	15.	250
				1830	0.32	16.	231
				1900	0.48	25.	225
				1930	0.50	26.	220
				2000	0.60	31.	221
				2030	0.71	37.	222
				2100	0.75	38.	227
				2130	0.64	33.	222
				2200	0.62	32.	222
				2230	0.37	19.	220
				2300	0.33	17.	222
				2330	0.23	12.	221

CURRENT DATA
UPPER METER
SALTERS POINT, MA

28 AUG 1985

29 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.21	11.	225	0000	0.48	24.	227
0030	0.08	4.	231	0030	0.24	12.	239
0100	0.05	2.	250	0100	0.11	6.	255
0130	0.06	3.	302	0130	0.04	2.	287
0200	0.24	12.	339	0200	0.03	2.	296
0230	0.31	16.	16	0230	0.15	8.	306
0300	0.48	25.	8	0300	0.22	11.	7
0330	0.63	32.	28	0330	0.48	25.	28
0400	0.74	38.	47	0400	0.68	35.	33
0430	0.79	41.	48	0430	0.69	35.	45
0500	0.57	29.	53	0500	0.75	38.	51
0530	0.23	12.	56	0530	0.68	35.	54
0600	0.13	7.	251	0600	0.41	21.	59
0630	0.38	20.	234	0630	0.08	4.	311
0700	0.42	22.	220	0700	0.10	5.	260
0730	0.49	25.	222	0730	0.37	19.	240
0800	0.51	26.	222	0800	0.40	21.	232
0830	0.55	28.	223	0830	0.53	27.	222
0900	0.67	34.	222	0900	0.46	24.	224
0930	0.61	32.	224	0930	0.56	29.	226
1000	0.51	26.	222	1000	0.66	34.	221
1030	0.49	25.	225	1030	0.68	35.	229
1100	0.38	20.	227	1100	0.58	30.	227
1130	0.16	8.	228	1130	0.67	34.	236
1200	0.05	3.	245	1200	0.58	30.	238
1230	0.09	5.	305	1230	0.43	22.	246
1300	0.11	6.	2	1300	0.23	12.	256
1330	0.29	15.	54	1330	0.16	8.	261
1400	0.21	11.	6	1400	0.10	5.	296
1430	0.31	16.	25	1430	0.18	9.	312
1500	0.41	21.	16	1500	0.34	17.	10
1530	0.51	26.	45	1530	0.48	25.	20
1600	0.65	33.	51	1600	0.63	32.	27
1630	0.67	35.	47	1630	0.71	36.	38
1700	0.72	37.	52	1700	0.82	42.	44
1730	0.62	32.	59	1730	0.73	38.	51
1800	0.29	15.	59	1800	0.66	34.	53
1830	0.07	4.	237	1830	0.47	24.	86
1900	0.31	16.	234	1900	0.25	13.	100
1930	0.42	22.	236	1930	0.05	3.	212
2000	0.47	24.	222	2000	0.36	18.	221
2030	0.57	29.	219	2030	0.49	25.	218
2100	0.60	31.	224	2100	0.58	30.	217
2130	0.74	38.	225	2130	0.52	27.	214
2200	0.70	36.	229	2200	0.57	29.	216
2230	0.60	31.	230	2230	0.55	28.	215
2300	0.55	28.	228	2300	0.56	29.	221
2330	0.57	29.	226	2330	0.47	24.	227

CURRENT DATA
UPPER METER
SALTERS POINT, MA

30 AUG 1985

31 AUG 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.44	22.	233	0000	0.76	39.	229
0030	0.38	20.	236	0030	0.65	33.	231
0100	0.31	16.	244	0100	0.40	20.	227
0130	0.13	7.	255	0130	0.23	12.	231
0200	0.11	6.	277	0200	0.17	9.	246
0230	0.00	0.	300	0230	0.27	14.	263
0300	0.08	4.	358	0300	0.23	12.	278
0330	0.21	11.	38	0330	0.15	8.	282
0400	0.40	21.	41	0400	0.17	9.	294
0430	0.50	26.	36	0430	0.16	8.	299
0500	0.54	28.	39	0500	0.20	10.	343
0530	0.72	37.	39	0530	0.13	7.	25
0600	0.61	31.	43	0600	0.31	16.	34
0630	0.50	26.	48	0630	0.43	22.	37
0700	0.52	27.	42	0700	0.44	23.	47
0730	0.21	11.	51	0730	0.57	29.	59
0800	0.06	3.	247	0800	0.37	19.	59
0830	0.27	14.	236	0830	0.05	3.	302
0900	0.40	21.	218	0900	0.22	11.	244
0930	0.53	27.	214	0930	0.51	26.	224
1000	0.62	32.	215	1000	0.66	34.	216
1030	0.55	28.	215	1030	0.80	41.	218
1100	0.59	30.	213	1100	0.79	41.	220
1130	0.51	26.	216	1130	0.75	39.	223
1200	0.34	17.	219	1200	0.57	30.	224
1230	0.35	18.	218	1230	0.23	12.	228
1300	0.23	12.	222	1300	0.30	15.	223
1330	0.14	7.	226	1330	0.21	11.	225
1400	0.05	3.	246	1400	0.02	1.	239
1430	0.07	3.	299	1430	0.00	0.	233
1500	0.07	4.	335	1500	0.00	0.	248
1530	0.15	8.	36	1530	0.03	1.	303
1600	0.22	11.	37	1600	0.00	0.	300
1630	0.36	19.	37	1630	0.02	1.	342
1700	0.41	21.	37	1700	0.14	7.	33
1730	0.48	25.	40	1730	0.40	21.	41
1800	0.54	28.	41	1800	0.60	31.	53
1830	0.57	29.	46	1830	0.66	34.	52
1900	0.36	18.	50	1900	0.61	32.	54
1930	0.20	10.	340	1930	0.39	20.	61
2000	0.10	5.	275	2000	0.13	7.	74
2030	0.26	13.	233	2030	0.04	2.	223
2100	0.32	17.	222	2100	0.36	18.	227
2130	0.38	19.	217	2130	0.46	24.	222
2200	0.54	28.	222	2200	0.59	31.	213
2230	0.64	33.	219	2230	0.61	31.	212
2300	0.82	42.	224	2300	0.72	37.	216
2330	0.97	50.	227	2330	0.75	38.	219

CURRENT DATA
UPPER METER
SALTERS POINT, MA

1 SEP 1985

2 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.75	38.	219	0000	0.68	35.	219
0030	0.76	39.	218	0030	0.73	38.	219
0100	0.62	32.	212	0100	0.74	38.	222
0130	0.46	24.	211	0130	0.62	32.	223
0200	0.29	15.	210	0200	0.39	20.	226
0230	0.09	5.	232	0230	0.14	7.	233
0300	0.01	0.	242	0300	0.02	1.	262
0330	0.00	0.	292	0330	0.11	6.	317
0400	0.02	1.	333	0400	0.11	6.	327
0430	0.06	3.	342	0430	0.19	10.	354
0500	0.22	11.	55	0500	0.14	7.	28
0530	0.36	19.	54	0530	0.29	15.	40
0600	0.47	24.	49	0600	0.45	23.	41
0630	0.58	30.	54	0630	0.53	27.	48
0700	0.80	41.	52	0700	0.52	27.	44
0730	0.70	36.	55	0730	0.61	32.	46
0800	0.54	28.	52	0800	0.74	38.	46
0830	0.37	19.	59	0830	0.60	31.	57
0900	0.07	3.	59	0900	0.35	18.	59
0930	0.18	9.	231	0930	0.12	6.	86
1000	0.53	27.	213	1000	0.03	1.	239
1030	0.69	35.	211	1030	0.11	6.	237
1100	0.70	36.	216	1100	0.21	11.	220
1130	0.90	46.	218	1130	0.39	20.	215
1200	0.73	38.	219	1200	0.38	19.	208
1230	0.62	32.	223	1230	0.31	16.	210
1300	0.59	30.	227	1300	0.40	21.	212
1330	0.49	25.	228	1330	0.50	26.	218
1400	0.37	19.	234	1400	0.51	26.	222
1430	0.25	13.	239	1430	0.33	17.	229
1500	0.18	9.	238	1500	0.25	13.	235
1530	0.19	10.	234	1530	0.06	3.	251
1600	0.28	15.	238	1600	0.09	4.	295
1630	0.13	7.	253	1630	0.06	3.	359
1700	0.05	3.	291	1700	0.18	9.	22
1730	0.18	9.	26	1730	0.34	17.	41
1800	0.23	12.	26	1800	0.32	17.	52
1830	0.33	17.	43	1830	0.38	20.	53
1900	0.43	22.	39	1900	0.35	18.	46
1930	0.41	21.	45	1930	0.40	21.	50
2000	0.42	21.	47	2000	0.28	14.	71
2030	0.25	13.	55	2030	0.31	16.	74
2100	0.14	7.	33	2100	0.34	18.	75
2130	0.01	1.	245	2130	0.31	16.	79
2200	0.16	8.	233	2200	0.09	5.	86
2230	0.28	15.	226	2230	0.04	2.	135
2300	0.43	22.	215	2300	0.12	6.	199
2330	0.55	28.	213	2330	0.40	21.	206

CURRENT DATA
UPPER METER
SALTERS POINT, MA

3 SEP 1985

4 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG, TRUE)
0000	0.48	25.	211	0000	0.33	17.	219
0030	0.50	26.	216	0030	0.41	21.	218
0100	0.63	33.	224	0100	0.40	21.	217
0130	0.70	36.	227	0130	0.38	20.	213
0200	0.54	28.	227	0200	0.40	21.	215
0230	0.45	23.	231	0230	0.35	18.	218
0300	0.23	12.	235	0300	0.25	13.	216
0330	0.18	9.	253	0330	0.11	6.	224
0400	0.09	5.	284	0400	0.04	2.	249
0430	0.16	8.	302	0430	0.12	6.	15
0500	0.12	6.	302	0500	0.15	8.	8
0530	0.10	5.	309	0530	0.23	12.	354
0600	0.04	2.	341	0600	0.29	15.	25
0630	0.19	10.	17	0630	0.34	17.	35
0700	0.31	16.	26	0700	0.32	16.	47
0730	0.46	24.	62	0730	0.36	19.	46
0800	0.57	29.	65	0800	0.33	17.	64
0830	0.59	30.	59	0830	0.33	17.	58
0900	0.50	26.	61	0900	0.53	27.	67
0930	0.38	20.	59	0930	0.45	23.	65
1000	0.14	7.	63	1000	0.45	23.	61
1030	0.05	3.	236	1030	0.31	16.	53
1100	0.18	9.	239	1100	0.14	7.	55
1130	0.34	17.	222	1130	0.06	3.	217
1200	0.38	19.	214	1200	0.17	9.	228
1230	0.48	25.	214	1230	0.25	13.	213
1300	0.61	32.	223	1300	0.29	15.	219
1330	0.66	34.	231	1330	0.36	19.	213
1400	0.64	33.	227	1400	0.42	22.	214
1430	0.59	31.	232	1430	0.41	21.	211
1500	0.62	32.	229	1500	0.26	14.	212
1530	0.31	16.	237	1530	0.26	14.	223
1600	0.27	14.	252	1600	0.13	6.	224
1630	0.18	9.	285	1630	0.09	4.	253
1700	0.18	9.	304	1700	0.08	4.	304
1730	0.22	12.	7	1730	0.12	6.	304
1800	0.25	13.	25	1800	0.16	8.	322
1830	0.29	15.	32	1830	0.12	6.	323
1900	0.42	22.	41	1900	0.17	9.	322
1930	0.55	28.	48	1930	0.11	6.	3
2000	0.61	31.	61	2000	0.20	10.	28
2030	0.58	30.	69	2030	0.33	17.	39
2100	0.38	20.	73	2100	0.45	23.	55
2130	0.34	18.	70	2130	0.67	35.	64
2200	0.29	15.	67	2200	0.54	28.	58
2230	0.17	9.	67	2230	0.55	28.	57
2300	0.11	6.	45	2300	0.23	12.	50
2330	0.11	6.	224	2330	0.09	5.	321

