PROCEEDINGS

VOLUME 2

Conference

In the matter of Pollution of the navigable waters of the Detroit River and Lake Erie and their Tributaries in the State of Michigan

SECOND SESSION JUNE 15-18, 1965

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service

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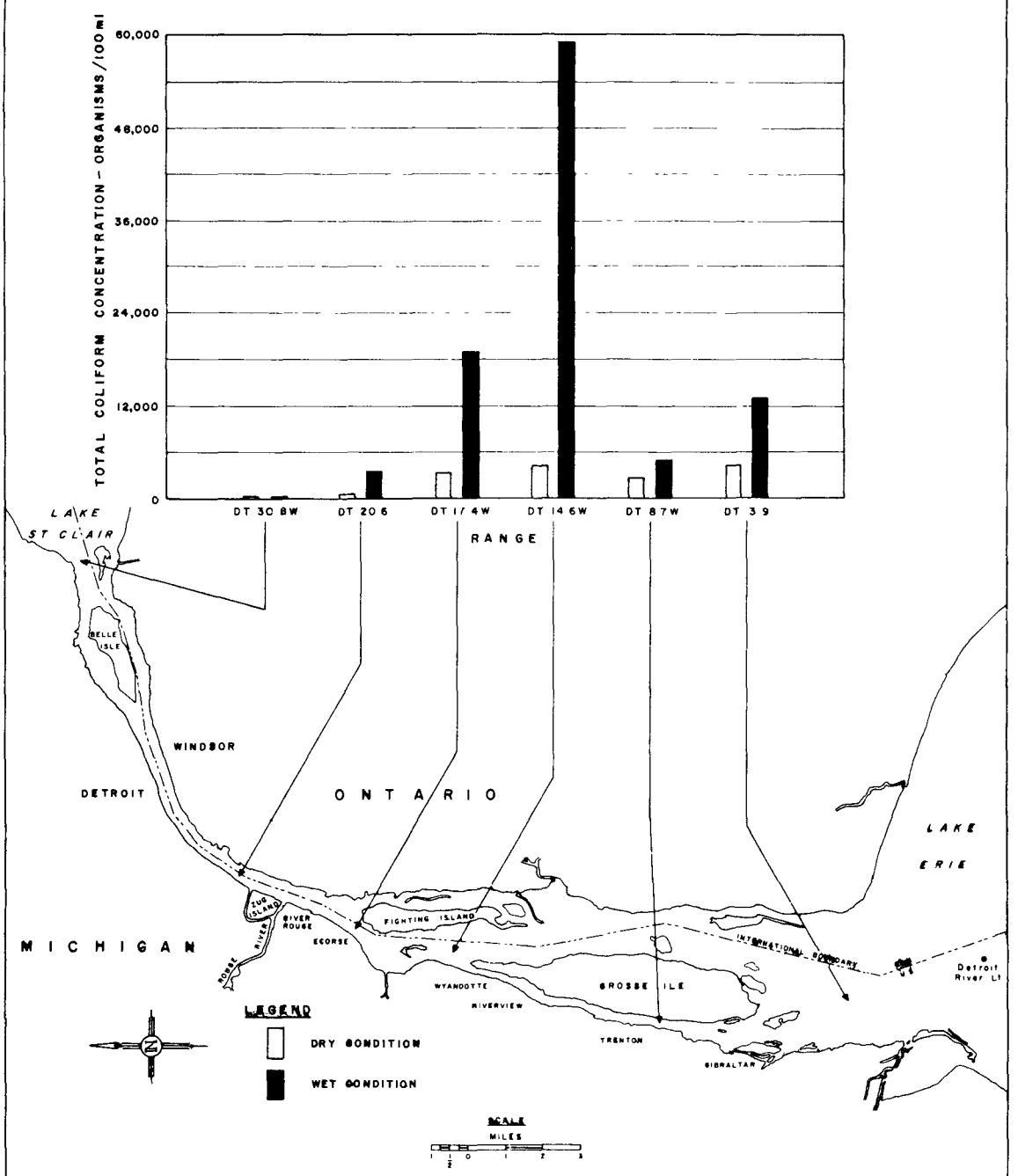
Figure 9-V shows the increase in geometric mean densities of total coliform organisms from the head of the Detroit River at the station nearest the United States shore. These values, under wet conditions, increased from 130 organisms per 100 ml at the headwaters, to 3,500 per 100 ml just above the Rouge River, to 59,000 in the lower River and, finally, a decrease to 15,000 per 100 ml at the mouth. Corresponding average densities during dry conditions were 110,550, 4,300, and 4,000 per 100 ml respectively.

(Figure 9-V follows.)

FIGURE 9-II



DETROIT RIVER-LAKE ERIE PROJECT

GEOMETRIC MEAN COLIFORM CONCENTRATIONS DURING WET & DRY CONDITIONS

STATION NEAREST U.S. SHORE

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

CHEMICAL AND PHYSICAL

PHENOLS

High levels of phenols in waters cause disagreeable tastes and odors in drinking water, taint the flesh of game fish, and will kill fish when concentrations are excessive. If phenols are present in raw water supplies in sufficient concentration to cause tastes and odors, expensive water treatment procedures may be required to eliminate the problem. IJC objectives call for average phenol concentrations not to exceed 2 micrograms/l (ppb) and maximum values not to exceed 5 micrograms/l (ppb) to prevent taste and odors in water supplies.

Phenol concentrations at all ranges in the Detroit River exceeded these criteria during the study period. Water quality at the head of the Detroit River met these criteria in 1962 but not 1963.

Records of the International Joint Commission reveal phenol concentrations frequently in excess of 10 micrograms/l in the St. Clair River below known sources of phenolic wastes. The flow in the St. Clair River accounts for 95 per cent of the flow of the Detroit River. The weighted average phenol concentration near the mouth of the St. Clair River during the period of the survey was 9 micrograms/l, representing a loading of 8,700 pounds of phenolic substances per day. Phenol concentrations in the lower Detroit River near the United States shore exceed

IJC objectives over 80 per cent of the time. The maximum values of phenol concentrations during the survey approached levels toxic to fish.

Major sources of phenol concentrations in the Detroit River are the Detroit Sewage Treatment Plant, Ford Motor Company, Great Lakes Steel Blast Furnace, Mobil Oil Company, Pennsalt Chemical Corporation West Plant, and Wyandotte Chemical Corporation North Works.

Phenolic pollution in the lower Detroit River could cause objectionable tastes and odors in both drinking water and fish flesh. While average concentrations in the upper river are above IJC objectives of 2 micrograms/l (ppb) they are usually not above the 5 micrograms/l (ppb) level at which most observers detect objectionable tastes and odors in water supplies.

Average phenol concentrations in the upper Detroit River ranged from 3 to 5 micrograms/l. Just below the Rouge River at a station near the United States shore the average value increased to 28 micrograms/l with lower values observed in mid-river. Further downstream but above the Trenton channel these average values decreased to 10 micrograms/l near the western shore. In the Trenton channel the average values rose to 30 micrograms/l near the shore and then decreased to 6 - 9 micrograms/l at the

mouth. Figure 10-V shows average phenol concentrations in the Detroit River.

Phenols did not exhibit any type of normal statistical distribution; thus extreme values are shown in Figure 10V and Table 2-V as the maximum observed value at several key locations and the per cent of samples exceeding 2 micrograms/l and 5 micrograms/l. At the head of the river 40 - 55 per cent of the samples exceeded 2 micrograms/l while 17-35 per cent exceeded 5 micrograms/l. Just above the Rouge River 38-59 per cent exceeded 2 micrograms/l while 23 -54 per cent exceeded 5 micrograms/l. Below the Rouge River 27-88 per cent exceeded 2 micrograms/l and 6 - 69 per cent exceeded 5 micrograms/l. At the mouth of the river 40-84 per cent of the samples exceeded 2 micrograms/l and 19-68 per cent of the samples exceeded 5 micrograms/l. The maximum value observed in the Detroit River during the survey was 650 micrograms/l and the next highest value was 180 micrograms/l, observed in the Trenton Channel.

(Table 2-V, consiting of 3 pages; and Figure 10-V follow)

TABLE 2-V. AVERAGE AND EXTREME PHENOL CONCENTRATIONS - DETROIT RIVER

Range	Feet	Maximum Concentration Observed µg/l	Average µg/l	Percent >2 µg/l	Percent >5 µg/l
DT 30.8W	100	12	3	58	13
	300	27	4	48	16
	500	18	4	56	24
	1,000	9	3	56	24
	2,500	21	4	50	16
DT 30.7E	500*	10	3	50	25
	850*	11	4	53	35
	980*	28	5	56	33
DT 28.4W	100	10	2	27	14
	300	13	2	36	9
	700	17	3	29	19
	1,300	11	2	33	19
DT 26.8W	52	32	6	61	33
	169	28	7	61	39
	292	70	8	61	39
	421	31	5	47	35
	689	19	5	39	33
	1,094	14	3	47	24
	1,478	13	4	53	27
	1,903	16	4	47	29
DT 25.7	50	14	3	33	22
	100	28	5	47	21
	300	11	3	42	21
	600	48	5	25	20
	2,000	49	5	32	21
	3,400*	49	6	42	21
DT 20.6	5	24	4	36	20
	50	650	5	50	31
	200	26	5	38	23
	400	50	6	44	28
	600	34	7	46	38
	700	24	4	42	23
	1,000	37	5	38	35
	1,500*	35	4	35	19
	1,800*	40	4	30	9
	2,000*	20	2	25	17
	2,300*	25	3	42	21

* = Canadian Stations.

