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SOUTHERN ARTHUR KILL SURVEYS

1956
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INTERSTATE SANITATION COMMISSION

New York • New Jersey • Connecticut

SOUTHERN ARTHUR KILL SURVEYS
1955

Technical Report No 56-1
INTERSTATE SANITATION COMMISSION

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TABLES AND ILLUSTRATIONS

ACKNOWLEDGEMENT

The samples obtained during the survey of October 3, 1955, were obtained from the deck of the ferryboat PIERMONT on her regular cruises between the shores of Perth Amboy, New Jersey and Tottenville, Staten Island. The samples so obtained were then carried to the waiting room in Perth Amboy where some temporary laboratory facilities had been established by the Commission staff.

It is therefore, with a deep sense of gratitude for the facilities and other assistance furnished for the furtherance of the survey, that acknowledgement is hereby tendered to the Sunrise Ferries, Inc; operators and owners of the ferry service.

The waters of the Arthur Kill, which separate Staten Island on the west from New Jersey, comprise part of the Interstate Sanitation District. As such, the quality of the Arthur Kill waters are of prime concern to the Interstate Sanitation Commission. In addition to this prime interest of the Commission, previous surveys of the Commission had indicated the present desirability of Arthur Kill surveys to determine the water quality at the mouth of the Raritan River and in the general vicinity of the proposed outfall of the Middlesex County Sewer Authority.

Accordingly, surveys of the Kill were conducted by staff members of the Commission during 1955 and in all a total of some 78 samples were obtained and analyzed.

This report describes and interprets the samples obtained and in general outlines the states of the Arthur Kill waters for the periods investigated. The surveys (conducted during September and October) were of insufficient length to record seasonal changes with any degree of reliability. However, changes during a tidal cycle and the profiles of the Kill from Outerbridge to Ward's Point (the southern portion of Arthur Kill) are described with some thoroughness.

RESULTS

GENERAL METHODOLOGY

Logic indicates and experience supports the tenet that a stream is subject to many influences. Of these many influences no single one continually dominates the character of the stream. This shifting domination engenders considerable changes in the stream which may appear capricious upon casual examination. For example to cite but one aspect of a tidal stream, the dissolved oxygen concentration, one can list three major influences on this stream characteristic:

a. The amount of oxygen being used in the stream.

b. The amount of oxygen being produced in the stream.

c. The amount of oxygen physically transferred into or out of the stream.

These influences, encompass everything that may alter the dissolved oxygen concentration since they include all oxygen either created or destroyed in the stream site and all oxygen brought into or carried away from the site. Of course, these influences may in turn depend on other influences. The amount of oxygen used, for instance, depends on the number and type of organisms employing oxygen in their metabolic activity which, in turn, depend to some extent on the amount of food material available, which depends to some extent on the pollutional load.

One approach towards the determination of the oxygen level in a stream is to determine each of the above oxygen influences under any conditions that may be encountered and then, by more or less simple addition, obtain the end result. At the present state of our knowledge this method is difficult to apply because the quantitative relationships necessary to determine a, b, and c, are not completely determined and their addition is far from simple.

A second and complementary approach to the problem is the pragmatic prognistication of the end result in a stream by extrapolation of past results without recourse to cause and effect relationships. This method requires a precise handling of observational data which is admirably supplied by statistical methods.

It is this second method which has been refined and developed by the Interstate Sanitation Commission staff and has been reported in previous technical reports of the Commission.

The underlaying basis of the Commission method is that almost all changes in tidal waters are cyclical in character. The method does not presuppose that only one cyclical change is taking place. There can be a number of super-imposed cyclical changes which in their totality can describe the changes encountered. Moreover, by use of the Commission method one is able to determine the conformance of the observational data to the cyclical changes, i.e. to observe whether there actually are cyclical changes.

The Commission method yields three basic constants as the result of analysis for any cyclical pattern.

1. K_1, the average value of dissolved oxygen, MPN/ml. or any other observed stream characteristic, about which the other values fluctuate.

2. K_2, the amplitude or one half of the total variation to be expected. Thus for a maximum value one adds K_2 to K_1, for a minimum value one subtracts K_2 from K_1.

