1958 UPPER NEW YORK HARBOR SURVEY

INTERSTATE SANITATION COMMISSION

New York
New Jersey
Connecticut

1958 UPPER NEW YORK HARBOR SURVEY*

*Excerpted from
1959 Annual Report
of the
Interstate Sanitation Commission

UPPER NEW YORK HARBOR SURVEY

INTRODUCTION

Water area surveys are necessary to evaluate the effectiveness of a pollution abatement program. Such surveys furnish information on minimum treatment required to obtain conditions for best usages of District waters. Under the continuation of its expanded program, the Interstate Sanitation Commission conducted such a water pollution survey in the Upper New York Harbor.

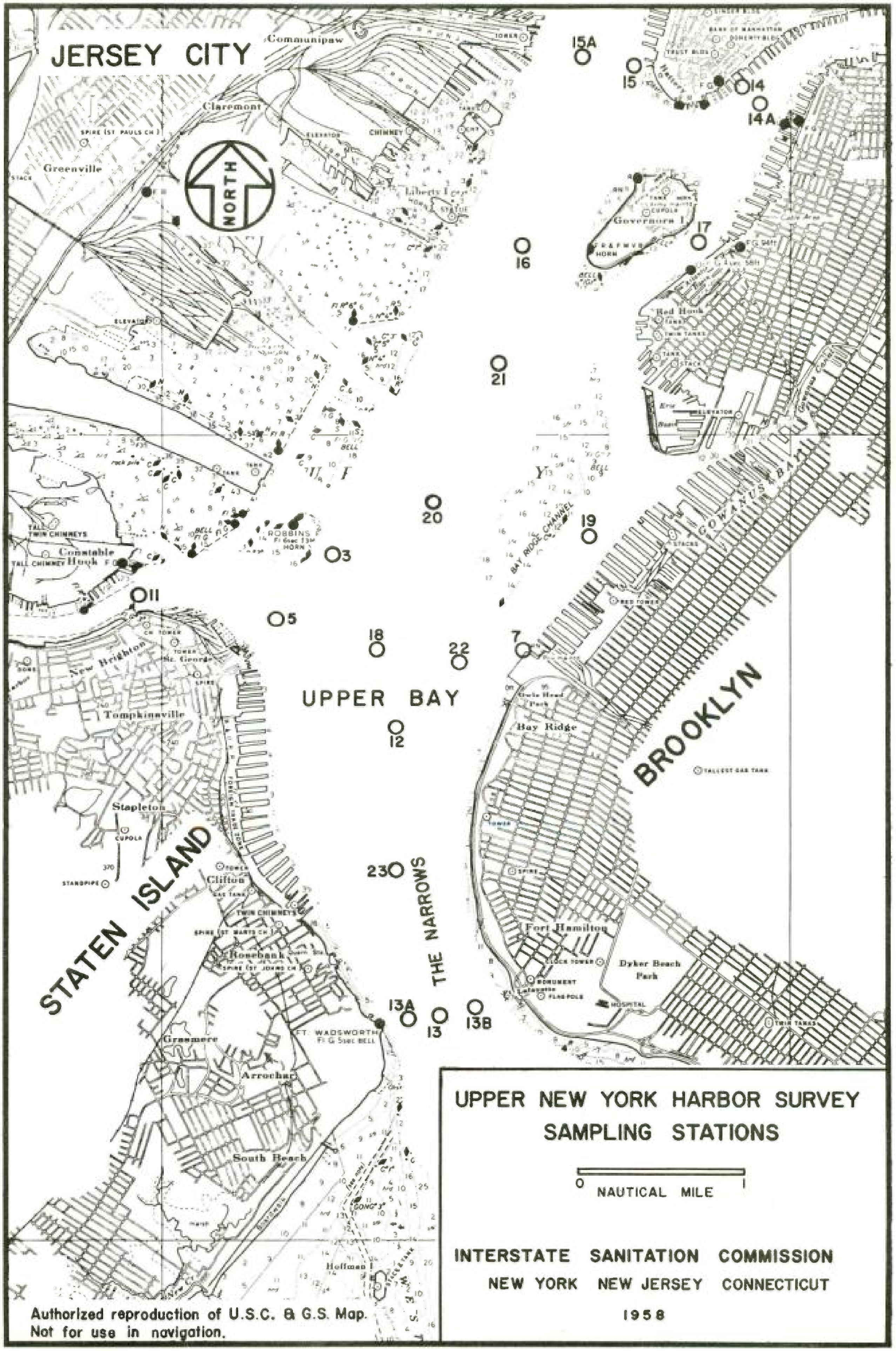
The Upper Harbor is one of the busiest ports and is bordered by one of the greatest concentrations of population in the country. This body of water is influenced by its connection with the Hudson and East Rivers on the north, by Newark Bay and Arthur Kill through the connecting waterway, Kill Van Kull, on the west and on the south, by the Lower Bay and Atlantic Ocean. A large part of the surrounding population and industry discharges its wastes without treatment into these waters. Interception and treatment are being planned for the remaining raw waste discharges.

The primary purpose of this survey was to determine accurately the present condition of the waters from the Narrows to the Battery. On the basis of this work we have attempted to estimate the future conditions in the Harbor as scheduled pollution abatement projects are completed and as population changes.

PROCEDURE

The map of Upper New York Harbor and the twenty sampling stations used during this survey is shown on the following page. Sampling stations were located so that profiles, representing conditions throughout the principal channels, could be formed. A description of these stations is given on Pages 2, 3 and 4.

The waters of the Upper Harbor were designated as Class "B" after public hearings by this Commission.


JERSEY CITY
Communipaw
Claremont
Greenville
NORTH
Liberty I.
Governors I.
Red Hook
Constable Hook
New Brighton
St. George
Tompkinsville
Stapleton
Clifton
Rosebank
Grasmere
Arrochar
South Beach
Hoffman I.
Owls Head Park
Bay Ridge
Fort Hamilton
Dyker Beach Park
UPPER BAY
THE NARROWS
BAY RIDGE CHANNEL
GOWANUS BAY
STATEN ISLAND
BROOKLYN
15A
15
14
14A
16
17
21
20
19
3
11
5
18
22
7
12
23
13A
13
13B
FT. WADSWORTH
UPPER NEW YORK HARBOR SURVEY
SAMPLING STATIONS
0 NAUTICAL MILE 1
INTERSTATE SANITATION COMMISSION
NEW YORK NEW JERSEY CONNECTICUT
1958
Authorized reproduction of U.S.C. & G.S. Map.
Not for use in navigation.

DESCRIPTION OF SAMPLING STATIONS
in
1958 UPPER NEW YORK HARBOR SURVEY

STATION # 3 At Passaic Valley Outfall (East-West alignment obtained by using Robbins Reef Light and forward Water Power on Naval Dock, North-South alignment using Statue of Liberty and Black Bell Buoy #1-G). Samples are taken here at depths of 5, 20 and 40 feet.

STATION # 5 Middle of ship channel going to Kill Van Kull. East-West alignment is established by aligning Fixed Green Range Lights on Esso Dock, Constable Hook, New Jersey. North-South alignment can be established using line of Black Buoys on main ship channel in Upper Harbor.