TABLE 2-V. AVERAGE AND EXTREME PHENOL CONCENTRATIONS - DETROIT RIVER – Continued

Range	Feet	Maximum Concentration Observed µg/l	Average µg/l	Percent >2 µg/l	Percent >5 µg/l
DT 19.0	100	79	28	100	100
	200	49	20	80	80
	300	36	16	100	80
	400	28	18	80	80
	800	9	2	40	20
	1,000	27	8	50	25
DT 17.4W	100	47	10	89	63
	200	43	9	84	56
	400	23	8	77	50
	800	50	8	73	42
	1,200	8	3	56	16
	1,600	7	3	42	9
	2,200*	9	2	28	8
DT 17.0E	400*	24	3	24	19
	700*	15	3	35	15
	900*	28	3	33	10
DT 14.6W	20	29	7	75	46
	100	24	7	68	48
	200	16	6	75	46
	300	158	5	67	46
	400	16	5	83	46
	800	16	4	63	29
	1,000	11	3	65	17
	2,000	4	2	35	0
	3,000	6	2	21	8
DT 12.0W	122	35	10	89	66
	322	124	8	81	52
	670	26	7	85	48
DT 9.6W	100	11	5	67	33
	300	11	5	67	33
	500	5	3	67	0
	900	20	8	67	33
DT 9.3E	500	11	2	39	13
	1,200	8	2	29	13
	2,000	84	6	39	9
	3,000	6	1	21	4
	4,000*	4	1	30	0
	4,500*	10	2	26	9
	5,000*	4	1	9	0
	5,600*	31	2	27	5

TABLE 2-V. AVERAGE AND EXTREME PHENOL CONCENTRATIONS - DETROIT RIVER – Continued

Range	Feet	Maximum Concentration Observed µg/l	Average µg/l	Percent >2 µg/l	Percent >5 µg/l
DT 8.7W	80	180	30	95	95
	280	50	12	92	78
	480	140	13	88	69
	680	23	8	83	62
	980	31	8	80	66
	1,240	19	6	74	49
DT 3.9	2,500	36	9	81	70
	3,500	42	7	70	48
	4,500	42	6	63	33
	5,500	19	4	63	33
	6,500	19	5	61	25
	7,500	12	4	56	30
	9,500	32	4	41	19
	11,500*	10	4	48	20
	13,500*	29	3	33	17
	15,000*	20	4	42	13
	16,500*	24	3	35	9
	17,500*	17	3	32	8
	18,500*	6	2	25	4
	19,000*	8	2	23	5
	19,300*	39	3	24	5

FIGURE 10-V

DETROIT RIVER–LAKE ERIE PROJECT

AVERAGE PHENOL CONCENTRATIONS AND PERCENT OF PHENOLS EXCEEDING 2 & 5 μg/l

DETROIT RIVER

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PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

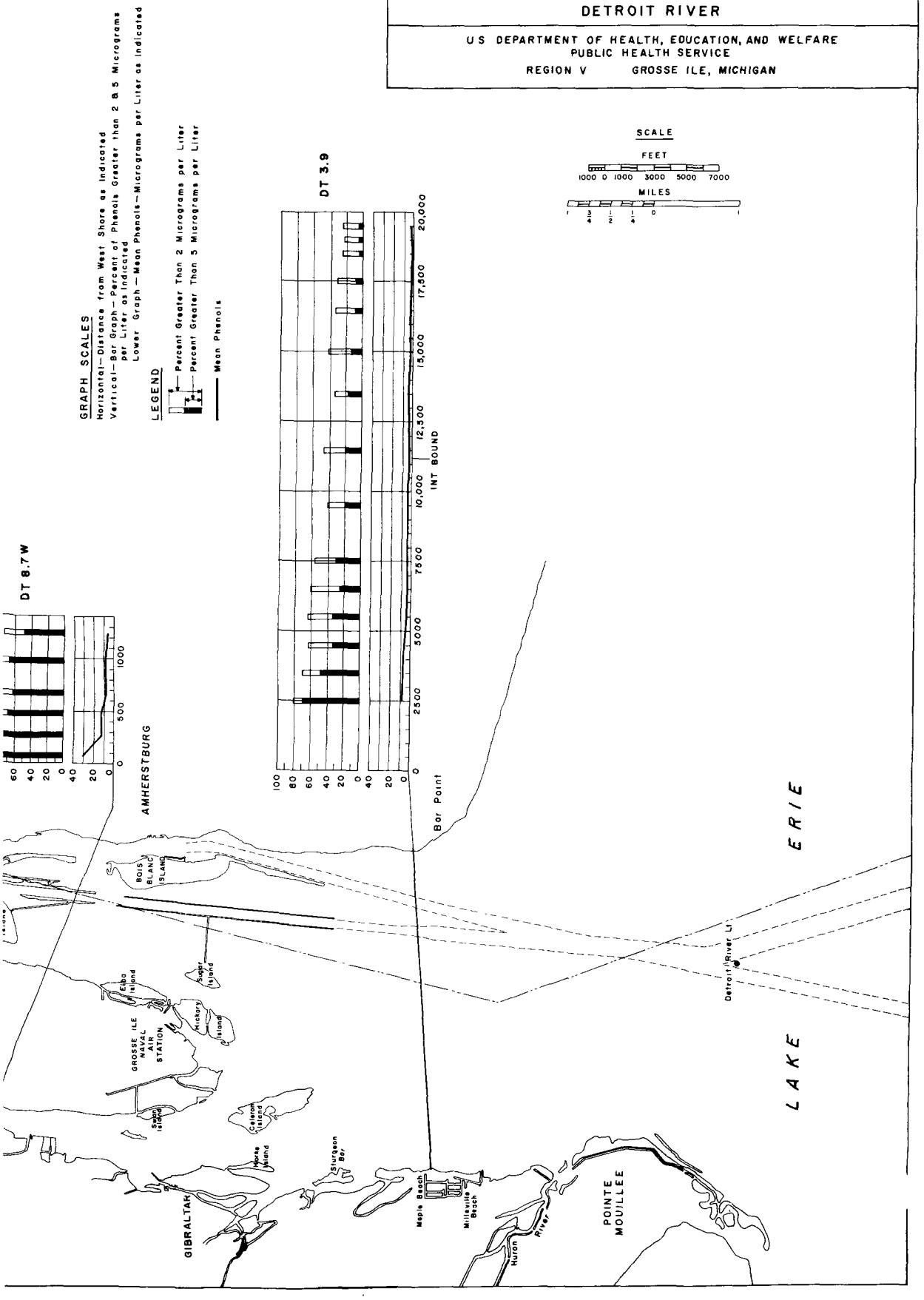

Table 3-V shows average and extreme phenol concentrations in the tributaries of the Detroit River. A maximum value of 10,980 micrograms/l was observed in Monguagon Creek and 290 micrograms/l in the Rouge River. Average phenol concentrations in the Rouge River, Conners Creek, and Monguagon Creek were 12, 6, and 1500 micrograms/l respectively.

TABLE 3-V

AVERAGE AND EXTREME PHENOL CONCENTRATION

TRIBUTARIES TO DETROIT RIVER

RANGE	MAXIMUM CONCENTRATION OBSERVED - MICROGRAMS/l	AVERAGE MICROGRAMS/l	PERCENT - 2 MICROGRAMS/l	PERCENT - 5 MICROGRAMS/l
Conners Creek	22	6	69	42
Rouge River	167	19	79	66
Monguagon Creek	10,980	1,490	98	98

Suspended and Settleable Solids

Excessive amounts of suspended solids in water can interfere with domestic and industrial water treatment processes, cause harmful effects to fish and other aquatic

life by clogging their gills and respiratory passages, cause turbidity which interferes with light transmission, and interfere with boating and aesthetic enjoyment of water. When a part of the suspended solids settles out on stream and lake bottoms as sludge or bottom deposits, damage to aquatic life can occur from the blanketing of the bottom, killing eggs and essential fish-food organisms, and destroying spawning beds. In addition, toxic materials, sometimes carried with suspended solids, can leach out and destroy aquatic life. Suspended solids cause especially serious problems in shallow, slow-moving waters, where they settle easily.

Suspended solids in the upper River were uniform with values of 5-10 mg/l in midriver and values of 15-20 mg/l near the United States shore. In the lower River and at the mouth, these values increased to a range of 14 - 65 mg/l with the higher values near the United States shore. In the upper Detroit River the range of settleable solids was 5 - 10 mg/l while values in the lower River and the mouth were in the range of 10 - 24 mg/l. In both cases the higher values were near the United States shore.

Average suspended solids in the tributaries of the Detroit River ranged from 22 mg/l in the Rouge River to 76 mg/l in Conners Creek and 162 mg/l in the Ecorse River.

Chlorides

Chloride concentrations above certain levels can interfere with domestic and industrial water supplies by causing objectionable tastes in drinking water, and corrosion in industrial processes.

Figure 11-V shows average chloride concentrations in the Detroit River, in the upper Detroit River the chloride concentration was uniform at 7 - 10 mg/l. Just below the Rouge River the mean chloride concentration increased to 9 - 35 mg/l with the higher values observed near the United States shore. In the lower river the mean values increased to 26 - 69 mg/l in the Trenton Channel and 28-58 mg/l at the mouth. Once again, the higher values were observed near the United States shore. Maximum values as high as 180 mg/l have occurred in the Detroit River.

(Figure 11-V follows.)

DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE CHLORIDE CONCENTRATIONS

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

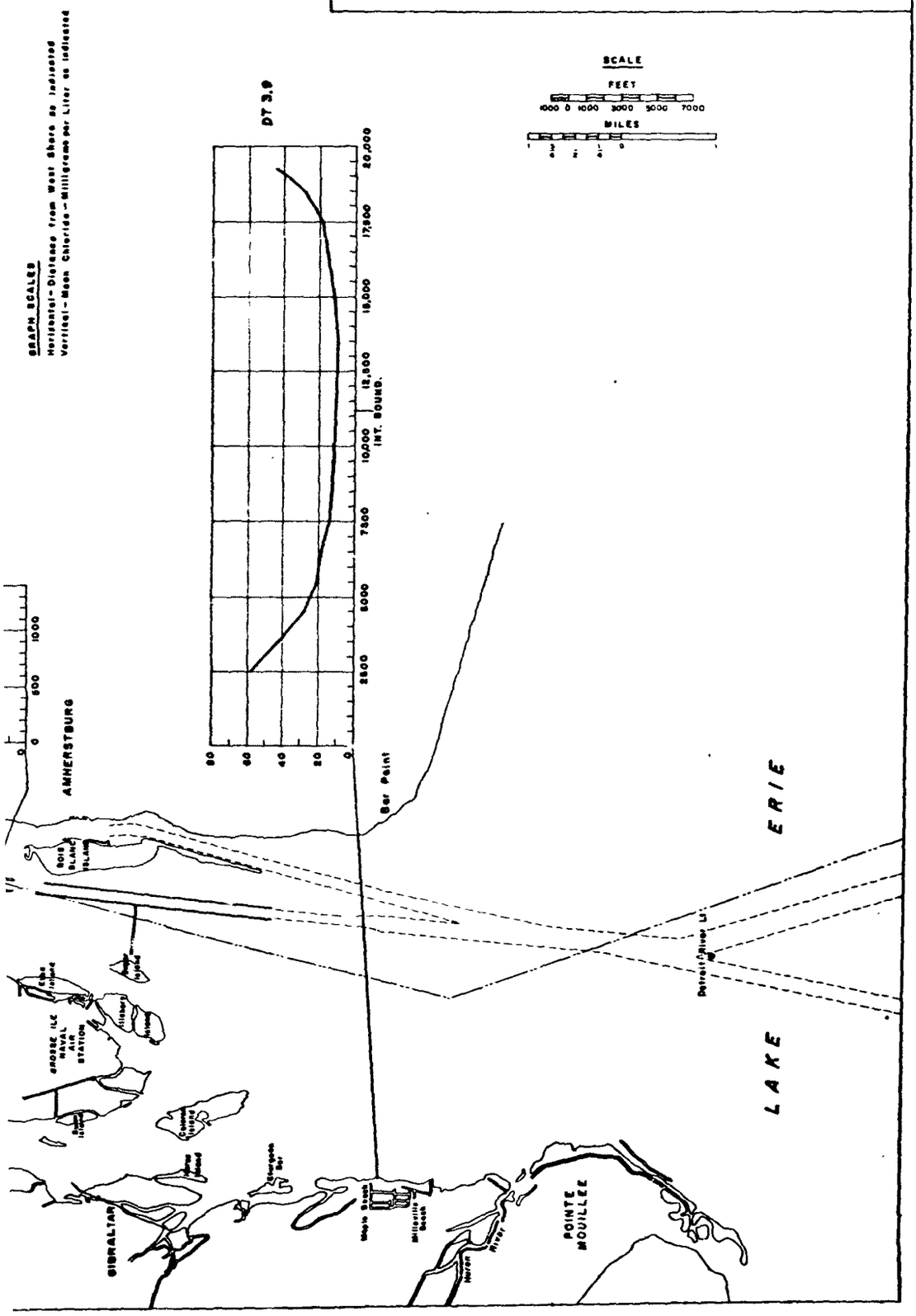

Figure 4-V shows average chloride concentrations in five zones representing less than 10, 10-20, 20-35, 35-50, and greater than 50 mg/l. The upper Detroit River is in the first zone representing less than 10 mg/l. Below the Rouge River to Wyandotte, United States waters are predominantly in the second and third zones representing average values up to 35 mg/l. Below Wyandotte to the mouth, especially along the United States shore, the two zones representing average chloride concentration in excess of 35 mg/l predominate.

In the tributaries of the Detroit River high chloride values are most noticeable in the Rouge River with a mean value of 66 mg/l. Ecorse River with a mean value of 91mg/l, and Monguagon Creek with a mean value of 360 mg/l.

Chlorides do not pollute the upper Detroit River. Below the Rouge River adjacent to the United States shore there is significant deterioration due to pollution from chloride sources. Mean values in excess of 50 mg/l could interfere with industrial water supply intakes located near the United States shore in the lower river.

(Figure 4-V follows.)

FIGURE 4-V

DETROIT RIVER-LAKE ERIE PROJECT

ZONES OF AVERAGE CHLORIDE CONCENTRATIONS

DETROIT RIVER

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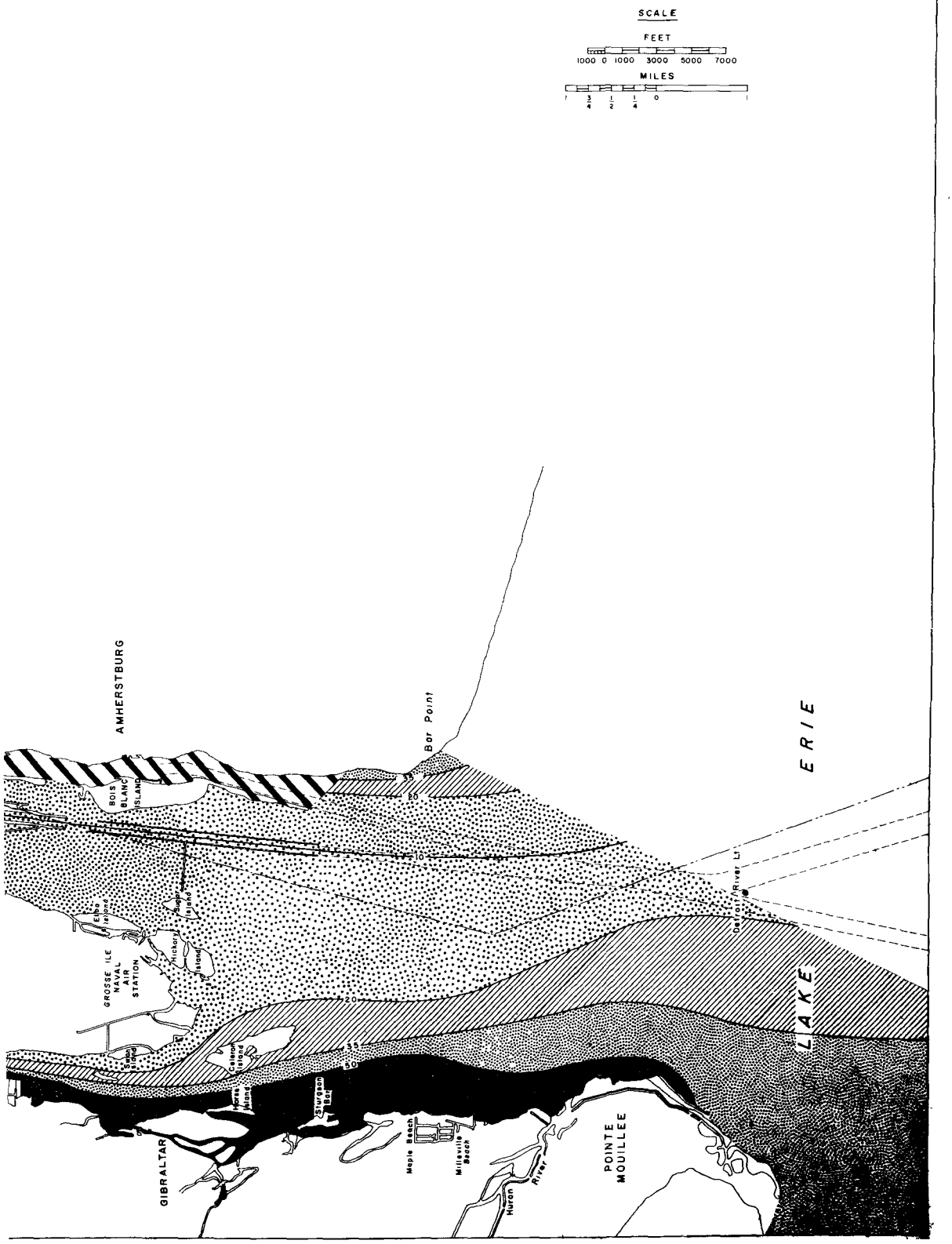
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



Iron

Excessive concentrations of iron in water can cause interference with domestic and industrial water supplies by causing tastes and stains. Iron, in relatively low concentrations, is toxic to certain species of fish and other aquatic life. IJC objectives state that iron concentrations should not exceed 0.3 mg/l (ppm). Average iron concentrations in the upper Detroit River generally meet this objective. The Rouge River and the lower Detroit River, however, had concentrations in excess of this objective; concentrations below the Rouge River average over two times this value. The lower Detroit River, especially near the United States shore, is degraded and polluted by iron concentrations.

At the head of the Detroit River in United States water, average iron concentrations were 0.10 to 0.13 mg/l. Downstream just above the Rouge River, these values increased to 0.18 to 0.34 mg/l. Below the Rouge River the average values near the United States shore increased to 0.39 to 0.52 mg/l. Downstream near Fighting Island, these values increased to 0.4 to 4.42 mg/l, with the higher values along the United States shore. Further downstream and in the Trenton Channel, the range was 0.47 - 0.63 mg/l. The maximum value observed during the survey of the Detroit River was

15.2 mg/l, approximately 5 miles downstream from the Rouge River.

Maximum iron concentrations between 1.5 and 2.6 mg/l were observed in the major tributaries of the Detroit River. Mean values at these tributaries ranged from 0.39 to 0.91 mg/l.

BOD and Dissolved Oxygen

Biochemical Oxygen Demand (BOD) is a measure of the amount of organic matter oxidized through biochemical processes. In general, a high BOD indicates the presence of a large amount of organic material. It is normal to find a BOD of 2 to 3 parts per million (or 2 or 3 mg/l) in river waters receiving natural drainage; a higher BOD may represent a drain on the dissolved oxygen present in the water.

The lack of dissolved oxygen (DO) in water creates an unfavorable environment for fish and other aquatic life. DO deficiencies can prevent propagation and, if great enough, kill fish. Low levels of DO can cause objectionable odors, thus interfering with recreational enjoyment of the water, and increase the corrosive properties of the water, thus interfering with domestic and industrial water supply.

In no reaches of the Detroit River do levels of dissolved oxygen cause interferences with water uses. However, a decrease in DO saturation, from 93 to 106% in the

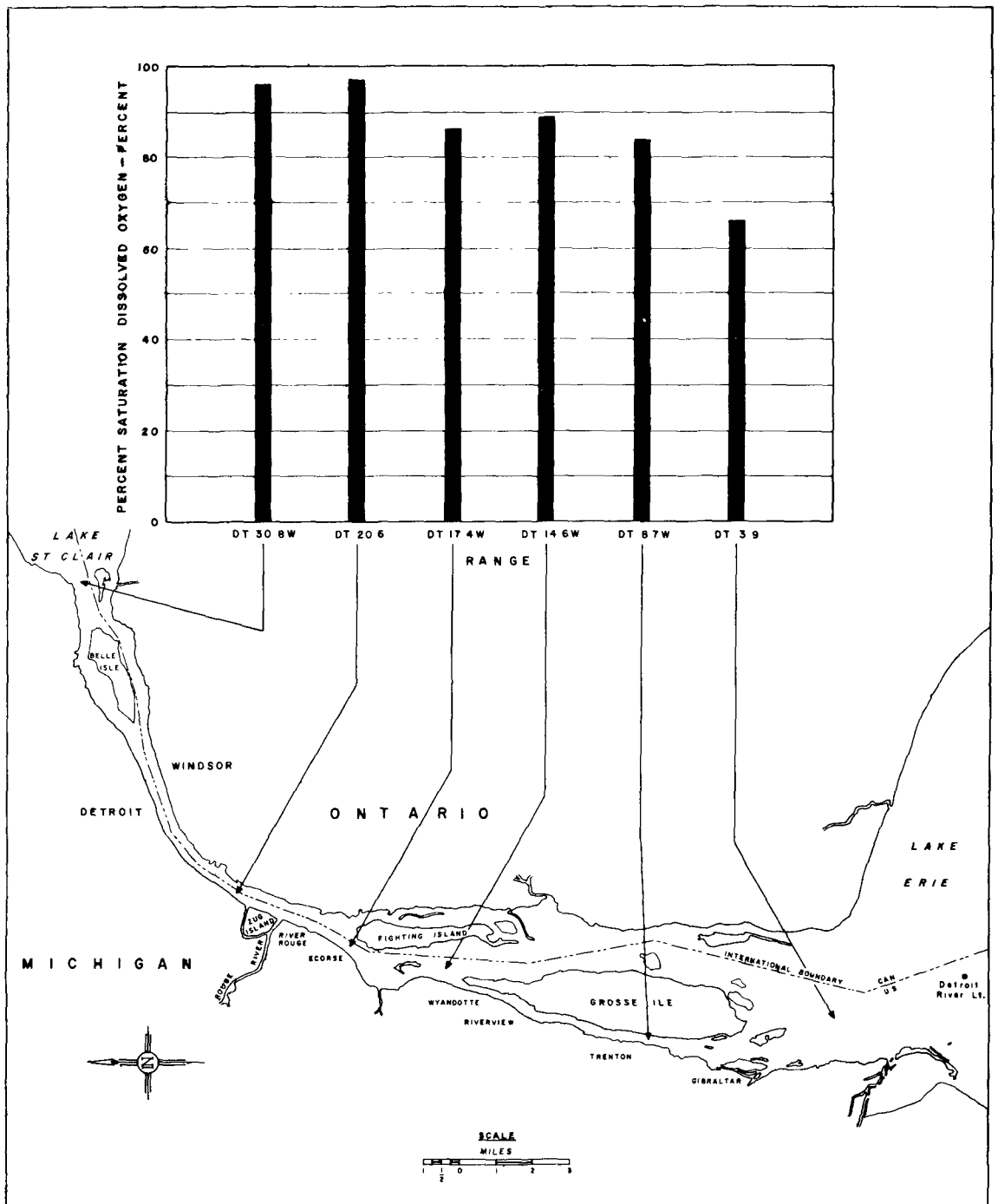
upper River to 67-82% at the mouth, due to the discharge of oxygen-consuming wastes in the vicinity of the Rouge River, is significant. Future problems may result if oxygen-consuming waste loads increase.

