Shellfish Sanitation Program Technical Report

nets

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Public Health Service

SANITARY SURVEY OF SHELLFISH WATERS
BUTTERMILK BAY, MASSACHUSETTS
JULY 1985

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
CENTER FOR FOOD SAFETY AND APPLIED NUTRITION
SHELLFISH SANITATION BRANCH

DRAFT

SANITARY SURVEY OF SHELLFISH WATERS
BUTTERMILK BAY, MASSACHUSETTS
JULY 1985

submitted to
Region I Shellfish Specialists

by

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DRAFT

EXECUTIVE SUMMARY

A survey was conducted during the period July 8-19, 1985 of Buttermilk Bay, Massachusetts to determine the degree of pollution in the bay during the summer, differentiate the sources of pollution and determine whether management practices could be established to permit harvesting of safe shellfish. A combination of water sampling for microbiological analysis, shoreline reconnaissance and drogue studies was used. The period had typical summer rains which resulted in bay waters being degraded so as not to meet the "approved" growing area criteria of the National Shellfish Sanitation Program.

Rainfall of 0.5 inch or more in 24 hours was found to pollute tributary streams and bay waters with unacceptable levels of fecal waste. Differential tests beyond those established for regulation of shellfish waters were used to show that the predominant sources of bacterial pollution in the bay are feces of humans and other warm-blooded animals. Drogue studies and water sampling showed that pollution can be rapidly distributed by tidal action throughout the bay. It is also removed relatively quickly once input ceases so that water quality meets recommended bacterial levels after about a day. For such areas, which are intermittently polluted, a "conditionally approved" classification must be developed or else shellstock made safe for consumption by relaying or depuration. If control agency resources are insufficient to provide for these practices, the area cannot meet the criteria for direct marketing of its shellfish and correctly remains in the "prohibited" or "restricted" classification.

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Buttermilk Bay, Massachusetts - July 1985

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INTRODUCTION

During the period of July 8 through 19, 1985 a sanitary survey of Buttermilk Bay and its immediate watershed was conducted. The chief of the Massachusetts Southeast Region Department of Environmental Quality Engineering (DEQE) Shellfish Section and the FDA Region I Shellfish Specialists requested Northeast Technical Services Unit (NTSU) to participate in the study to help obtain more specialized information on the sanitary quality of the bay for the harvesting of clams (*Mya arenaria* and *Mercenaria mercenaria*) than was available using state resources alone. The purposes of the study were:

1. To obtain indicator bacteria data on bay water from which to determine proper classification of the area

2. To employ relationships between different bacterial indicators to determine the probable sources and hazards of bacterial levels found

3. To define the relationship between rainfall and runoff into the bay from which performance criteria for managing the shellfishery can be established

4. To identify specific pollution problems impacting the clam resources so control efforts can be directed to their correction

Previous study work by DEQE personnel had shown sporadic high bacterial levels in the bay which resulted in closure of the westernmost shoreline (Wareham) of Buttermilk Bay and the northeastern portion of Little Buttermilk Bay. Pollution sources suspected of causing high bacterial counts in the bay were the more densely populated areas along the western and northern shores.

Habitation around the entire bay is served by subsurface waste disposal systems. There is also runoff from a few farms where domestic animals or fowl are kept as well as drainage from actively cultivated cranberry bogs. In addition, there is a large bird population inhabiting the area during some parts of the year.

The survey was conducted by NTSU with the full participation of Massachusetts and FDA Region I personnel. Samples were analyzed by NTSU and Massachusetts microbiologists at the Lakeville DEQE laboratory. Supporting bacterial indicator differentiation work was conducted during and following the survey at the NTSU laboratory.

This report was prepared for shellfish control officials familiar with the bay, its pollution sources, and classification problems. Therefore, it does not report a comprehensive study of the bay but covers only information developed during the specific survey period. It is intended to assist in formulating control practices necessary for ensuring safety of shellfish harvested from the bay.

MATERIALS AND METHODS

Sampling Stations The sampling stations for collection of stream and bay samples are shown in Figure 1 and described in Table 1. Bay stations were selected to correlate with previous DEQE sampling stations to facilitate comparison with previous data. Minor adjustments were made in their spacing to optimize coverage of the study area. Stream stations were selected to isolate potential pollution sources. New stations were added as suspected sources were found by the shoreline crew.

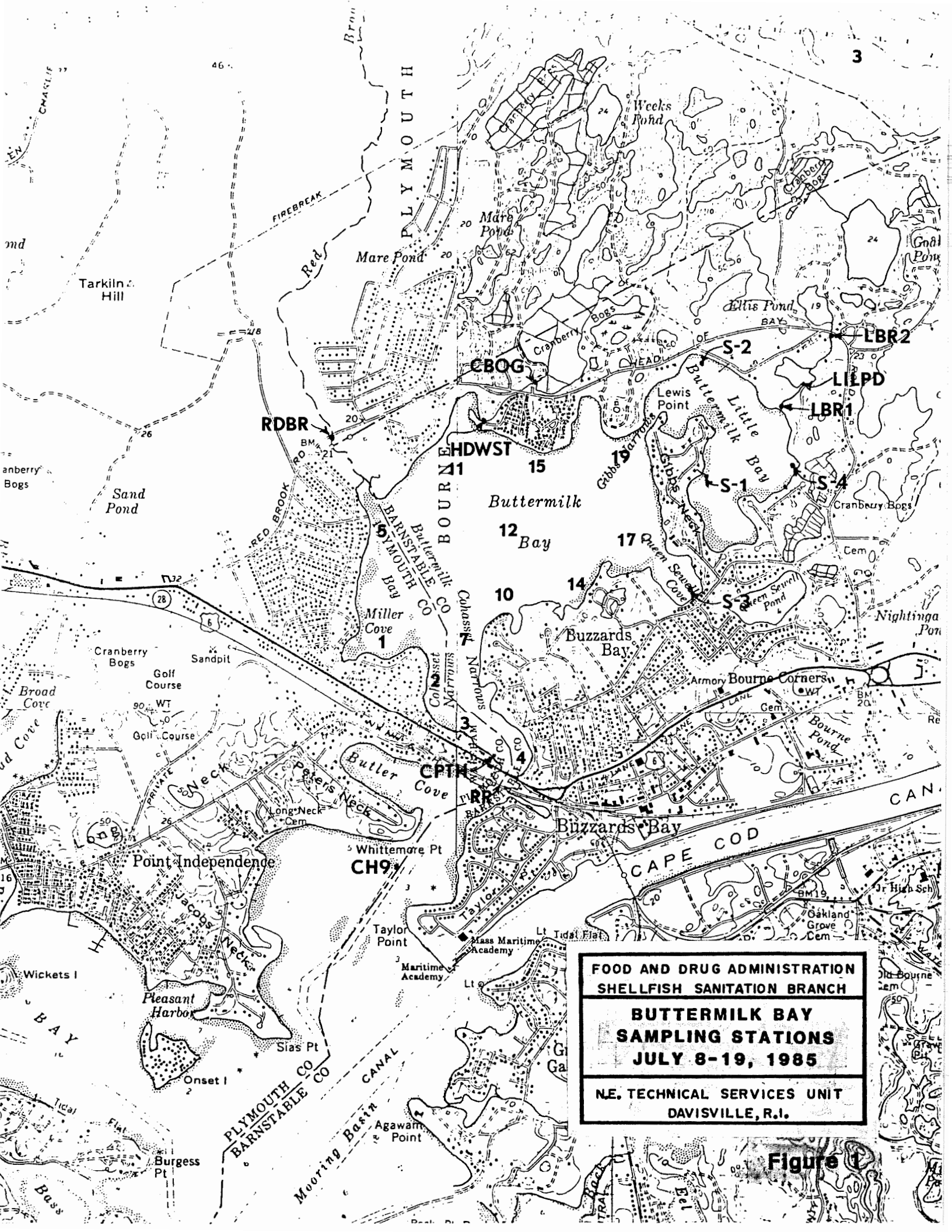

FOOD AND DRUG ADMINISTRATION
SHELLFISH SANITATION BRANCH
BUTTERMILK BAY
SAMPLING STATIONS
JULY 8-19, 1985
N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.
CBOG
RDBR
HDWST
LBR2
LBR1
LILPD
S-1
S-2
S-3
S-4
CPTH
RR1
CH91
Buttermilk Bay
Buzzards Bay
CAPE COD CANAL
Point Independence
Pleasant Harbor
Wickets I
Onset I
Sias Pt
Burgess Pt
Taylor Point
Agawam Point
Whittemore Pt
Lewis Point
Gibbs Neck
Queen Sewell Cove
Miller Cove
Colossett Narrows
Mare Pond
Sand Pond
Ellis Pond
Weeks Pond
Tarkiln Hill
Long Neck Cem
Bourne Corners
Cranberry Bogs
Golf Course
Sandpit
Mass Maritime Academy
Oakland Grove Cem
Jr High Sch
PLYMOUTH
BOURNE
BARNSTABLE CO
PLYMOUTH CO
Mooring Basin
FIREBREAK
RED BROOK RD