STATION # 7 In center of Boil of Owls Head Treatment Plant. Outfall is located opposite the north end of the treatment plant building.

STATION #11 Located in the Kill Van Kull, at mid-channel and directly opposite Flashing Green, Black Buoy #3.

STATION #12 Center of junction of Main Channel with Bay Ridge Channel, 10 yards to west of Flashing Red Gong Buoy #22.

STATION #13 Middle of channel in Narrows (midway between light on Fort Lafayette and light on Fort Wadsworth). Samples were taken at depths of 5, 40 and 80 feet.

STATION #13A 300 yards east of Flshing Green Light on Fort Wadsworth (using same East-West alignment used for Station #13).

STATION #13B 300 yards West of Flashing Red Light on Fort Lafayette (using same East-West alignment used for Station #13).

STATION #14 Ten yards off Pier #11 in East River.

STATION #14A Mid-channel of East River in line with Pier #11 (Manhattan) and Pier #10 (Brooklyn). Samples were taken at depths of 5, 20 and 40 feet.

STATION #15 Ten yards off Pier "A" in the Hudson River.

STATION #15A Mid-channel of Hudson River in line with Pier "A" (Manhattan) and tower on Central Railroad of New Jersey Ferry Pier on Jersey Shore. Samples were taken at depths of 5, 20 and 40 feet.

STATION #16 In main ship channel 10 yards to the East of Flashing Green Bell Buoy #31.

STATION #17 Mid-channel of Buttermilk Channel and opposite Private Bell Buoy #3.

STATION #18 Mid-channel off 69th Street Ferry Dock, Brooklyn. East-West alignment obtained by using two gas holders at rear of 69th Street and two tall smoke-stacks on Constable Hook, N.J. (Note: gas holders do not close in.) North-South line formed by Red Buoys #24, #26 and #28 on main ship channel.

STATION #19 In mid-channel of Bay Ridge Channel, approximately 300 yards off Black Can #5. East-West alignment Black Can #5 and Pier #2 at Bush Terminal.

STATION #20 In main ship channel 10 yards to west of Flashing Red Bell Buoy #26.

STATION #21 In main ship channel 10 yards to west of Flashing Red Bell Buoy #30.

STATION #22 In mid-channel of Bay Ridge Channel. East-West alignment of Flashing Red Beacon on 69th Street Ferry Dock (Brooklyn) and Flashing Bell Buoy #24. North-South alignment of Flashing Green Bell Buoy #3 and Flashing Red Gong Buoy #22.

STATION #23 In mid-channel of main shipping channel. East-West alignment of tower on Fort Hamilton High School, Brooklyn shore with twin chimneys on Merritt, Chapman and Scott Pier at Rosebank, Staten Island. North-South alignment, Flashing Red Gong Buoy #22 with Flashing Green Light on Fort Wadsworth.

The Tri-State Compact requires that in Class "B" waters an average dissolved oxygen content be maintained, at the five foot depth, of not less than 30 percent saturation during any week of the year. Therefore, during this survey all samples were taken at the five foot depth.

Two boats were used with each covering one half the sampling stations. The survey was started on June 16, 1958 and was terminated August 14, 1958. Each station was sampled three times a day, and four days a week for nine weeks. Chlorides, temperature, pH and dissolved oxygen were determined on all samples taken.

Five weeks of sampling had been completed when the Passaic Valley Sewage Treatment Plant found it necessary, due to construction, to bypass its entire two weeks of sampling to measure the effect during the time of bypassing and two weeks to measure the recovery after primary treatment was resumed.

The data was obtained and analyzed in general as outlined in Appendix "B" of the 1958 Annual Report of the Interstate Sanitation Commission. Although the curve of best fit was sinusoidal for some stations, others were best described by other types of curves.

DISCUSSION

General

The Commission's intensive sampling program was conducted in such a manner as to obtain a quantitative estimate of the quality of the waters. Since we are interested in the general condition of the harbor, no attempt was made to investigate specific local shoreline points. The principal movement of water is over the main channel stations - 13, 23, 12, 18, 20, 21, 16 and 15A. (These station numbers do not run consecutively since they are a combination of new and old stations used in various harbor studies.) Another profile of concern is from the center of the main channel through Buttermilk Channel and to the

East River (described by Sampling Stations 21, 17 and 14A).

The subject of currents in the Upper New York Harbor is covered in existing publications. It will suffice here to state that during the flood phase of the current cycle, the principal movement of water is through the Narrows, up the harbor toward the Hudson and East Rivers. Also, part of the flood waters go in a westerly direction through the Kill Van Kull. During the ebbing phase, the current reverses and flows in general from the Hudson and East Rivers in a southerly direction and out through the Narrows. The ebbing waters of Kill Van Kull flow into the Upper Harbor and then in a southerly direction out through the Narrows.

Results Obtained

The weighted mean percent saturation of dissolved oxygen and chloride concentrations observed at each of the sampling stations are given in Table I. The values listed as Set I are those obtained during the first five weeks of the survey. During this period, a portion of the sedimentation tanks of Passaic Valley were out of service for modernization. This reduced the sedimentation capacity and made it necessary to bypass the excess flow into Newark Bay. The treated portion was discharged at Robbins Reef. Thus, the values observed during Set I are higher than would have been observed if all flow had been discharged directly into the harbor. The values under Set II represent the conditions existing for two weeks during the time when Passaic Valley was bypassing its total untreated flow to the harbor at Robbins Reef. Set III gives the conditions observed during the two weeks immediately after treatment was resumed. During Set III the majority of the flow was discharged after treatment into New York Harbor and the untreated portion of flow into Newark Bay. This bypassing was due to an unanticipated construction problem.

Plate I shows the Percent Saturation of Dissolved Oxygen versus Sampling Stations along the

T a b l e I

MEAN PERCENT SATURATION OF DISSOLVED OXYGEN
and
CHLORIDE CONCENTRATIONS for SETS I, II and III

STATION	MEAN % SATURATION			MEAN PPM CHLORIDES in Thousands		
	Set I	Set II	Set III	Set I	Set II	Set III
13	62.4	43.3	54.3	13.5	14.1	14.0
23	58.5	39.9	51.1	13.3	14.3	13.9
12	55.4	37.3	47.3	13.1	14.1	13.7
18	53.4	36.8	43.3	12.9	13.9	13.6
20	50.0	33.99	43.6	12.7	13.7	13.4
21	46.0	31.76	42.5	12.5	13.5	12.9
16	45.6	30.0	42.0	11.7	12.8	12.2
15A	44.5	29.8	42.5	11.1	12.2	11.9
22	51.3	35.1	44.1	13.1	14.1	13.8
19	41.2	25.9	36.8	13.1	13.7	13.7
17	32.7	21.1	28.0	12.8	13.6	13.4
14A	32.1	21.2	26.7	12.6	13.4	13.2
13A	63.6	44.3	55.8	13.5	14.1	14.0
13B	61.5	42.6	53.8	13.5	14.3	14.0
5	50.1	29.9	38.8	12.5	13.5	13.0
11	48.6	26.87	33.3	12.4	13.1	12.9
15	43.66	28.85	39.3	11.9	12.3	12.5
14	30.7	20.33	26.5	12.9	13.4	13.3
3	53.1	35.8	44.1	12.9	13.8	13.3
7	51.6	37.6	46.8	13.0	13.6	13.4