In the upper Detroit River, the BOD ranged from 2 to 4 mg/l. Below the Rouge River, the average value increased to 8 mg/l, but returned to the 2-4 mg/l range at the mouth. BOD in the rouge river was less than 6 mg/l during the period sampled.

From the head of the Detroit River to the Rouge River the average saturation for DO ranged from 93 to 106%. All values observed were in excess of 5 mg/l. Figure 12-V shows the average DO saturation at selected ranges on the Detroit River at stations nearest the United States shore. With the exception of the mouth of the Detroit River (range DT 3, 9), the average saturation percentages were relatively constant across each range. Figure 12A-V presents DO values differently, showing minimum concentrations in mg/l at selected ranges during the survey (including 1964 data).

(Figures 12-V and 12A-V follow.)

FIGURE 12-V



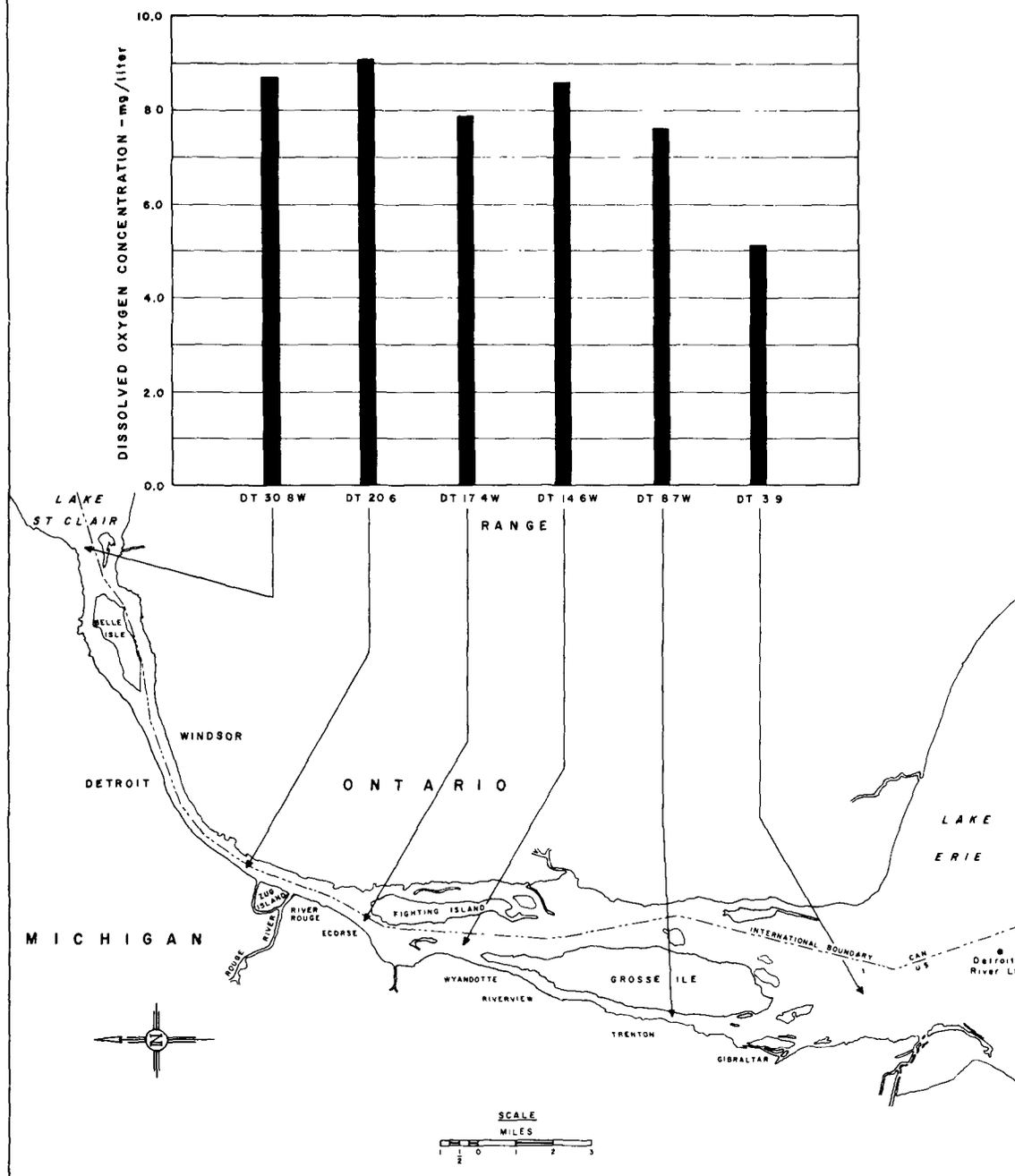
DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE PERCENT SATURATION DISSOLVED OXYGEN

STATION NEAREST U.S. SHORE
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 12A-V



DETROIT RIVER-LAKE ERIE PROJECT

MINIMUM DISSOLVED OXYGEN CONCENTRATIONS

STATION NEAREST U.S. SHORE
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

Nitrogen Compounds

Nitrates in drinking water in concentrations greater than 10 mg/l can cause serious illness (methemoglobinemia) in infants. Nitrates also cause interference with many industrial processes. Ammonia can interfere with domestic water treatment by combining with applied chlorine to form chloramines instead of the more effective disinfecting agent, free chlorine. Ammonia in water supplies is usually regarded as evidence of recent pollution from human or animal wastes, if concentrations exceed 0.10 mg/l.

Nitrogen compounds are not present in the Detroit River in concentrations sufficient to cause illness in infants using this supply as drinking water, nor are the existing levels sufficient to cause interference with industrial processes. Average ammonia concentrations as high as 0.41 mg/l could cause water treatment difficulties and necessitate excessive dosages of chlorine to achieve adequate disinfection in domestic water treatment processes.

Nitrogen compounds and phosphates are commonly referred to as essential plant nutrients, or more simply, nutrients. Although only the inorganic forms of nitrogen (nitrates, nitrites, and ammonia) are readily available for plant utilization, other less stable forms can be changed to this available form in the presence of dissolved oxygen

and thus are considered in this discussion. All nitrogen compounds are reported as nitrogen.

These compounds coupled with phosphorus can stimulate the growth of alga in bodies of water where other environmental factors are satisfactory. In small quantities alga are desirable as a major source of food for fish. When algal growth exceeds certain limits, nuisances result from undesirable blooms. These are unsightly, can result in obnoxious odors, and can be toxic to fish. A commonly accepted level of inoranic nitrogen compounds (nitrates, nitrites and ammonia) above which undesirable blooms can be expected to occur is 0.03 mg/l. In the lower section of the Detroit River, especially as it enters Lake Erie, these values are regularly exceeded and pollution from industrial and domestic sources could be expected to cause excessive blooms in the lower river and Lake Erie.

In the upper and lower River mean nitrate values range from 0.10 to 0.24 mg/l. At the mouth, the range increases to 0.22 - 0.40 mg/l. Nitrites throughout the River are fairly constant at 0.001 - 0.002 mg/l, except at the mouth of the River where the range increases to 0.003 to 0.011 mg/l. At the head of the Detroit River, mean ammonia nitrogen was 0.08 - 0.14 mg/l. Downstream just above

the Rouge River, these values increased to 0.16 - 0.41 mg/l. Below the Rouge River, the mean concentration remained in this range to the mouth. Organic nitrogen throughout the River had mean values between 0.15 and 0.30 mg/l. In the Rouge River, the mean nitrate concentration was 0.39 mg/l with nitrites, ammonia, and organic nitrogen 0.007, 0.51, and 0.16 mg/l respectively.

Phosphates

Soluble phosphates in relatively small concentrations are readily available as an essential plant nutrient. The insoluble portion of the total phosphate concentration can be converted to the soluble form and thus become available for such plant utilization. Soluble phosphates in concentrations greater than 0.015 mg/l (reported as phosphorus), in combination with inorganic nitrogen compounds in excess of 0.03 mg/l and accompanied by satisfactory environmental conditions such as light and heat, may produce over-abundant growths of algae with unpleasant odors and detrimental to fish life.

At the head of the Detroit River total phosphate concentrations averaged 0.03 to 0.30 mg/l. Downstream at a point just above the Rouge River, these values increased to 0.01 - 0.48 mg/l, with the higher values along the United

States Shore. Below the Rouge River, phosphate mean concentrations continue in this same range until the mouth, where the 3,500 feet nearest the United States shore had mean values of 0.89 - 1.20 mg/l. The remaining section to the international boundary had values of 0.18 - .24 mg/l. Phosphates in the Rouge River averaged 0.18 mg/l, with a maximum value of 0.30 mg/l.

