

## **REPORT ON SURVEY SAMPLES TAKEN FROM WESTCOTT COVE AND COVE HARBOR IN 1998**

November 25, 1998

The scope of this sampling was to provide information on the bacteriological quality of water coming from various drainage sites entering the Westcott Cove and Cove Harbor recreational shellfishing areas. These sample results were compared with results from samples collected in previous years to determine if any changes have occurred in the quality of the drainage water entering these shellfishing beds.

Locations monitored included storm drain outfalls, catch basins, storm water pump stations, the Soundview Pond, the Noroton River and recreational shellfish beds. Storm drain outfalls were identified by reviewing city maps. Previously documented septic systems along the shore in this area were found to be connected to the city sewers. Shellfish bed water samples were taken at the State of Connecticut's Aquaculture Division's designated locations.

The primary participants in this year's survey were the members of the Shellfish Commission of Stamford and the Stamford Health Department's Laboratory. All rain information was provided by the Inspections Division of the Stamford Health Department. Sample collection for all of the survey work for this year was performed by the Shellfish Commission. Previous years samples were taken by the Stamford Health Department's Environmental Health Division. Additional information on the bacteriological quality of water from the recreational shellfish beds was obtained from the State of Connecticut's Aquaculture Laboratory in Milford.

Samples were collected in disposable sterile containers using proper standard collection procedure and analyzed by procedures defined by the Food and Drug Administration(FDA) or the United States Environmental Protection Agency(USEPA). All samples analyzed at the Stamford Health Department Laboratory were analyzed the day they were received, within two hours of receipt in the laboratory and within four hours of collection.

Soundview Pond has been under fairly consistent observation by the health department with a total of 26 sets of samples taken since 1986, with the greatest single year's sampling in 1989 of 8 sets of samples. No samples were collected in 1994, 1996, or 1997, and only one sample was taken in 1991, 1992, and 1993. The average enterococcus count for past years was 6,709 colony forming units (CFUs) per 100 mL with a minimum value of 100 and maximum of greater than 60,000 CFUs per 100 mL. The average fecal coliform value was 10,085 with a minimum of 100 and maximum of greater than 90,000 CFU per 100 mL.

The raw data from the 26 sets of samples taken from Soundview Pond in 1988 gave an average enterococcus value was 2,399 CFUs per 100 mL of samples with a range from 5 to 12,600 CFUs per 100 mL. The average fecal coliform value was 3,162 CFUs per 100 mL with a range from 20 to greater than 50,000 CFUs per 100 mL. The first table shows the mean values at each site for the years previous to 1998 and compares it to those samples from 1998.

In each group, samples were taken after both wet and dry periods. The ratio of higher bacteria levels found in the earlier tests to the newer test was maintained under all weather conditions.

Table I

Location Mean value	Inlet at Van Buskirk	Outlet at Soundview Ave.	Pipe headwall	outlet to Cummings Lagoon
1986 to 1995 enterococcus	9,492.9	7,313.5	2,933.3	1,164.4
1998 enterococcus	4,563.9	2,197.3	1,717.7	1,118.6
1986 to 1995 fecal coliform	19,999.6	6,602.4	23,480.0	5,483.0
1998 fecal coliform	3,316.8	5,363.4	2,223.1	1,745.3

All bacteria is reported as colony forming units per 100 mL of sample.

There are several factors which might explain the significant decrease in bacteria levels for all locations. The first factor to consider is the rabies epidemic<sup>1</sup>, which began in 1991, and reduced the raccoon population by up to 95%. Raccoon habitation of the storm drains was well documented during the program "Operation Shellfish" and was considered a primary cause of the high bacteria levels in Stamford's storm drains. Another factor to consider was an extremely wet spring<sup>2</sup>, with significant rain weekly which would not have allowed a build-up of contaminants on land and in the storm drains. The lower level of bacteria found at the outfall into Cummings Lagoon was correlated with a test point where Cummings Lagoon flows into Westcott Cove. This showed the high values (greater than 14 fecal coliforms/100 mL) at the fishing pier occurred after a significant rain (greater than 0.5 inches) and were directly related with the highest readings at the outfall. Values greater than 1,700 CFUs at the outfall, occurring several days past a significant rainfall, did not affect the bacteriological quality of the water at the fishing pier. This next table shows this relationship.