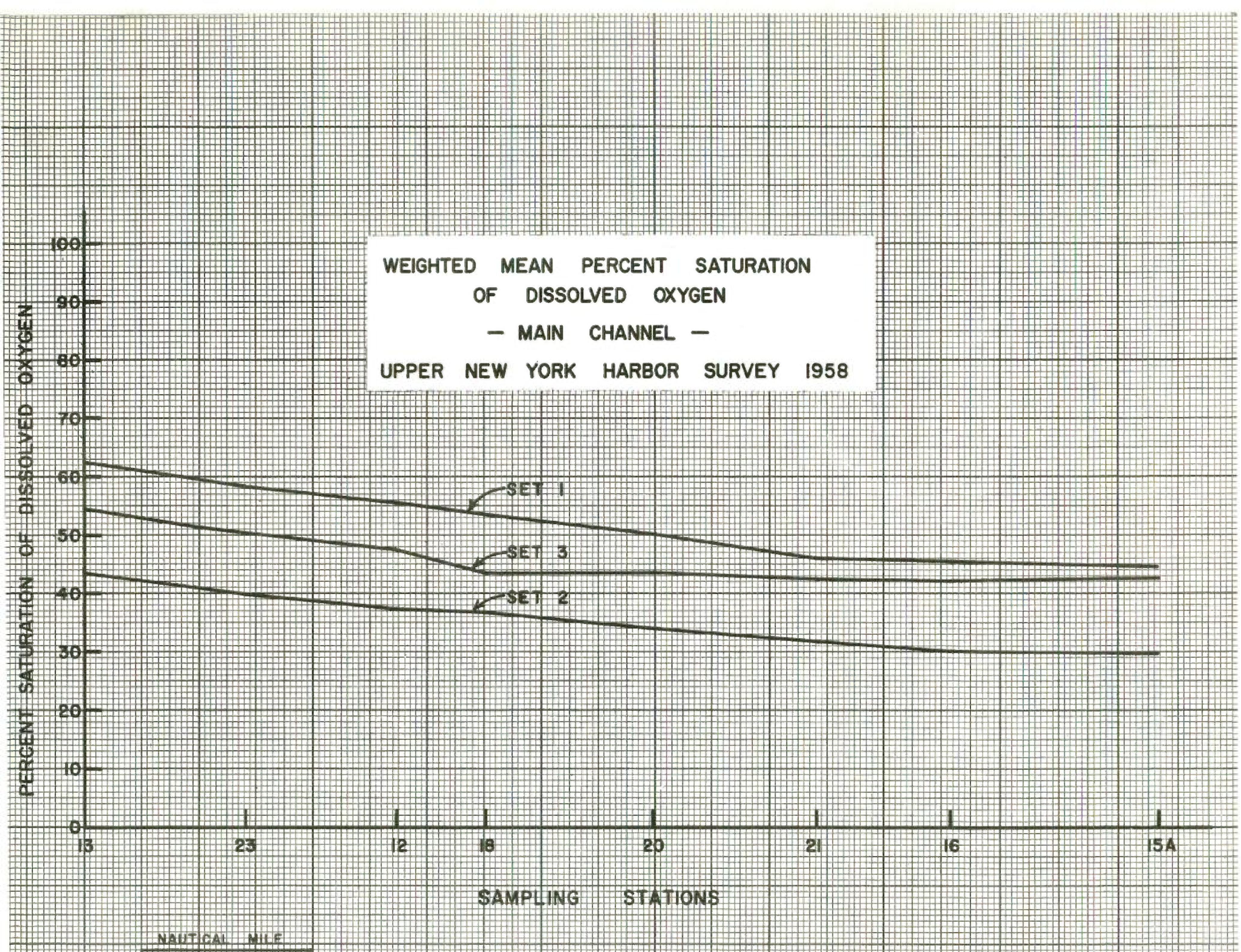

WEIGHTED MEAN PERCENT SATURATION OF DISSOLVED OXYGEN
— MAIN CHANNEL —
UPPER NEW YORK HARBOR SURVEY 1958
PERCENT SATURATION OF DISSOLVED OXYGEN
100
90
80
70
60
50
40
30
20
10
0
SET 1
SET 3
SET 2
13
23
12
18
20
21
16
15A
SAMPLING STATIONS
NAUTICAL MILE
0

PLATE I

main channel. It is interesting to note that the Set I curve varies from a maximum of 62.4 percent at Station 13 (center of Narrows) to a minimum of 44.5 percent at Station 15A (center of Hudson River opposite the Battery). When Passaic Valley started bypassing its flow, it took between two and three days for the full effect of this additional B.O.D. load to be exerted throughout the harbor. The curve marked Set II shows how the observed percent saturation dropped 19.1 percent to 43.3 percent at Station 13. At Station 15A, the value dropped 14.7 percent to 29.8 percent. It is of particular interest to note that the curve in Set II closely parallels the curve in Set I.

The curve for Set I is believed to represent a condition of equilibrium in the Harbor after a period of almost constant pollutional loading. It is felt that the Set II curve serves to illustrate that the effect of a significant change in the pollutional load of the Upper Harbor will result in a curve similar to that in Set I.

The curve in Set III represents the mean condition observed by two weeks of sampling during the recovery period. The bypassing was terminated on August 4, 1958 and the first data used in computing the mean values for Set III is that obtained on August 6, 1958. The last samples were taken on August 14, 1958. The mean condition observed (42.5) at Station 15A indicates that the condition had almost recovered to the original value of 44.5 percent. The pollutional load being discharged into the Harbor during Set III was a little larger than that for Set I. Therefore, a full recovery to the conditions observed in Set I would not be expected. However, if more time had elapsed before the start of sampling for Set III, it is believed that the extra pollution would have moved through the Harbor and a recovery curve would result which would approximately parallel the curve observed in Set I. The degree of recovery observed becomes less and less along the main channel proceeding from the Battery to the Narrows. Thus, the normal seaward flow has moved the extra pollutional load closer toward the Narrows and causes a differential recovery along this profile, due to the slow net movement through the Harbor.

Plate II shows a variation in mean chloride concentration along the main channel for Sets I, II and III. The mean chloride concentrations for Set I were lower than for Sets II and III, while Set III was lower than Set II. Table II gives the mean percent of apparent fresh water observed at each sampling station. These values are obtained by assuming 100 percent sea water to have a chloride concentration of 18,000 p.p.m. This change in the percent of fresh water present at the five foot depth is shown in Plate III. This shows that the amount of fresh water present at the five foot depth was highest for Set I; then, decreased a small amount for Set II and then increased for Set III. The greatest change was a 6.8 percent in fresh water at Station 15A between Sets I and II, while the change between Sets I and III is 3.6 percent. Considering that the average summer runoff of the Hudson River has been estimated at 9,000 cubic feet per second, this would involve changes of approximately 400 and 200 million gallons per day respectively, in the fresh water runoff. The latter change is no greater than the flow from some of the treatment plants. It is not felt that a change of runoff of these magnitudes would be enough to materially affect the flushing time during the survey period. It is believed, however, that larger variations in the Hudson River runoff could affect the flushing time (the time in which the pollution remains in the Harbor) and thus the amount of the pollutional load which is exerted in the Harbor waters.