CURRENT DATA
UPPER METER
SALTERS POINT, MA

5 SEP 1985

6 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.15	8.	247	0000	0.24	12.	41
0030	0.31	16.	235	0030	0.06	3.	269
0100	0.30	15.	230	0100	0.19	10.	251
0130	0.41	21.	232	0130	0.27	14.	232
0200	0.41	21.	240	0200	0.37	19.	229
0230	0.44	23.	243	0230	0.31	16.	223
0300	0.50	26.	246	0300	0.42	21.	222
0330	0.50	26.	248	0330	0.44	23.	224
0400	0.28	15.	269	0400	0.31	16.	234
0430	0.18	9.	292	0430	0.20	10.	229
0500	0.16	8.	323	0500	0.16	8.	238
0530	0.16	8.	325	0530	0.13	7.	278
0600	0.21	11.	326	0600	0.14	7.	314
0630	0.21	11.	354	0630	0.14	7.	316
0700	0.14	7.	326	0700	0.12	6.	324
0730	0.27	14.	330	0730	0.14	7.	329
0800	0.18	9.	13	0800	0.17	9.	339
0830	0.30	15.	26	0830	0.22	11.	0
0900	0.38	20.	33	0900	0.25	13.	31
0930	0.38	20.	33	0930	0.22	12.	24
1000	0.41	21.	30	1000	0.28	14.	61
1030	0.50	25.	59	1030	0.40	21.	64
1100	0.41	21.	59	1100	0.45	23.	71
1130	0.28	15.	62	1130	0.27	14.	74
1200	0.06	3.	252	1200	0.22	11.	73
1230	0.17	9.	253	1230	0.09	5.	73
1300	0.30	16.	241	1300	0.06	3.	220
1330	0.40	21.	232	1330	0.21	11.	232
1400	0.47	24.	232	1400	0.22	11.	231
1430	0.56	29.	239	1430	0.28	14.	218
1500	0.50	26.	239	1500	0.36	19.	225
1530	0.45	23.	252	1530	0.52	27.	243
1600	0.36	19.	264	1600	0.55	28.	245
1630	0.29	15.	269	1630	0.36	19.	241
1700	0.25	13.	283	1700	0.36	19.	268
1730	0.18	9.	315	1730	0.42	22.	274
1800	0.15	8.	299	1800	0.27	14.	270
1830	0.25	13.	288	1830	0.29	15.	259
1900	0.16	8.	294	1900	0.24	13.	253
1930	0.13	7.	305	1930	0.23	12.	245
2000	0.12	6.	313	2000	0.18	9.	250
2030	0.12	6.	314	2030	0.13	7.	252
2100	0.27	14.	359	2100	0.05	3.	260
2130	0.31	16.	35	2130	0.11	6.	41
2200	0.41	21.	38	2200	0.24	12.	39
2230	0.47	24.	54	2230	0.26	13.	43
2300	0.51	26.	53	2300	0.39	20.	43
2330	0.36	19.	51	2330	0.20	10.	49

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CURRENT DATA
UPPER METER
SALTERS POINT, MA

7 SEP 1985

8 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.09	5.	65	0000	0.21	11.	28
0030	0.04	2.	254	0030	0.19	10.	27
0100	0.17	9.	227	0100	0.11	5.	5
0130	0.27	14.	228	0130	0.06	3.	303
0200	0.41	21.	226	0200	0.02	1.	289
0230	0.48	25.	223	0230	0.06	3.	235
0300	0.44	23.	229	0300	0.10	5.	220
0330	0.47	24.	233	0330	0.15	8.	226
0400	0.58	30.	235	0400	0.05	3.	217
0430	0.67	35.	239	0430	0.07	4.	210
0500	0.60	31.	240	0500	0.07	4.	210
0530	0.45	23.	241	0530	0.13	7.	205
0600	0.32	17.	245	0600	0.25	13.	203
0630	0.18	9.	250	0630	0.09	5.	203
0700	0.10	5.	272	0700	0.04	2.	216
0730	0.10	5.	278	0730	0.00	0.	234
0800	0.06	3.	274	0800	0.02	1.	263
0830	0.00	0.	278	0830	0.01	1.	133
0900	0.01	1.	272	0900	0.00	0.	323
0930	0.01	1.	276	0930	0.02	1.	313
1000	0.04	2.	297	1000	0.00	0.	319
1030	0.04	2.	323	1030	0.00	0.	324
1100	0.05	2.	7	1100	0.08	4.	15
1130	0.12	6.	35	1130	0.26	13.	33
1200	0.20	10.	23	1200	0.43	22.	49
1230	0.20	10.	0	1230	0.53	27.	59
1300	0.19	10.	6	1300	0.52	27.	48
1330	0.06	3.	9	1330	0.33	17.	46
1400	0.00	0.	264	1400	0.17	9.	32
1430	0.21	11.	249	1430	0.04	2.	315
1500	0.37	19.	243	1500	0.00	0.	237
1530	0.42	22.	237	1530	0.09	5.	217
1600	0.47	24.	243	1600	0.22	11.	219
1630	0.60	31.	247	1630	0.21	11.	235
1700	0.43	22.	245	1700	0.23	12.	238
1730	0.50	26.	250	1730	0.30	15.	241
1800	0.28	15.	260	1800	0.36	19.	240
1830	0.30	15.	236	1830	0.32	16.	230
1900	0.40	21.	230	1900	0.20	10.	233
1930	0.36	18.	234	1930	0.10	5.	240
2000	0.38	20.	224	2000	0.07	4.	252
2030	0.30	15.	222	2030	0.02	1.	249
2100	0.27	14.	221	2100	0.11	5.	257
2130	0.12	6.	220	2130	0.03	2.	261
2200	0.01	1.	217	2200	0.00	0.	269
2230	0.02	1.	221	2230	0.00	0.	301
2300	0.00	0.	32	2300	0.07	4.	29
2330	0.04	2.	26	2330	0.21	11.	41

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CURRENT DATA
UPPER METER
SALTTERS POINT, MA

9 SEP 1985

10 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.31	16.	43	0000	0.19	10.	281
0030	0.42	22.	45	0030	0.13	7.	304
0100	0.45	23.	40	0100	0.20	10.	7
0130	0.51	26.	40	0130	0.23	12.	36
0200	0.39	20.	41	0200	0.21	11.	28
0230	0.11	6.	38	0230	0.31	16.	24
0300	0.02	1.	310	0300	0.10	5.	16
0330	0.04	2.	214	0330	0.06	3.	221
0400	0.16	8.	218	0400	0.04	2.	217
0430	0.23	12.	220	0430	0.22	11.	220
0500	0.32	16.	217	0500	0.28	14.	222
0530	0.33	17.	224	0530	0.27	14.	217
0600	0.35	18.	224	0600	0.30	15.	215
0630	0.42	21.	229	0630	0.38	19.	216
0700	0.55	28.	227	0700	0.42	22.	215
0730	0.57	29.	223	0730	0.58	30.	224
0800	0.40	21.	233	0800	0.70	36.	229
0830	0.29	15.	249	0830	0.53	27.	219
0900	0.29	15.	264	0900	0.37	19.	219
0930	0.15	7.	267	0930	0.29	15.	219
1000	0.25	13.	289	1000	0.18	9.	215
1030	0.06	3.	261	1030	0.13	7.	215
1100	0.02	1.	279	1100	0.10	5.	210
1130	0.04	2.	302	1130	0.04	2.	225
1200	0.11	6.	303	1200	0.01	0.	264
1230	0.12	6.	5	1230	0.11	6.	45
1300	0.31	16.	21	1300	0.20	10.	32
1330	0.44	23.	29	1330	0.43	22.	39
1400	0.39	20.	22	1400	0.66	34.	38
1430	0.26	13.	20	1430	0.66	34.	42
1500	0.07	3.	65	1500	0.66	34.	44
1530	0.05	3.	238	1530	0.31	16.	40
1600	0.13	7.	225	1600	0.08	4.	39
1630	0.21	11.	222	1630	0.05	3.	209
1700	0.31	16.	226	1700	0.10	5.	232
1730	0.26	14.	225	1730	0.17	9.	232
1800	0.28	14.	224	1800	0.17	9.	221
1830	0.54	28.	223	1830	0.20	10.	223
1900	0.41	21.	227	1900	0.30	15.	225
1930	0.56	29.	233	1930	0.48	25.	221
2000	0.52	27.	233	2000	0.50	26.	220
2030	0.42	22.	232	2030	0.69	35.	231
2100	0.32	17.	236	2100	0.64	33.	232
2130	0.22	11.	243	2130	0.64	33.	235
2200	0.21	11.	248	2200	0.68	35.	235
2230	0.19	10.	254	2230	0.59	30.	238
2300	0.22	12.	253	2300	0.45	23.	238
2330	0.21	11.	263	2330	0.39	20.	243

CURRENT DATA
UPPER METER
SALTERS POINT, MA

11 SEP 1985

12 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.24	12.	252	0000	0.09	4.	250
0030	0.09	5.	283	0030	0.09	5.	257
0100	0.09	5.	303	0100	0.05	2.	295
0130	0.09	5.	306	0130	0.11	6.	302
0200	0.25	13.	18	0200	0.26	13.	24
0230	0.36	18.	35	0230	0.49	25.	38
0300	0.63	33.	38	0300	0.59	30.	39
0330	0.53	27.	40	0330	0.63	32.	44
0400	0.41	21.	63	0400	0.72	37.	47
0430	0.21	11.	71	0430	0.52	27.	45
0500	0.11	5.	310	0500	0.23	12.	32
0530	0.17	9.	222	0530	0.16	8.	249
0600	0.33	17.	232	0600	0.18	9.	236
0630	0.54	28.	227	0630	0.37	19.	216
0700	0.41	21.	225	0700	0.34	17.	216
0730	0.55	28.	226	0730	0.37	19.	215
0800	0.63	32.	224	0800	0.33	17.	221
0830	0.57	29.	226	0830	0.44	23.	223
0900	0.59	30.	226	0900	0.47	24.	224
0930	0.50	26.	224	0930	0.60	31.	226
1000	0.45	23.	223	1000	0.46	24.	226
1030	0.33	17.	221	1030	0.46	24.	231
1100	0.22	11.	219	1100	0.43	22.	233
1130	0.12	6.	226	1130	0.23	12.	245
1200	0.03	2.	245	1200	0.10	5.	244
1230	0.05	2.	298	1230	0.07	4.	253
1300	0.11	6.	10	1300	0.11	6.	300
1330	0.22	11.	8	1330	0.20	10.	356
1400	0.30	15.	10	1400	0.31	16.	42
1430	0.54	28.	43	1430	0.46	24.	38
1500	0.65	33.	50	1500	0.52	27.	37
1530	0.55	28.	52	1530	0.62	32.	57
1600	0.41	21.	62	1600	0.71	36.	58
1630	0.16	8.	60	1630	0.66	34.	63
1700	0.02	1.	48	1700	0.37	19.	61
1730	0.01	0.	229	1730	0.15	8.	71
1800	0.01	0.	220	1800	0.10	5.	230
1830	0.22	11.	217	1830	0.32	17.	234
1900	0.45	23.	219	1900	0.44	23.	218
1930	0.43	22.	224	1930	0.49	25.	213
2000	0.71	37.	227	2000	0.61	32.	220
2030	0.60	31.	227	2030	0.62	32.	224
2100	0.73	38.	226	2100	0.83	43.	226
2130	0.69	36.	228	2130	0.83	43.	229
2200	0.54	28.	228	2200	0.68	35.	225
2230	0.46	24.	223	2230	0.57	29.	223
2300	0.27	14.	222	2300	0.50	25.	227
2330	0.20	10.	228	2330	0.21	11.	229

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CURRENT DATA
UPPER METER
SALTERS POINT, MA

13 SEP 1985

14 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.18	9.	225	0000	0.28	14.	225
0030	0.22	11.	225	0030	0.17	9.	225
0100	0.19	10.	229	0100	0.12	6.	228
0130	0.08	4.	230	0130	0.00	0.	237
0200	0.00	0.	252	0200	0.01	1.	268
0230	0.00	0.	20	0230	0.16	8.	29
0300	0.42	21.	25	0300	0.33	17.	37
0330	0.56	29.	32	0330	0.61	32.	38
0400	0.63	33.	38	0400	0.77	40.	42
0430	0.73	37.	43	0430	0.78	40.	39
0500	0.67	34.	49	0500	0.77	40.	43
0530	0.36	18.	44	0530	0.70	36.	57
0600	0.06	3.	274	0600	0.36	18.	71
0630	0.30	16.	251	0630	0.10	5.	349
0700	0.40	21.	235	0700	0.24	13.	233
0730	0.44	22.	224	0730	0.44	23.	230
0800	0.45	23.	223	0800	0.44	23.	225
0830	0.50	26.	223	0830	0.61	31.	219
0900	0.60	31.	220	0900	0.56	29.	218
0930	0.62	32.	224	0930	0.68	35.	220
1000	0.57	30.	227	1000	0.71	37.	220
1030	0.34	17.	224	1030	0.80	41.	224
1100	0.33	17.	228	1100	0.73	37.	223
1130	0.12	6.	221	1130	0.46	24.	223
1200	0.01	1.	240	1200	0.34	17.	227
1230	0.01	1.	260	1230	0.20	10.	231
1300	0.01	0.	1	1300	0.07	4.	244
1330	0.04	2.	12	1330	0.04	2.	300
1400	0.22	11.	31	1400	0.06	3.	6
1430	0.18	9.	46	1430	0.23	12.	51
1500	0.36	18.	43	1500	0.35	18.	48
1530	0.50	26.	44	1530	0.55	28.	55
1600	0.61	32.	46	1600	0.60	31.	56
1630	0.67	34.	52	1630	0.74	38.	51
1700	0.73	38.	56	1700	0.78	40.	44
1730	0.54	29.	70	1730	0.73	38.	45
1800	0.30	15.	73	1800	0.49	36.	61
1830	0.13	6.	159	1830	0.43	22.	73
1900	0.22	12.	237	1900	0.11	6.	98
1930	0.47	24.	227	1930	0.23	12.	215
2000	0.53	27.	217	2000	0.50	26.	224
2030	0.58	30.	218	2030	0.54	28.	219
2100	0.66	34.	217	2100	0.64	33.	213
2130	0.63	32.	220	2130	0.71	36.	213
2200	0.76	39.	225	2200	0.73	38.	213
2230	0.58	30.	222	2230	0.73	37.	215
2300	0.42	22.	226	2300	0.63	33.	222
2330	0.37	19.	223	2330	0.69	36.	222