3 t_o, the elapsed time from an arbitrary starting point at the end of which period of elapsed time the average value first occurs.

For tidal cycle analyses the arbitrary starting time used by the Commission is the time of maximum ebb current, although the time of maximum flood, the time of flood or ebb slack, or any other time can be used. Since the maximum value, according to the Commission method of analysis, occurs at one quarter of a cycle after the average value first occurs, the time of occurence of the maximum value is fixed after t_o is determined.

Once the analysis has been completed for any body of observational data, one can at once state with confidence the central value about which the other values cluster (K_1) the magnitude of the fluctuations (K_2) and the time of occurence of the maximum value (t_o+1/4 cycle).

Although the end result desired for each cyclical analysis is easy to determine there are a variety of computational methods to reach the end, result. Three methods have been devised and used by the Commission staff, all of them variations on the basic Commission method. The methods are described as (1) Rigorous, (2) Semi-rigorous, and (3) Approximate. The approximate method is applicable to the analysis of data which is equally spaced throughout the cycle under study. The semi-rigorous method is applicable to the analysis of data where the data is not equally spaced throughout the cycle as for instance where one quarter of a tidal cycle has been sampled. The rigorous method is applicable where two or more cycles of approximately equal importance are to be analyzed and the samples are irregulary spaced throughout the cycles. The amount of computational time in each of the methods (1), (2), and (3) are in the ratios of 120:6:1, and to date because of this only methods (2) and (3) have been extensively employed.

In the body of this report following method (2), the semi-rigorous, has been used except as noted.

INTERPRETATION OF RESULTS

Profiles

The samples obtained during the survey of September 6, 1955 enable a plotting of the Arthur Kill surface profile from Outerbridge to the southern mouth of the Kill. Figures 2, 3, and 4 present profiles for: salinity (as percent seawater); dissolved oxygen (as percent of saturation); and log (MPN/ml.), respectively.

The salinity profile demonstrates the rather complicated regimen of tides and currents that existed at the time of the survey.

Data for the salinity values in Figure 2 are obtained from Tables I, II, and IV. The plotted values are the "average" values (K_1 values) which were gotten from the statistical analyses. The more complete data of Stations 1, 2, and 3 were used to correct the single sample values of salinity obtained. (For details of this obtention see Table IV.) It is evident from Figure 2 that sampling took place primarily during the flood current influence period and hence the profile is more representative of the flood rather than the ebb period.

The average salinity values shown in Figure 2 indicate that the water area in the vicinity of Stations 1, 2, and 3 is subject to two influences:

1. The comparatively fresh water in the Channel 5-4; and
2. The comparatively salt water in the Channel 6-7.

TABLE I

SUMMARY OF STATISTICAL ANALYSES

September 6, 1955

STATION I	K_1	K_2	to(degree
D.O. (ppm)	3.89	0.27	341.
D.O. (% Sat.)	48.97	2.64	310.
Salinity (% Seawater)	63.66	2.60	210.
Temp. (°C.)	21.56	1.53	213.
*MPN/ml.	14.90	26.21	229.
*Log MPN/ml.	1.08602	1.66666	219.
*Anti-log MPN/ml.	12.19	46.41	-

STATION 3			
D.O. (ppm)	3.57	0.42	65.
D.O. (% Sat.)	45.28	4.38	73.
Salinity (% Seawater)	62.48	4.70	218.
Temp. (°C.)	22.08	1.05	216.
*MPN/ml.	10.75	19.56	233.
*Log MPN/ml.	0.94183	1.95450	210.
*Anti-log MPN/ml.	8.75	90.05	-