Plate IV shows a variation in the mean percent saturations of dissolved oxygen and chloride concentrations from the main channel through Buttermilk Channel to the East River. The former profile shows how the mean percent saturation in Buttermilk Channel and East River drops well below the conditions at Station 21 in the main channel. This extra suppression of dissolved oxygen in the East River may possibly be attributed to the large

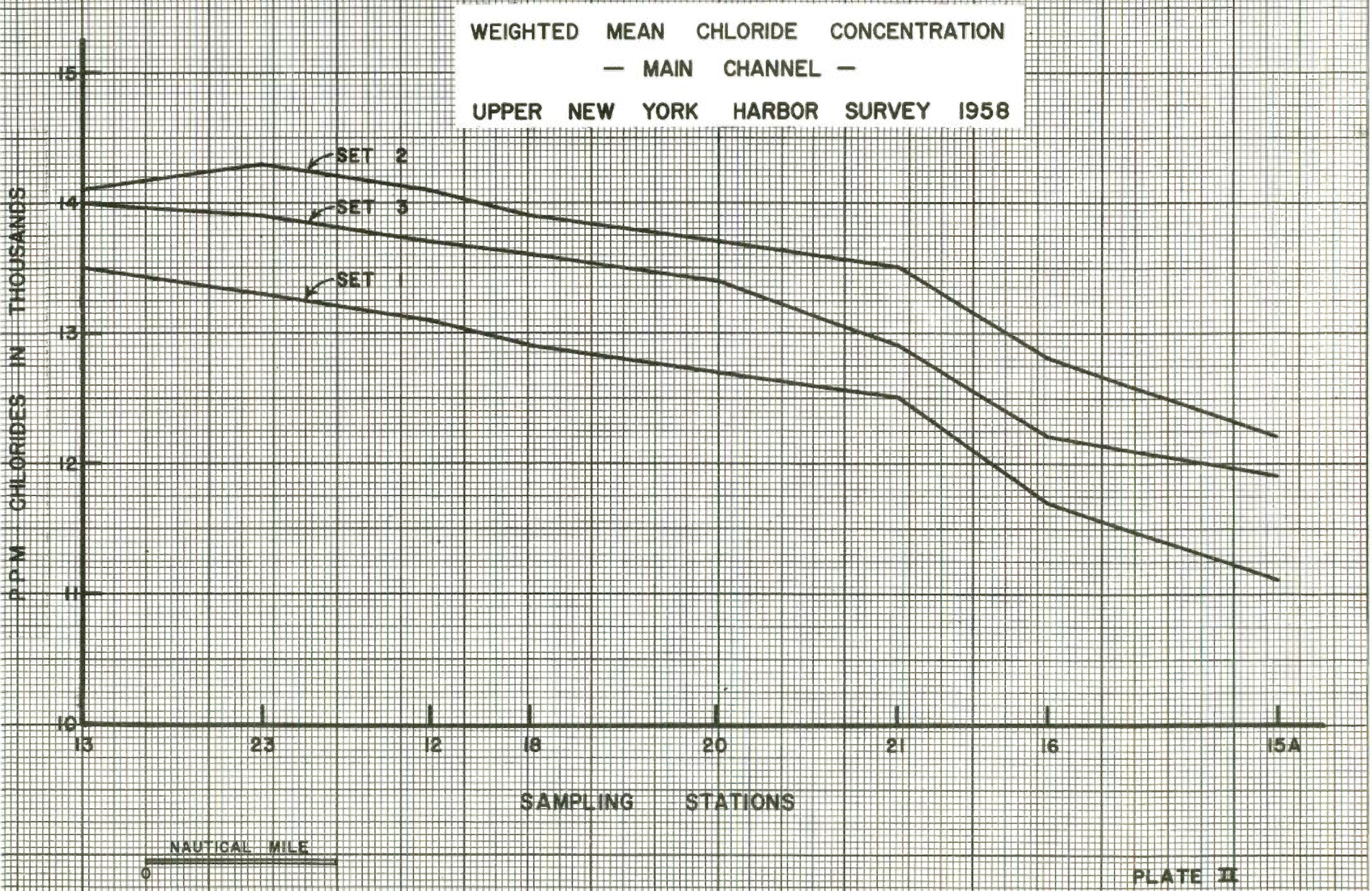
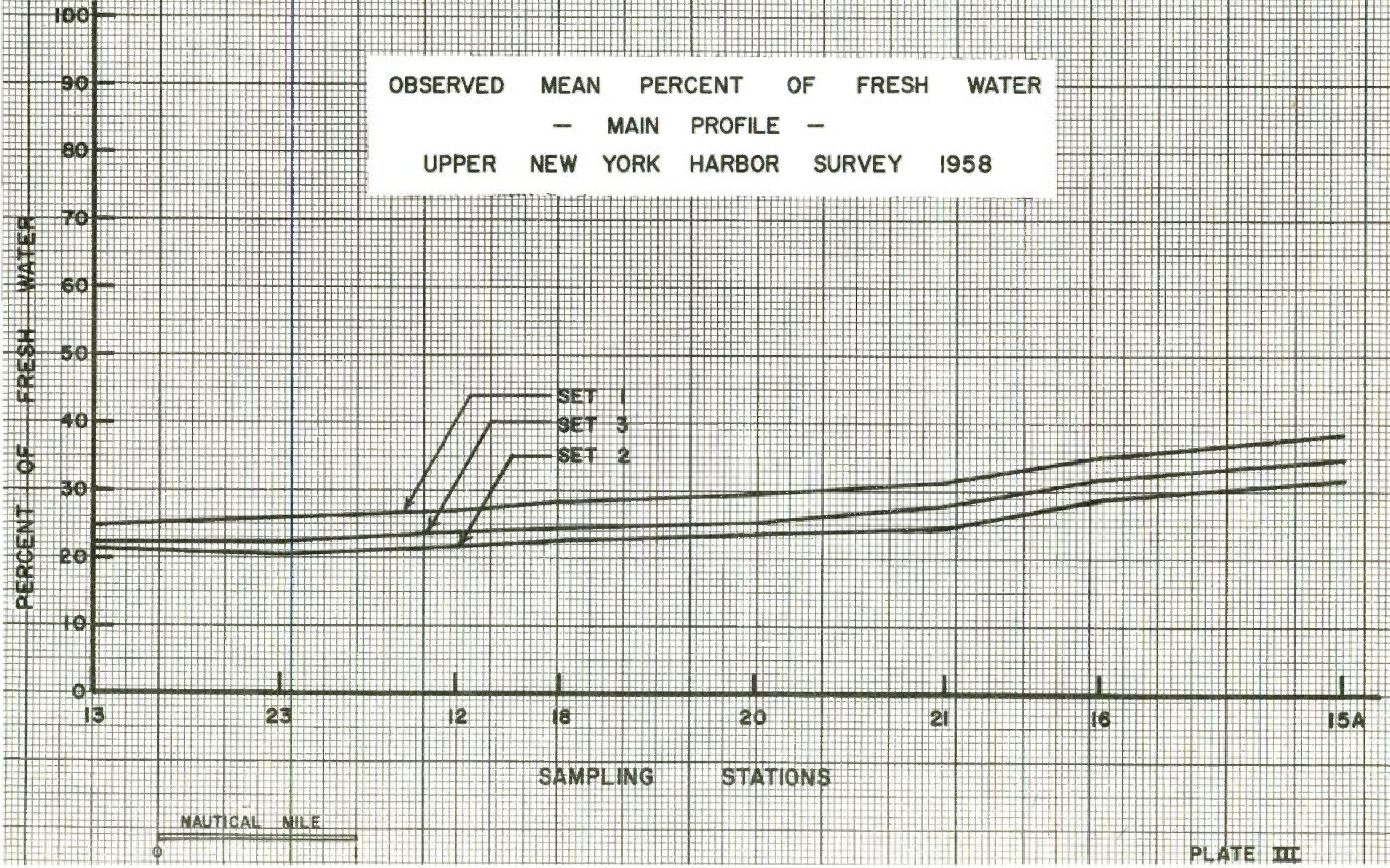