Figure 1

TABLE 1

BUTTERMILK BAY - STATION DESCRIPTIONS

STATION	DESCRIPTION	
B-01	BAY STATION	1 SEE MAP - FIGURE 1
B-02	" "	2 " " " "
B-03	" "	3 " " " "
B-04	" "	4 " " " "
B-04A	" "	MID STREAM BETW B-04 & B-04A
B-04B	" "	OPP B-04 NR CAPT HARRIS
B-05	" "	5 SEE MAP - FIGURE 1
B-05A	" "	OPPOSITE B-05 IN STREAM FLOW
B-05B	" "	CULVERT AT ROAD NR B-05
B-07	" "	7 SEE MAP - FIGURE 1
B-10	" "	10 " " " "
B-11	" "	11 " " " "
B-12	" "	12 " " " "
B-14	" "	14 " " " "
B-15	" "	15 " " " "
B-17	" "	17 " " " "
B-19	" "	19 " " " "
BS-CH9	" "	CH9 " " CHANNEL MARKER '9' SOUTH OF WHITTEMORE PT.
BS-RR	" "	AT RR BRIDGE - MOUTH OF BAY
BS-01	" "	S-1 SEE MAP - SAMPLED FROM SHORE
BS-02	" "	S-2 " " " " "
BS-03	" "	S-3 " " " " "
BS-04	" "	S-4 " " " " "
CBOG	CRANBERRY BOG	
CPTH	CAPTAIN HARRIS' DISCHARGE PIPE	
ELECAV	ELECTRIC AVENUE	
HDWYST	HIDEAWAY BEACH STREAM - THOMPSON RD	
LBR 1	MOUTH OF TRIBUTARY NR BS-04	
LBR 2	TRIB TO LITTLE BUTTERMILK	
LILPD	LILY POND	
MKPCIN	MAKE PEACE BOGS - INLET	
MKPCOT	" " " - OUTLET	
MRSH DR	MARSH DRAINAGE (next to BS-04)	
OHBC	OLD HEAD OF BAY CREEK - AT ROAD	
OHBCMO	" " " " " AT MOUTH (ENTERING BAY)	
RDBR	RED BROOK - AT HEAD OF BAY ROAD	
RDBRFL	" " AT FISH LADDER	
RDBRGP	" " AT GAS PIPELINE	
RDBR495	" " AT HWY 495	
WHTIP	WHITE ISLAND POND OUTLET	

Sampling Methods Bay water samples were collected by two or three person crews of FDA and DEQE personnel using a survey boat provided by DEQE. Another two or three person crew collected stream samples and conducted surveillance of the shoreline and watershed. Bay samples were collected primarily within an hour of low tide to capture the minimal dilution of pollution sources. On four of the ten sampling days an additional set of samples was taken near high tide for comparison purposes. Samples were collected in sterile Nalgene bottles and kept on ice until assayed, normally within six hours of collection. At the time of sampling, physical data were recorded as follows: For all bay stations, the surface and bottom water temperature and salinity were measured using a Beckman RS5-3 electrodeless induction salinometer (Beckman Instruments, Inc., Cedar Grove, NJ). Depth of water and prevailing weather conditions were also recorded on the sample bottle labels. For all stream samples, water temperature and salinity were measured using a thermometer and hydrometer set. Flow variations were noted as they occurred following rainfall.

Analysis Methods All bay and stream samples were assayed for total and fecal coliform content by the five tube Most Probable Number (MPN) procedure (APHA 1970). MPNs for Escherichia coli (E. coli) were obtained using the MUG method (Rippey et.al. 1987). A third of the samples were also assayed for fecal streptococci (FS) content by a method recommended by the Environmental Protection Agency for improved FS recovery (EPA 1978). The method employs primary isolation of FS by a five tube MPN series using Azide Dextrose Broth (DIFCO) as in the APHA method. Confirmation is on Bile Esculin Azide (BEA) Agar (DIFCO). Isolates exhibiting brownish-black colonies with brown halos on BEA are recorded as FS positive. In addition,

these positive colonies were subcultured on Brain Heart Infusion (BHI) Agar slants (DIFCO) for later biochemical differentiation.

RESULTS AND DISCUSSION

Rainfall Implications The nearest station recording weather information for the National Weather Services is is the Cranberry Experiment Station at East Wareham (Lat. 41° 46'N, Long. 70° 40' W) approximately two miles west of the bay. This station recorded rainfalls for 1983-85 as follows:

Inches/Day > or =	Total Number 1983-1985	Average per Season (May-September)
0.25	65	22
0.50	42	14
0.75	27	9
1.00	17	6
1.50	7	2
2.00	3	1

Therefore it can be expected that rain of 0.50 inch or greater in a 24 hour period falls about 14 times during the average summer season. Rains greater than 1.00 inch in 24 hours have just less than half the 0.50 inch frequency. Rain which affected bay water quality during the survey period July 8 through 19, 1985 fell on the 11th, 16th and 17th. Comparison with the sampling crew rain gauge established near the bay and the official record is shown in Table 2. These are typical of summer rainfall events in this area, which at times can be quite intense.

TABLE 2

BUTTERMILK BAY, JULY 1985
RAINFALL IN WATERSHED

DATE JULY	EAST WAREHAM	SURVEY GAUGE	- NOTES
1-10	0	-	rain comm. 2340h
11	0.34	0.41	ended by 0730 h
12	-	-	
13	-	-	
14	-	-	
15	T	-	
16	0.11	0.1	overnight
17	1.54	1.86	during day
18	-	0.03	overnight
19	-	-	
20	-	-	

Stream Samples The rainfalls of July 11th and 17th caused increases in flow of the tributaries sampled. These flows were not accompanied by large increases in bacterial levels as is frequently observed. Total coliform ranged from a low of 23 MPN/100 ml at the White Island Pond outlet to highs of 16,000 MPN/100 ml or greater at Hideaway Village Stream on the 9th, 10th, 15th and 16th. Fecal coliform ranged from a low of 2.0 MPN/100 ml at the Makepeace Cranberry Bog inlet to a high of 3500 MPN/100 ml at Hideaway Village Stream on the 16th. For the highest level bacterial sources there appeared to be little correlation with rainfall. This is demonstrated for the four key stream stations by separating the data into dry weather and wet weather days as shown in Tables 3 and 4.

TABLE 3

BUTTERMILK BAY - DRY WEATHER
MEDIAN BACTERIOLOGICAL RESULTS - STREAM STATIONS

STA	NO	MED_TC	MED_FC
CBOG	2	690	35
HDWYST	4	10700	915
OHBC	2	795	47
RDBR	3	220	31

TABLE 4

BUTTERMILK BAY - RAIN DATES
MEDIAN BACTERIOLOGICAL RESULTS - STREAM STATIONS

STA	NO	MED_TC	MED_FC
CBOG	2	900	110
HDWYST	5	9200	490
OHBC	3	1100	70
RDBR	4	790	395

Note that the Red Brook Station showed the biggest increase in FC medians for rain dates. The daily values for Red Brook (Appendix) show that there was a tripling of FC densities for the days of rainfall (July 11, 16, and 17). The other stream stations did not experience this more typical response. The stream inputs are summarized by the median and maximum values in Table 5.

TABLE 5

BUTTERMILK BAY - STREAM STATIONS
SUMMARY OF BACTERIOLOGICAL DATA
MEDIANS AND MAXIMUMS OF SELECTED STATIONS

STA	NO	MED_TC	MAX_TC	MED_FC	MAX_FC
CBOG	4	900	1100	48	170
HDWYST	9	9200	17000	490	3500
OHBC	5	1100	1100	70	490
RDBR	7	790	2200	110	490

Bay Samples The bacterial levels in the bay stations are summarized in Table 6 which gives overall median and maximum values found during the survey period and percentages of samples greater than TC 230 MPN/100 ml and FC 43 MPN/100 ml. These values were separated into dry and rain date results for Tables 7 and 8. The NSSP "approved" growing area criteria for TC requires that the median value not exceed 70 MPN/100 ml with no more than 10 percent of the samples exceeding 230 MPN/100 ml for the five tube test. As an alternative many states have adopted the NSSP recommended FC criteria of a median value not exceeding 14 MPN/100 ml with no more than 10 percent of the samples exceeding 43 MPN/100 ml for the five tube test. Many investigators have shown that FC give a truer indication of the presence of fecal material especially where land runoff is present and may be carrying TC from soil or other sources of lesser sanitary significance. Either of these approved criteria must also be met for the open periods of a "conditionally approved" area.

Table 6 shows that for the aggregate of all samples eight of the 17 principal stations (considering 5 and 5A together) failed to meet one or more of the NSSP recommended criteria for "approved" areas. Daily values for selected stations were plotted on logarithmic-probability paper to determine their normality of distribution for statistical interpretation as described by Velz (Velz, 1951). If such data forms a straight line it can be compared to the slope of the standard distribution line for a large number of samples taken from water whose quality is not changing (Velz line). This slope is dependent on the number of tubes inoculated per dilution in arriving at the MPN values; in this case five. For data from water of changing quality, the estimate of the true mean bacterial density is taken as the 50 percentile value from the

TABLE 6

BUTTERMILK BAY - BAY STATIONS

SUMMARY OF BACTERIOLOGICAL DATA

MEDIANS AND MAXIMUMS AND PERCENTAGES

GREATER THAN UPPER LIMITS

STA	NO	MED TC	MAX TC	%>230	MED_FC	MAX_FC	%>43
B-01	12	11	230	0	4	79	8
B-02	12	11	330	8	4	79	8
B-03	12	13	230	0	8	49	8
B-04	13	46	490	8	17	490	23
B-04A	2	90	130		33	49	
B-04B	2	280	490		102	170	
B-05	7	27	230	0	2	13	0
B-05A	8	1950	16000	100	330	1200	100
B-05B	2	506000	920000		147000	240000	
B-07	12	12	490	8	2	70	8
B-10	12	12	330	8	3	79	17
B-11	12	6	16000	17	2	330	17
B-12	12	5	49	0	2	17	0
B-14	12	15	79	0	5	33	0
B-15	13	2	700	15	2	130	15
B-17	12	3	490	8	2	130	8
B-19	12	7	180	0	2	13	0
BS-CH9	1	2	2		2	2	
BS-RR	2	9	13		9	13	
BS-01	12	12	170	0	7	70	8
BS-02	12	75	1700	42	14	70	25
BS-03	13	12	5400	31	8	3500	38
BS-04	13	79	5400	38	33	330	38