*By approximate method

TABLE II

SUMMARY OF STATISTICAL ANALYSES

September 6, 1955

STATION 2T	K_I	K_2	to(degre
D.O. (ppm)	3.19	0.81	169.
D.O. (% Sat.)	40.34	11.34	173.
Salinity (% Seawater)	57.26	10.74	198.
Temp. (°C.)	22.86	0.29	314.
*MPN/ml.	15.20	24.94	226.
*Log MPN/ml.	1.14955	1.69265	216.
*Anti-log MPN/ml.	14.11	49.28	-
STATION 2M			
D.O. (ppm)	2.54	1.21	182.
D.O. (% Sat.)	32.22	16.45	183.
Salinity (% Seawater)	64.61	3.59	206.
Temp. (°C.)	22.11	0.70	218.
*MPN/ml.	12.08	21.97	234.
*Log MPN/ml.	1.00524	1.57600	222.
*Anti-log MPN/ml.	10.12	37.67	-
STATION 2B			
D.O. (ppm)	3.46	0.39	102.
D.O. (% Sat.)	44.72	4.91	103.
Salinity (% Seawater)	67.10	3.01	170.
Temp. (°C.)	22.45	0.28	301.
*MPN/ml.	12.20	19.17	216.
*Log MPN/ml.	0.94309	1.52640	221.
*Anti-log MPN/ml.	8.77	33.60	-

* By approximate method

TABLE III

SUMMARY OF STATISTICAL ANALYSES

October 3, 1955

STATION I	K_1	K_2	to(degre
ph	7.47	0.07	235.
Salinity °/00	13.60	0.37	206.
Temperature °C.	18.79	0.95	331.
Dissolved Oxygen ppm	3.95	0.74	192.
% Saturation	47.35	8.40	196.
B.O.D. ppm	1.02	0.36	12.
MPN/ml.	20.22	13.16	14.
Log MPN/ml.	1.23	0.32	23.
Anti-Log MPN/ml.	17.	2.1	
STATION 2			
ph	7.23	0.06	223.
Salinity °/00	13.05	0.35	206.
Temperature °C.	18.20	0.94	322.
Dissolved Oxygen ppm	3.82	0.70	189.
% Saturation	45.20	6.45	206.
B.O.D. ppm	1.15	0.44	41.
MPN/ml.	27.85	12.54	19.
Log MPN/ml.	1.37	0.12	51.
Anti-Log MPN/ml.	24.	1.3	
STATION 3			
ph	7.19	0.05	279.
Salinity °/00	13.19	0.27	168.
Temperature °C.	18.15	1.00	336.
Dissolved Oxygen ppm	3.24	0.42	185.
% Saturation	38.58	4.36	192.
B.O.D. ppm	0.94	0.20	335.
MPN/ml.	96.17	20.85	149.
Log MPN/ml.	1.82	0.03	18.
Anti-Log MPN/ml.	66.	1.1	

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If one conceives of Arthur Kill to be a fresh water stream such as the Raritan River then it would be reasonable to expect a decrease in salinity as one proceeds upstream, i.e. along Stations 4-5-1-2-3-9-8- or along Stations 7-6-1-2-3-9-8. That this is not the case is shown by Figure 2 in which appears that there is only a slight change from Station 1 to Station 8 and indeed it appears that there was a slight increase in salinity Station 1 to 8. The fact that ship channel 5-4 contained much fresher water than channel 6-7 can of course be attributed to the relative closeness of channel 5-4 to the mouth of the Raritan River. However, the t_o values of approximately 200 degrees for both the September 6 and October 3 surveys indicate that maximum salinity values are obtained at the end of the flood current period. Since the flood currents are directed to the North, in the area of Arthur Kill that was surveyed, this demonstrates that there is an increase of salinity to the south of Arthur Kill.

For a fresh water stream there are considerable changes in salinity over a tidal cycle in the upper layers of the stream. Salinity changes at the surface over a tidal cycle are frequently 2 1/2 to 10 times change at middle and bottom layers as indicated (by previous Commission surveys, notably those of the Raritan River.)

In summary, the surveys showed that Arthur Kill is not a fresh water stream although there is a slight increase of salinity apparent from Woodbridge Creek to Tottenville. Inasmuch as there is little to no net fresh water flow apparent in the southern Arthur Kill (as shown by the salinity pages) it is further evident that some other natural agency will be of prime importance in the natural purification of wastes contained in these waters. From the consideration of the average salinity values obtained it appears that portion of the fresh water at Station 4 that reaches Outerbridge is diluted with about 65% of Bay water before it reaches Outerbridge.