All but two soluble phosphate concentrations in the upper Detroit River were less than 0.001 mg/l, with the highest value located near the United States shore just below the combined sewer outfall at Conners Creek. Below the Rouge River soluble phosphate levels increased to levels ranging from less than 0.001 mg/l to 0.40 mg/l, with the same dispersion pattern apparent. At the mouth soluble phosphates of 0.176 to 0.204 mg/l were found. Throughout the lower River soluble phosphate concentrations exceeded the level at which nuisance algal blooms occur.

pH

Extreme pH values can cause interference with domestic and industrial water supplies by affecting taste, corrosiveness, and the efficiency of chlorination and coagulation processes; interferences with irrigation and fish propagation can also be produced. A drop in pH is experienced

in the Detroit River from its head to a point 5 miles below the Rouge River. Average values do not indicate interferences with water use in the Detroit River at this time, but are indicative of significant quantities of acid wastes entering the watercourse.

pH values in the upper Detroit River were uniform, as shown by average values between 8.2 and 8.3 Just below the Rouge River the average pH dropped to 7.6 near the United States shore and to 8.0 away from shore. Approximately 2 miles downstream the average pH dropped again to 7.2 near the United States shore. From this point to the mouth there was a gradual rise in pH until a mean value of 8.0 was reached. The low individual value during the survey was 3.0 at a point approximately 2 miles below the Rouge River at sampling range DT 17.4W.

ABS

Concentrations of ABS (Alkyl Benzne Sulfonate) in excess of 500 micrograms/l have caused foaming in receiving streams, causing interference with recreational and aesthetic enjoyment of the water and with domestic water treatment processes. Existing levels in the Detroit River are well below this value, but average concentrations in the Trenton Channel have increased to 250 micrograms/l, indicating potential problems in the future if waste loads increase.

ABS in the upper section of the Detroit River averaged 20- 40 micrograms/l. Below the Rouge River, it increased from 30 to 60 micrograms/l. In the Trenton Channel, these average values increased to 110 to 250 micrograms/l. At the mouth of the River the average ABS values ranged from 40 to 70 micrograms/l.

In Conners Creek, ABS averaged 230 micrograms/l, while the Rouge River averaged 180 micrograms/l, and Monguagon Creek 500 micrograms/l. The ABS concentration in the tributaries was roughly five times that found in the Detroit River.

Alkalinity

At extreme pH values, alkalinities can cause interference with domestic and industrial water uses, and interference with fish and other aquatic life. The ranges of alkalinity found in the Detroit River do not indicate interference with any water use.

Mean alkalinity concentrations in the entire Detroit River were 68 - 86 mg/l, with no trend evident. Alkalinity values in the tributaries were in this same range with the exception of the Ecorse River, where the average alkalinity was 136 mg/l.

Temperature

Extremely high temperatures can kill fish and cause corrosion problems in water supplies. High temperatures will

also accelerate the rate of utilization of the biochemical oxygen demand in the water.

Mean temperature values for the period of the study are meaningless from a practical standpoint because of their extreme dependence upon the season of the year. Study of the year reveals an increase of 2-3°C between the head of the Detroit River and a point just above the Trenton Channel. The difference between the head and mouth of the River on any given day was found to be 1-2°C, with warmer waters found near the United States shore at the mouth. The highest temperature found in the Detroit River was 28°C, or 82°F, just below the Rouge River.

The Rouge River and Conners Creek were approximately 2-5°C warmer than the Detroit River on any given day, while Monguagon Creek was as much as 10°C warmer. The maximum value on any tributary during the survey was 35°C or 95°F, which was in Monguagon Creek.

The 1° - 3° rise throughout the length of the entire River does not appear to cause any interferences with water use that are not present in the natural state. The temperatures in the River will support all water uses except the propagation of certain cold-water game fish which probably could not survive even the natural temperatures of the upper River.

Chemical Oxygen Demand

Chemical oxygen demand indicates a possible demand on the dissolved oxygen resources of the receiving stream from wastes, usually of an industrial nature, not susceptible to biochemical degradation. The oxygen-consuming strength of these wastes cannot be measured in the BOD determination.

Chemical oxygen demand in the upper Detroit River ranged from mean values of 0 - 9 mg/1. Below the Rouge River this range increased to 28-37 mg/1 and in the Trenton Channel from 160-240 mg/1, with higher values along the west shore. One station at the mouth had average COD values of 30 mg/1.

The significant observed increase in COD in the Detroit River from its head to the lower reaches and particularly the Trenton Channel is indicative of industrial waste discharge. It is difficult to equate COD concentrations in wastes to population equivalents, as is commonly done in BOD wastes, because an unknown amount of the COD concentration actually exerts a demand upon the oxygen resources of the river. The increase does represent the effect of sources of pollution which place some demand upon these resources.

Conductivity

High values of specific conductance indicate excessive mineralization, which can interfere with domestic

and industrial water supplies as well as irrigation and fish propagation.

The specific conductance of the Detroit River in its upper section varied between 190 and 220 umhos/cm. Below the Rouge River, the range increased to 220-390 umhos/cm, with higher values again along the United States shore. In the Trenton Channel, specific conductance increased to an average value of 500 umhos/cm near the west shore. At the mouth of the River, the range decreased to 240-330 umhos/cm.

The values encountered in the Detroit River indicate an approximate twofold increase between the head of the River and a point in the Trenton Channel. These levels do not indicate potential interference with water use in the Detroit River.

Toxic Metals

These metals consist of cadmium, chromium, copper, lead, nickel, and zinc. Toxic metals present a health hazard in drinking water in which they are present in concentrations greater than those listed in the Public Health Service drinking water standards. They can also interfere with industrial processes and act as toxic agents for fish and other aquatic life.

Copper values in all parts of the river except

the head averaged less than 0.01 mg/l. At the head of the river, the average was 0.02 mg/l. In over 55 per cent of all samples analyzed, copper was not detected at the 0.01 mg/l level. The maximum value found was 0.11 mg/l.

Nickel averaged 0.01 to 0.02 mg/l throughout the river with a tendency toward higher values near the junction with the Rouge River. The maximum value found was 0.30 in the Trenton Channel with other high values located throughout the length of the river. Over 70 per cent of the samples analyzed showed concentrations greater than 0.01 mg/l.

Zinc was fairly constant, with average values in the range 0.02 to 0.05 mg/l. The maximum value found was 0.60 mg/l in the Trenton Channel. Over 90 per cent of the samples showed concentrations greater than 0.01 mg/l.

Lead was found in average concentrations varying from 0.01 to 0.04 mg/l, with higher values found below the Rouge River and in the Trenton Channel.

Chromium was found in average concentrations at 0.01 mg/l and less, with higher values in the lower Detroit River and especially in the Trenton Channel. The maximum value found during the survey was 0.04 mg/l below the Rouge River. Chromium was detected at 0.01 mg/l level in only 15 per cent of the samples analyzed.

Cadmium was also found in average concentrations

less than 0.01 mg/l, with higher values in the Trenton Channel. The maximum value found during the survey was 0.08 mg/l in the channel, with cadmium being detected at the 0.01 mg/l level in only 10 per cent of the samples analyzed.

Toxic metals in Conners Creek were in the same range as the Detroit River and many times in lesser concentrations. Copper was frequently found in significant concentrations in the Rouge River, with one value 0.40 mg/l and a mean value of 0.09 mg/l. Other toxic metals in the Rouge River averaged between 0.01 and 0.02 mg/l. Toxic metals in Monguagon Creek were generally high, with a maximum zinc concentration of 0.56 mg/l.

Other metals showing high values at Monguagon Creek were lead, nickel, and copper, with maximum values of 0.09, 0.05, and 0.04 mg/l respectively.

Average concentrations of copper were less than those expected to interfere with water use but one extreme value at the head of the River indicates a possible toxic hazard to fish and other aquatic life. No other value of similar magnitude was found.

Average and maximum concentrations of nickel, zinc, and chromium found in the Detroit River do not indicate interference with water use.

Average values of lead approached levels of 0.05

mg/l, which represent a threat to the health and welfare of consumers of domestic water supplies. The maximum value encountered approaches the limit of 0.10 mg/l, which represents a potential threat to fish and other aquatic life. Further increases in any magnitude of waste loadings to the Detroit River containing lead may represent a threat to the health and welfare of the users of the lower Detroit River and to fish life in that reach of the River.

Average cadmium values indicated no interference with domestic water use or propagation of fish and other aquatic life. A maximum value of 0.08 mg/l did exceed recommended limits for these uses, and careful surveillance should be made of future levels of this substance.

Higher levels of copper and lead were found in the Rouge River and Monguagon Creek.

Oil and Grease

Analysis for oil and grease was not made on river or lake samples due to difficulty in obtaining a representative sample. Observations were made of visible floating oil, which for the most part was noticed in marinas and other areas of shallow or slow-moving water. Remedial measures to abate oil and grease pollution should be made with the objective of keeping effluents from all wastes as low as practicable. IJC effluent recommendations of not more than 15 ppm oil and grease in the effluent appear to be applicable in this instance.

Cyanide

Cyanides are toxic to man as well as fish and other aquatic life. PHS drinking water standards recommend limiting cyanide concentrations to 0.01 mg/l. Cyanide concentrations above 0.025 mg/l are considered detrimental to fish and other aquatic life. A mandatory limit of 0.20 mg/l has been set for cyanide concentrations in drinking water by the PHS standards.

In the upper Detroit River, cyanides were present in 15 per cent of the samples analyzed, with a maximum concentration of 0.01 mg/l. In the lower River above the Trenton Channel, cyanides were found in 21 per cent of the samples analyzed equal to or in excess of 0.01 mg/l, with one value 0.05 mg/l. In the Trenton Channel cyanides were found in 18 per cent of the samples equal to or in excess of 0.01 mg/l, with a maximum value of 0.03 mg/l. At the mouth of the Detroit River, 35 per cent of all samples analyzed contained cyanides equal to or in excess of 0.01 mg/l, with a maximum value of 0.09 mg/l, 7,500 feet from the United States shore.

Cyanide concentrations found in the lower Detroit River pose a potential interference with domestic water supply and fish and wildlife propagation.

Hardness

Hardness in the Detroit River increased from approximately 100 mg/l at the head of the river to 130 mg/l near the mouth. Hardness in the raw water supply at the City of Monroe intake in Lake Erie has averaged 128 mg/l over the past few years. This increase is due to the discharge of industrial and municipal wastes containing calcium and magnesium. Hardness interferes with municipal water supplies by increasing the amount of soap and detergent required for household use.

BIOLOGICAL

Microscopic Plants and Animals

Phytoplankton, free-floating microscopic plants, are of basic importance in aquatic environments, since they provide the first step in the food chain of fishes. By the process of photosynthesis, phytoplankton are able to synthesize protoplasm from the nutrients available in the waters, utilzing sunlight for energy. Zooplankton, the animal plankton, form the food of many young fishes at the critical post-hatching period. The microcrustacean plankters are important animals in the transformation of algal cell material into fish flesh. As primary consumers, they feed upon the phytoplankton. In order to support game fish at the top of the food chain pyramid, the waters must produce large

quantities of zooplankton.

Plankton in excessive numbers can create nuisances. Some species may become toxic. Many cause water treatment problems by clogging filter beds and producing tastes and odors. Through the uptake of nutrients released to the waters by domestic wastes, industrial waters, and land drainage, algae can occur in such abundance as to accelerate significantly the aging of lakes.