TABLE 7

BUTTERMILK BAY - DRY WEATHER

MEDIAN BACTERIOLOGICAL RESULTS - BAY STATIONS

STA	NO	MED_TC	MED_FC
B-01	8	9	2
B-02	8	5	3
B-03	8	12	6
B-04	8	28	12
B-04B	1	70	33
B-05	5	22	2
B-05A	3	790	330
B-07	8	5	2
B-10	8	6	3
B-11	8	3	2
B-12	8	1	1
B-14	8	9	5
B-15	8	2	1
B-17	8	2	2
B-19	8	6	2
BS-CH9	1	2	2
BS-RR	1	13	13
BS-01	8	9	5
BS-02	8	36	11
BS-03	7	7	5
BS-04	7	49	8

TABLE 8

BUTTERMILK BAY - RAIN DATES

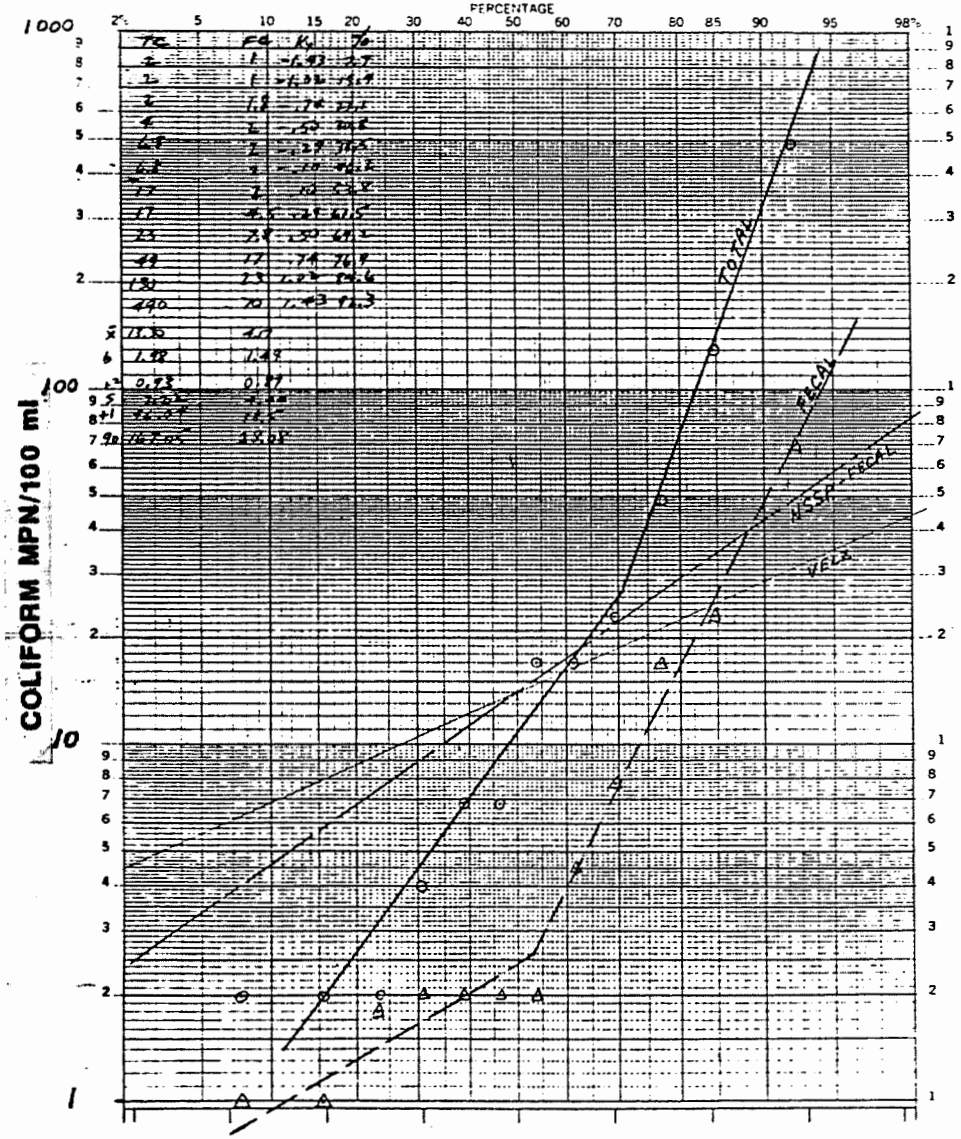
MEDIAN BACTERIOLOGICAL RESULTS - BAY STATIONS

STA	NO	MED_TC	MED_FC
B-01	4	102	26
B-02	4	150	17
B-03	4	64	12
B-04	5	110	23
B-04A	2	90	33
B-04B	1	490	170
B-05	2	129	8
B-05A	5	2200	350
B-05B	2	506000	147000
B-07	4	77	14
B-10	4	77	3
B-11	4	590	51
B-12	4	18	5
B-14	4	32	9
B-15	5	220	17
B-17	4	25	9
B-19	4	20	7
BS-RR	1	5	5
BS-01	4	13	9
BS-02	4	290	20
BS-03	6	490	90
BS-04	6	410	95

plot. The amount the slope is greater than the standard distribution slope indicates the degree of real changes in water quality during the sampling period. When the data does not form a straight line, it is not uniformly distributed and the cause should be determined. Usually a break in the line is caused by samples being taken under differing pollution conditions such as a mixture of dry and wet weather or high and low tide dilution effects. Data should be separated in these instances and analyzed separately.

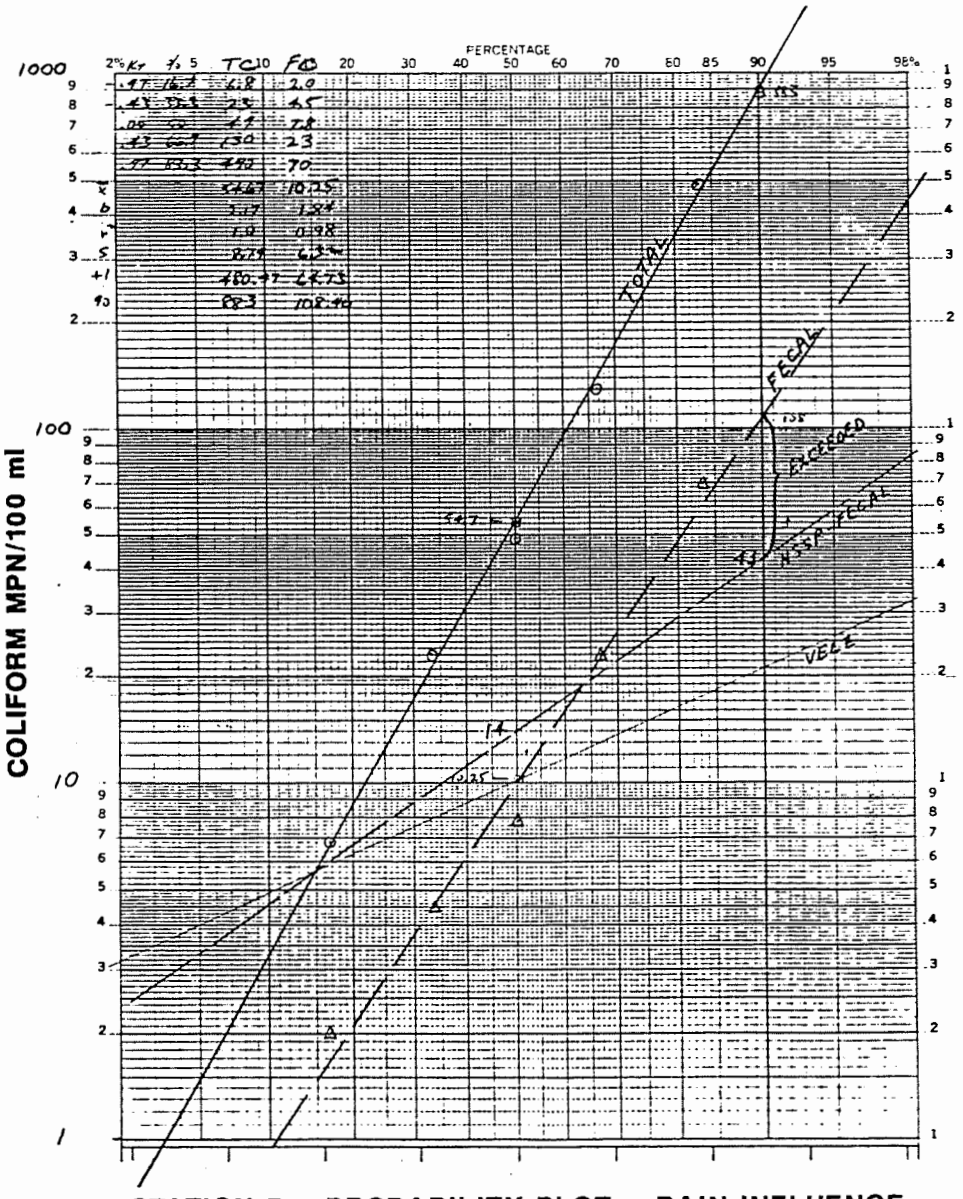
Examples for this survey are shown in Figures 2 through 5. In Figure 2 for Station B-07 the breaks in the plots for both total and fecal coliform are evident as well as the extreme variability in comparison to the Velz slope and NSSP recommended upper limit on variability. Of interest is that graphically this station is seen to exceed the 90th percentile upper limit of 43 FC whereas by sample count it does not (less than 10% of samples exceed 43). In Figure 3 improved agreement of the data with a straight line for the rain days is evident. The remaining steepness of slope, however, is indicative of other sources of variability which can be related to a mixture of high and low tide samples plus influences from different amounts of rainfall and undetected pollution sources activated on the dates plotted. From this analysis it can be concluded that Station B-07 does not meet the NSSP recommended limits under adverse hydrographic conditions, in this case rainfall. Conversely, a similar analysis of the data for dry weather days would show that water quality is acceptable then.