There may well be substantially different profiles for flood current and ebb current surface conditions. In the flood current period "pockets" of relatively fresh water are probably interspersed in the flooding salt water, since the flooding waters may enter Arthur Kill through either channel 4-5 or channel 7-6, each of which channel have substantially different salinities. On the ebb current it is to be expected that a lesser difference will be apparent in these channels since the channels would be dominated to a greater extent by the ebbing Raritan River waters.

The dissolved oxygen profile shown in Figure 3 indicates that conditions in the northern portion of Arthur Kill are considerably worse than conditions in either Raritan Bay or the mouth of the Raritan River. (Compare Station 8 with either Station 4 or 7) However, as previously noted for the salinity values in Figure

2, the conditions shown here are more truly representative of flood current conditions. A previous report of the Commission (Technical Report Number 55-8) indicates that the average dissolved oxygen at Victory Bridge was at approximately 70% percent of saturation, which is of course considerably higher than that appearing near Outerbridge (about 40 percent of saturation). Therefore, in view of all the Commission survey data it appears that the major site of depressed dissolved oxygen values in Arthur Kill are to the north of Outerbridge, rather than the Raritan River waters. However, it is necessary to exercise caution on the comparative effects of the Raritan River and Arthur Kill on Raritan River. For it would appear that although wastes discharged to Arthur Kill are responsible for the low saturation values in Arthur Kill the mobility of the wastes in the Raritan River waters are more responsible for the general level of saturation in the inner portion of Raritan Bay.

Coliform concentration as MPN's per milliliter are shown in Figure 4. This profile indicates that fairly large concentrations of coliform organisms are associated with the low dissolved oxygen concentrations in the Arthur Kill. Similarly, it appears that approximately equal concentrations of coliforms are present at Station 4 which station represents the concentrations in the Raritan River water. However, as noted above for dissolved oxygen concentrations, it appears that the effect of the coliform organisms in the Raritan River waters is of much greater importance to inner Raritan Bay due to the fresh water flow from the Raritan River. In effect the lack of river flow in Arthur Kill localizes the pollutional effects.

Cross Sections

Both the September 6 and October 3 surveys indicate a surprising lack of lateral stratification. Stations 1, 2t, and 3 show little to no difference in salinity, temperature, and dissolved oxygen. There is a higher coliform concentration evident in the vicinity of Station 3 for the October 3 survey, however, this was probably due to the discharge from Tottenville sewer outfall. That this same comparatively high average count was not experienced for the September 6 survey as compared to the October 3 survey (10.75 MPN/ml. versus 66. MPN/ml.) can be attributed to the fact that it was necessary to obtain samples closer to the outfall on October 3 than on September 6.

The vertical cross section obtainable from the data of the September 6 survey (Stations 2T, 2M, and 2B) indicate that there is as little vertical stratification as surface horizontal stratification.

In all the cross section of Arthur Kill near Tottenville appears to be typical of a tidal strait with comparatively minor fresh water flows.

CONCLUSIONS

The described surveys of the Commission indicate that:

a. There is a negligible amount of fresh water flow emanating from the southern end of Arthur Kill.

b. The Kill waters are comparatively well mixed both laterally and vertically.

c. Pollutional conditions are generally worse as one proceeds northward up Arthur Kill especially as regards dissolved oxygen concentrations. (About 40% of saturation at Outerbridge).

d. Due to the lack of net flow out of the Kill, pollutional conditions of the Kill are primarily attributable to pollution sources discharging into the Kill.

An examination of pollution sources discharging to the Kill in the vicinity of the survey area shows three main pollution sources.

1. Raw sewage discharge from Tottenville, estimated at 5000 people.

2. Treated sewage effluent from the Woodbridge Sewage Treatment Plant. With an influent population of 21,000 it is estimated that the effluent is equivalent to a population of 4700 (estimated on the basis of Commission samples).

3. Wastes contained in Woodbridge Creek, estimated at less than 1000 population equivalent.

From a cursory examination it appears that these wastes are not sufficient to depress dissolved oxygen levels to the extent observed. This would indicate that major pollutional sources are extant "upkill" of the survey area.