CURRENT DATA
UPPER METER
SALTERS POINT, MA

15 SEP 1985

16 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.48	25.	223	0000	0.57	30.	218
0030	0.33	17.	222	0030	0.48	25.	219
0100	0.28	14.	223	0100	0.33	17.	223
0130	0.16	8.	229	0130	0.22	11.	224
0200	0.09	5.	247	0200	0.07	4.	232
0230	0.06	3.	288	0230	0.08	4.	290
0300	0.09	5.	298	0300	0.16	8.	17
0330	0.26	14.	20	0330	0.24	12.	29
0400	0.48	25.	41	0400	0.31	16.	33
0430	0.70	36.	42	0430	0.55	28.	41
0500	0.72	37.	40	0500	0.67	35.	43
0530	0.93	48.	45	0530	0.82	42.	40
0600	0.81	42.	53	0600	0.76	39.	41
0630	0.61	31.	68	0630	0.84	43.	45
0700	0.37	19.	91	0700	0.75	39.	57
0730	0.15	8.	137	0730	0.72	37.	68
0800	0.31	16.	219	0800	0.28	15.	98
0830	0.48	24.	223	0830	0.23	12.	189
0900	0.59	30.	225	0900	0.38	19.	215
0930	0.61	31.	220	0930	1.20	62.	219
1000	0.72	37.	218	1000	0.68	35.	215
1030	0.75	39.	216	1030	0.87	45.	214
1100	0.67	34.	219	1100	0.72	37.	216
1130	0.73	37.	223	1130	0.85	44.	217
1200	0.79	41.	223	1200	0.64	33.	216
1230	0.59	30.	227	1230	0.56	29.	223
1300	0.34	18.	229	1300	0.45	23.	225
1330	0.19	10.	242	1330	0.41	21.	234
1400	0.09	5.	298	1400	0.30	15.	241
1430	0.15	8.	303	1430	0.00	0.	244
1500	0.28	14.	30	1500	0.21	11.	247
1530	0.43	22.	44	1530	0.10	5.	249
1600	0.48	25.	44	1600	0.20	10.	24
1630	0.70	36.	45	1630	0.35	18.	32
1700	0.77	40.	44	1700	0.56	29.	37
1730	0.77	40.	43	1730	0.66	34.	43
1800	0.71	36.	49	1800	0.77	39.	40
1830	0.91	47.	53	1830	0.55	28.	45
1900	0.45	23.	75	1900	0.93	48.	49
1930	0.36	19.	103	1930	0.68	35.	32
2000	0.14	7.	119	2000	0.34	18.	80
2030	0.30	15.	210	2030	0.18	9.	107
2100	0.51	26.	219	2100	0.18	9.	210
2130	0.60	31.	218	2130	0.41	21.	221
2200	0.60	31.	214	2200	0.45	23.	220
2230	0.63	33.	214	2230	0.57	29.	213
2300	0.71	36.	215	2300	0.58	30.	212
2330	0.66	34.	216	2330	0.73	38.	213

CURRENT DATA
UPPER METER
SALTERS POINT, MA

17 SEP 1985

18 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.78	40.	214	0000	0.62	32.	211
0030	0.56	29.	216	0030	0.78	40.	213
0100	0.55	28.	219	0100	0.74	38.	216
0130	0.53	27.	217	0130	0.65	34.	217
0200	0.40	21.	221	0200	0.52	27.	219
0230	0.28	14.	225	0230	0.27	14.	221
0300	0.13	7.	236	0300	0.14	7.	226
0330	0.07	4.	279	0330	0.09	5.	292
0400	0.15	8.	13	0400	0.16	8.	7
0430	0.14	7.	25	0430	0.20	11.	10
0500	0.00	0.	39	0500	0.19	10.	359
0530	0.37	19.	40	0530	0.20	10.	16
0600	0.63	32.	44	0600	0.37	19.	38
0630	0.76	39.	44	0630	0.44	22.	43
0700	0.69	36.	44	0700	0.73	38.	53
0730	0.75	38.	51	0730	0.69	35.	39
0800	0.91	47.	59	0800	0.69	35.	43
0830	0.32	16.	85	0830	0.58	30.	47
0900	0.34	17.	111	0900	0.71	37.	56
0930	0.16	8.	211	0930	0.47	24.	79
1000	0.50	26.	216	1000	0.12	6.	84
1030	0.57	29.	221	1030	0.26	14.	220
1100	0.67	35.	217	1100	0.51	26.	227
1130	0.71	36.	215	1130	0.51	26.	222
1200	0.71	37.	217	1200	0.59	30.	217
1230	0.72	37.	219	1230	0.64	33.	215
1300	0.70	36.	221	1300	0.68	35.	219
1330	0.75	39.	224	1330	0.69	36.	218
1400	0.60	31.	221	1400	0.81	41.	220
1430	0.45	23.	229	1430	0.57	29.	221
1500	0.28	15.	234	1500	0.48	25.	227
1530	0.19	10.	244	1530	0.30	15.	228
1600	0.12	6.	244	1600	0.19	10.	240
1630	0.11	6.	260	1630	0.09	5.	281
1700	0.12	6.	290	1700	0.10	5.	299
1730	0.26	14.	32	1730	0.19	10.	25
1800	0.47	24.	35	1800	0.28	15.	35
1830	0.64	33.	38	1830	0.31	16.	43
1900	0.74	38.	38	1900	0.54	28.	38
1930	0.81	42.	43	1930	0.67	34.	47
2000	0.86	44.	49	2000	0.56	29.	39
2030	0.74	38.	60	2030	0.66	34.	42
2100	0.35	18.	73	2100	0.61	31.	46
2130	0.16	8.	90	2130	0.57	29.	52
2200	0.15	7.	216	2200	0.41	21.	78
2230	0.35	18.	223	2230	0.06	3.	93
2300	0.46	24.	224	2300	0.15	8.	219
2330	0.54	28.	211	2330	0.33	17.	234

CURRENT DATA
UPPER METER
SALTERS POINT, MA

19 SEP 1985

20 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.49	25.	225	0000	0.14	7.	250
0030	0.52	27.	212	0030	0.28	14.	253
0100	0.55	28.	214	0100	0.51	26.	235
0130	0.62	32.	218	0130	0.51	26.	232
0200	0.27	14.	220	0200	0.51	26.	239
0230	0.37	19.	224	0230	0.65	33.	239
0300	0.24	13.	226	0300	0.64	33.	243
0330	0.18	9.	234	0330	0.53	27.	242
0400	0.08	4.	241	0400	0.52	27.	240
0430	0.11	6.	277	0430	0.17	9.	249
0500	0.11	6.	302	0500	0.20	10.	261
0530	0.12	6.	336	0530	0.12	6.	283
0600	0.12	6.	52	0600	0.09	4.	300
0630	0.09	5.	59	0630	0.06	3.	321
0700	0.16	8.	50	0700	0.12	6.	327
0730	0.44	23.	50	0730	0.16	8.	355
0800	0.54	28.	61	0800	0.27	14.	45
0830	0.56	29.	53	0830	0.36	19.	43
0900	0.75	38.	50	0900	0.48	25.	52
0930	0.56	29.	51	0930	0.63	33.	47
1000	0.87	45.	56	1000	0.54	28.	46
1030	0.49	25.	73	1030	0.63	32.	50
1100	0.01	1.	74	1100	0.76	39.	55
1130	0.24	12.	230	1130	0.37	19.	69
1200	0.46	24.	237	1200	0.01	0.	51
1230	0.50	25.	230	1230	0.13	7.	250
1300	0.65	33.	227	1300	0.32	16.	251
1330	0.60	31.	224	1330	0.39	20.	240
1400	0.81	42.	226	1400	0.43	22.	230
1430	0.84	43.	231	1430	0.50	26.	231
1500	0.57	29.	234	1500	0.49	25.	226
1530	0.55	28.	235	1530	0.51	26.	238
1600	0.42	21.	232	1600	0.50	26.	237
1630	0.32	16.	235	1630	0.38	20.	243
1700	0.14	7.	248	1700	0.32	17.	246
1730	0.15	8.	260	1730	0.14	7.	249
1800	0.06	3.	266	1800	0.09	5.	263
1830	0.02	1.	277	1830	0.07	3.	270
1900	0.04	2.	300	1900	0.03	2.	272
1930	0.16	8.	320	1930	0.05	3.	274
2000	0.24	12.	47	2000	0.02	1.	320
2030	0.31	16.	40	2030	0.13	7.	30
2100	0.59	30.	50	2100	0.29	15.	55
2130	0.76	39.	48	2130	0.47	24.	50
2200	0.76	39.	49	2200	0.70	36.	47
2230	0.61	32.	55	2230	0.66	34.	44
2300	0.61	31.	62	2300	0.76	39.	45
2330	0.09	5.	57	2330	0.63	33.	50

CURRENT DATA
UPPER METER
SALTERS POINT, MA

21 SEP 1985

22 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.40	21.	55	0000	0.52	27.	43
0030	0.07	4.	282	0030	0.53	27.	52
0100	0.20	10.	280	0100	0.44	22.	52
0130	0.24	12.	253	0130	0.05	2.	278
0200	0.36	18.	230	0200	0.22	11.	267
0230	0.37	19.	227	0230	0.32	16.	240
0300	0.40	20.	226	0300	0.39	20.	234
0330	0.40	21.	236	0330	0.39	20.	238
0400	0.41	21.	236	0400	0.38	20.	240
0430	0.40	21.	238	0430	0.35	18.	239
0500	0.22	11.	248	0500	0.37	19.	233
0530	0.15	3.	250	0530	0.33	17.	236
0600	0.10	5.	272	0600	0.35	18.	247
0630	0.05	3.	323	0630	0.27	14.	237
0700	0.20	10.	20	0700	0.07	4.	235
0730	0.11	6.	349	0730	0.05	2.	326
0800	0.25	13.	65	0800	0.06	3.	25
0830	0.19	10.	46	0830	0.00	0.	40
0900	0.27	14.	54	0900	0.01	1.	316
0930	0.33	17.	53	0930	0.06	3.	266
1000	0.50	26.	55	1000	0.04	2.	270
1030	0.56	29.	53	1030	0.07	4.	262
1100	0.55	28.	43	1100	0.06	3.	273
1130	0.58	30.	46	1130	0.14	7.	28
1200	0.79	41.	52	1200	0.28	14.	35
1230	0.50	26.	58	1230	0.37	12.	40
1300	0.22	12.	56	1300	0.34	17.	48
1330	0.06	3.	268	1330	0.31	16.	46
1400	0.24	12.	256	1400	0.22	11.	30
1430	0.37	19.	234	1430	0.08	4.	265
1500	0.41	21.	236	1500	0.28	14.	238
1530	0.40	20.	224	1530	0.34	18.	233
1600	0.43	22.	225	1600	0.37	19.	235
1630	0.37	19.	228	1630	0.38	20.	234
1700	0.33	17.	231	1700	0.47	24.	231
1730	0.33	17.	235	1730	0.43	22.	235
1800	0.23	12.	238	1800	0.44	23.	234
1830	0.16	8.	247	1830	0.57	29.	220
1900	0.16	8.	251	1900	0.49	25.	224
1930	0.16	8.	250	1930	0.55	23.	224
2000	0.16	8.	244	2000	0.49	25.	222
2030	0.14	7.	248	2030	0.40	21.	223
2100	0.11	5.	257	2100	0.42	22.	224
2130	0.07	4.	324	2130	0.29	15.	223
2200	0.23	12.	23	2200	0.24	13.	227
2230	0.51	26.	48	2230	0.12	6.	237
2300	0.64	33.	45	2300	0.06	3.	292
2330	0.72	37.	45	2330	0.17	9.	358

(S3)

CURRENT DATA
UPPER METER
SALTERS POINT, MA

23 SEP 1985

24 SEP 1985

TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)	TIME (EST)	SPEED (KTS)	SPEED (CM/S)	DIRECTION (DEG. TRUE)
0000	0.28	14.	20	0000	0.06	3.	255
0030	0.35	18.	35	0030	0.10	5.	312
0100	0.40	21.	32	0100	0.16	8.	25
0130	0.32	17.	38	0130	0.37	19.	37
0200	0.20	10.	31	0200	0.54	28.	39
0230	0.11	6.	298	0230	0.47	24.	44
0300	0.14	7.	238	0300	0.45	23.	44
0330	0.27	14.	223	0330	0.26	14.	34
0400	0.29	15.	213	0400	0.11	6.	262
0430	0.31	16.	213	0430	0.19	10.	246
0500	0.42	21.	218	0500	0.32	16.	219
0530	0.52	27.	219	0530	0.37	19.	219
0600	0.61	31.	215	0600	0.35	18.	223
0630	0.51	26.	216	0630	0.33	17.	216
0700	0.57	29.	224	0700	0.36	18.	223
0730	0.54	28.	228	0730	0.35	18.	225
0800	0.42	22.	228	0800	0.35	18.	230
0830	0.27	14.	230	0830	0.31	16.	237
0900	0.34	17.	241	0900	0.37	19.	229
0930	0.11	6.	252	0930	0.47	24.	237
1000	0.13	7.	250	1000	0.31	16.	238
1030	0.12	6.	249	1030	0.22	11.	236
1100	0.13	7.	250	1100	0.17	9.	244
1130	0.09	5.	274	1130	0.06	3.	256
1200	0.09	5.	358	1200	0.09	5.	302
1230	0.22	11.	6	1230	0.23	12.	5
1300	0.30	16.	11	1300	0.33	17.	19
1330	0.41	21.	35	1330	0.36	18.	36
1400	0.53	28.	47	1400	0.49	25.	36
1430	0.41	21.	42	1430	0.50	26.	42
1500	0.23	12.	20	1500	0.49	25.	40
1530	0.10	5.	292	1530	0.39	20.	40
1600	0.16	8.	237	1600	0.36	19.	38
1630	0.25	13.	219	1630	0.10	5.	315
1700	0.30	15.	218	1700	0.07	4.	246
1730	0.42	22.	217	1730	0.19	10.	238
1800	0.47	24.	219	1800	0.28	14.	224
1830	0.62	32.	221	1830	0.40	21.	218
1900	0.63	32.	224	1900	0.42	22.	218
1930	0.64	33.	224	1930	0.36	19.	322
2000	0.68	35.	225	2000	0.42	22.	219
2030	0.46	24.	227	2030	0.42	22.	219
2100	0.40	21.	228	2100	0.39	20.	226
2130	0.20	10.	224	2130	0.31	16.	222
2200	0.10	5.	222	2200	0.17	9.	229
2230	0.03	1.	241	2230	0.17	9.	232
2300	0.04	2.	252	2300	0.04	2.	247
2330	0.03	2.	254	2330	0.05	3.	273