Figures 4 and 5 show a similar result for Station B-17. Note that this station also fails to meet the recommended limits on variability for periods



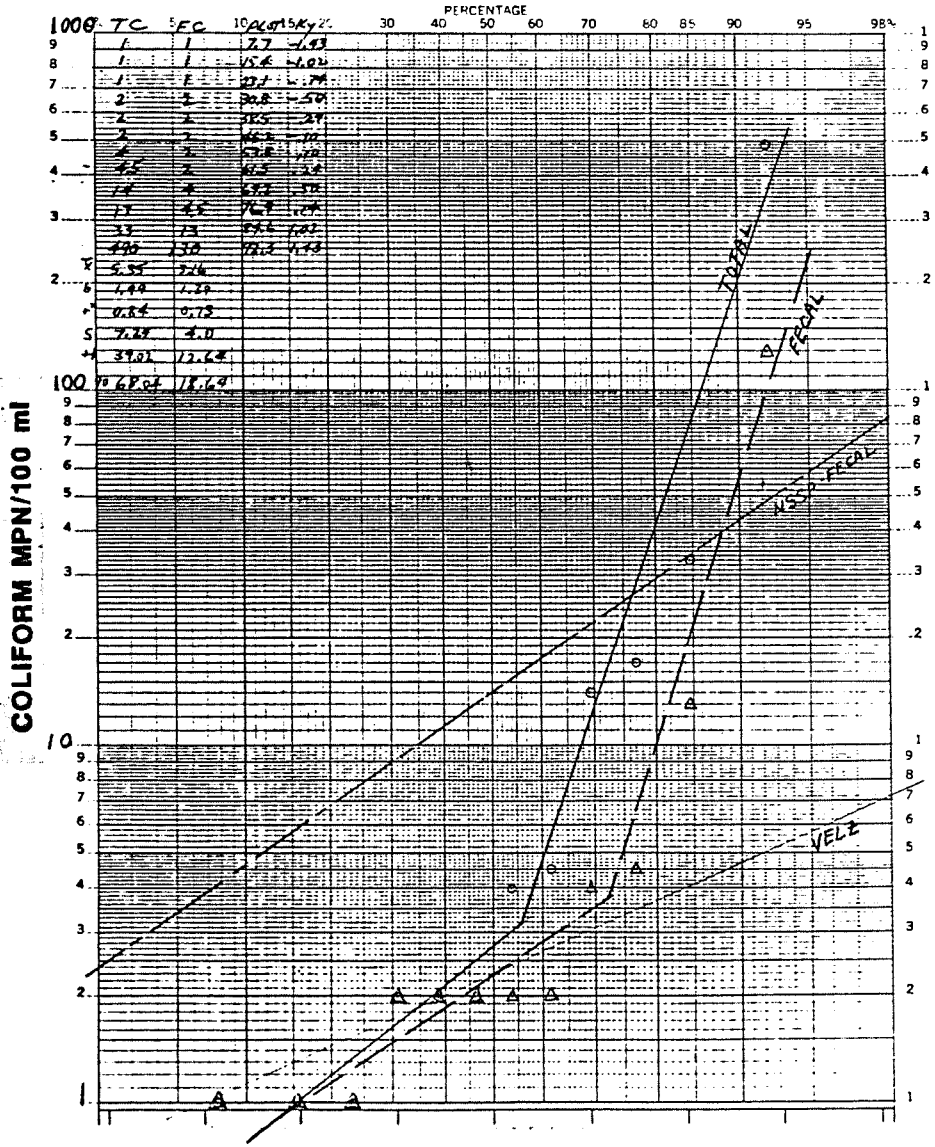
STATION 7 – PROBABILITY PLOT – ALL DATA

Figure 2



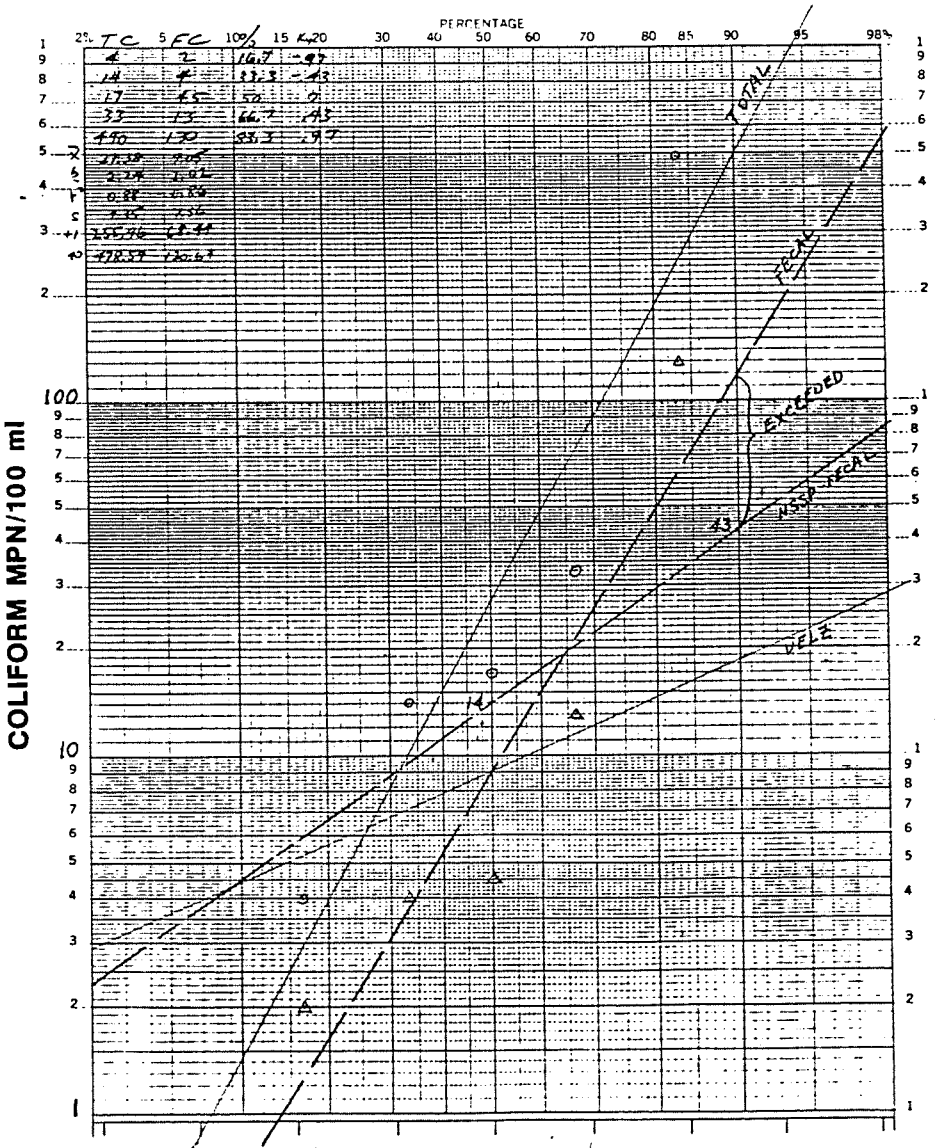
STATION 7 – PROBABILITY PLOT – RAIN INFLUENCE

Figure 3



STATION 17 - PROBABILITY PLOT - ALL DATA

Figure 4



STATION 17 - PROBABILITY PLOT - RAIN INFLUENCE

Figure 5

of rain influence. Likewise, analysis of bay stations B-01, B-02, B-03 and BS-01 show that they would exceed the variability limit for the rain days. The three remaining bay stations, B-12, B-14, and B-19, were the only stations meeting the NSSP recommended limits for all conditions during the survey.

Bacterial Indicator Interpretation The rapid method used in this survey for obtaining E. coli densities has been shown to give results equivalent to the IMViC method (APHA, 1985). Since the method involves a reaction in the confirmatory media tubes used to obtain the final FC density values, a direct comparison can be made between the FC densities and the E. coli densities. A review of the individual values for FC and E. coli (code: ECMUG) in the Appendix shows that over 99 percent of the FC found in the survey were E. coli. This supports the conclusion that the source of coliform to the bay is predominantly warm-blooded animal feces.

Since the E. coli determination alone fails to separate human versus other warm-blooded animal sources, the positive FS isolates were subjected to biochemical differentiation by a recommended method (EPA 1978) to help determine their public health significance. Thus, if S. bovis and/or S. equinus predominate, the source is recent animal, whereas, if typical S. faecalis is found, the source is most likely to be human feces. For the survey as a whole 60 samples were differentiated for FS. Of these, 54 samples, or 90 percent, contained FS species typical of warm-blooded animals and 22 samples or 37% contained FS species of typical S. faecalis indicative of human fecal origin. In addition, these human-associated isolates were from widely distributed samples and were associated with sources having the highest indicator counts, particularly following rainfall. It should also be noted

that only one isolate in over 500 diferentiated was indicative of a recent non-human, warm-blooded animal source (S. bovis). These findings support the conclusion that while there may be other non-human, warm-blooded animal pollution causing elevated indicator levels (FC and FS) in the bay there is clearly a significant portion (37 percent) derived from human sources. A complete description of this analysis is contained in a separate report (Chandler, 1987).