SURVEY METHODS

Sampling Stations

Sampling was conducted at each of the stations indicated with the frequency indicated below.

Station No.	Number of Samples
1	21
2 Top	21
2 Middle	4
2 Bottom	4
3	21
4	1
5	1
6	1
7	1
8	1
9	1

All samples, except those at 2-Middle and 2-Bottom, were at a depth of five feet while 2-Middle and 2-Bottom were at depths of fifteen (15) and thirty (30) feet respectively.

Sampling Methods

All samples were obtained by means of a 2.2 liter Foerst water sampler. The sampler was lowered to the desired depth and then closed by means of a metal messenger. (See figure) Once at the surface the samples were discharged into a standard dissolved oxygen bottle. About 1000 milliliters were allowed to flow through the dissolved oxygen bottle and another 900 milliliters through a bottle for the biochemical oxygen demand sample. The "spillover" from the dissolved oxygen and biochemical oxygen demand samples was collected in a quart mason jar, which jar was retained for further analysis of salinity and pH. The temperature of the water samples were obtained by means of a Weston Dial Thermometer (0 to 50°C.) from the "spillover" portion of the samples.

Laboratory Procedures

A temporary field laboratory was established for the October 3 survey; in the Perth Amboy waiting room of the Perth Amboy to Tottenville ferry.

Dissolved oxygen determinations were made in the field laboratory whereas for the September 6 survey dissolved oxygen samples were transported to the Commission laboratories at 110 William Street for analyses However, in both instances the samples were "fixed" immediately after obtaining the samples.

For both surveys lactose tubes were innoculated in the field for the determination of the Most Probable Number of coliform organisms (MPN/ml.). The tubes were then stored without refrigeration until the end of the survey day when they were transferred to 35°C. incubators in the Commission laboratory.

pH, Biochemical Oxygen Demand (BOD) and salinities were all determined in the laboratory rather than the field, and "Standard Methods for the Examination of Water and Sewage" (1955 Edition) was used as a guide, whereever applicable.

A P P E N D I X

INVESTIGATION: Arthur Kill and Middlesex County Outfall Site

DATE: September 6, 1955

INVESTIGATORS: Cross, F.; De Falco, Jr.,P.; Diachishin, A.

MAX. EBB CURRENT	03:13) 15:45)	NARROWS E.S.T.
MAX. FLOOD CURRENT	08:29) 20:57)	ARTHUR KILL E.S.T.

The current direction was slack to ebbing for the major portion of the survey.

Samples were taken from the Supervisor of New York Harbor Vessel Mamonet.

Climatological

Wind direction - SE to ESE from 8-12 M.P.H.

Weather - Hazy to clear

Air Temperature - 23° - 25°C.

INVESTIGATION: Arthur Kill, between Perth Amboy and Tottenville, in the ferry lane.

DATE: October 3, 1955

INVESTIGATORS: Gross, F.; De Falco, Jr., P.; Boxer, J. Diachishin, A.

MAX. EBB CURRENT	02:07 14:41	)	NARROWS EST
MAX. FLOOD CURRENT	08:08 20:37	)	ARTHUR KILL EDST

The current direction was slack until 3:30 P.M. and then became North until end of survey.

SAMPLES: All samples are surface samples, 5 feet

Station I
a) Location Perth Amboy, New Jersey

Station 2
a) Location Mid-channel

Station 3
a) Location Tottenville, Staten Island

Samples were taken from Perth Amboy - Tottenville ferry.

Climatological

Wind direction was North at a velocity of approximately 12-15 MPH until noon time. The direction then became NE until 3:00 P.M. reducing velocity to approximately 3-5 MPH. Afterwards the direction became E with a velocity of approximately 1-3 MPH until 6:00 P.M. The velocity then increased to 12-15 with the direction still E until the end of survey.

The weather was cloudy in the morning and cleared up in the late afternoon. The air temperature varied from a low of 13.5°C. - to a high of 24.2°C.