CURRENT DATA
UPPER METER
SALTTERS POINT, MA

25 SEP 1985

TIME SPEED SPEED DIRECTION

(EST)	(KTS)	(CM/S)	(DEG. TRUE)
0000	0.06	3.	315
0030	0.11	6.	26
0100	0.18	9.	37
0130	0.41	21.	38
0200	0.44	22.	41
0230	0.29	15.	35
0300	0.59	30.	40
0330	0.45	23.	40
0400	0.45	23.	38
0430	0.30	15.	44
0500	0.09	5.	306
0530	0.21	11.	252
0600	0.34	17.	219
0630	0.43	22.	211
0700	0.49	25.	214
0730	0.55	28.	219
0800	0.44	23.	220
0830	0.43	22.	227
0900	0.74	38.	223
0930	0.31	16.	225
1000	0.33	17.	223
1030	0.23	12.	227
1100	0.17	9.	228
1130	0.05	3.	244
1200	0.07	4.	285
1230	0.14	7.	303
1300	0.18	9.	3
1330	0.25	13.	26
1400	0.36	19.	24
1430	0.17	9.	30
1500	0.47	24.	35
1530	0.73	38.	43
1600	0.54	28.	60

CURRENT DATA
UPPER METER
SALTERS POINT, MA

***** END OF DATA *****

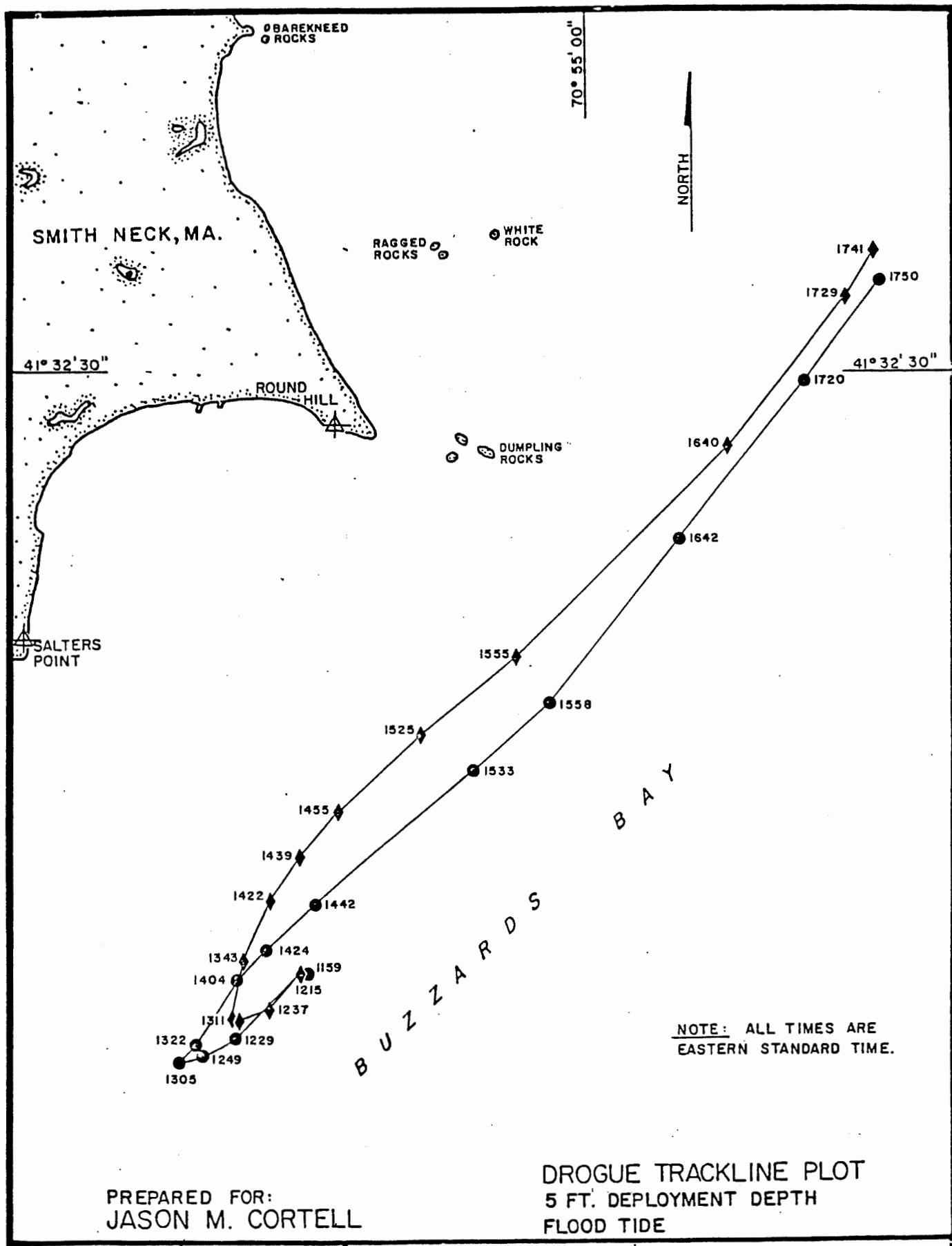
2109 RECORDS TYPED

	GOOD	BAD
IR	1445	0
PD	1445	0

1445 RECORDS WRITTEN TO TAPE FILE

Appendix B

DROGUE STUDIES



PREPARED FOR:
JASON M. CORTELL

DROGUE TRACKLINE PLOT
5 FT. DEPLOYMENT DEPTH
FLOOD TIDE

FIGURE NO.

SURVEY DATE
AUG 15 1985

SCALE

1: 25,000

BY

J.A. DOYLE

OCEAN SURVEYS, INC.

OLD SAYBROOK, CONNECTICUT



DROGUE VELOCITY DATA

5 FT. DEPLOYMENT DEPTH - FLOOD TIDE
BUZZARDS BAY, MA

DEPLOYMENT/DROGUE ID: ●

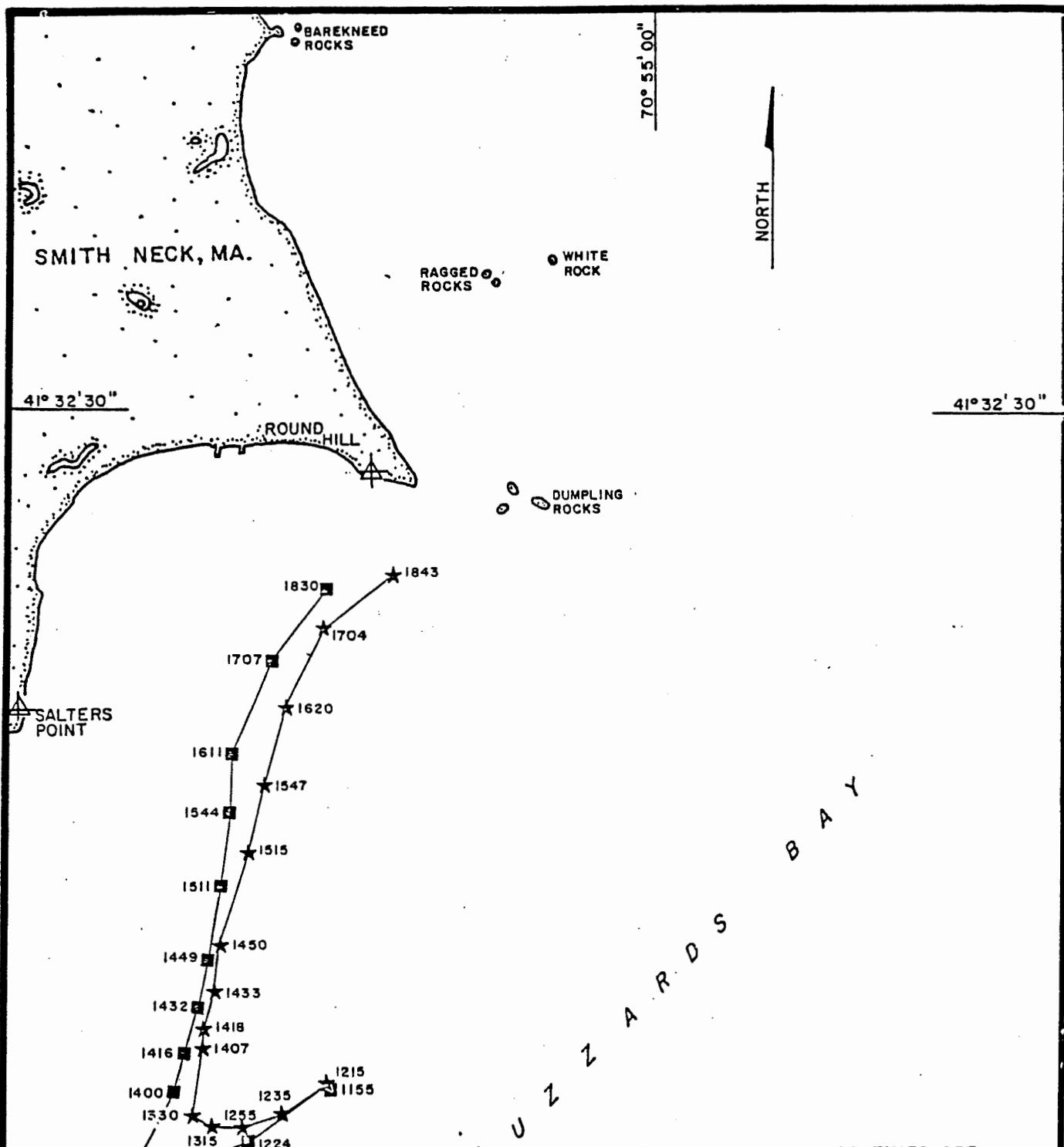
DATE: 15 AUG 1985

TIME INTERVAL (EST) (HR:MIN) (HR:MIN)		SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)	
1159	-	1229	24.5	0.48	210
1229	-	1249	14.6	0.28	227
1249	-	1305	12.4	0.24	238
1305	-	1322	12.2	0.24	28
1322	-	1404	14.4	0.28	18
1404	-	1424	15.8	0.31	29
1424	-	1442	29.9	0.58	32
1442	-	1533	32.1	0.62	34
1533	-	1558	31.7	0.62	33
1558	-	1642	37.6	0.73	22
1642	-	1720	41.5	0.81	23
1720	-	1750	33.3	0.65	21

DEPLOYMENT/DROGUE ID: ♦

DATE: 15 AUG 1985

TIME INTERVAL (EST) (HR:MIN) (HR:MIN)		SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)	
1215	-	1237	16.7	0.32	207
1237	-	1256	13.5	0.26	234
1256	-	1311	4.5	0.09	257
1311	-	1343	13.8	0.27	357
1343	-	1422	13.8	0.27	8
1422	-	1439	24.5	0.48	19
1439	-	1455	29.5	0.57	25
1455	-	1525	29.9	0.58	31
1525	-	1555	32.2	0.63	35
1555	-	1640	52.0	1.01	30
1640	-	1729	31.0	0.60	22
1729	-	1741	35.1	0.68	15



PREPARED FOR:
JASON M. CORTELL

DROGUE TRACKLINE PLOT
10 FT. DEPLOYMENT DEPTH
FLOOD TIDE

FIGURE NO.	SURVEY DATE AUG-15-1985
SCALE 1: 25,000	BY J.A.DOYLE

OCEAN SURVEYS, INC.