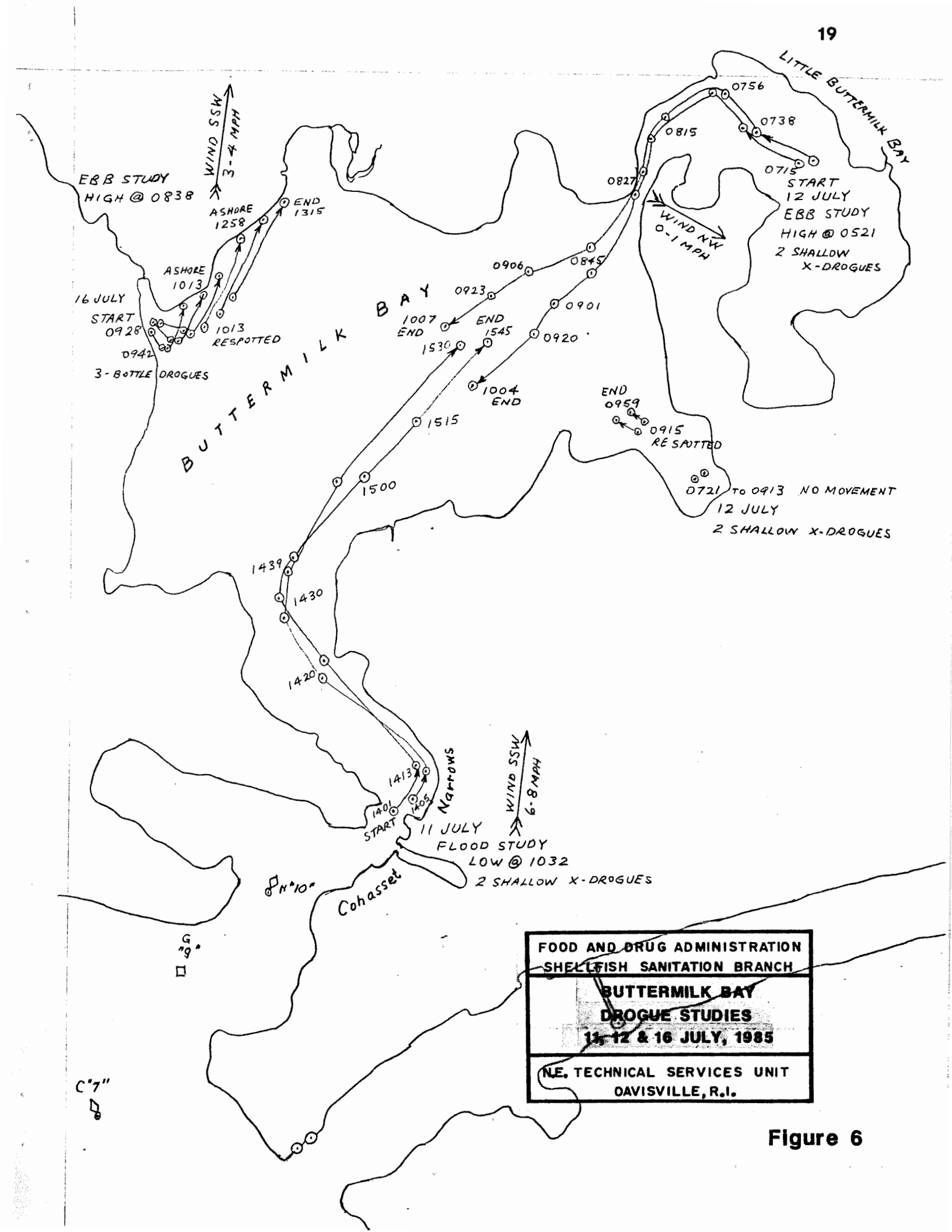
Physical Data and Hydrographic Factors The physical data taken during the survey period is presented for each station in the Appendix. The average surface and bottom salinities and temperatures for the bay stations are shown in Table 9.

TABLE 9
BUTTERMILK BAY - BAY STATIONS
SUMMARY OF PHYSICAL DATA
AVERAGES

STA	NO	TTEMP	BTEMP	TSAL	BSAL
B-01	12	22.3	21.7	32.5	32.9
B-02	12	22.3	22.0	32.5	32.6
B-03	12	22.1	22.0	32.5	32.6
B-04	13	21.8	21.8	32.6	32.6
B-04A	2	20.3	19.9	32.8	33.4
B-04B	2	21.6	21.1	32.2	32.8
B-05	5	23.3	23.1	31.9	32.2
B-05A	8	22.3	22.3	12.7	27.7
B-05B	2	23.3	.	25.9	.
B-07	12	22.5	22.3	32.2	32.3
B-10	12	22.9	22.4	31.9	32.2
B-11	12	23.6	23.2	31.5	32.5
B-12	12	23.2	22.7	32.0	32.6
B-14	12	23.0	22.7	31.8	32.0
B-15	14	23.6	23.4	31.3	32.2
B-17	12	23.7	22.9	31.3	32.4
B-19	12	24.1	23.7	30.4	31.3
BS-CH9	1	21.3	20.9	33.7	33.8
BS-RR	2	21.3	21.2	33.6	32.0
BS-01	12	25.6	.	27.8	.
BS-02	12	24.6	.	25.5	.
BS-03	13	25.2	.	27.9	.
BS-04	13	25.0	.	23.6	.

Temperatures ranged from lows of just over 19°C near the mouth of the bay to highs of 27.5°C in the shallow inner end of Little Buttermilk Bay on the warmest day. Salinities ranged from lows just over 20°/₀₀ in Little Buttermilk Bay where there is reduced flushing of fresh water inputs to highs near 34°/₀₀ just inside the mouth. Lower individual values such as at station B-05A and BS-04 were related to reduced mixing at these locations of higher stream input following rainfall.

Hydrographic studies employing drogues were done on July 11, 12, 15, 16 and 17 to determine the direction and approximate velocity of currents in various parts of the bay and how they affect distribution of pollution sources. In deeper areas cruciform drogues consisting of one foot square sheet aluminum panels and half gallon plastic milk bottles were used. For shallow areas one quart plastic milk bottles alone were used. These were ballasted with sand to leave just the cap above the surface. The drogue tracks with days and times performed are shown in Figures 6 and 7. The flood tide studies of July 11 and 15, show that dilution water from Cohassett Narrows readily flows well into the center of the bay in about one and a half hours. Similarly, the ebb tide study of July 12 showed that flow from Little Buttermilk Bay out to the bay center occurs rapidly (less than three hours). This rapid exchange accounts for the ability of the bay to flush pollutants relatively quickly after a rainfall event. Conversely, the studies of Queen Sewell Cove on July 12 and the cove west of Hideaway Village on July 15 showed that these areas flush very slowly. This serves to explain the elevated bacterial levels for samples in or near these locations. The studies on July 16 of Red Brook and the cove west of Hideaway Village showed that even on ebb tide a southwest wind can hold water from Red Brook and Hideaway Stream against the northern