WEIGHTED MEAN CHLORIDE CONCENTRATION
— MAIN CHANNEL —
UPPER NEW YORK HARBOR SURVEY 1958
SET 2
SET 3
SET 1
P.P.M. CHLORIDES IN THOUSANDS
15
14
13
12
11
10
13
23
12
18
20
21
16
15A
SAMPLING STATIONS
NAUTICAL MILE
0

PLATE II

Table II

MEAN PERCENT FRESH WATER OBSERVED
at Each SAMPLING STATION

STATION	PERCENT FRESH WATER Set I	Set II	Set III
13	25	21.4	22.3
23	26	20.5	22.4
12	27	21.6	23.9
18	28.3	22.7	24.6
20	29.6	23.6	25.4
21	31.3	24.6	28.0
16	35.0	28.8	32.0
15A	38.4	31.6	34.8
22	27.2	21.7	23.3
19	27.2	23.9	23.9
17	28.9	24.4	25.6
14A	30.0	25.6	26.7
13A	25	21.7	22.2
13B	25	20.6	22.2
5	30.6	25	27.8
11	31.1	27.2	28.3
15	33.9	31.7	30.6
14	28.3	25.6	26.1
3	28.3	23.3	26.1
7	27.8	24.4	25.6



OBSERVED MEAN PERCENT OF FRESH WATER
— MAIN PROFILE —
UPPER NEW YORK HARBOR SURVEY 1958
PERCENT OF FRESH WATER
100
90
80
70
60
50
40
30
20
10
0
SET 1
SET 3
SET 2
13
23
12
18
20
21
16
15A
SAMPLING STATIONS
NAUTICAL MILE
0
1

PLATE III

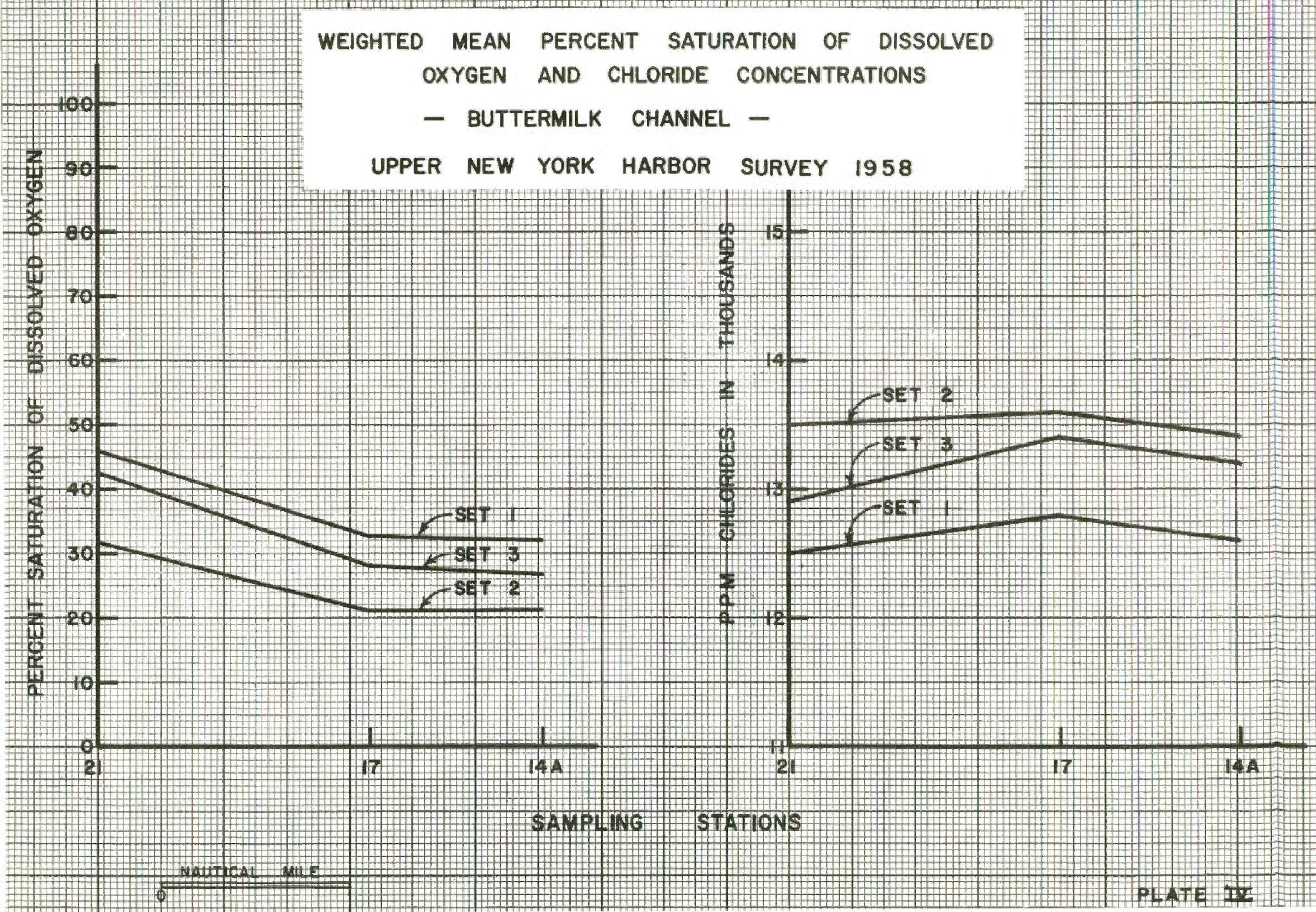

WEIGHTED MEAN PERCENT SATURATION OF DISSOLVED OXYGEN AND CHLORIDE CONCENTRATIONS
— BUTTERMILK CHANNEL —
UPPER NEW YORK HARBOR SURVEY 1958
PERCENT SATURATION OF DISSOLVED OXYGEN
0
10
20
30
40
50
60
70
80
90
100
SET 1
SET 3
SET 2
PPM CHLORIDES IN THOUSANDS
11
12
13
14
15
SET 2
SET 3
SET 1
21
17
14A
21
17
14A
SAMPLING STATIONS
NAUTICAL MILE
0

PLATE IV

amount of pollution in the comparatively smaller waterway together with the apparently poor net flow. Here again it is important to notice the drop in percent saturation (From Set I and Set II) caused by the additional pollutional load.