Table II

Date	tide	Fishing pier		Outfall to Cummings Lagoon		days after rain < 0.5"	5 day rain
		Enterococcus	Fecal coliform	Enterococcus	Fecal Coliform		
3/30	low	2	2	315	750		0
4/02	low	106	218	1,500	3,700	1	1.39
4/06	ebb	< 2	8	15	640	5	0
4/07	flood	< 2	< 2	210	220	6	0
4/13	low	6	< 2	2,000	2,000	4	1.10
4/16	low	< 2	< 2	200	600	7	0.031

<sup>1</sup> State of Connecticut Department of Health Services, April 1991, *CONNECTICUT EPIDEMIOLOGIST*, *Epidemiology section*, Volume 11 No. 3.

<sup>2</sup> Information collected by the Environmental Health Division of the Stamford Health Department. For the three month period of April, May and June, the total rainfall for 1998 was 15.624 inches, the average rain for the same three month interval for 12 years was 10.940 inches, and the only year which had more rain than 1998 was 1989 with 21.624 inches. This was confirmed by the NOAA Station #5N-06-7970-3 at the Stamford Museum and Nature Center.

Date	tide	Fishing pier		Outfall to Cummings Lagoon		days after rain < 0.5"	5 day rain
		Enterococcus	Fecal coliform	Enterococcus	Fecal Coliform		
4/20	ebb		46		2,100	1	1.171
4/23	flood		2		20	3	0.831
4/27	flood	6	30	300	1,400	7	0.210
4/30	low		6		2,200	10	0.201
5/04	low	< 2	< 2	1,200	400	3	0.561
5/11	low	70	1,800	4,600	11,000	1	1.28
5/12	flood	85	60	800	1,500	2	1.28
5/14	flood		2		100	4	0.82
5/19	ebb	< 5	< 5	125	210	9	0.1
6/11	low		8		4,100	11	0.445
6/25	flood		2		1,800	7	0

Other samples taken from this area included samples taken from the two storm water pump stations at West Beach and Cummings Park. Samples from the West beach pump station showed no elevations at any time. Samples at the Cummings Park pump station showed elevations, but did not appear to affect and could not be correlated with bacteria levels in the Westcott Cove shellfish waters.

An attempt was made to correlate the large geese population found in Cummings Park during the spring months with the outfall into Cummings Lagoon by taking samples at the catch basin found in the playing field. Although the bacteria levels found after rains of greater than 1.00" were elevated, the contribution of this source to the outfall to Cummings lagoon seemed to be extremely small, and was not related to bacteria levels found in Westcott Cove.

For Cove Harbor, three outfalls and the Noroton River were monitored. All of these sources empty first into Holly Pond before entering shellfish waters. Holly Pond enters shellfish waters on both the east and west sides of Cove Island. No significant survey of this area had been performed previous to this year. Our sampling point for this outflow was at the foot bridge to Cove Island, which is the west entrance to Cove Harbor. Results of the samples from the storm water outfalls were variable, not totally rain dependent, and generally much higher than found in most storm drain waters. Comparing the average bacteria value of these outfalls in the following table with those from Soundview Pond shows these outfalls to be significantly higher.

Table III

	1) Inlet to Soundview Pond	2) Outlet to Cummings Lagoon	3) Outfall at Cove Road	4) Outfall at Birch St.	5) Outfall at Matthews St.	6) Noroton River at US 1

Fecal Coliform	3,316.8	1,745.3	11,701.7	53,274.3	14,569.6	1,293.5
% of 1	100.00	52.62	352.80	1,606.20	439.27	39.00
Enterococcus	4,563.9	1,118.6	13,384.1	14,896.4	12,626.3	682.5
% of 1	100.00	24.51	293.26	326.40	276.66	14.95

As shown in the table, fecal coliform values from the Noroton River and from the outfall to Cummings Lagoon (from Soundview Pond) are comparable; enterococcus counts are higher at Soundview Pond. When the inlet to Soundview Pond (which is storm drain water) is compared to the outfalls from the Cove area, we see that they carry a higher density of bacteria than the outfall from Soundview Pond. The three Cove outfalls are similar with each other, even though the fecal coliform values from Birch Street is much higher than the others.

The samples from each of these were compared with each other and with how rain might have affected the levels of bacteria. Since bacteria levels were over shellfish water and recreation water limits, values over the mean bacteria level were considered to be elevated. From the 22 Matthews Street storm outfall samples, three of the highest nine bacteria readings were due to recent significant rain; six were not related and no source was determined. For the 15 samples taken at the Birch Street outfall, one could be directly related to a rain greater than 0.5 inches; eight could not be related and no direct source was discovered. From the end of Cove Road, 24 samples were taken; two of the thirteen elevated bacteria levels could be connected to significant rain. The samples taken from the Noroton River showed five of nine samples with elevated bacteria levels to be directly related to rain. The next table shows the dates of samples and their relation to rain in a comparative fashion.