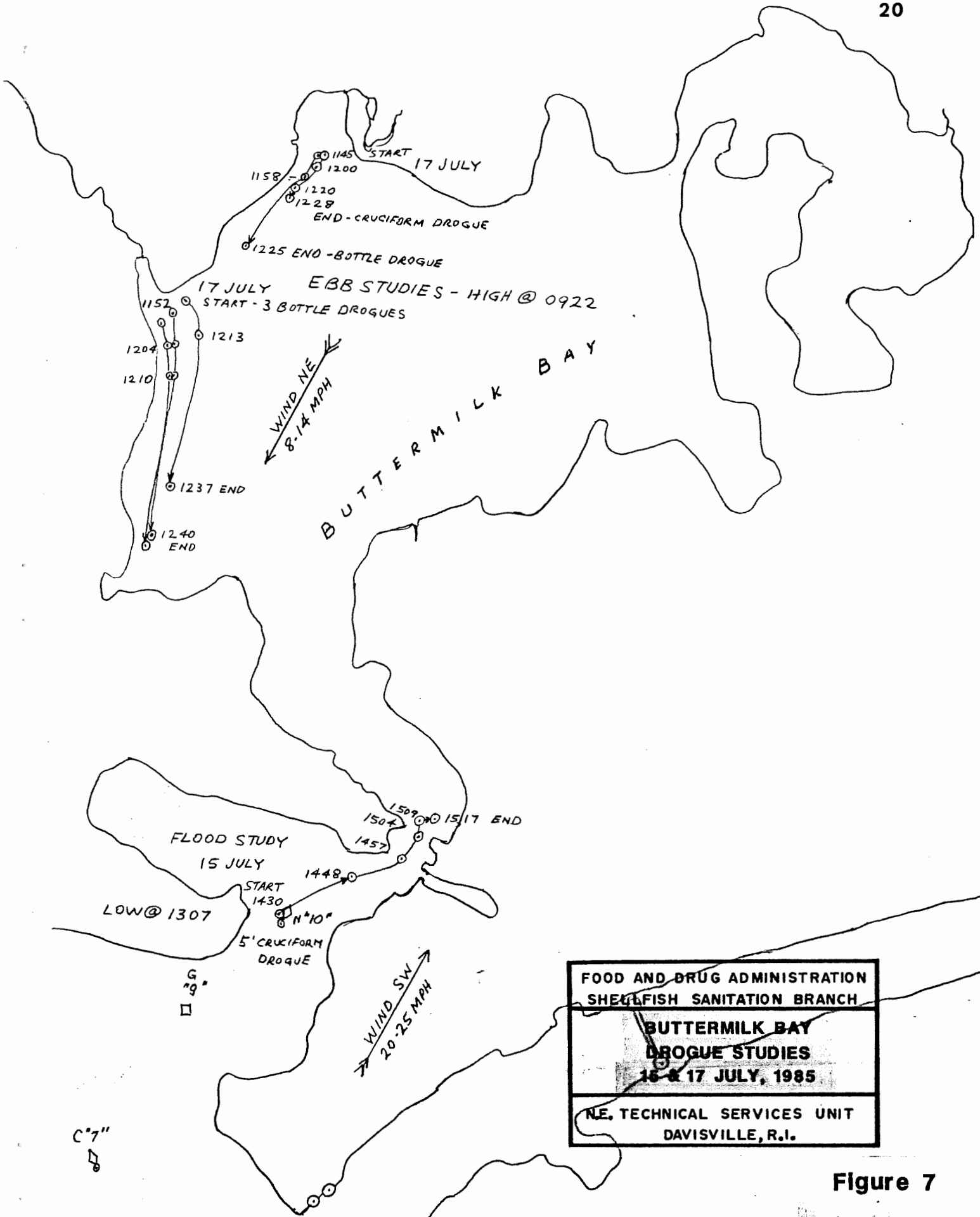


FOOD AND DRUG ADMINISTRATION
SHELLFISH SANITATION BRANCH

BUTTERMILK BAY
DROGUE STUDIES
11, 12 & 16 JULY, 1985

N.E. TECHNICAL SERVICES UNIT
OAVISVILLE, R.I.

Figure 6



FOOD AND DRUG ADMINISTRATION
SHELLFISH SANITATION BRANCH

BUTTERMILK BAY
DROGUE STUDIES
15 & 17 JULY, 1985

N.E. TECHNICAL SERVICES UNIT
DAVISVILLE, R.I.

Figure 7

shoreline and prevent it from mixing with central bay water. Conversely, the ebb tide study of July 17 showed that polluted water from both these sources can hug the western shore and flow southerly into the shallows of Miller Cove during northeast wind conditions. This finding explains the higher bacterial levels being more persistent along the western shoreline of the bay.

CONCLUSIONS

1. Only the east central segment of Buttermilk Bay met the "approved" growing area criteria of the NSSP during this survey.

2. Rainfall records for the immediate area show that rainfall similar to the survey period is not unusual. Rainfall greater than approximately one half inch results in the runoff and activation of pollution sources which contaminate the bay to unacceptable levels for shellfish harvesting.

3. The portions of Buttermilk Bay most seriously affected by pollution resulting from rainfall are: Little Buttermilk Bay; the north shore of Buttermilk Bay; and the southwestern segment of Buttermilk Bay from Red Brook to the mouth of the bay.

4. Fecal coliforms found in bay waters, streams and other sources of pollution entering the bay were nearly 100 percent Escherichia coli and are therefore of high sanitary significance.

5. Fecal streptococci differentiation showed that 90 percent of the FS organisms were typical of warm-blooded animals not specifically human and

37 percent were of the most typical human specie. A large proportion of the bacterial pollution in the bay is, therefore, most probably from human sources and is of high sanitary significance.

6. Hydrographic studies showed that pollution sources entering the bay may be rapidly distributed by tidal action to shellfishing areas of the bay within a short time (less than one half tide cycle). Conversely, tide action also brings clean dilution water to mix and flush away pollution rapidly once a pollution event ceases. This occurs in all areas except the eastern part of Little Buttermilk Bay and Queen Sewell Cove.

7. The hazard level from human and animal waste inputs to the bay and their rapid distribution following periods of input indicate that strict adherence to shellfish harvesting standards and controls must be maintained.

8. Judging from improvement in water quality following the rainfalls of July 11th and 16-17th, the period for water quality to return to acceptable levels following a significant rainfall is approximately one day. Time for pollution clearance and shellfish purification is needed.

9. A "conditionally approved" management program for harvesting the shellfish resources in the bay when conditions meet the NSSP criteria could be developed. This would involve significant additional workload for establishing the necessary performance criteria and monitoring the area during periods open to harvest.

10. Shellfish resources of Buttermilk Bay could also be utilized by subjecting all shellstock to relaying or controlled purification (depuration) prior to marketing.

11. In the absence of the preceeding practice (9. or 10.), results of this survey plus those available from monitoring samples taken by Massachusetts personnel support the necessity for Buttermilk Bay to be placed in the "prohibited" of "restricted" classification in compliance with NSSP requirements.

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APPENDIX

BUTTERMILK BAY

BAY STATIONS - RAW DATA

STA=B-01

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
		4	4	4	4	3	8	8	8	6
708	850	20.0	20.0	33.0	33.0	4	11.0	2.0	2.0	1
708	1337	22.6	20.0	32.9	33.6	7	7.8	2.0	1.0	.
709	847	20.8	20.6	33.0	33.0	4	4.5	2.0	2.0	.
709	1335	22.7	21.7	33.2	33.5	6	17.0	11.0	11.0	.
710	911	22.5	21.6	32.7	33.5	5	11.0	2.0	2.0	.
711	954	23.4	22.9	32.9	33.3	4	23.0	13.0	13.0	2
712	1100	24.5	23.4	31.6	33.2	5	2.0	.	.	.
715	1152	21.9	21.6	33.2	33.2	4	11.0	7.8	4.5	.
716	1348	21.2	21.2	32.0	33.1	3	230.0	79.0	79.0	.
717	1429	22.5	22.1	30.3	30.5	3	180.0	38.0	38.0	.
718	1415	22.5	22.5	31.9	31.9	4	33.0	4.0	4.0	.
719	1528	23.5	23.0	33.4	33.1	3	2.0	1.0	1.0	.

STA=B-02

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	840	21.4	20.9	32.6	32.8	10	23.0	4.5	2.0	1
708	1332	19.8	19.4	33.8	33.6	13	4.0	4.0	4.0	.
709	836	21.2	20.8	32.8	32.9	10	1.8	1.0	1.0	.
709	1328	20.3	20.1	33.6	33.6	12	1.8	1.8	1.8	.
710	903	22.7	22.4	32.8	32.9	10	11.0	11.0	11.0	.
711	950	23.5	23.0	32.4	32.7	10	130.0	6.8	6.8	1
712	1055	24.4	23.2	32.0	32.2	10	11.0	4.0	4.0	.
715	1146	23.1	23.0	32.7	32.6	11	23.0	4.5	4.5	.
716	1343	23.1	22.9	31.8	32.0	9	330.0	23.0	23.0	.
717	1427	22.7	22.7	30.2	30.0	10	170.0	79.0	79.0	.
718	1410	22.1	22.3	31.9	32.2	10	4.5	1.0	1.0	.
719	1523	23.0	22.9	33.1	33.2	10	4.5	2.0	2.0	.

STA=B-03

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	834	21.2	21.1	32.7	33.0	9	13.0	7.8	4.5	4.5
708	1326	19.6	19.6	33.8	33.7	12	11.0	7.8	7.8	.
709	830	21.1	20.9	32.7	32.9	9	4.5	1.0	1.0	.
709	1323	20.8	20.6	33.5	33.8	10	23.0	7.8	2.0	.
710	859	22.4	22.2	33.0	33.2	10	9.3	4.0	4.0	.
711	946	23.1	23.1	32.7	32.8	8	79.0	13.0	7.8	6.8
712	1053	24.0	23.7	31.9	32.0	10	4.5	4.5	4.5	.
715	1141	22.7	22.8	32.7	32.8	10	33.0	13.0	17.0	.
716	1338	22.8	22.9	32.0	32.1	8	49.0	11.0	11.0	.
717	1421	22.5	22.5	30.1	30.1	10	230.0	49.0	49.0	.
718	1406	22.2	22.2	31.9	32.0	9	13.0	4.5	2.0	.
719	1519	23.3	23.0	32.7	32.9	8	4.0	4.0	4.0	.

BUTTERMILK BAY

BAY STATIONS - RAW DATA

STA=B-04

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	823	21.0	21.1	32.7	32.8	8	46.0	17.0	7.8	2.0
708	1322	20.0	19.5	33.6	33.6	10	490.0	490.0	170.0	.
709	824	21.0	21.1	32.8	32.8	8	4.5	4.5	2.0	.
709	1312	20.9	20.6	33.6	33.6	9	33.0	33.0	33.0	.
710	853	22.1	22.2	33.2	33.2	8	110.0	23.0	21.0	.
711	940	23.2	23.2	32.8	32.8	8	49.0	13.0	13.0	2.0
712	1048	23.6	23.8	31.9	31.9	8	33.0	7.8	7.8	.
715	1135	22.4	22.3	33.1	33.1	9	23.0	23.0	23.0	6.8
716	1332	22.6	22.6	32.3	32.2	8	46.0	13.0	13.0	.
717	956	19.3	19.4	32.9	33.1	9	230.0	79.0	49.0	.
717	1412	22.4	22.4	30.5	30.4	6	130.0	79.0	79.0	1.0
718	1401	22.0	22.2	32.0	31.9	6	4.0	4.0	4.0	1.0
719	1512	23.0	23.0	32.9	32.9	7	13.0	7.8	7.8	1.0

STA=B-04A

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
716	908	20.7	20.4	33.5	33.6	17	49	17	6.8	4.5
717	958	19.9	19.5	32.1	33.2	18	130	49	49.0	.