ARTHUR KILL SURVEY - SEPTEMBER 6, 1955

Station No.	Time EDT	pH	Chlorides ppm	% Sea Water	Temp. °C	Dissolved Oxygen obs. ppm	Dissolved Oxygen % Sat.	BOD ppm	MPN per ml.
1	11:48	7.39	11640	65	22.4	3.60	46.2	1.19	7.8
	12:39	7.32	11880	66	22.7	3.70	47.9	1.43	7.8
	14:15	7.32	11830	66	23.2	3.70	48.3	1.91	33.
	14:51	7.35	11870	66	22.8	3.90	50.5	2.09	11.
2	11:40	7.33	11550	64	22.6	4.00	51.3	1.47	7.8
	12:33	7.37	12200	68	22.6	3.91	50.6	1.65	13.
	14:10	7.38	11910	66	22.9	3.79	49.2	1.77	17.
	14:46	7.29	11890	66	22.9	3.39	44.0	1.49	23.
2M	11:42	7.30	12070	67	22.3	3.50	45.0	1.18	4.5
	12:35	7.33	12050	67	22.8	3.90	50.6	1.82	7.8
	14:12	7.39	12380	69	22.6	3.25	42.2	0.91	13.
	14:48	7.31	11980	67	22.9	3.30	42.9	0.82	23.
2B	11:44	7.42	12660	70	22.2	3.69	47.7	1.26	1.8-
	12:37	7.39	12560	70	22.3	3.60	46.6	1.01	23.
	14:14	7.39	12340	69	22.5	3.20	41.5	1.18	13.
	14:50	7.33	12230	68	22.6	3.20	41.5	1.00	11.
3	11:36	7.29	11590	64	22.5	3.59	46.0	1.27	4.5
	12:30	7.23	11870	66	22.8	3.50	45.3	1.37	4.5
	14:07	7.38	12010	67	23.2	3.10	40.5	1.05	17.
	14:45	7.32	12040	67	23.0	3.20	41.7	2.18	17.
4	11:56	7.17	10730	60	22.6	3.98	50.7	1.07	17.
5	11:52	7.38	11790	65	22.3	4.08	52.3	1.16	4.5
6	12:17	7.48	12710	71	22.4	4.20	54.5	1.18	2.0
7	12:15	7.42	12770	71	22.3	4.40	57.1	1.46	1.8-
8	11:25	7.39	11830	66	23.8	3.10	40.8	1.05	17.
9	11:30	7.29	12160	68	22.4	2.99	38.6	0.54	13.

ARTHUR KILL SURVEY - OCTOBER 3, 1955
S T A T I O N 1

Time EDT	pH	Chlorides ppm	Sea H_2O %	T °C.	Dissolved O_2 obs. ppm	Dissolved O_2 sat. ppm	Dissolved O_2 % sat.	BOD ppm	MPN per ml.
9:10	7.08	13260	74	17.0	4.2	8.5	49	1.1	13.
9:50	7.11	13510	75	17.2	3.8	8.5	45	0.8	4.5
10:20	7.42	13400	74	17.1	5.1	8.5	60	0.4	13.
10:50	7.29	13390	74	17.1	4.9	8.5	58	0.3	13.
11:20	7.25	13330	74	17.3	4.3	8.5	51	1.0	6.8
11:50	7.29	13410	74	17.6	4.7	8.4	56	0.8	17.
1:19	7.19	13270	74	18.4	3.4	8.3	41	0.9	13.
1:48	7.29	13330	74	19.0	3.8	8.2	46	0.6	4.5
2:17	7.19	13250	74	18.0	3.6	8.3	43	0.9	4.
2:46	7.23	13370	74	18.6	4.7	8.2	57	1.0	17.
3:20	7.29	12990	72	18.9	3.5	8.3	42	1.0	17.
3:50	7.22	13010	72	18.9	4.0	8.2	49	1.0	49.
4:20	7.15	12990	72	19.0	2.9	8.3	35	1.3	31.
4:48	7.27	12830	71	19.0	3.2	8.2	39	1.2	49.
5:18	7.27	12830	71	19.1	2.9	8.2	35	1.8	33.
5:48	7.09	12570	70	18.6	3.2	8.3	39	1.5	23.
6:20	7.10	12590	70	18.6	2.7	8.3	33	1.2	23.