By referring to Table I it can be seen that there was little difference in the percent saturation values obtained at Stations 13A, 13 and 13B across the Narrows. For Set I a maximum of 63.6 percent saturation was obtained at Station 13A (on the west side) and a minimum of 61.5 percent (on the east side). Considering all three sets of data, the mean values were in all cases lower on the east side. The flow through the Narrows is apparently well mixed since the difference in mean values is small.

The variation indicated by considering Stations 12, 22, and 19 shows the degradation of quality when proceeding from the main channel into the Bay Ridge Channel. (See Plate V) This reflects the influence of the raw sewage discharges along the Brooklyn shore.

The Kill Van Kull also brings pollution into the Upper Bay. The quality of these waters compared with those in the main channel in the Harbor is demonstrated by Plate V which shows the mean percent saturation values at Stations 11, 5 and 18. The saturation values dropped from a mean of 53.4 percent in the main channel to 48.6 percent at the mouth of the Kull.

The observed hourly variations in the percent saturation of dissolved oxygen showed that the values rose and fell with the flooding and ebbing current. However, no slug of pollution similar to that found in the Arthur Kill was defined in the Upper Harbor due to the net discharge through the Narrows.

<u>Future Sampling in Upper Harbor</u>

The curves obtained for the percent saturation

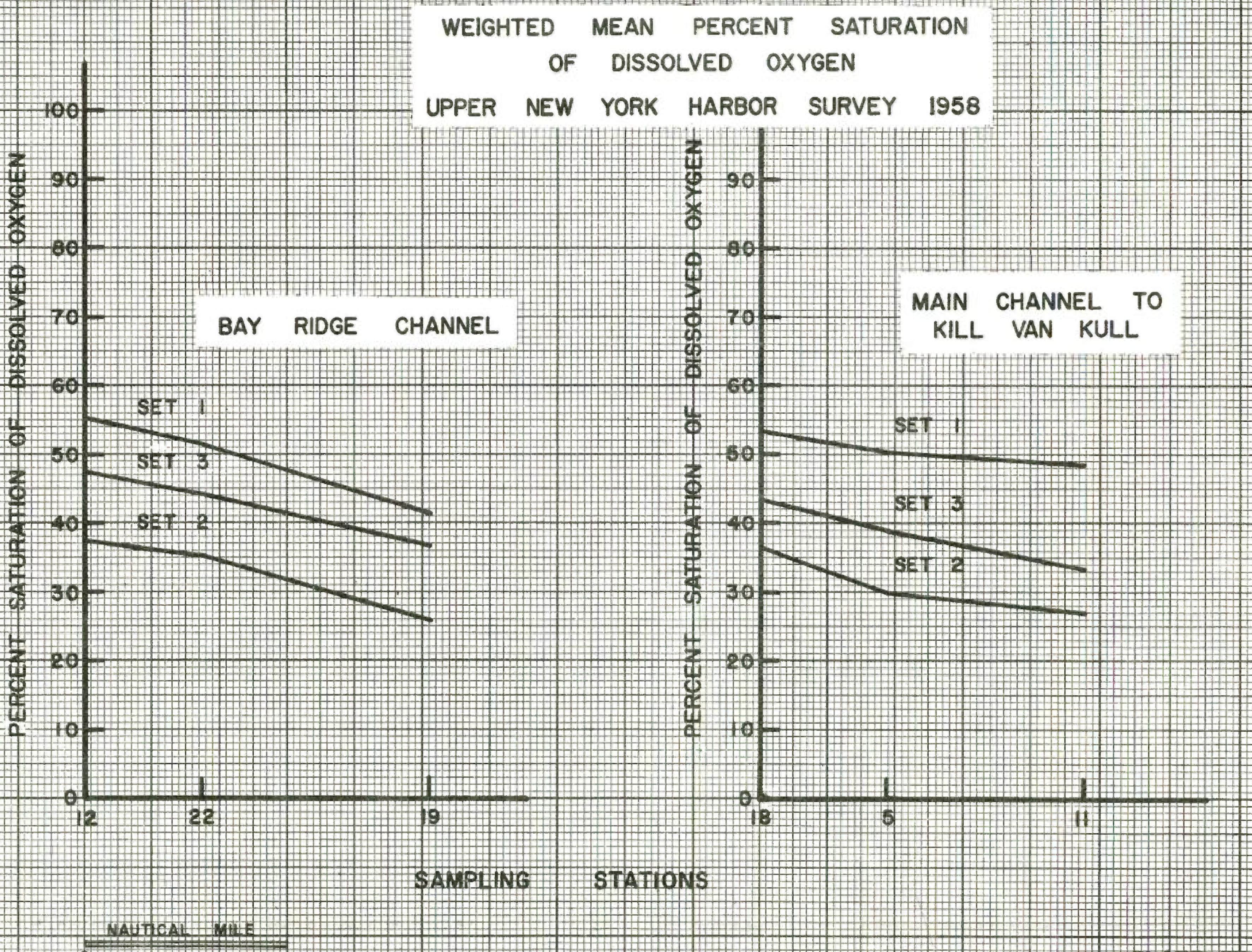

WEIGHTED MEAN PERCENT SATURATION
OF DISSOLVED OXYGEN
UPPER NEW YORK HARBOR SURVEY 1958
PERCENT SATURATION OF DISSOLVED OXYGEN
BAY RIDGE CHANNEL
MAIN CHANNEL TO
KILL VAN KULL
SET 1
SET 3
SET 2
0
10
20
30
40
50
60
70
80
90
100
12
22
19
18
5
11
SAMPLING STATIONS
NAUTICAL MILE
0

PLATE V

of dissolved oxygen along the main channel present some interesting possibilities with regard to future sampling. The curve for Set I represents a condition of equilibrium which existed in the Harbor during a five week period. A regression equation was determined to describe the variation in the curve labelled Set I and is as follows:

$$Y = 62.84 - 4.97\ X + .31\ X^2$$

This equation will give the theoretical distance above the Narrows, at which the lowest percent saturation of dissolved oxygen would occur. In this case, the distance would be 8.0 miles above Station 13.

The percent saturation of dissolved oxygen at this critical point, as indicated by the regression equation, is 42.9 percent. This critical point occurs in the Hudson River approximately opposite Houston Street in Manhattan or 1.8 miles upstream from Station 15A. A similar regression equation was determined for Set II data and using the same procedure, it was found, theoretically, that the critical point occurred a distance of 8.1 miles north of Station 13 in the Hudson River and had a percent saturation value of 28.8 percent.