STA=B-04B

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
715	1515	23.0	22.8	32.8	32.9	5	70	33	33	.
717	1000	20.2	19.5	31.7	32.7	5	490	170	130	.

STA=B-05

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	918	.	21.7	.	32.5	3	130	1.8	1	1
708	1353	22.1	21.9	33.2	33.1	5	13	1.0	1	.
709	909	22.5	22.5	31.6	32.0	2	79	1.0	1	1
709	1350	22.8	23.1	33.0	32.9	5	11	2.0	2	.
710	921	.	23.2	.	31.8	2	27	2.0	2	.
711	1007	24.6	24.6	31.3	31.3	3	230	13.0	13	2
712	1110	24.7	24.8	30.6	31.6	3	22	2.0	1	.

BUTTERMILK BAY
BAY STATIONS - RAW DATA

STA=B-05A

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
711	1012	24.1	24.1	9.3	9.3	3	2400	170	110	79
715	1210	19.7	.	11.0	.	2	1700	330	330	130
716	924	20.0	22.9	4.1	32.2	4	16000	1200	1200	220
716	1405	21.9	23.3	19.4	30.8	3	490	130	130	49
717	1016	20.7	19.8	6.9	32.1	3	2200	1100	1100	.
717	1448	24.3	.	30.8	.	1	2200	350	350	230
718	1438	22.7	23.9	12.7	31.7	2	790	170	170	17
719	1545	25.3	20.1	7.6	30.4	2	330	330	330	79

STA=B-05B

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
716	1415	23.3	.	25.9	.	0	92000	54000	54000	.
716	1417	23.3	.	25.9	.	0	920000	240000	240000	5400

STA=B-07

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	900	21.3	21.4	32.6	32.6	7	17.0	1.0	1.0	1
708	1341	19.4	19.2	33.8	33.9	9	17.0	17.0	17.0	.
709	858	22.0	22.0	32.5	32.5	6	6.8	1.8	1.8	.
709	1340	20.2	20.2	33.8	33.7	8	4.0	2.0	2.0	.
710	916	22.8	22.8	32.7	32.8	5	6.8	2.0	2.0	.
711	958	23.9	23.8	32.2	32.2	5	23.0	4.5	4.5	1
712	1105	24.1	23.9	31.9	32.1	5	2.0	2.0	2.0	.
715	1157	23.8	23.2	32.3	32.4	5	49.0	7.8	7.8	.
716	1354	23.5	22.7	31.4	32.0	4	130.0	23.0	23.0	.
717	1437	22.8	22.8	29.7	29.8	5	490.0	70.0	70.0	.
718	1422	22.3	22.3	31.6	31.6	6	2.0	1.0	1.0	.
719	1532	23.4	23.4	32.2	32.3	5	2.0	2.0	2.0	.

STA=B-10

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	907	21.7	21.5	32.3	32.5	5	4.0	1.0	1.0	2
708	1348	19.6	19.2	33.8	33.8	8	49.0	49.0	11.0	.
709	903	22.3	21.9	32.1	32.5	6	4.5	4.5	4.5	.
709	1344	20.9	20.3	33.6	33.8	9	21.0	9.2	9.2	.
710	936	23.1	22.9	32.8	32.9	7	1.0	1.0	1.0	.
711	1001	24.5	23.9	32.0	32.2	5	23.0	2.0	2.0	1
712	1108	25.0	24.1	31.2	31.9	6	7.8	2.0	4.5	.
715	1201	24.0	23.8	31.9	32.2	5	17.0	4.5	2.0	.
716	1358	23.6	23.1	31.0	31.9	7	130.0	4.5	4.5	.
717	1439	23.2	22.9	29.0	29.3	5	330.0	79.0	79.0	.
718	1426	22.8	22.5	30.8	31.4	6	2.0	2.0	2.0	.
719	1535	23.8	23.2	32.2	32.4	7	2.0	1.8	1.8	.

BUTTERMILK BAY
BAY STATIONS - RAW DATA

STA=B-11

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	925	22.2	22.0	33.0	33.1	5	2.0	1.0	1.0	1
708	1356	22.8	22.4	33.0	33.1	8	4.5	2.0	2.0	.
709	916	22.8	22.6	32.4	32.8	6	1.0	1.0	1.0	.
709	1353	23.8	23.8	33.0	33.0	7	6.8	2.0	2.0	.
710	929	23.5	23.2	32.3	32.9	6	13.0	1.0	1.0	.
711	1019	24.5	24.3	31.5	32.2	5	950.0	22.0	22.0	2
712	1115	25.4	24.6	30.9	32.6	5	4.0	2.0	2.0	.
715	1218	24.6	24.2	31.5	32.2	5	14.0	4.5	4.5	.
716	1430	23.3	22.7	26.2	32.3	5	16000.0	330.0	330.0	.
717	1459	23.5	22.5	30.3	31.1	5	230.0	79.0	79.0	.
718	1450	22.6	22.4	31.9	32.3	5	1.0	1.0	1.0	.
719	1555	24.1	23.7	31.5	32.4	5	2.0	1.0	1.0	.

STA=B-12

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	930	21.8	21.0	32.3	33.6	5	1.0	1.0	1.0	1
708	1401	22.1	22.1	33.2	33.2	8	17.0	4.5	4.5	.
709	921	22.7	21.6	31.6	33.1	6	1.0	1.0	1.0	.
709	1353	22.5	22.6	33.2	33.1	8	11.0	2.0	1.0	.
710	933	23.2	23.3	32.5	32.6	6	4.5	4.5	4.5	.
711	1023	24.3	23.1	32.0	32.7	6	4.5	1.0	1.0	1
712	1120	25.5	24.5	31.7	32.8	5	1.0	1.0	1.0	.
715	1221	23.4	23.3	32.4	32.7	5	6.8	4.5	2.0	.
716	1435	23.3	22.4	31.0	33.0	5	49.0	4.5	4.5	.
717	1503	23.0	23.1	29.9	29.9	4	31.0	17.0	6.8	.
718	1453	22.8	22.8	31.6	31.4	4	1.0	1.0	1.0	.
719	1558	23.5	22.4	32.5	33.3	5	1.0	1.0	1.0	.

STA=B-14

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	933	21.8	21.6	32.5	32.4	4	7.8	2.0	2.0	2
708	1406	20.0	19.5	33.8	33.8	7	33.0	33.0	17.0	.
709	926	22.7	22.5	31.8	32.1	4	1.0	1.0	1.0	.
709	1400	21.7	20.6	33.3	33.7	6	17.0	17.0	17.0	.
710	942	23.1	22.9	32.8	32.8	6	13.0	4.5	4.5	.
711	1026	24.6	24.5	31.4	31.7	4	17.0	4.0	4.0	2
712	1122	24.9	24.5	31.7	31.8	4	11.0	4.5	2.0	.
715	1225	24.2	23.9	31.6	31.7	4	27.0	4.5	4.5	.
716	1437	23.6	23.3	30.1	31.2	4	46.0	14.0	6.1	.
717	1511	23.1	23.0	29.7	29.7	4	79.0	33.0	33.0	.
718	1500	22.8	22.5	31.4	31.4	4	1.8	1.0	1.0	.
719	1601	24.1	24.1	32.0	32.0	4	4.5	4.5	4.5	.

BUTTERMILK BAY
BAY STATIONS - RAW DATA

STA=B-15

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	950	22.0	22.3	32.5	33.1	6	2	2.0	2.0	1.0
708	1420	23.0	23.0	32.3	32.8	8	1	1.0	1.0	.
709	941	22.4	22.7	31.7	32.7	6	1	1.0	1.0	.
709	1415	24.3	23.8	32.4	32.7	9	2	1.0	1.0	.
710	955	23.7	23.8	31.7	32.0	7	.	.	.	.
711	1036	24.5	24.6	30.0	32.4	6	220	14.0	14.0	1.0
712	1130	25.7	25.7	31.5	32.5	6	1	1.0	1.0	.
715	1236	24.3	24.2	31.8	31.7	6	17	2.0	2.0	4.0
716	933	23.8	23.1	29.6	32.4	8	49	17.0	17.0	1.8
716	1450	23.5	23.3	29.7	30.2	4	460	7.8	7.8	49.0
717	1025	22.4	22.5	30.2	31.7	7	700	130.0	130.0	.
717	1538	24.2	22.6	30.8	31.9	5	79	49.0	49.0	2.0
718	1516	22.9	21.8	31.8	32.7	5	1	1.0	1.0	1.0
719	1613	23.7	23.8	32.1	32.2	5	2	2.0	2.0	1.0

STA=B-17

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	940	22.4	22.3	31.7	32.9	6	2.0	2.0	2.0	1
708	1412	22.4	22.5	32.8	32.9	9	4.5	2.0	2.0	.
709	931	22.8	22.1	31.7	32.7	6	1.0	1.0	1.0	.
709	1405	23.1	23.1	32.9	32.9	8	2.0	2.0	2.0	.
710	946	23.7	23.1	32.4	32.9	6	4.0	4.0	4.0	.
711	1029	24.9	24.6	30.9	32.0	6	17.0	4.5	4.5	2
712	1125	25.4	24.5	31.3	32.2	7	1.0	1.0	1.0	.
715	1230	24.4	24.4	31.2	31.2	6	14.0	2.0	2.0	.
716	1440	23.2	23.2	29.0	31.4	5	33.0	13.0	13.0	.
717	1516	23.6	20.3	29.9	32.4	5	490.0	130.0	130.0	.
718	1505	23.9	21.1	30.7	32.6	6	1.0	1.0	1.0	.
719	1606	24.2	24.2	31.5	32.2	6	2.0	2.0	2.0	.