OLD SAYBROOK, CONNECTICUT



DROGUE VELOCITY DATA

10 FT. DEPLOYMENT DEPTH - FLOOD TIDE
BUZZARDS BAY, MA

DEPLOYMENT/DROGUE ID: ■

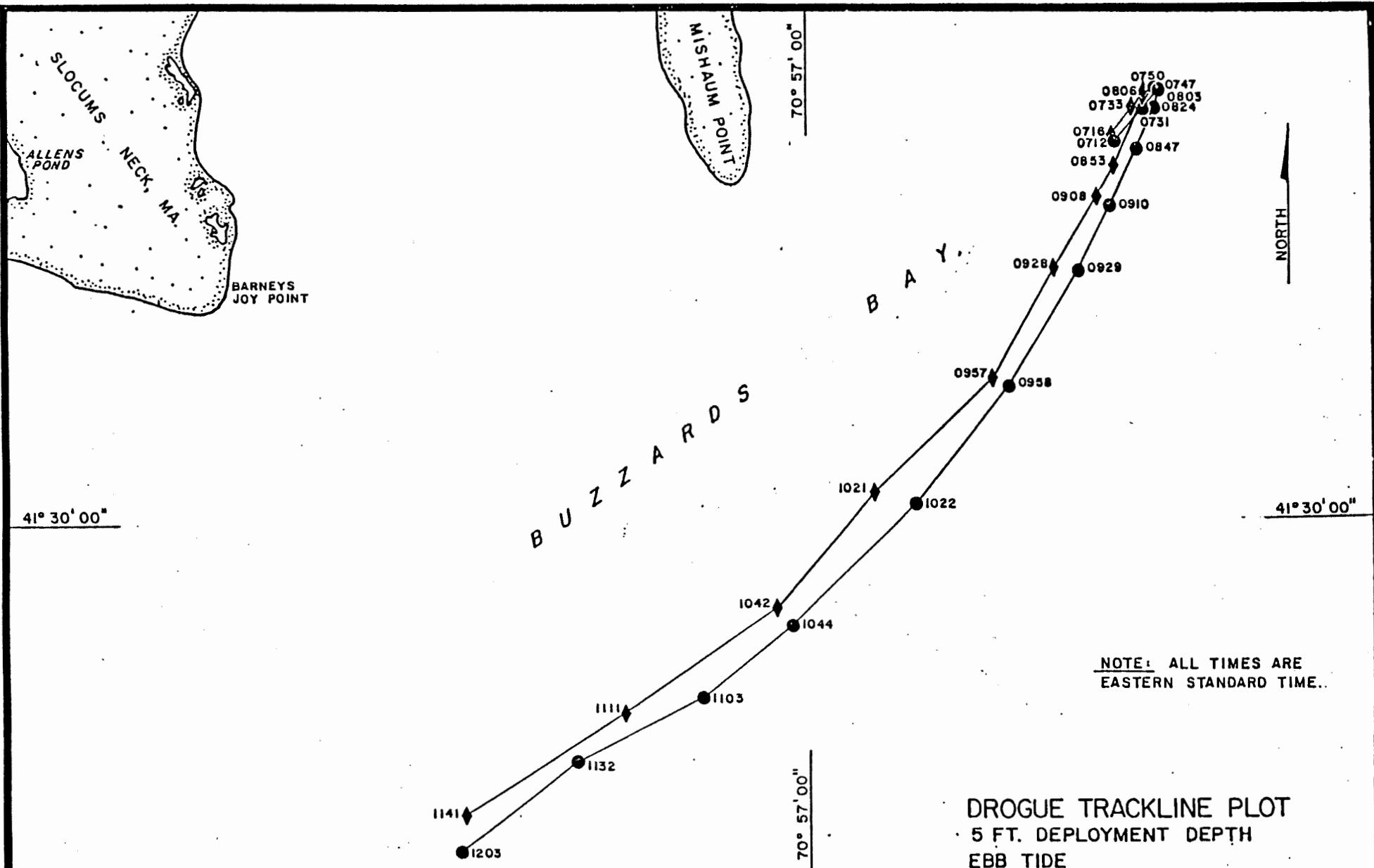
DATE: 15 AUG 1985

TIME INTERVAL (EST) (HR:MIN) (HR:MIN)		SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)	
1155	-	1224	23.1	0.45	218
1224	-	1246	19.8	0.38	234
1246	-	1304	13.5	0.26	245
1304	-	1318	10.6	0.21	262
1318	-	1400	13.9	0.27	11
1400	-	1416	17.1	0.33	359
1416	-	1432	21.0	0.41	1
1432	-	1449	20.1	0.39	356
1449	-	1511	24.4	0.47	353
1511	-	1544	15.9	0.31	352
1544	-	1511	15.3	0.30	346
1611	-	1707	12.6	0.24	8
1707	-	1830	7.8	0.15	23

DEPLOYMENT/DROGUE ID: ★

DATE: 15 AUG 1985

TIME INTERVAL (EST) (HR:MIN) (HR:MIN)		SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)	
1215	-	1235	19.3	0.37	221
1235	-	1255	16.0	0.31	238
1255	-	1315	10.0	0.19	257
1315	-	1330	9.6	0.19	284
1330	-	1407	12.7	0.25	352
1407	-	1418	12.8	0.25	350
1418	-	1433	18.1	0.35	359
1433	-	1450	19.4	0.38	350
1450	-	1515	27.4	0.53	2
1515	-	1547	15.5	0.30	358
1547	-	1620	17.1	0.33	359
1620	-	1704	14.0	0.27	12
1704	-	1843	6.3	0.12	36



PREPARED FOR:
JASON M. CORTELL

OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT



DROGUE VELOCITY DATA

5 FT. DEPLOYMENT DEPTH - EBB TIDE
BUZZARDS BAY, MA

DEPLOYMENT/DROGUE ID: ●

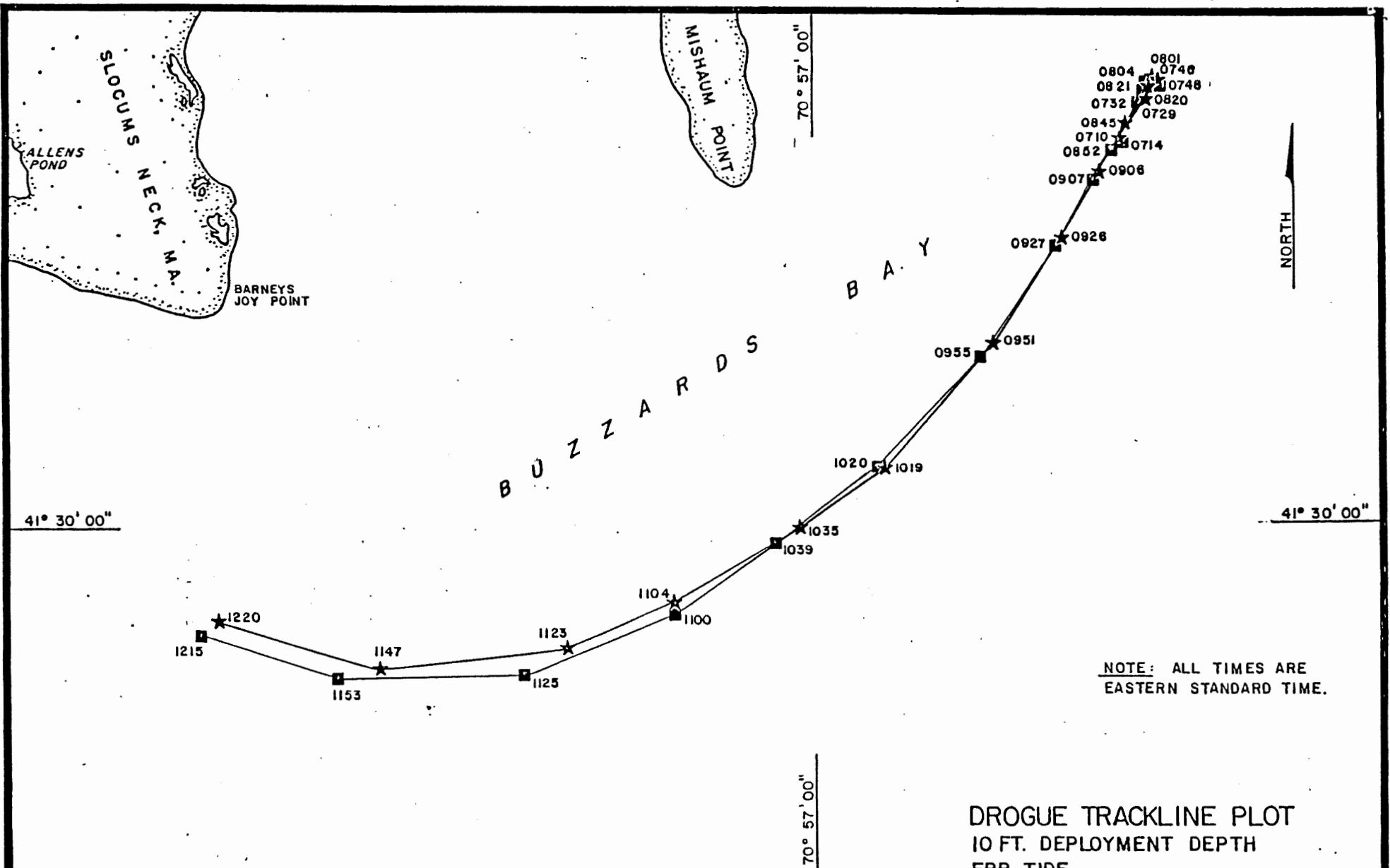
DATE: 16 AUG 1985

TIME INTERVAL (EST) (HR:MIN)	SPEED (CM/SEC)	DIRECTION (DEG TRUE)
0712 - 0731	19.0	26
0731 - 0747	10.6	27
0747 - 0803	0.8	11
0803 - 0824	6.7	177
0824 - 0847	15.2	191
0847 - 0910	21.1	190
0910 - 0929	30.0	191
0929 - 0958	36.2	196
0958 - 1022	49.1	203
1022 - 1044	60.7	211
1044 - 1103	46.7	216
1103 - 1132	37.9	220
1132 - 1203	36.6	216

DEPLOYMENT/DROGUE ID: ♦

DATE: 16 AUG 1985

TIME INTERVAL (EST) (HR:MIN)	SPEED (CM/SEC)	DIRECTION (DEG TRUE)
0716 - 0733	17.9	23
0733 - 0750	18.5	15
0750 - 0806	0.7	36
0806 - 0825	6.6	179
0825 - 0853	18.0	188
0853 - 0908	18.7	195
0908 - 0928	32.7	196
0928 - 0957	34.4	194
0957 - 1021	53.6	210
1021 - 1042	55.2	205
1042 - 1111	49.5	221
1111 - 1141	48.3	222



DROGUE TRACKLINE PLOT
 10 FT. DEPLOYMENT DEPTH
 EBB TIDE

PREPARED FOR:
 JASON M. CORTELL

FIGURE NO.	DATE
	16 AUG 1985
SCALE	BY
1:25,000	J. A. DOYLE

OCEAN SURVEYS, INC.
 OLD SAYBROOK, CONNECTICUT



DROGUE VELOCITY DATA

10 FT. DEPLOYMENT DEPTH - EBB TIDE
BUZZARD'S BAY, MA

DEPLOYMENT/DROGUE ID: ■

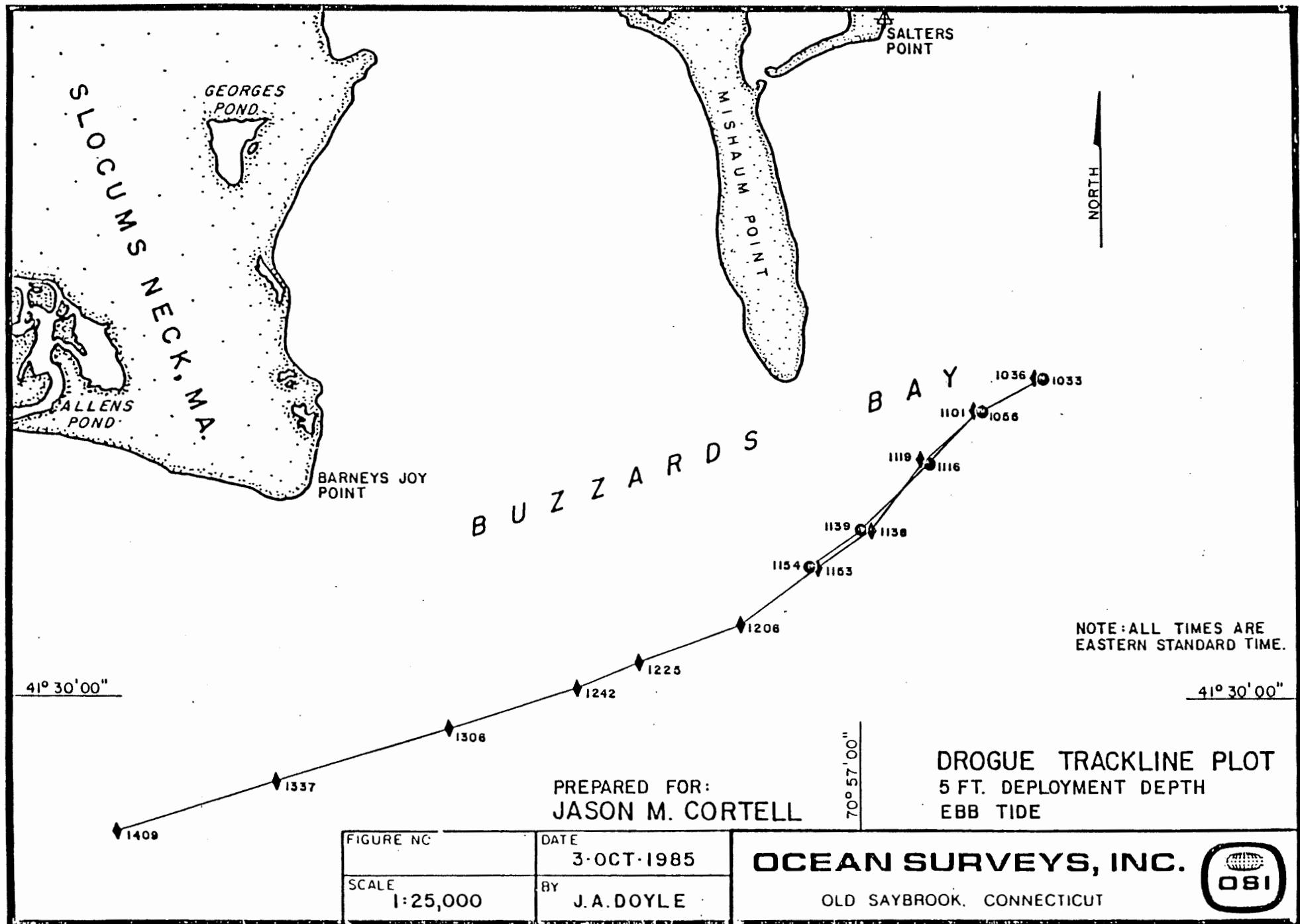
DATE: 16 AUG 1985

TIME INTERVAL (EST) (HR:MIN)	SPEED (CM/SEC)	DIRECTION (DEG TRUE)
(HR:MIN)	(KTS)	
0714 - 0732	18.6	17
0732 - 0748	8.7	16
0748 - 0804	2.1	339
0804 - 0821	4.1	188
0821 - 0852	17.1	193
0852 - 0907	17.9	200
0907 - 0927	28.9	194
0927 - 0955	37.5	199
0955 - 1020	46.9	208
1020 - 1039	51.6	216
1039 - 1100	45.7	220
1100 - 1125	51.0	233
1125 - 1153	53.0	255
1153 - 1215	49.1	273