Low oxygen-producing potentials in the lower water strata and the mud-water interface of lakes create acid conditions that liberate nutrients bound in the mud-water interface region to overlying waters. These phosphates further contribute to nuisance blooms and augment algae problems.

In addition to studies of free-floating plants and animals, attached slimes and other microscopic organisms were collected from numerous points in the Detroit River and Lake Erie and examined (see Figure 11-VI). Many of these organisms form massive colonies in organically enriched and highly polluted waters. One such species is Sphaerotilus, a filamentous slime bacterium, commonly referred to as "sewage fungus," one of the most unsightly products of pollution. These bacteria form ragged white, yellow, pink, or brown masses on all solid objects in rivers and lakes, and may even form a carpet over mud surfaces. At times, drifting

masses of sewage fungus may continue to grow in open waters of large rivers and cause trouble to fishermen by fouling lines and nets. Another growth, the filamentous green algae Cladophora, may also be associated with polluted and nutrient-enriched waters. When dead and windrowed upon beaches, it decays and produces obnoxious odors and may become a fly -breeding habitat. Abundant growths of this algae may become a nuisance on beaches, prohibit swimming, and interfere with recreation.

The Detroit River, from head to mouth, was found to contain low numbers of planktonic algae, counts ranging from 50/ml to 4,675/ml and averaging 500/ml. Low concentrations of animal plankton were also found.

Plankton entering the River from Lake St. Clair were carried as a "standing crop" down the River to its mouth with little change in density or species composition either vertically (in depth) or horizontally (across the River). The rate of travel of the population down the 27-mile stretch of the waterway is too rapid for the domestic and industrial wastes to appreciably alter the numbers of plankton. Diatoms, silica-walled alga (brown or greenish in color), usually made up 70 per cent or more of the phytoplankton populations.

The early spring diatom pulse in Lake St. Clair

raises the counts in the Detroit River to levels averaging 2,000/ml. At that time, diatoms have reported to cause trouble at the Detroit filter plant by reducing filter runs and increasing coagulation costs.

The observed turbid condition of the Detroit River was not associated with the concentration of living organisms in the waters since plankton populations were not dense enough to contribute appreciably to turbidity. Rather the cause of the turbid water is attributable to a combination of the fine clay particles carried in suspension from the water masses from Lake St. Clair, and inorganic and organic particulate matter from industrial and domestic wastes of the Detroit area.

The sewage fungus, Sphaerotilus, was found growing attached to bridge abutments, pilings, piers, buoys, and slide racks suspended in the waters to capture these organisms. It was abundant in the Detroit River below the Rouge River and Detroit Sewage Treatment Plant outfall (Figure 13-V). The growth of these slime bacteria was caused by the discharge of inadequate treated municipal and industrial wastes of organic origin in the Detroit area.

(Figure 13-V follows.)

FIGURE 13-V

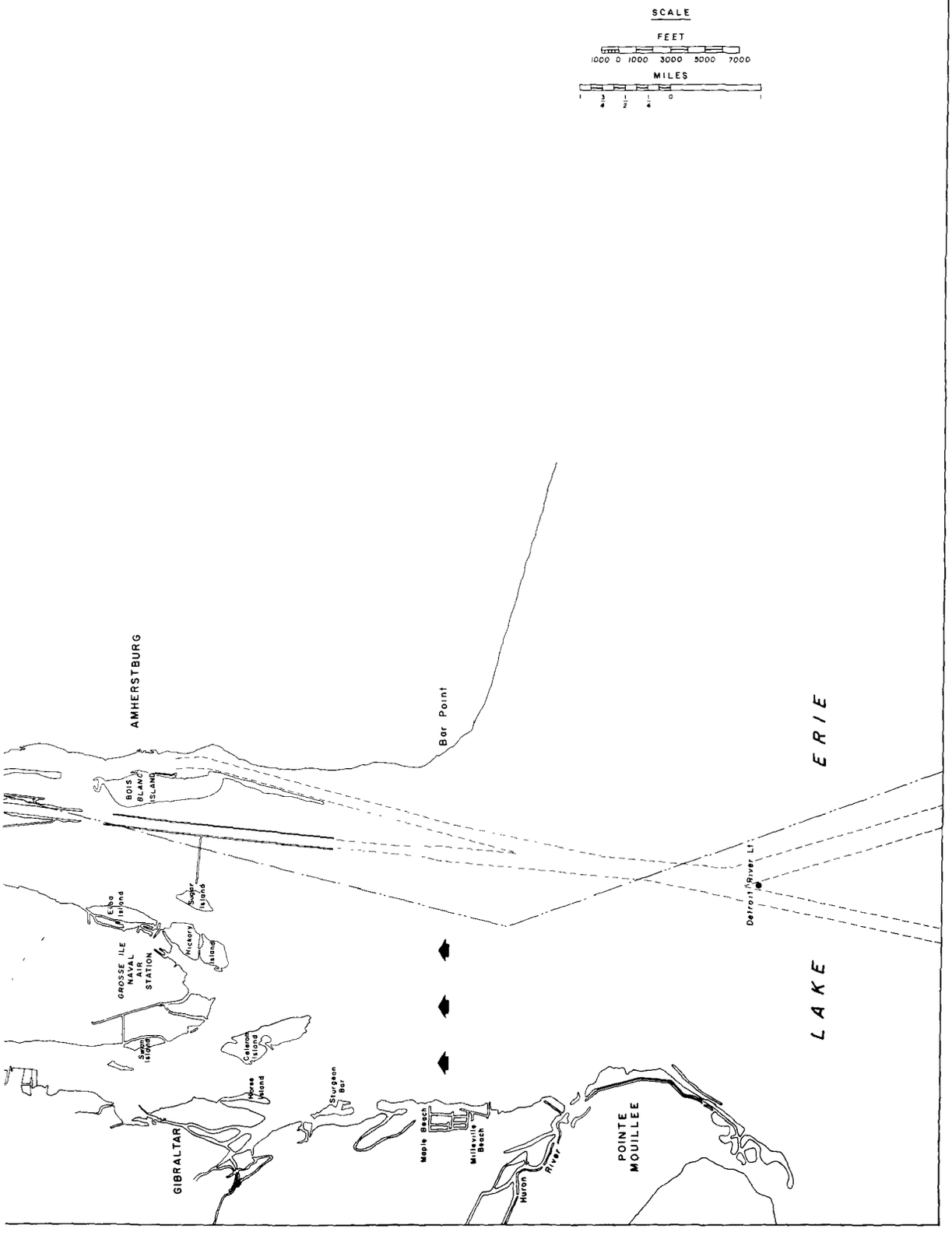
DETROIT RIVER-LAKE ERIE PROJECT

DISTRIBUTION OF FILAMENTOUS SEWAGE BACTERIA

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



The elimination of sensitive organisms and the seemingly unlimited food supply from organic solids permit the surviving tolerant forms to increase inordinately in numbers.

Under conditions of drastic pollution even the tolerant forms may be destroyed and no signs of life will be apparent in the bottom muds. Consequently, the presence or absence of certain bottom organisms in a sample becomes meaningful and enables a trained observer to assess the quality of the water passing over the organisms.

Bottom samples in the Detroit River were collected at various locations during the spring, summer, and fall seasons of 1963.

Bottom samples collected at the headwaters down to the northern tip of Belle Isle contained a pollution-sensitive association of organisms (Figure 14-V and Table 4-V). Environmental conditions and character of the substrata were ideal for the presence of a variety of clean-water associated species. The water in this reach of the River was not degraded.

(Figure 14-V; and also Table 4-V of two pages, follow.)