STA=B-19

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	943	22.6	22.6	31.2	32.2	6	2.0	1.0	1.0	1
708	1416	23.0	23.0	32.6	32.7	9	4.5	4.5	4.5	.
709	935	23.1	22.6	30.9	32.3	7	6.8	1.0	1.0	.
709	1410	24.1	24.0	32.3	32.3	9	1.0	1.0	1.0	.
710	950	24.0	24.0	31.2	31.3	5	7.8	1.0	1.0	.
711	1033	24.8	24.6	29.9	30.0	4	22.0	2.0	2.0	1
712	1128	25.4	25.7	30.5	32.4	7	6.8	2.0	2.0	.
715	1233	24.5	24.4	30.2	30.2	6	22.0	4.5	4.5	.
716	1443	23.3	23.7	28.4	28.8	4	180.0	11.0	11.0	.
717	1522	24.7	22.7	27.5	31.0	5	17.0	13.0	13.0	.
718	1510	24.5	22.0	29.8	31.9	6	1.0	1.0	1.0	.
719	1608	25.1	24.9	30.8	30.6	6	23.0	2.0	2.0	.

BUTTERMILK BAY
BAY STATIONS - RAW DATA

STA=BS-CH9

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
719	1109	21.3	20.9	33.7	33.8	13	2	2	2	1

STA=BS-RR

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
710	1511	21.7	21.3	33.6	30.3	15	4.5	4.5	4.5	.
719	1115	21.0	21.1	33.6	33.7	17	13.0	13.0	13.0	4.5

'0' for depth should be null

STA=BS-01

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	855	.	.	.	.	0	11.0	7.8	7.8	1.0
708	1343	27.0	.	29.7	.	0	1.0	1.0	1.0	.
709	840	23.5	.	29.1	.	0	7.8	4.5	4.5	1.0
709	1340	27.0	.	28.8	.	0	4.5	4.5	4.5	.
710	945	25.5	.	29.0	.	0	11.0	6.8	6.8	.
711	925	26.2	.	28.4	.	0	12.0	4.5	4.5	1.0
712	1055	27.2	.	28.5	.	0	2.0	.	.	.
715	1417	25.0	.	28.2	.	0	17.0	4.5	4.5	.
716	1351	23.5	.	27.6	.	0	14.0	11.0	11.0	.
717	1034	23.0	.	24.4	.	0	.	.	.	.
717	1433	26.0	.	24.7	.	0	170.0	70.0	70.0	6.8
718	1418	26.2	.	26.9	.	0	26.0	14.0	14.0	4.5
719	1528	27.0	.	28.5	.	0	49.0	22.0	22.0	.

STA=BS-02

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	915	.	.	.	.	0	6.1	1.0	1.0	1.0
708	1415	24.0	.	26.9	.	0	1700.0	46.0	21.0	.
709	920	22.5	.	25.6	.	0	14.0	9.3	9.3	4.0
709	1405	25.8	.	28.9	.	0	70.0	70.0	49.0	.
710	1015	25.0	.	26.4	.	0	250.0	26.0	21.0	.
711	1010	24.5	.	21.2	.	0	330.0	14.0	14.0	1.8
712	1114	26.0	.	25.0	.	0	17.0	7.8	7.8	.
715	1458	23.0	.	26.8	.	0	49.0	2.0	2.0	.
716	1320	23.5	.	20.4	.	0	490.0	49.0	49.0	.
717	1050	22.5	.	25.6	.	0	.	.	.	.
717	1530	26.5	.	23.8	.	0	79.0	14.0	14.0	17.0
718	1445	25.8	.	28.8	.	0	23.0	13.0	13.0	1.0
719	1555	26.0	.	26.8	.	0	330.0	33.0	33.0	.

BUTTERMILK BAY
BAY STATIONS - RAW DATA

STA=BS-03

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	1315	25.5	.	29.0	.	0	6.8	6.8	6.8	2
709	825	23.0	.	29.8	.	0	2.0	2.0	2.0	1
709	1330	27.0	.	29.9	.	0	1.0	1.0	1.0	.
710	925	24.5	.	26.7	.	0	12.0	4.5	4.5	.
711	915	25.0	.	29.3	.	0	49.0	11.0	6.8	2
712	1044	27.0	.	28.0	.	0	7.8	7.8	7.8	.
715	1400	25.5	.	29.0	.	0	2.0	1.0	1.0	.
716	905	24.0	.	28.1	.	0	5400.0	3500.0	3500.0	.
716	1358	24.0	.	25.1	.	0	490.0	70.0	70.0	.
717	1015	23.0	.	25.6	.	0	1300.0	490.0	490.0	.
717	1411	26.0	.	25.5	.	0	490.0	110.0	110.0	.
718	1406	27.4	.	27.6	.	0	130.0	79.0	49.0	79
719	1505	26.0	.	29.4	.	0	7.8	4.5	2.0	.

STA=BS-04

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	1355	24.5	.	24.4	.	0	49	4.5	4.5	2.0
709	900	22.8	.	27.1	.	0	17	7.8	7.8	2.0
709	1352	26.0	.	26.0	.	0	1	1.0	1.0	.
710	1000	25.0	.	26.4	.	0	22	17.0	17.0	.
711	945	26.0	.	27.3	.	0	330	79.0	79.0	9.3
712	1105	27.5	.	26.9	.	0	79	33.0	33.0	.
715	1438	25.0	.	23.8	.	0	790	130.0	130.0	17.0
716	915	23.0	.	21.6	.	0	230	33.0	33.0	.
716	1335	23.8	.	25.2	.	0	1400	170.0	170.0	.
717	1040	22.8	.	24.4	.	0	490	110.0	70.0	.
717	1453	26.0	.	10.2	.	0	5400	330.0	330.0	.
718	1430	26.5	.	14.6	.	0	79	4.5	4.5	.
719	1541	26.5	.	28.4	.	0	46	7.8	7.8	.

BUTTERMILK BAY
STREAM STATIONS - RAW DATA

STA=CBOG

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	937	.	.	.	.	0	280	23	23	49
708	1430	25.5	.	0.3	.	0	.	.	.	.
710	1045	24.0	.	1.3	.	0	700	170	170	.
711	1015	23.8	.	0.6	.	0	1100	49	49	22
715	1510	24.0	.	0.3	.	0	1100	46	33	490

STA=CPTH

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	1025	.	.	.	.	0	9200	700	79	170
709	1010	21.5	.	31.1	.	0	.	.	.	.
711	1045	23.5	.	31.1	.	0	2400	230	230	790

STA=ELECAV

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
710	1504	21.4	21.4	33.8	33.8	7	23	7.8	7.8	.

STA=HDWYST

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	955	.	.	.	.	0	5400	79	49	21
709	935	21.5	.	1.2	.	3	16000	2400	2400	2200
710	1055	24.0	.	1.9	.	0	17000	110	110	.
711	1020	24.0	.	0.8	.	0	2200	220	220	490
715	1527	23.5	.	0.4	.	0	16000	1700	1700	.
716	930	22.5	.	0.7	.	0	9200	490	220	.
716	1300	23.0	.	0.6	.	0	17000	3500	3500	.
717	1120	22.3	.	0.4	.	0	7900	490	490	.
718	1456	28.5	.	0.7	.	0	1700	130	130	130

STA=LBR1

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
710	1351	.	.	.	.	0	70	13	13	.
717	1100	23	.	24.7	.	0	1100	330	330	.

BUTTERMILK BAY
STREAM STATIONS - RAW DATA

STA=LBR2

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
710	1408	.	.	.	.	0	790	11	11	.

STA=LILPD

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
711	1445	.	.	.	.	0	790	6.1	6.1	2

STA=MKPCIN

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
715	1140	24.5	.	0.4	.	0	79	13	13.0	4.5
716	1023	24.5	.	1.7	.	0	31	2	4.5	.

STA=MKPCOT

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
716	1048	23.5	.	0.2	.	0	170	33	33	11

STA=MRSHDR

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
717	1500	26.1	.	2.4	.	0	1300	790	790	1300

STA=OHBC

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	922	.	.	.	.	0	490	23	23	22
709	900	12.5	.	0.0	.	0	.	.	.	.
710	1020	15.0	.	0.3	.	0	1100	33	33	.
711	1000	14.5	.	0.0	.	0	950	70	49	330
715	1452	14.5	.	0.5	.	0	1100	70	70	.
717	1525	15.5	.	0.5	.	0	1100	490	490	490

BUTTERMILK BAY
STREAM STATIONS - RAW DATA

STA=OHBCMO

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
711	1425	28	.	10.2	.	0	170	11	11	2

STA=RDBR

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
708	1012	.	.	.	.	0	220	31	31	46
709	1000	15.5	.	0.0	.	0	.	.	.	.
710	1120	19.5	.	0.4	.	0	49	17	17	.
711	1030	18.8	.	1.3	.	0	790	490	490	220
715	1535	19.0	.	0.3	.	0	1400	110	110	.
716	943	18.0	.	0.7	.	0	790	330	330	170
717	1130	19.0	.	0.2	.	0	2200	460	460	.
718	1514	21.5	.	0.2	.	0	79	22	14	13

STA=RDBRFL

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
710	1410	18	.	0	.	0	220	26	26	.

STA=RDBRGP

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
716	1102	23	.	.	.	0	350	7.8	7.8	.

STA=RDBR495

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
715	1030	18.5	.	0.8	.	0	49	13	13	130

STA=WHTIP

DATE	TIME	TTEMP	BTEMP	TSAL	BSAL	DEPTH	TC	FC	ECMUG	FS
715	1135	24.5	.	0.4	.	0	23	4.5	2	17