For future investigations in the Harbor it will now be possible to take numerous samples at Stations 13 and 15A and determine the mean condition at these two stations. The mean value observed at Station 13 in the Narrows may then be substituted into the regression equation for Set I data in place of the constant 62.84. This will then become the adjusted equation which will describe the variation of the percent saturation up the main channel to and including Station 15A. This projected mean value, using the adjusted regression equation, can then be compared with the observed mean as a check. This equation may prove to be sufficiently accurate for routine investigations of mean conditions in the Upper Harbor during the summer months. It should also be noted that this procedure gives an error, if applied to Set II data, varying from zero at Station 13, to 5.4 percent saturation of dissolved oxygen at

Station 15A. Thus, this approach, if applied to future sampling, should not produce an error greater than approximately 6 percent saturation of dissolved oxygen. If mean percent saturation values are determined in the future through sampling at Stations 13 and 15A and a predicted value is then obtained for Station 15A, using the adjusted regression equation, which is lower than that observed by more than 6 percent saturation, then it might indicate that prior to the sampling period, additional pollution had been discharged into the Harbor and had not had time to flush out. Thus, a condition of differential recovery would exist at the sampling stations prior to the establishing of a new level of equilibrium. This situation is indicated in our observed values for Set III, along the main profile (See Plate I).

Data from Stations 21, 17 and 14A provide a secondary profile which passes from the main channel through Buttermilk Channel to the East River. The regression equation is:

$$Y = 46.00 - 14.56\ X + 3.68\ X^2$$

and describes the variation of the percent saturation with the Set I data, as determined. The constant in this latter regression equation will be the "Y" value determined at Station 21 when using the adjusted regression equation for the main channel and an "X" value of 4.27 miles, the distance from Station 13 to Station 21. Using these regression equations and concentrated sampling at approximately two points in the Harbor, it may be possible to predict the variation of percent saturation of dissolved oxygen at various points in the Harbor.

The distances to be used in the regression equations for the main and Buttermilk Channels are tabulated in Table III which follows on the next page.

T a b l e III

CUMULATIVE DISTANCES BETWEEN STATIONS

MAIN CHANNEL

Station	Distance (Miles)
13	0.00
23	.94
12	1.82
18	2.34
20	3.32
21	4.27
16	5.05
15A	6.22

BUTTERMILK CHANNEL

Station	Distance (Miles)
21	0.00
17	1.43
14A	2.35

Further work will be conducted to investigate certain possibilities indicated by the analysis of this data.

Predicted Future Conditions

Millions of dollars are being spent annually for the abatement of pollution in and adjoining the waters of the Upper Harbor. It is of interest to estimate what future dissolved oxygen levels may be expected in the Harbor when this pollution abatement program is completed. Using the data obtained in this survey and estimates as to the changes in pollutional load, predictions were made as to what future percent saturation of dissolved oxygen values will be in the Harbor.

Considering the flows involved, estimates were made of the B.O.D. load applied in the Upper Harbor. We haveestimated that the observed Set I curve would have been lowered by approximately 10 percent saturation of dissolved oxygen, along the main channel, if Passaic Valley had been discharging 100 percent of its treated effluent directly into the Harbor. Therefore, the normal dissolved oxygen level in the Upper Harbor for the summer of 1958 would be better described by the corrected curve shown on Plate VI than indicated by the Set I curve.

Assuming that Passaic Valley Sewage Treatment Plant discharges all of its treated wastes into the Harbor, giving consideration to the future population changes and completion of the Wards Island Sewage Treatment Plant Expansion and the Newtown Creek Pollution Control Project, we have estimated that the mean percent saturation of dissolved oxygen at Station 13 will be 65 percent in the summer of 1965. Also, with the same considerations plus the additional improvement of waters due to completion of the North River and Red Hook Plants, and the expansion of the Port Richmond Sewage Treatment Plant, we have estimated that the mean percent saturation value at Station 13 in the Narrows will rise to 70 percent during the summer of 1970. Plates VI and VII show the predicted mean percent saturation values for 1965 and 1970 in the main channel and in Buttermilk and Bay Ridge Channels.

SUMMARY AND CONCLUSIONS

(1) A significant pollutional load introduced into the Harbor, at any point, will affect every sampling station.

(2) Regression equations have been developed which describe the variation in percent saturation of dissolved oxygen in the main channel and also through Buttermilk Channel to the East River. They may be useful in predicting conditions throughout the Harbor with limited sampling.

(3) The point at which the lowest dissolved oxygen values occurred in the Hudson River was calculated to be approximately 1.8 miles upstream from Station 15A.

(4) An observation of the effect of a change in pollutional loading from the Passaic Valley Sewage Treatment Plant indicates that from 2 to 3 days are required for pollution from their outfall to exert its influence throughout the Harbor.

(5) The values observed in the Set I data are estimated to be higher by approximately 10