FIGURE 14-V

DETROIT RIVER-LAKE ERIE PROJECT

AREAS OF POLLUTION AS INDICATED BY BOTTOM ORGANISM ASSOCIATIONS

U.S. WATERS
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

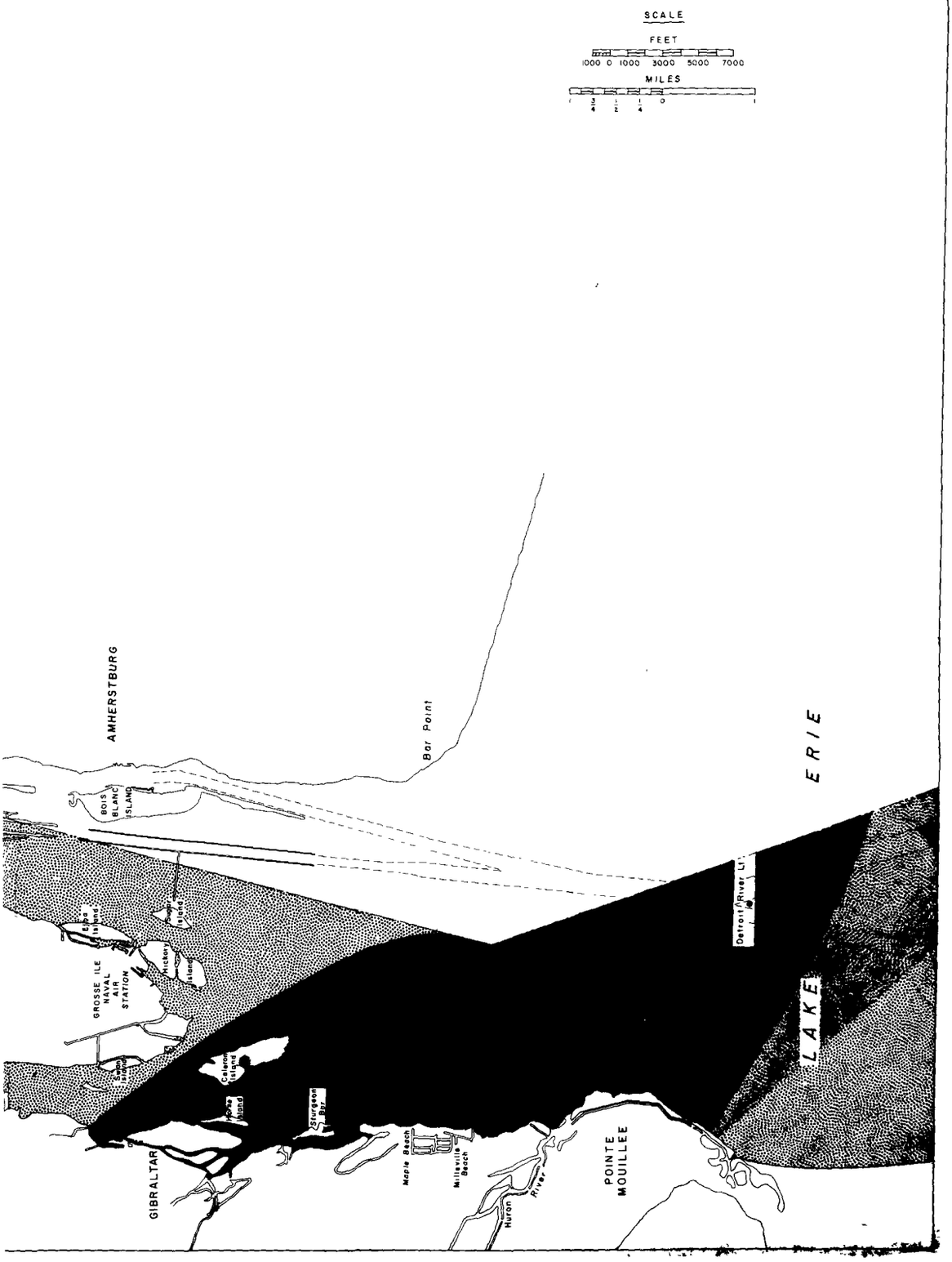


TABLE 4-V. SUMMARY OF BOTTOM ORGANISM DATA, DETROIT RIVER

MEAN NUMBER PER SQUARE FOOT OF BOTTOM

		SENSITIVE FORMS			INTERMEDIATE FORMS				TOLERANT FORMS	
Detroit River Mile	Range	Caddisfly Larvae	Mayfly Naiads	Mussles	Snails	Fingernail Clams	Scuds	Midge Larvae	Leeches	Sludgeworms
30.8	R-98	17	1	1	2	1	2	2	1	2
	R-104	1	1	-	1	1	-	1	-	-
	R-106	30	1	1	2	3	1	1	-	1
28.4	R-114	11	-	1	-	1	1	-	-	4
	R-118	2	-	1	3	56	1	-	1	3
	R-120	3	1	1	3	16	1	1	-	1
25.7	R-122	-	-	-	-	-	-	-	1	206
	R-125	1	-	1	6	82	1	1	-	1
20.6	R-3	1	-	-	1	2	1	-	3	79
	R-7	4	1	1	2	15	1	1	-	-
	R-11	1	-	-	1	7	1	1	-	-
19.0	R-139	-	-	-	-	-	-	-	-	48
	R-141	-	-	-	-	-	-	-	-	12
	R-143	-	-	-	-	11	-	6	-	11
17.4	R-17	-	-	-	-	1	-	-	2	24,400
	R-21	1	-	-	1	2	1	-	1	31
	R-25(1)	1	-	-	-	-	-	-	-	-
14.6	R-32	1	-	-	1	3	-	-	4	62
	R-40	-	-	-	2	1	-	-	1	1
	R-44(2)	1	-	-	-	-	-	1	1	1

TABLE 4-V – Continued

Detroit River Mile	Range	Caddisfly Larvae	Mayfly Naiads	Mussels	Snails	Fingernail Clams	Scuds	Midge Larvae	Leeches	Sludgeworms
12.0	R-86	-	-	-	-	-	-	2	1	15,500
	R-89	-	-	-	1	-	-	-	1	24
9.3	R-46	-	-	-	3	-	1	1	1	17
	R-50	-	-	-	2	-	1	-	1	38
	R-54	-	-	-	1	1	-	-	1	2
8.7	R-91	1	-	-	19	2	1	-	13	2
	R-94	-	-	-	1	1	-	2	1	372
	R-96	1	-	-	2	1	-	-	1	-
3.9	R-66	-	-	-	8	-	-	1	1	148
	R-69	-	-	-	3	1	-	1	1	1,134
	R-73	-	-	-	2	4	-	-	3	116
Rouge River		-	-	-	-	-	-	-	-	9,520

(1) No macro-bottom organisms, Summer Survey.
(2) No macro-bottom organisms, Spring Survey.

A short distance downstream from Belle Isle (Figure 14-V), bottom samples collected near the Michigan shore did not contain sensitive or even intermediate forms; only a preponderance of pollution-tolerant sludgeworms and leeches thrived. Below the combined sewer outlets at Conners Creek, along the Michigan shoreline downstream to Zug Island, clusters of sludgeworms inhabited the entire stretch of the bottom sludges. This reflects the addition and settling of organic material of sewage origin from the combined sewer overflows of the City of Detroit. In contrast, the midstream floor of the River contained many sensitive clean-water associated animals and was similar to the character of the area upstream from Belle Isle.

The reach of the River from Zug Island downstream to the mouth was polluted as indicated by the disappearance of sensitive organisms and the predominance of intermediate and tolerant forms. Habitats suitable to support a variety of bottom organisms have been destroyed by the deposition of organic solids and oils, especially in areas nearest the Michigan shore.

Three distinct areas of severely polluted waters were evident (Figure 14-V). One area was located along the Michigan shoreline, opposite the communities of Ecorse and River Rouge, downstream from the effluent of the Detroit Sewage Treatment Plant and the confluence of

the severely polluted Rouge River. Only tolerant leeches and sludgewords were found. Sludgeworms occurred in numbers as great as 24,000 per square foot. Field personnel found the bottom composed of ooze, sludge, many sludgeworms, with the appearance and odor of crankcase oil and sewage odor. Another area was confined to the reach downstream from the Wayne County Sewage Treatment Plant along the Riverview shorefront, where sludgeworms were found in numbers of 15,000 per square foot. Field personnel found muck, sludge, nauseating heavy oil odor, sludgeworms, dead snail shells and clam shells anchored in gray clay. The third area occurred where the Detroit River enters Lake Erie east of Pointe Mouillee. As the velocity of flow is reduced, suspended organic solids settle to the bottom, forming thick sludges that support sludgework populations of 5,800 per square foot.

Clinging mayfly nymphs, pollution-sensitive organisms normally occurring with clean-water bottom organisms associations on stony bottom, inhabited the upper ranges of the river. Burrowing mayfly nymphs, another sensitive form which lives in mud, were collected opposite the western side of Belle Isle. Below the Rouge River and the Detroit Sewage Treatment Plant outfall, dredge hauls from soft bottoms in habitats once thriving with burrowing

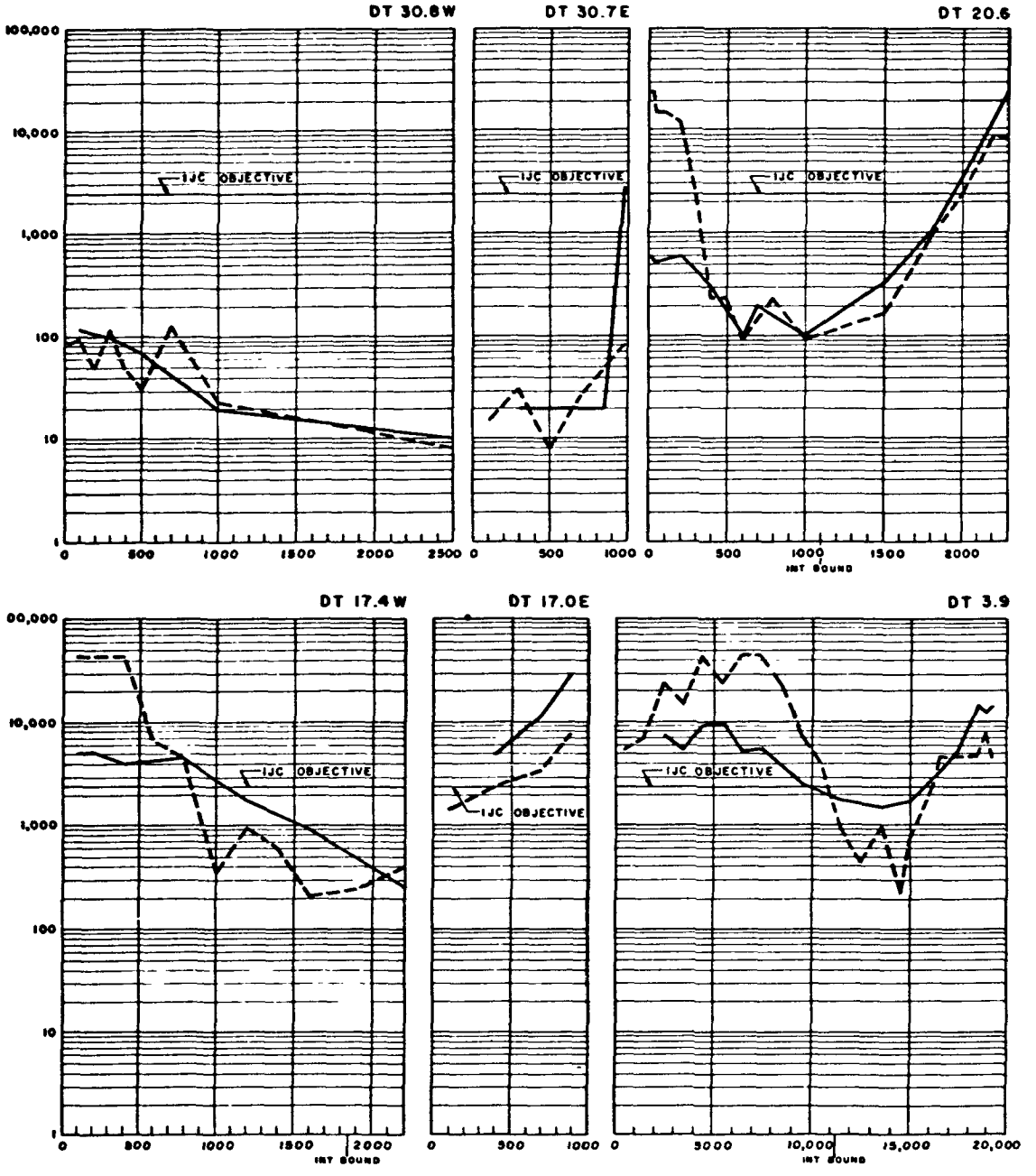
mayfly nymphs did not yield even a single specimen either in the river or lake. Habitats suitable for the support of this once abundant organism have been totally destroyed by pollution.

Evaluation of the bottom fauna in the Detroit River from its headwaters to its mouth shows a change from a community of clean-water associated organisms above significant sources of pollution to a community of predominantly pollution-tolerant organisms below known sources of pollution. Pollution from industrial and domestic sources causes this significant change in population composition, and damages habitats for desirable bottom-dwelling organisms.

TRENDS IN WATER QUALITY

One approach to evaluating trends in water quality and pollution abatement is to compare existing water quality levels and waste discharges with those found during past surveys. Figures 15-V, 16-V, and 17-V compare levels of total coliform organisms, phenols, and chlorides found during this Project with those found during the 1946-48 IJC survey.