Table IV

Day	Noroton River		Cove Road		Birch Street		Matthews Street		last sig. rain
	FC	Ent	FC	Ent	FC	Ent	FC	Ent	
4/16	200	150							4/09
4/20	1,900		1,300						4/20
4/23	340		280				400		4/20
4/27	320	480	3,000	400					4/20
4/30	200	100	300	100			17,200	1,800	4/20
5/04	580	200	700	100			14,000	60,000	5/01
5/11	980	1,500	4,300	5,400			>100,000	12,800	5/10
5/14	220		380				17,000		5/10
5/18	550	520	1,430	>50,000			27,000	18,200	5/10
5/27	500	380	50	430	320	1,080	800	1,000	5/24
6/01	>5,000	>5,000	1,500	3,300			400	<100	5/31
6/04	920	360	1,200	1,600	1,720	1,080	2,000	620	5/31

Day	Noroton River		Cove Road		Birch Street		Matthews Street		last sig. rain
	FC	Ent	FC	Ent	FC	Ent	FC	Ent	
6/08	>10,000	400	3,000	1,800	>50,000	4,100	18,000	>50,000	5/31
6/11	1,100		1,400		15,600		8,000		5/31
6/15	1,000	1,000	30,000	5,000	>500,000	8,000	18,000	>50,000	5/31
6/22	1,200	1,400	2,000	<1,000	5,000	7,000	4,000	2,000	6/13
6/25	1,300		11,200		16,800		4,900		6/17
6/29	1,000	600	10,000		3,900		16,000		6/17
7/06	800	1,000	<1,000	2,000	<1,000	1,000	33,000	<1,000	6/29
7/09	200		9,500		1,300		5,200		7/04
7/13	500	200	42,000	5,800	11,000	1,200	6,200	1,900	7/04
7/16	640	280	33,000	71,000	80,000	18,200	14,800	40,000	7/04
7/23	300	160	23,000	5,000	35,000	16,000	5,200	5,800	7/23
7/27	2,200	360	72,500	37,800	22,000	18,200	8,200	2,800	7/23
8/04	1,360	1,560							7/23
8/06	320	500	27,800	36,800	19,000	88,000	2,000	3,000	7/23
<i>M</i>	1,294	683	11,702	13,384	50,843	14,896	14,468	12,626	

Figure 1 is a clearer manner of viewing this information. The disharmonic nature of these outfalls is shown best by viewing fecal coliform levels, but does show by viewing enterococcus levels as well. Rainfall has an affect on all outfalls only for the samples on 6/15. The cause of this variability and the higher bacteria counts have been referred to the Operations Department for further investigation.

The bacteria levels from these storm drains were then sorted by the time they were collected to see if surges from the sanitary sewers might account for the readings. Using an hour span and viewing only sampling points with more than one sample during that span, the highest mean bacteria values were found between the hours of 6:00 AM to 9:00 AM, with values dramatically smaller between 5:00 AM to 6:00 AM and between 9:00 AM to 2:00 PM. No samples were collected after 4:00 PM. These figures correspond with water usage and with the demand on the sanitary sewer lines and so provides further evidence that exfiltration from the sanitary lines to the storm drains may be occurring. It should be noted that the highest bacteria level found, of greater than 500,000 fecal coliform bacteria per 100 mL of sample, was collected between 10:00 and 11:00 AM at Birch Street and was not included because it was the only sample from Birch Street during this time period.

Table V

Date	Cove Road	Birch Street	Matthews Street
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	FC	Ent	FC	Ent	FC	Ent
5:00 to 6:00 AM	2,650	3,700	1,000	1,000		
6:00 to 9:00 AM	18,723	23,916	25,468	38,105	11,540	19,667
9:00 AM to 4:00 PM	3,151	10,705	5,625	16,080	11,100	9,136

There was no evidence to support the idea that raccoons are a major contributor of bacteria levels at this time. Bacteria levels were inconsistent, not related to rain and even applying the defunct method of using fecal coliform to enterococcus ratios, there is no support for the raccoon habitation of these storm drains at this time. Other possible sources should be investigated.

Samples from the foot bridge at Cove Island were significantly higher than at the fishing pier at Cummings Beach; elevated values were mostly directly related to bacteria levels at the Noroton River and to rain events and rather than to the storm drain outfalls. The relationship between the Noroton River and samples at the footbridge can be seen in Figure 2. Viewing Figure 3, which adds the values from the footbridge with those of the storm drains, shows some slight correlation in only one sampling day. The affect of the storm drains at the foot bridge is not significant.