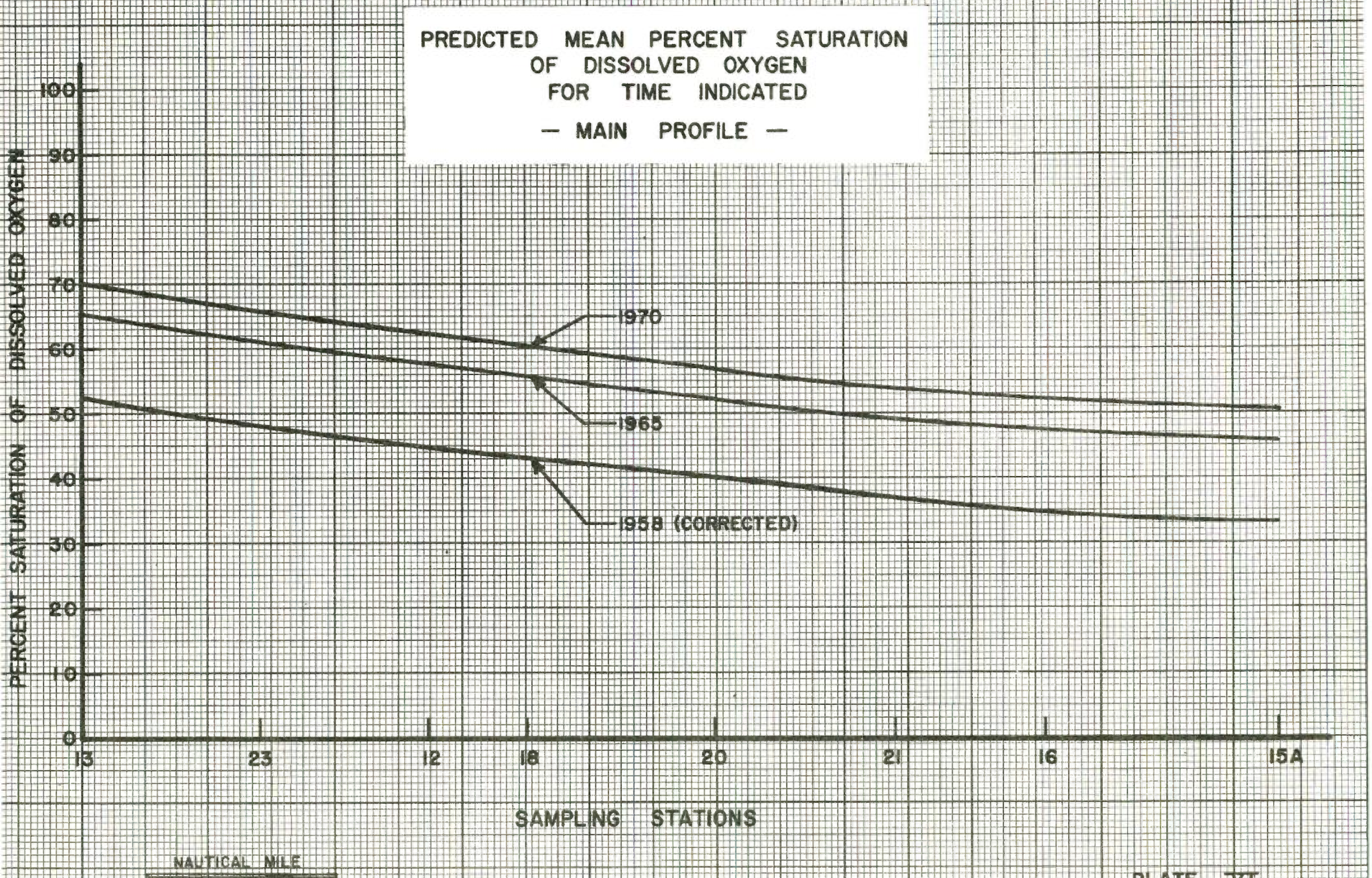

PREDICTED MEAN PERCENT SATURATION
OF DISSOLVED OXYGEN
FOR TIME INDICATED
— MAIN PROFILE —
PERCENT SATURATION OF DISSOLVED OXYGEN
100
90
80
70
60
50
40
30
20
10
0
1970
1965
1958 (CORRECTED)
13
23
12
18
20
21
16
15A
SAMPLING STATIONS
NAUTICAL MILE
0

PLATE VI

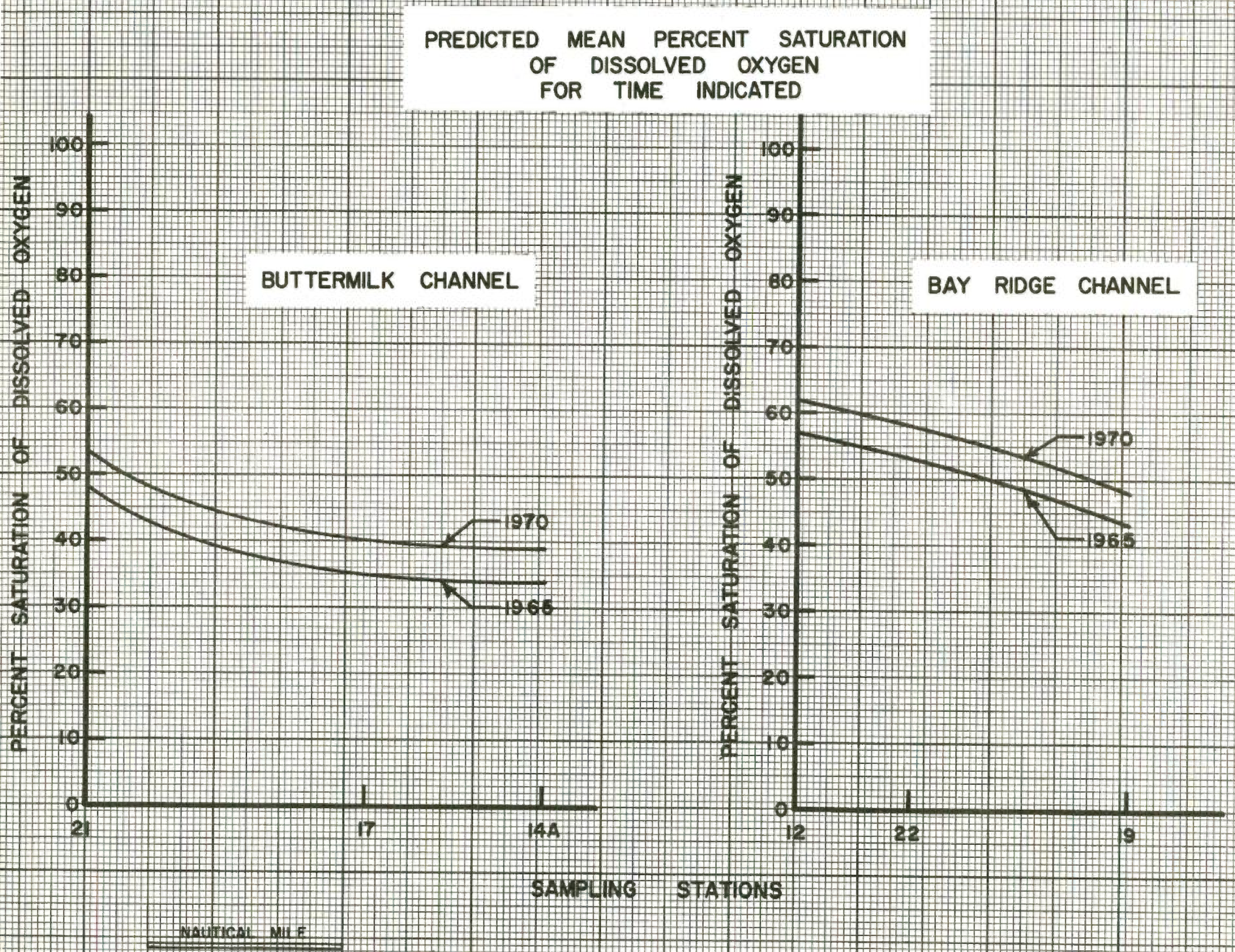

PREDICTED MEAN PERCENT SATURATION
OF DISSOLVED OXYGEN
FOR TIME INDICATED
PERCENT SATURATION OF DISSOLVED OXYGEN
BUTTERMILK CHANNEL
100
90
80
70
60
50
40
30
20
10
0
1970
1965
21
17
14A
BAY RIDGE CHANNEL
1970
1965
12
22
19
SAMPLING STATIONS
NAUTICAL MILE
0

PLATE VII

percent saturation of dissolved oxygen, along the main channel than would have been obtained if Passaic Valley had discharged its entire flow, after treatment, into the Upper Harbor.

(6) This lower level indicates that for normal conditions a portion of the Harbor would have been below minimum Tri-State Compact requirements of 30 percent saturation of dissolved oxygen.

(7) Subject to the limitations discussed in the body of this report, it is estimated that:

> (a) The mean percent saturation of dissolved oxygen at Station 13 (Narrows) will be approximately 65 percent during the summer of 1965.
>
> (b) The mean percent saturation of dissolved oxygen at Station 13 will be approximately 70 percent during the summer of 1970.