DEPLOYMENT/DROGUE ID: ★

DATE: 16 AUG 1985

TIME INTERVAL (EST) (HR:MIN)	SPEED (CM/SEC)	DIRECTION (DEG TRUE)
(HR:MIN)	(KTS)	
0710 - 0729	19.9	19
0729 - 0746	9.6	16
0746 - 0801	1.8	224
0801 - 0820	1.5	224
0820 - 0845	14.2	197
0845 - 0906	20.6	195
0906 - 0926	29.1	195
0926 - 0951	39.3	198
0951 - 1019	45.9	205
1019 - 1035	50.6	219
1035 - 1104	38.6	224
1104 - 1123	51.9	238
1123 - 1147	56.3	244
1147 - 1220	33.3	269



DROGUE VELOCITY DATA

5 FT. DEPLOYMENT DEPTH - EBB TIDE
BUZZARDS BAY, MA

DEPLOYMENT/DROGUE ID: ♦

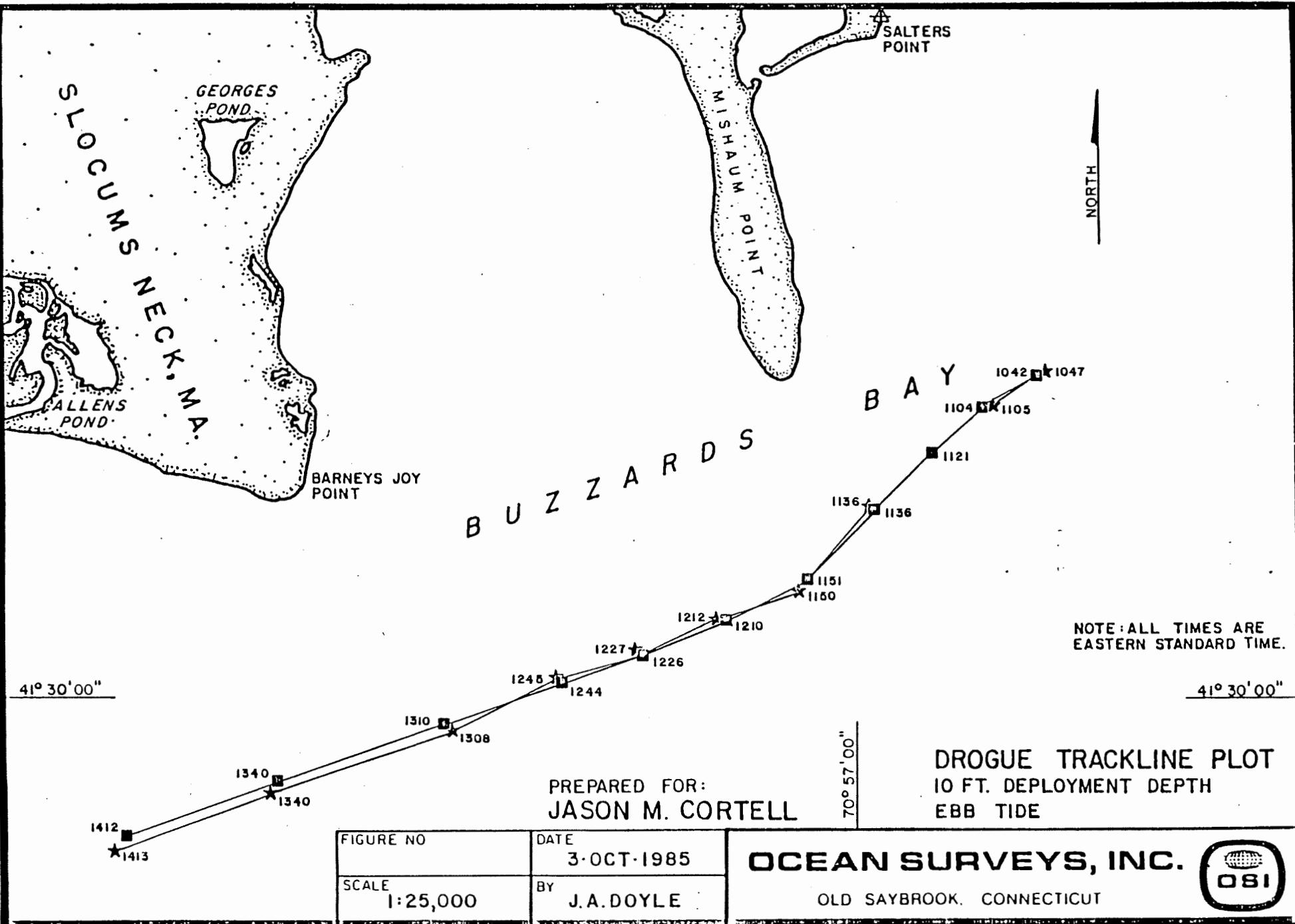
DATE: 3 OCT 1985

TIME INTERVAL (HR:MIN) (HR:MIN)		SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)	
1033	-	1056	24.7	0.48	240
1056	-	1116	32.1	0.62	224
1116	-	1139	33.2	0.65	223
1139	-	1154	35.6	0.69	233

DEPLOYMENT/DROGUE ID: ♦

DATE: 3 OCT 1985

TIME INTERVAL (HR:MIN) (HR:MIN)		SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)	
1036	-	1101	22.4	0.44	240
1101	-	1119	35.3	0.69	226
1119	-	1138	39.1	0.76	218
1138	-	1153	36.4	0.71	233
1153	-	1206	59.4	1.15	232
1206	-	1225	46.7	0.91	249
1225	-	1242	32.4	0.63	245
1242	-	1306	46.2	0.90	251
1306	-	1337	48.1	0.93	251
1337	-	1409	43.3	0.84	251



DROGUE VELOCITY DATA

10 FT. DEPLOYMENT DEPTH - EBB TIDE
BUZZARDS BAY, MA

DEPLOYMENT/DROGUE ID: ■

DATE: 3 OCT 1985

TIME INTERVAL (HR:MIN)	TIME INTERVAL (HR:MIN)	SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)
1042	- 1104	24.0	0.47	238
1104	- 1121	33.1	0.64	226
1121	- 1136	43.3	0.84	224
1136	- 1151	53.7	1.04	222
1151	- 1210	39.1	0.76	242
1210	- 1226	46.7	0.91	245
1226	- 1244	37.5	0.73	250
1244	- 1310	40.3	0.78	249
1310	- 1340	47.8	0.93	249
1340	- 1412	42.2	0.82	248

DEPLOYMENT/DROGUE ID: ★

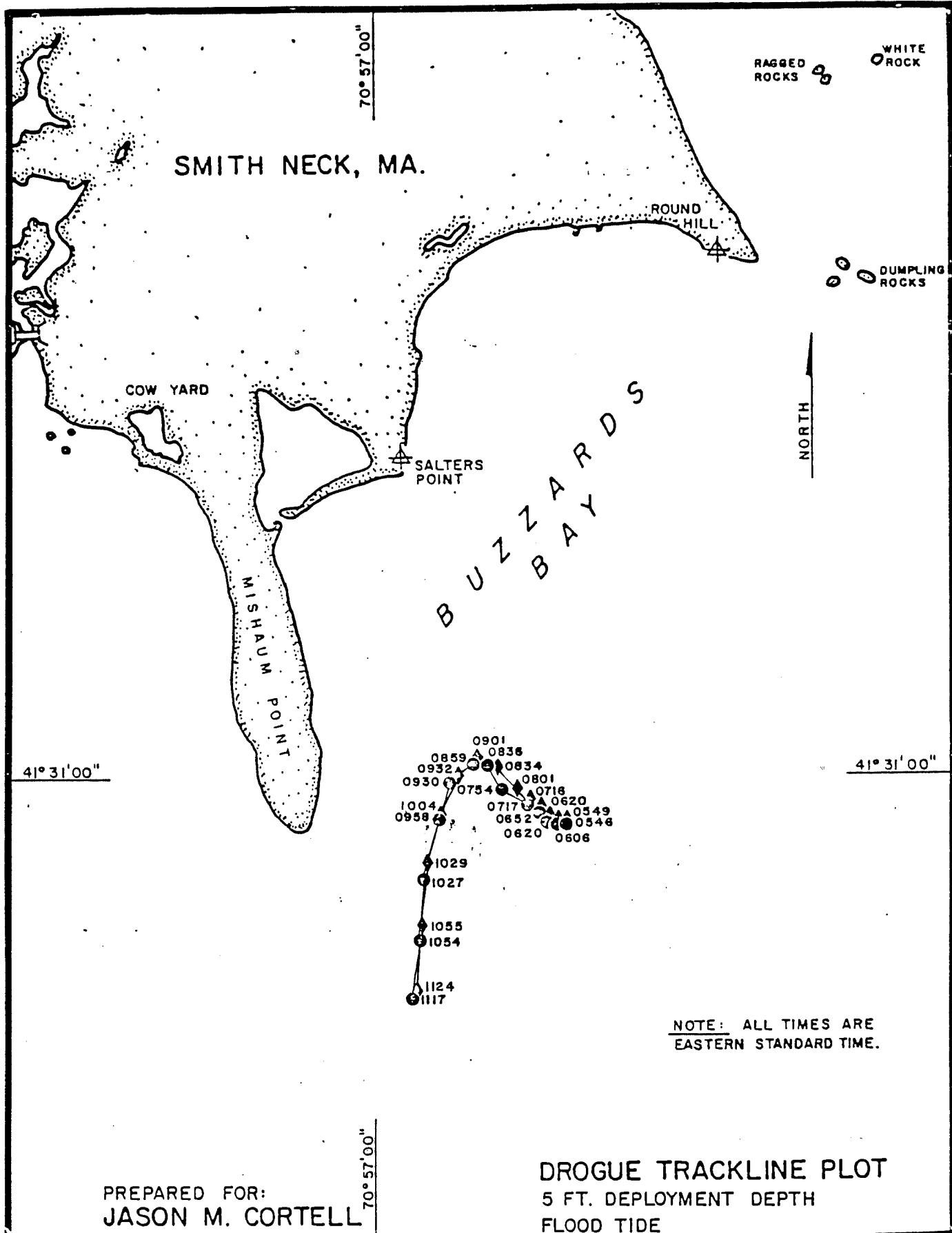
DATE: 3 OCT 1985

TIME INTERVAL (HR:MIN)	TIME INTERVAL (HR:MIN)	SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)
1047	- 1105	25.5	0.50	235

DEPLOYMENT/DROGUE ID: ★

DATE: 3 OCT 1985

TIME INTERVAL (HR:MIN)	TIME INTERVAL (HR:MIN)	SPEED (CM/SEC)	SPEED (KTS)	DIRECTION (DEG TRUE)
1136	- 1150	65.5	1.27	220
1150	- 1212	31.4	0.61	248
1212	- 1227	48.6	0.94	244
1227	- 1245	36.6	0.71	252
1245	- 1308	42.5	0.83	243
1308	- 1340	49.0	0.95	248
1340	- 1413	42.8	0.83	248



PREPARED FOR:
JASON M. CORTELL

DROGUE TRACKLINE PLOT
5 FT. DEPLOYMENT DEPTH
FLOOD TIDE

FIGURE NO.	SURVEY DATE 4-OCT-1985
SCALE 1: 25,000	BY J.A.DOYLE

OCEAN SURVEYS, INC.