The final grouping of water samples were taken from the shellfish beds. The sampling was done by the State of Connecticut Aquaculture Department, the Stamford Health Department Inspections Division and the Stamford Shellfish Commission. Samples were analyzed by both the State Aquaculture Laboratory in Milford and the Stamford Health Department Laboratory. 16 sets were taken from Westcott Cove and 14 sets were taken from Cove Harbor. Five of the Cove Harbor samples were taken within one day of the survey samples. Samples collected by the Shellfish Commission were analyzed for more than the fecal coliform by the A-1 MPN method for compliance. These samples compared the approved method with membrane filtration for fecal coliforms, enumeration of *E. coli*, and obtained enterococcus counts from the designated shellfish water collection sites.

Composite information for each sample location is shown in the next table and shows samples from the Cove Harbor area to be of poorer quality than those taken from Westcott Cove. Westcott Cove had a composite of the five sampling sites a failure rate of 11.76% or 8 out of 68 samples. The composite of the nine Cove Harbor sampling site had 23 of 104 samples fail or 22.12%. This is a further indication that factors other than normal runoff are affecting the shellfish waters in the Cove Harbor area.

Table VI

location	# of samples	# of Samples > 14.0	% > 14.0	Arithmetic mean	Geometric mean
Westcott Cove, buoy #4, 4.0	15	1	6.67%	7.5	3.43
West Beach, buoy 10, 4.1	11	2	18.18%	16.3	4.39
West of Lagoon, 4.2	14	2	14.29%	7.7	3.09
Cummings' breakwall, 4.3	12	1	8.33%	9.3	4.01

location	# of samples	# of Samples > 14.0	% > 14.0	Arithmetic mean	Geometric mean
South of Vincent Island, 5.0	16	2	12.5%	9.6	2.62
East of Gilbert Island, 6.0	14	4	28.57%	13.7	5.82
Cove Harbor, 7.0	14	3	21.43%	13.7	5.83
Cove Harbor speed buoy, 7.1	4	0	0%	4.8	3.14
Entrance to Cove Marina, 7.3	13	4	30.77%	10.0	4.40
Horseshoe point, 8.0	14	2	14.29%	12.9	5.78
Holly Pond outlet, 9.0	4	0	0%	3.80	3.14
WSW of Pratt Island, 10.0	14	4	28.57%	11.1	5.47
Between 10.0 & 12.0, 11.0	14	3	21.43%	12.5	3.81
Cove Rocks, Three Sisters, 12.0	13	3	23.03%	10.6	3.21

In summary, the primary influence for the Westcott Cove recreational shellfish area, i.e. Soundview Pond, has improved significantly over past years. No other significant sources of runoff were identified. The primary factor influencing the bacteria quality of the water in the shellfish area is still rain and therefore runoff. The samples taken from the shellfish waters support this conclusion. The results from this sampling are so consistent that there is a possibility that testing is not necessary to reopen these beds after a significant rain event.

Contrarily, samples from the various sources of drainage to the Cove Harbor recreational shellfish area show levels much higher than from the Soundview Pond. This is reflected in the samples taken from the shellfish waters. The influences on the shellfish water is also mostly rain related, but is not consistent and so monitoring of the bacteria levels after rain is absolutely necessary. The information also suggests that the storm drains leading to Holly Pond and Cove Harbor be investigated for any exfiltration from the sanitary sewers into the storm drains.

With the concerns and evaluation of the different sites concluded, the bacteriological methods and sampling methods were evaluated.

Two methods for evaluating fecal coliform were reviewed, the MPN by A-1 broth and the membrane filtration using M-FC broth. The amount of *Escherichia coli* in each sample was determined using nutrient agar with MUG for the membrane filtration test and EC broth with MUG for the MPN tests. An examination for enterococcus bacteria was also performed in the same samples.

The first comparison was of the MPN method using A-1 media with the membrane filtration method using M-FC broth. The samples were divided grouping the results of the fecal coliform tests (0-10, 10 to 20, 20 to 30 etc. ...). The mean of each series indicated that the two method gave comparable results even though individual tests might be significantly different. This was particularly noted in the area of most importance, fecal coliform > 14, where closure of a shellfish area can occur. The MPN method showed values above the cutoff point two times when the membrane method did not. There were no times that the membrane method would have closed an area that the MPN method did not. The next table shows this and other comparisons.