ARTHUR KILL SURVEY - OCTOBER 3, 1955
S T A T I O N 2

Time EDT	pH	Chlorides ppm	Sea H_2O %	T °C.	Dissolved O_2 obs. ppm	Dissolved O_2 sat. ppm	Dissolved O_2 % sat.	BOD ppm	MPN per ml.	Remarks
9:30	7.22	13370	74	17.4	3.9	8.4	46	0.9	6.8	
10:07	7.23	13370	74	17.4	4.6	8.4	46	0.4	23.	
10:40	7.33	13430	75	17.1	4.4	8.5	52	0.7	13.	Driftwood - med.
11:05	7.38	13170	73	17.5	4.2	8.4	50	0.9	79.	
11:37	7.21	13410	74	17.5	4.6	8.4	55	1.0	33.	
12:05	7.29	13260	74	17.9	4.7	8.4	56	1.0	13.	
1:40	7.31	13160	73	18.8	4.2	8.2	51	1.0	17.	
2:03	7.23	13160	73	18.8	3.9	8.2	48	1.5	23.	
2:34	7.22	13090	73	18.9	3.5	8.2	43	1.0	17.	
3:05	7.21	13030	72	19.0	4.0	8.2	49	1.2	13.	
3:37	7.19	13030	72	19.0	3.2	8.2	39	1.1	22.	
4:09	7.28	12910	72	19.3	3.1	8.2	38	1.1	33.	
4:35	7.31	13040	72	19.0	2.8	8.2	34	1.4	49.	
5:10	7.22	12770	71	19.1	3.2	8.2	39	1.2	33.	
5:37	7.19	12860	71	19.0	2.9	8.2	35	2.3	23.	
6:05	7.12	12230	68	18.0	3.7	8.4	44	1.2	33.	
6:40	7.09	12560	70	18.4	3.4	8.3	41	1.3	33.	

ARTHUR KILL SURVEY - OCTOBER 3, 1955

STATION 3

Time EDT	pH	Chlorides ppm	Sea H_2O %	T °C.	Dissolved O_2 obs. ppm	sat. ppm	% sat.	BOD ppm	MPN per ml.	Remarks
9:20	7.11	14300	79	17.4	3.9	8.4	46	1.0	33.	
9:56	7.08	13330	74	17.1	3.6	8.5	42	0.7	33.	
10:26	7.29	13250	74	17.1	4.2	8.5	49	1.0	350.	
10:56	7.22	13210	73	17.2	3.9	8.5	46	0.7	170.	Sewage - sl.
11:28	-	13190	73	17.2	3.4	8.5	40	0.9	23.	
11:57	7.21	13270	74	17.6	3.4	8.4	40	0.8	23.	
1:26	7.19	13270	74	18.5	1.6*	8.3			170.	Driftwood & garbage - sl.
1:57	7.17	13290	74	18.6	3.4	8.3	41	1.0	130.	Sewage - sl.
2:25	7.22	13140	73	18.6	3.7	8.3	45	1.5	33.	Garbage - sl.
2:55	7.19	13210	73	18.9	3.2	8.2	39	1.1	33.	
3:27	7.29	13200	73	19.0	3.4	8.2	41	1.3	49.	Sewage, fecal matter, contraceptives
3:57	7.29	12960	72	19.0	4.3	8.2	52	1.1	49.	Sewage, contraceptives
4:26	7.22	12810	71	19.0	3.0	8.2	37	1.2	79.	
4:55	7.27	12790	71	19.0	2.9	8.2	35	1.1	170.	Sewage, fecal matter
5:25	7.19	12600	70	19.4	2.4	8.2	29	1.4	130.	Fecal matter, sewage
5:55	7.15	12870	71	18.9	1.3	8.3	16	0.4	79.	Driftwood
6:27	7.11	13030	72	18.4	3.0	8.3	36	1.7	31.	

- Lost * Results doubtful.