OLD SAYBROOK, CONNECTICUT



DROGUE VELOCITY DATA

5 FT. DEPLOYMENT DEPTH - FLOOD TIDE
BUZZARDS BAY, MA

DEPLOYMENT/DROGUE ID: ●

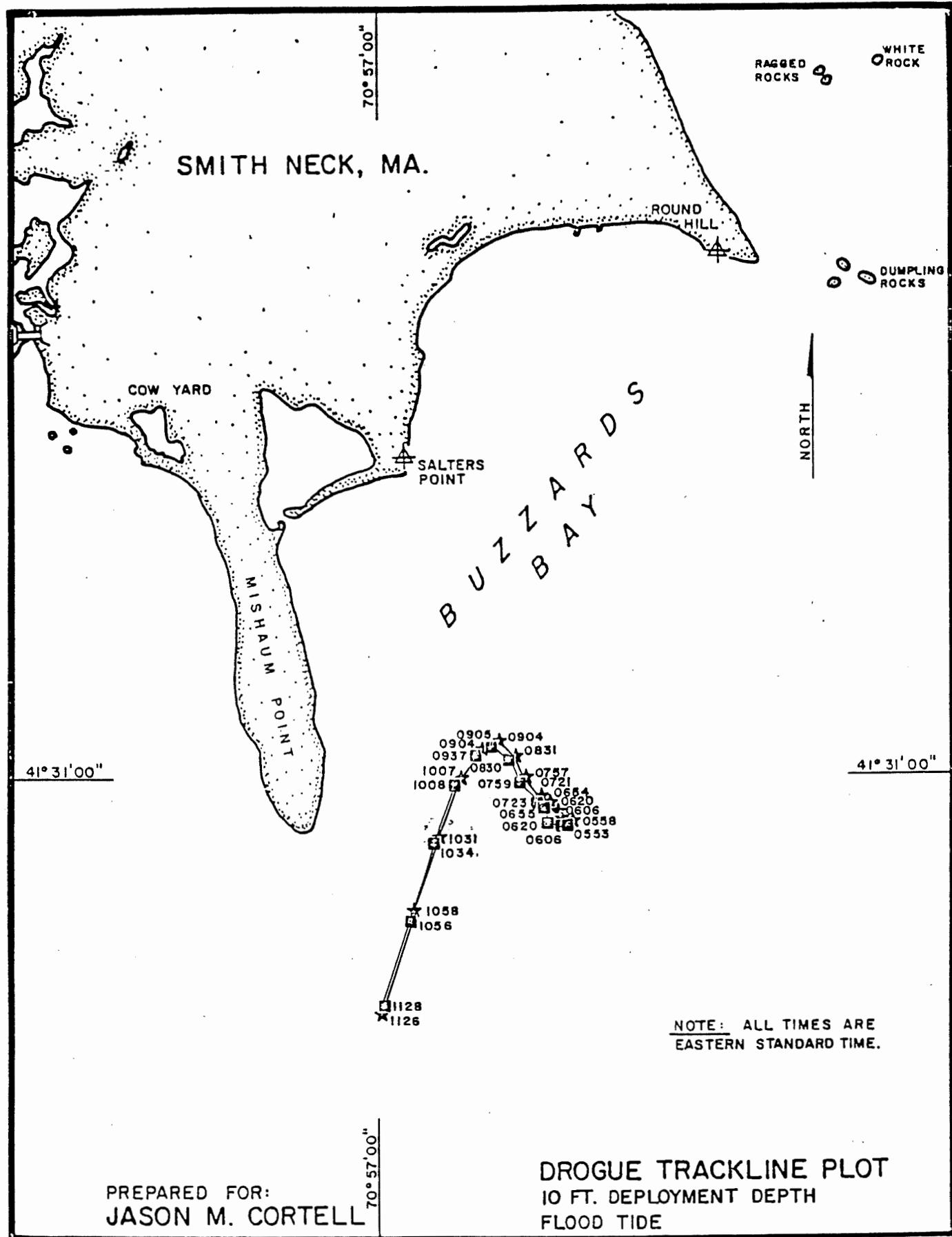
DATE: 4 OCT 1985

TIME INTERVAL		SPEED	DIRECTION
(HR:MIN)	(HR:MIN)	(CM/SEC) (KTS)	(DEG TRUE)
0546	- 0606	3.1	0.06
0606	- 0620	6.2	0.12
0620	- 0652	3.0	0.06
0652	- 0717	4.4	0.08
0717	- 0754	6.7	0.13
0754	- 0836	5.3	0.10
0836	- 0859	5.0	0.10
0859	- 0930	7.7	0.15
0930	- 0958	10.8	0.21
0958	- 1027	17.0	0.33
1027	- 1054	17.7	0.34
1054	- 1117	19.9	0.39

DEPLOYMENT/DROGUE ID: ♦

DATE: 4 OCT 1985

TIME INTERVAL		SPEED	DIRECTION
(HR:MIN)	(HR:MIN)	(CM/SEC) (KTS)	(DEG TRUE)
0547	- 0606	3.6	0.07
0606	- 0620	5.5	0.11
0620	- 0651	2.1	0.04
0651	- 0716	2.9	0.06
0716	- 0801	5.6	0.11
0801	- 0834	7.1	0.14
0834	- 0901	5.8	0.11
0901	- 0932	6.2	0.12
0932	- 1004	10.9	0.21
1004	- 1029	16.0	0.31
1029	- 1055	18.6	0.36
1055	- 1124	18.4	0.36



PREPARED FOR:
JASON M. CORTELL

DROGUE TRACKLINE PLOT
10 FT. DEPLOYMENT DEPTH
FLOOD TIDE

FIGURE NO.	SURVEY DATE 4-OCT-1985
SCALE 1: 25,000	BY J.A.DOYLE

OCEAN SURVEYS, INC.

OLD SAYBROOK, CONNECTICUT



DROGUE VELOCITY DATA

10 FT. DEPLOYMENT DEPTH - FLOOD TIDE
BUZZARDS BAY, MA

DEPLOYMENT/DROGUE ID: ■

DATE: 4 OCT 1985

TIME INTERVAL		SPEED	DIRECTION
(HR:MIN)	(HR:MIN)	(CM/SEC) (KTS)	(DEG TRUE)
0553	- 0606	3.3	0.06
0606	- 0620	4.2	0.08
0620	- 0655	4.0	0.08
0655	- 0723	2.9	0.06
0723	- 0759	5.2	0.10
0759	- 0830	6.4	0.12
0830	- 0905	5.1	0.10
0905	- 0937	4.8	0.09
0937	- 1008	9.4	0.18
1008	- 1034	19.5	0.38
1034	- 1056	27.0	0.52
1056	- 1128	25.7	0.50

DEPLOYMENT/DROGUE ID: ★

DATE: 4 OCT 1985

TIME INTERVAL		SPEED	DIRECTION
(HR:MIN)	(HR:MIN)	(CM/SEC) (KTS)	(DEG TRUE)
0558	- 0606	6.6	0.13
0606	- 0620	7.3	0.14
0620	- 0654	3.4	0.07
0654	- 0721	2.9	0.06
0721	- 0757	5.6	0.11
0757	- 0831	6.1	0.12
0831	- 0904	5.1	0.10
0904	- 0935	4.7	0.09
0935	- 1007	9.3	0.18
1007	- 1031	19.5	0.38
1031	- 1058	24.5	0.48
1058	- 1126	25.0	0.49

Appendix C

WATER QUALITY
Field and Laboratory Methods

Water Quality - Field And Laboratory Methods

Field Measurements

Water quality measurements that were conducted in the field included tests for dissolved oxygen, temperature, pH, and specific conductance.

Dissolved oxygen tests were conducted with a Yellow Springs Model 57 Dissolved Oxygen/Temperature analyser with a 100 foot cable. The instrument was calibrated daily via the Winkler method. Measurements were conducted at one meter intervals through the water column.

Temperature was measured with the same Yellow Springs instrument also with measurements being made at one meter intervals. The temperature calibration of the instrument was checked with a certified thermometer. Instrument readings were found to be accurate to less than one half of one degree.

Hydrogen-ion concentration (pH) was measured with a portable Corning expanded scale pH meter. Calibration was checked daily with 7.0 pH standard. Water samples for testing were collected with a Kemmerer bottle which was lowered to the desired water depth, triggered, and the sample brought to the surface where it was tested.

Specific conductance was measured with a Hydrolabs conductivity meter with a 100 foot cable. The instrument calibration was checked daily with a known standard and measurements were made at one meter intervals.

Laboratory Analyses.

Water and sediment samples collected in the field were placed on ice for transportation to the analytical laboratory. All analyses were conducted by Arnold Green Testing Laboratories of Natick, Massachusetts which is a Commonwealth Certified Laboratory.

Analytical procedures for water were conducted in keeping with:

Methods For The Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, Washington, DC.

Standard Methods For the Examination of Water and Wastes, 15th and 16th Editions, 1980, 1985. American Public Health Association, American Water Works Association, Water Pollution Control Federation.

Laboratory data reports not included within the text are attached to this description.

Analytical procedures for sediment were conducted in keeping with:

Ecological Evaluation of Proposed Discharge of Dredge or Fill Material Into Navigable Waters, Ecological Effects Laboratory, U.S. Army Engineers, Vicksburg, MI.

Methods For The Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, Washington, DC.

ASTM D 422, Standard Method for Particle-size Analysis of Soils, American Society For Testing And Materials.



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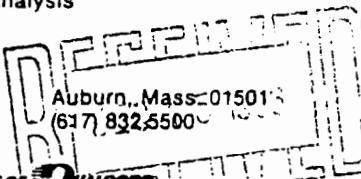
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To: JASON M. CORTELL
244 2nd Avenue
Waltham, MA 02154

Date: 12/12/86
Job No: 69845-1
Lab No: 3264
Order No: 0593
Date Rec'd: 9/18/85

Material: Water
Book No: 257p15

SUPPLEMENTAL REPORT

Sample ID:	DDT (ug/l)	Sample ID:	DDT (ug/l)
1S	<0.012	7S	<0.012
1M	<0.012	7M	<0.012
1B	<0.012	7B	<0.012
2S	<0.012	13S	<0.012
2M	<0.012	13M	<0.012
2B	<0.012	13B	<0.012
5S	<0.012	FINISH	<0.012
5M	<0.012		
5B	<0.012		
6S	<0.012		
6M	<0.012		
6B	<0.012		

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To: JASON M. CORTELL
244 2nd Avenue
Waltham, MA 02154

Date: 12/12/86
Job No: 70378-1
Lab No: 3333
Order No: 0599
Date Rec'd: 10/2/85

Material: Sludge
Book No: 257p17

SUPPLEMENTAL REPORT

Sample ID: Dartmouth Wastewater Treatment Facility

DDT <0.00025 ug/g

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**To: JASON M. CORTELL
244 2nd Avenue
Waltham, MA 02154**

**Date: 12/12/86
Job No: 71331-2
Lab No: 3422
Order No: 0600
Date Rec'd: 10/22/85**

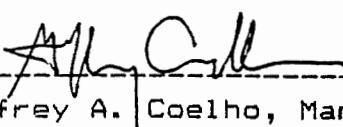
**Material: Sediment
Book No: 257p17**

SUPPLEMENTAL REPORT

DDT (ug/g)

Station #1	<0.00025
Station #7	<0.00025
Station #10	<0.00025
Station #11	<0.00025
Station #13	<0.00025
Station #14	<0.00025
Station #18	<0.00025

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TO: JASON M. CORTELL & ASSOC. DATE: 9/30/85 MATERIAL: WATER
244 2ND AVE. JOB NO. 69670-1 BOOK NO. 168-7 SM
WALTHAM, MA 02154 LAB NO. 3238 SPECIFICATIONS:
ATTN: ORDER NO.0590
SAMPLE ID: 20 WATER DATE REC'D: 9/13/85

pH	TOTAL SUSPENDED SOLIDS (mg/l)	BIOCHEMICAL OXY. DEMAND (mg/l)
----	-------------------------------	--------------------------------

STATION 1:

Surf	8.2	26	3.0
Middle	8.2	22	<2
Bottom	8.2	35	2.5

STATION 2:

Surf	8.2	24	4.5
Middle	8.2	31	3.5
Bottom	8.2	29	2.5

STATION 5:

Surf	8.2	37	<2
Middle	8.1	36	2.0
Bottom	8.2	37	2.5

STATION 6:

Surf	8.2	35	2.5
Middle	8.3	28	<2
Bottom	8.2	34	2.5

STATION 7:

Surf	8.2	32	3.7
Middle	8.2	34	2.5
Bottom	8.2	33	2.0



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PAGE 2
JASON CORTELL
JOB #69670-1

	pH	TOTAL SUSPENDED SOLIDS (mg/l)	BIOCHEMICAL OXY. DEMAND (mg/l)	SPECIFIC CONDUCTANCE (µhos/cm)
STATION 13:				
Surf	8.2	39	4.0	56,700
Middle	8.2	29	<2	56,700
Bottom	8.2	36	<2	38,300

FINISH

pH	7.0
Biochemical Oxygen Demand (mg/l)	22.0
Total Suspended Solids (mg/l)	7
Total Dissolved Solids (mg/l)	280
Ammonia (mg/l)	0.37
Nitrate (mg/l)	13.7
Phosphate, Total (mg/l)	0.63
Sulfate (mg/l)	30

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Jeffrey Coelho, Lead Chemist



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TO: JASON M. CORTELL & ASSOC. DATE: 10/10/85 MATERIAL: WATER

244 2ND AVE. JOB NO. 59845-1 BOOK NO. 163 AP

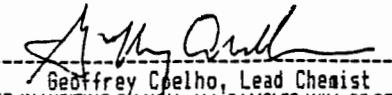
WALTHAM, MA 02154 LAB NO. 3264 SPECIFICATIONS:

ATTN: ORDER NO. 0593

SAMPLE ID: 19 Water Samples	DATE REC'D: 9/18/85				
	1S	1M	1B	2S	2M
Arsenic (mg/L)	0.30	0.32	0.28	0.29	0.34
Cadmium (mg/L)	0.10	0.08	0.10	0.11	0.10
Chromium (mg/L)	0.04	0.05	0.06	0.05	0.05
Copper (mg/L)	0.11	0.21	0.17	0.11	0.17
Lead (mg/L)	0.30	0.40	0.45	0.35	0.40
Mercury (mg/L)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Nickel (mg/L)	0.47	0.44	0.44	0.52	0.50
Zinc (mg/L)	0.09	0.15	0.15	0.10	0.16
	2B	5S	5M	5B	6S
Arsenic (mg/L)	0.28	0.29	0.36	0.28	0.34
Cadmium (mg/L)	0.10	0.08	0.09	0.09	0.10
Chromium (mg/L)	0.04	0.04	0.03	0.05	0.05
Copper (mg/L)	0.15	0.10	0.15	0.14	0.10
Lead (mg/L)	0.40	0.35	0.40	0.45	0.40
Mercury (mg/L)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Nickel (mg/L)	0.43	0.43	0.46	0.47	0.45
Zinc (mg/L)	0.14	0.09	0.18	0.15	0.10

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TO: JASON M. CORTELL & ASSOC. DATE: 10/10/85 MATERIAL: WATER

244 2ND AVE. JOB NO. 59845-1 BOOK NO. 163 AP

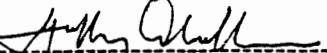
WALTHAM, MA 02154 LAB NO. 3264 SPECIFICATIONS:

ATTN: ORDER NO. 0593

SAMPLE ID: 19 Water Samples	DATE REC'D: 9/18/85				
	6M	6B	7S	7M	7B
Arsenic (mg/L)	0.41	0.27	0.33	0.41	0.30
Cadmium (mg/L)	0.10	0.11	0.10	0.09	0.12
Chromium (mg/L)	0.06	0.05	0.05	0.06	0.07
Copper (mg/L)	0.20	0.17	0.09	0.28	0.20
Lead (mg/L)	0.45	0.30	0.35	0.45	0.35
Mercury (mg/L)	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Nickel (mg/L)	0.45	0.45	0.34	0.47	0.51
Zinc (mg/L)	0.17	0.15	0.08	0.20	0.18
	13S	13M	13B	FINISH	----
Arsenic (mg/L)	0.42	0.40	0.31	0.24	-----
Cadmium (mg/L)	0.08	0.09	0.09	<0.02	-----
Chromium (mg/L)	0.06	0.05	0.05	<0.02	-----
Copper (mg/L)	0.09	0.15	0.14	0.16	-----
Lead (mg/L)	0.30	0.45	0.35	<0.10	-----
Mercury (mg/L)	<0.0005	<0.0005	<0.0005	<0.0005	-----
Nickel (mg/L)	0.44	0.48	0.47	<0.02	-----
Zinc (mg/L)	0.09	0.14	0.14	0.08	-----

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10TH DAY OF OCTOBER 1985

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Geoffrey Coelho, Lead Chemist

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TO: JASON M. CORTELL & ASSOC. DATE 10/17/85 MATERIAL: WATER

244 2ND AVENUE JOB NO. 69845-1 BOOK NO. 167-34 SC

WALTHAM, MA 02154 LAB NO. 3264 SPECIFICATIONS:

ATTN: ORDER NO. 0593

SAMPLE ID: 19 WATER DATE REC'D: 9/18/85

All results in ug/l: 1S 1M 1B 2S 2M

Endrin <0.006 <0.006 <0.006 <0.006 <0.006

Lindane <0.004 <0.004 <0.004 <0.004 <0.004

Methoxychlor <0.011 <0.011 <0.011 <0.011 <0.011

Toxaphene <0.24 <0.24 <0.24 <0.24 <0.24

2,4-D <0.002 <0.002 <0.002 <0.002 <0.002

2,4,5-TP(Silvex) <0.002 <0.002 <0.002 <0.002 <0.002

PCB <0.065 <0.065 <0.065 <0.065 <0.065

2B 5S 5M 5B 6S

Endrin <0.006 <0.006 <0.006 <0.006 <0.006

Lindane <0.004 <0.004 <0.004 <0.004 <0.004

Methoxychlor <0.011 <0.011 <0.011 <0.011 <0.011

Toxaphene <0.24 <0.24 <0.24 <0.24 <0.24

2,4-D <0.002 <0.002 <0.002 <0.002 <0.002

2,4,5-TP(Silvex) <0.002 <0.002 <0.002 <0.002 <0.002

PCB <0.065 <0.065 <0.065 <0.065 <0.065



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The seal of the University of Michigan, featuring a central shield with a balance scale, surrounded by a circular border.

PAGE 1
JACOB MARTEL
100-107647-1

All results in ug/l:	1%	10%	1%	1%
Endrin	0.004	0.004	0.004	0.004
Lindane	0.004	0.004	0.004	0.004
Methoxychlor	0.001	0.001	0.001	0.001
Toxaphene	0.04	0.04	0.04	0.04
2,4-0	-	0.002	0.002	0.002
2,4,5-TP (Silvex)	0.007	0.007	0.007	0.007
PPG	0.2	0.2	0.2	0.2
	100	100	100	100
Endrin	0.001	0.001	0.001	0.001
Lindane	0.004	0.004	0.004	0.004
Methoxychlor	0.011	0.011	0.011	0.011
Toxaphene	0.24	0.24	0.24	0.24
2,4-0	0.002	0.002	0.002	0.002
2,4,5-TP (Silvex)	0.002	0.002	0.002	0.002
PPG	0.085	0.085	0.085	0.085

COMMENT: Date extracted: 9/03/85, 9/24/85

Date analyzed: 3/23/95 - 10/16/95

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17TH DAY OF OCTOBER 1995
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Judy Cull
2/21/97, 2010, Legal Channel

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TO: JASON M. CORTELL & ASSOC. DATE 9/26/85 MATERIAL: WATER
244 2ND AVENUE JOB NO. 69844-1 BOOK NO. 163-28 AP
WALTHAM, MA 02154 LAB NO. 3263 SPECIFICATIONS:
ATTN: ORDER NO. 0592
SAMPLE ID: 19 WATER SAMPLES DATE REC'D: 9/18/85

	1S	1M	1B	2S	2M
pH	8.2	8.2	8.2	8.2	8.2
Total Suspended Solids (mg/l)	29	19	37	26	38
Biochemical Oxygen Demand (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
	28	56	5M	58	66
pH	8.2	8.2	8.2	8.2	8.2
Total Suspended Solids (mg/l)	64	25	22	23	19
Biochemical Oxygen Demand (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
	6M	68	76	7M	78
pH	8.2	8.2	8.2	8.2	8.2
Total Suspended Solids (mg/l)	39	24	10	15	24
Biochemical Oxygen Demand (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
	13S	13M	13B	Finish	
pH	8.2	8.2	8.2	7.1	
Total Suspended Solids (mg/l)	28	24	34	37	
Biochemical Oxygen Demand (mg/l)	<1.0	<1.0	<1.0	50	
Total Dissolved Solids (mg/l)	-	-	-	261	



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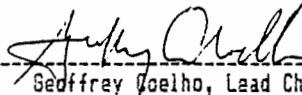


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PAGE 2
JASON CORTELL
JOB #69844-1

	13S	13M	13B	Finish
Amonia (mg/l)	-	-	-	8.5
Nitrate (mg/l)	-	-	-	1.4
Phosphate, Total (mg/l)	-	-	-	3.7
Sulfate (mg/l)	-	-	-	42

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Geoffrey Correll, Lead Chemist

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CONAM INSPECTION *author of Dulcor*
California, Texas, Illinois, Pennsylvania, Minnesota, Ohio

TO: JASON CORTELL & ASSOC **DATE 10/18/85** **MATERIAL: WATER**

244 2ND AVENUE **JOB NO. 70377-1** **BOOK NO. 169 RPA**

WALTHAM MA 02154 **LAB NO. 3332** **SPECIFICATIONS:**

ATTN: **ORDER NO. ~~HERE~~ 0596^{CYR}**

SAMPLE ID: 20 Water samples **DATE REC'D: 10/2/85**

	I-B	I-M	I-T	2-a	2-M
PH	8.3	8.3	8.3	8.3	8.3
Biochemical Oxygen Demand(mg/l)	<1	<1	<1	<1	<1
Total Suspended Solids(mg/l)	43	33	42	63	30
Specific Conductance(umhos/cm)	26,800	52,800	52,800	52,800	52,800
	2-T	5-B	5-M	5-T	6-B
PH	8.3	8.3	8.3	8.3	8.3
Biochemical Oxygen Demand(mg/l)	<1	<1	<1	<1	<1
Total Suspended Solids(mg/l)	31	39	52	31	33
Specific Conductance(umhos/cm)	52,800	52,800	52,800	44,400	52,800
	6-M	6-T	7-B	7-M	7-T
PH	8.3	8.3	8.3	8.3	8.3
Biochemical Oxygen Demand(mg/l)	1.0	<1	<1	1.0	1.0
Total Suspended Solids(mg/l)	28	23	32	28	27
Specific Conductance(umhos/cm)	52,800	26,800	9240	52,800	44,400
	13-B	13-M	13-T	SEAWATER	
PH	8.3	8.3	8.3	8.3	
Biochemical Oxygen Demand(mg/l)	<1	<1	<1	<1	
Total Suspended Solids(mg/l)	39	28	30	50	
Specific Conductance(umhos/cm)	44,400	52,800	52,800	52,800	

Page 1. of 2.

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**East Natick Industrial Park
6 Huron Drive • Natick, MA 01760
(617) 235-7330, 653-5950
Telex 948459 GREENELAB NTIK**

**Nondestructive • Chemical • Pollution • Metallurgical
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Branch Laboratories:
**Springfield, Mass. 01109 Auburn, Mass. 01501
(413) 734-6548 (617) 832-5500**

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TO: JASON CORTELL & ASSOC. DATE 10/18/85 MATERIAL: WATER
244 2ND AVENUE JOB NO. 70913-1 BOOK NO. 175 ap
WALTHAM MA 02154 LAB NO. 3386 SPECIFICATIONS:
ATTN: ORDER NO. ~~None~~ 0596

FINISH	
pH	6.8
Biochemical Oxygen Demand(mg/l)	7.5
Total Suspended Solids(mg/l)	7.6
Total Dissolved Solids(mg/l)	301
Amonia(mg/l)	0.12
Nitrate(mg/l)	12
Phosphate, Total(mg/l)	2.9
Sulfate(mg/l)	37

IN WITNESS WHEREOF, I HAVE HEREUNTO SET MY HAND THIS
18TH DAY OF OCTOBER 1985
ARNOLD GREENE TESTING LABORATORIES
DIVISION OF CONAM INSPECTION

UNLESS STIPULATED IN WRITING, SAMPLES WILL BE RETAINED FOR 30 DAYS AND THEN DISPOSED OF.
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California, Texas, Illinois, Pennsylvania, Minnesota, Ohio

TO: JASON M CORTELL & ASSOC DATE 10/23/85 MATERIAL: WATER

244 2ND AVENUE JOB NO. 70778-1 BOOK NO. 163 AP

WALTHAM MA 02154 LAB NO. 3374 SPECIFICATIONS:

ATTN: ORDER NO. ~~NAME~~ O 597

SAMPLE ID: 18 water samples DATE REC'D: 10/8/85

	1S	1M	1B	2S	2M
pH	8.1	8.2	8.2	8.2	8.2
Total Suspended Solids(mg/l)	39	50	28	18	39
Biochemical Oxygen Demand(mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
Specific Conductance(umhos/cm)	62,000	58,500	58,500	56,600	58,500
	2B	5S	5M	5B	6S
pH	8.2	8.2	8.2	8.2	8.2
Total Suspended Solids(mg/l)	29	60	47	20	26
Biochemical Oxygen Demand(mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
Specific Conductance(umhos/cm)	60,000	60,000	58,500	62,000	62,000
	6M	6B	7S	7M	7B
pH	8.2	8.2	8.2	8.2	8.2
Total Suspended Solids(mg/l)	51	24	54	24	30
Biochemical Oxygen Demand(mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0
Specific Conductance(umhos/cm)	56,600	58,500	60,000	58,500	58,500

UNLESS STIPULATED IN WRITING BY YOU, ALL SAMPLES WILL BE RETAINED FOR 30 DAYS AND THEN DISPOSED OF.
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Page 2.
Jason M Cortell
Job # 70778-1

	13S	13M	13B
pH	8.2	8.2	8.2
Total Suspended Solids(mg/l)	29	34	70
Biochemical Oxygen Demand(mg/l)	<1.0	<1.0	<1.0
Specific Conductance(umhos/cm)	62,000	58,500	62,000

IN WITNESS WHEREOF, I HAVE HEREUNTO SET MY HAND THIS
23RD DAY OF OCTOBER 1985
ARNOLD GREENE TESTING LABORATORIES
DIVISION OF CONAM INSPECTION

Anthony Daskalakis
Geoffrey Coelho, Lead Chemist

8801 1 88