Table VII.

range	fecal coliform per 100 mL		<i>E. coli</i> by MUG		enterococcus by membrane filtration
	MPNs by A-1	filtration	nutrient agar	EC broth	
0 to 10	3.6 < 1.7 3.6 3.6 11.0 11.0 11.0 3.6 14.0 < 1.7 1.7 < 1.7 3.6	1 < 2 2 2 < 2 < 2 2 3 4 4 6 8 9	< 1 0 0 2 0 0 0 0 4 2 4 6	 < 1.7 1.7 5.8 3.6 < 1.7 < 1.7 3.6	< 1 < 2 < 2 < 2 2 4 3 < 1 4 4 4 < 2 1
mean std. dev.	5.1 4.9	3.15 2.97			1.69 1.84
10 to 20	11 11 3.6 18 28 8.1 18 36	10 11 12 14 14 14 16 18	10 12 14	8.1 1.7 28	< 2 4 < 2 1 8 4 9 < 1
mean std. dev.	16.7 10.8	13.63 2.62			3.25 3.65
20 to 30	22 28 22 22 28	20 20 24 25 28		11 11 14	2 7 2
mean std. dev.	24.4 3.3	23.4 3.44			3.76 2.89
30 to 40	36 50	38 38		11	8
mean std. dev.	43.0 9.9	38.0 0.0			8.0 0.0
40 to 50	36 50 50	42 43 44		11 18 22	< 2

range	fecal coliform per 100 mL		<i>E. coli</i> by MUG		enterococcus by membrane filtration
	MPNs by A-1	filtration	nutrient agar	EC broth	
	50	47			
mean	46.5	44.0			
std. dev.	7.0	2.16			
> 50	> 50	56		8.1	

*Escherichia coli* was evaluated in some samples and the number is consistently less than the number of fecal coliform found in samples. The possible application of *Escherichia coli* as the primary indicator organisms has been explored in other states<sup>3</sup>, and evaluation of it in our samples will continue.

All enterococcus values, which are used as indicators for bathing waters, were consistently low in all samples evaluated. This would be consistent with their use as indicators along beaches for signs of recent fecal pollution and would indicate that testing for enterococcus will not add any appreciable information when testing shellfish waters.

Duplicate and time studies were performed on samples taken from the survey sites in the Westcott Cove area and were analyzed for both fecal coliform and enterococcus bacteria. When counts were particularly high, there was some discrepancy between duplicate samples, but generally the results agreed with each other within a four colony range as indicated in the following table.

Table VIII.

Fecal coliform			enterococcus		
number of colonies		% difference	number of colonies		% difference
62	59	2.48	19	13	18.75
11	11	0.00	12	12	0.00
12	6	33.33	3	2	20.00
2	2	0.00	8	8	0.00
22	20	4.76	0	0	
4	2	33.33	9	8	5.88
15	15	0.00	18	17	2.86
23	19	9.52	12	11	4.35
0	0	0.00	38	35	4.11
			38	36	2.70

<sup>3</sup> Mudgett, C. C., Ruden, R., Austin, C. C., May 1998, "A Beach-Associated Outbreak of *Escherichia coli* O157:H7", *Journal of Environmental Health*, pp.7-13.

			34	28	9.68
			91	81	5.81
			3	1	50.00
151.00	134.00	5.96	285.00	252.00	6.15

As is shown, the cumulative difference is less than 10%, though individual results can be higher. Duplicate sampling does show that a single sample is representative of the area from which the water was collected.

Samples from the Westcott Cove area were collected over time on the same day on several occasions to determine the variance of the water quality over time. Significant differences were noted in some cases. Again a table will allow a review of the information collected. For the purposes of this study, tides are considered low or high two hours on either side of the peak. Flood tide is between the defined low tide and the defined high tide and ebb tide is between the defined high tide and the defined low tide.

Date	time	fecal coliform	enterococcus	tide
07/09	8:35	22	2	flood
	8:55	8	2	flood
mean std. dev.		15 98	2 0	
7/13	8:30	38	< 2	low
	9:45	< 2	< 2	flood
	10:40	2	< 2	flood
	12:20	2	< 2	flood
	2:00	2	< 2	high
mean std. dev.		9.2 16.1	0 0	
7/16	9:20	16	8	ebb
	11:20	22	< 4	low
mean std. dev.		19 4.24	4	
7/23	9:00	10	< 2	flood
	10:00	22	< 2	flood
mean std. dev.		16 8.49	0 0	

This reflects the changing water quality from one moment to the next, in some cases related to tide and in others not which presents a challenge as to when to sample. The difference shown

between sampling at a low tide and later might cause closures when the general water quality is good.

This study will be ongoing with more information added over the next year with more emphasis on the Cove Harbor area. More of the time studies will be performed as will a continued review of *Escherichia coli* and the several methods for determining the presence of fecal coliform bacteria.