(Figure 15-V follows)



LEGEND

——— 1962-1963 Detroit Project Data (MF)
— — — 1946-1948 IJC Data (MPN)

SCALE

Horizontal—Distance from West Shore as Indicated
Vertical—Log Scale Total Coliform per 100ml as Indicated

DETROIT RIVER-LAKE ERIE PROJECT

MEDIAN COLIFORM CONCENTRATIONS

DETROIT RIVER

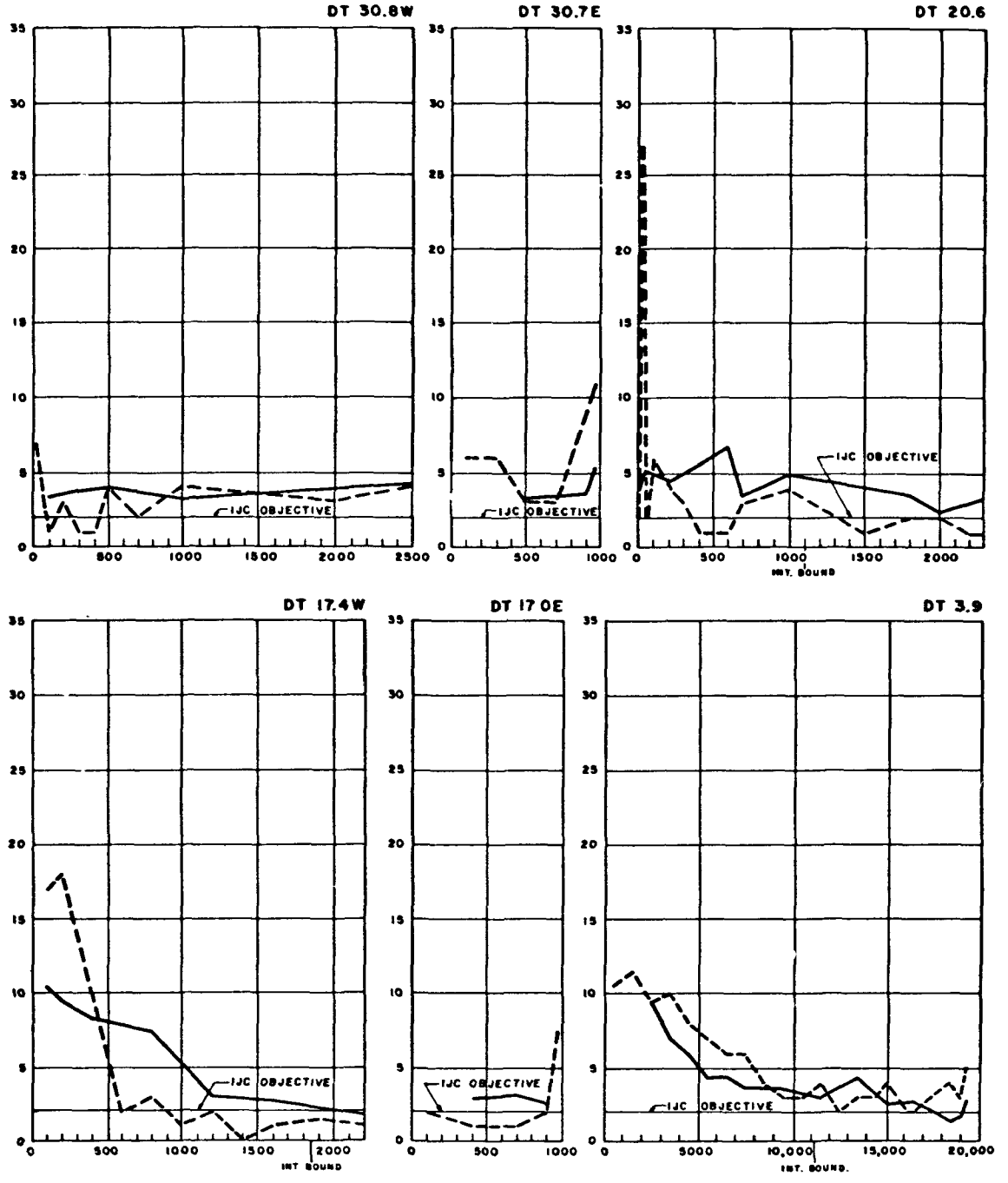
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

In United States waters, particularly near the shore, there has been an improvement in water quality as measured by total coliform organisms, except at the head of the River, where satisfactory water quality was found during both surveys.

Figure 16-V depicting phenols, shows little change at the head of the Detroit River. At downstream ranges the values adjacent to the United States shore were considerably lower during the 1963 period, while phenol concentrations away from this shore were higher during this period. At the mouth there was a slight improvement in water quality as determined by average phenol concentrations in United States waters.

(Figure 16-V follows.)

FIGURE 16-X



DETROIT RIVER-LAKE ERIE PROJECT

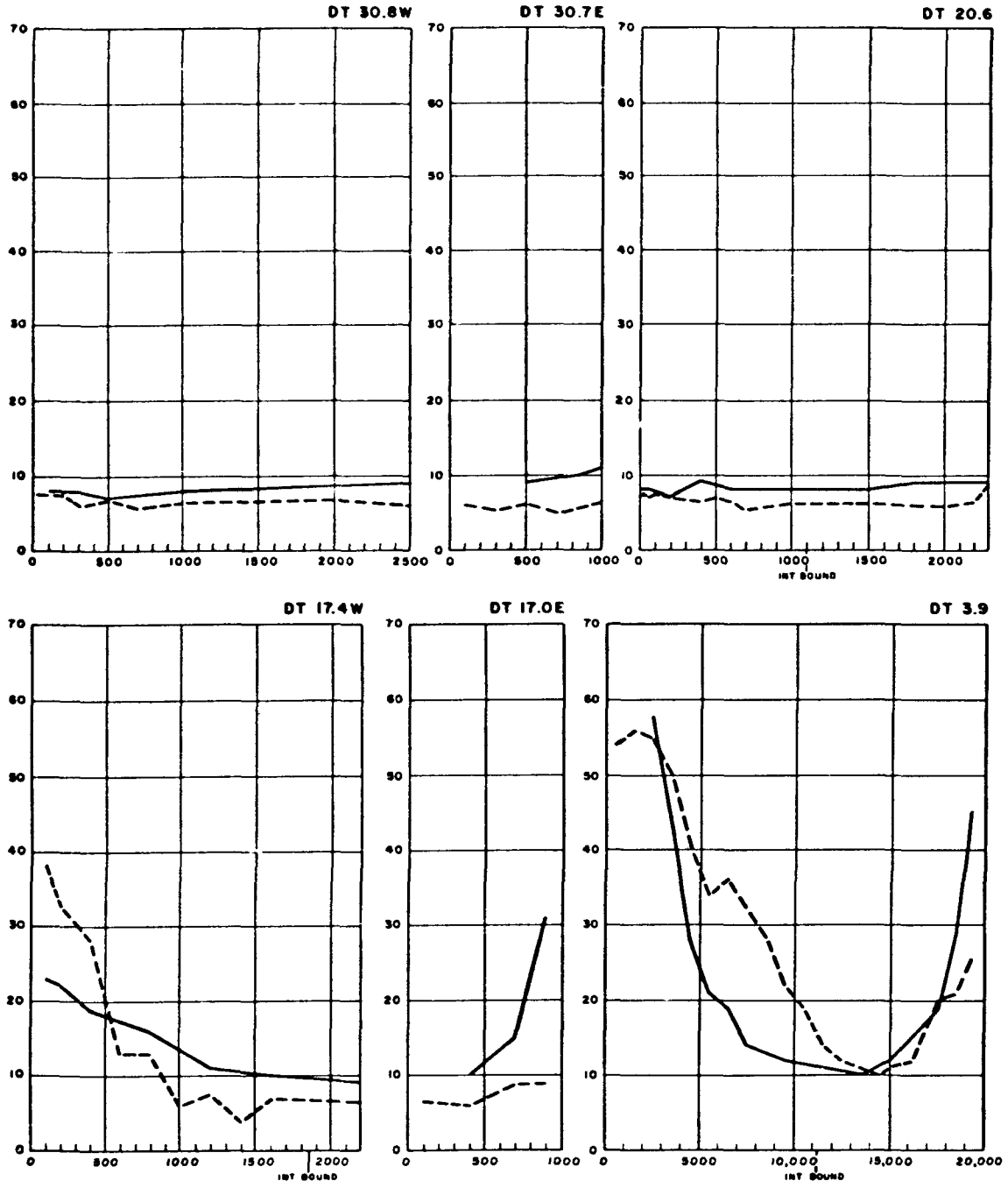
AVERAGE PHENOL CONCENTRATIONS

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

Figure 17-V shows mean chloride concentrations during the two surveys. Little change in chloride concentrations in the upper Detroit River was noted. In the lower River, chloride concentrations during the 1946-48 IJC survey were higher near the United States shore, while offshore values were higher during the 1962-63 survey. The reverse situation occurred at the mouth. Generally speaking, very little change in chloride concentrations occurred between the two surveys.

(Figure 17-V follows)



LEGEND

——— 1962–1963 Detroit Project Data (MF)
— — — 1946–1948 IJC Data (MPN)

SCALE

Horizontal–Distance from West Shore as Indicated
Vertical– Avg. Chloride–Milligrams per Liter as Indicated

DETROIT RIVER–LAKE ERIE PROJECT

AVERAGE CHLORIDE CONCENTRATIONS

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

Table 5-V compares waste loadings found during the IJC and PHS surveys for selected measures of water quality. The 1946-48 loadings represent industrial sources only, while 1962-63 results are given for industrial and domestic sources. Comparison of industrial waste loadings reveals a substantial reduction during the intervening 15 years in all five measures of water quality considered. A 22% reduction in ammonia and 51% reduction in suspended solids industrial wastes loadings are shown while reduction of phenols, oil and grease, and cyanides exceeded 70 per cent.

Domestic waste loadings for these waste constituents were not available in the 1946-48 IJC report. Table 5-V indicates large amounts of all constituents (except cyanides) in the domestic waste sources studied in the 1962-63 survey. Even though real progress has been made in reducing industrial waste loadings in the area, concentrations of these constituents in the River will not be substantially lowered until both industrial and domestic waste sources are reduced.

(Table 5-V follows.)

TABLE 5 - V

SUMMARY OF WASTE LOADINGS FOUND DURING INTERNATIONAL JOINT COMMISSION AND PUBLIC HEALTH SURVEYS

DETROIT RIVER - UNITED STATES SIDE

Survey	Source	Total Waste Flow (MGD)	Phenols (lbs)	Cyanides (lbs)	Ammonia (lbs)	Oils (gallons)	Suspended Sol. (lbs)
1946-48 IJC	Industrial	1,173*	4,890	3,690	11,010	16,240	1,669,200
1962-63 PHS	Industrial	1,090	1,410	1,030	8,530	3,350	822,000
% Reduction Industrial Waste Loadings (1948-1963)			71%	72%	22%	79%	51%
1962-63 PHS	Domestic	541	1,270	3	34,300	16,000	626,000

* Included steam generating plants

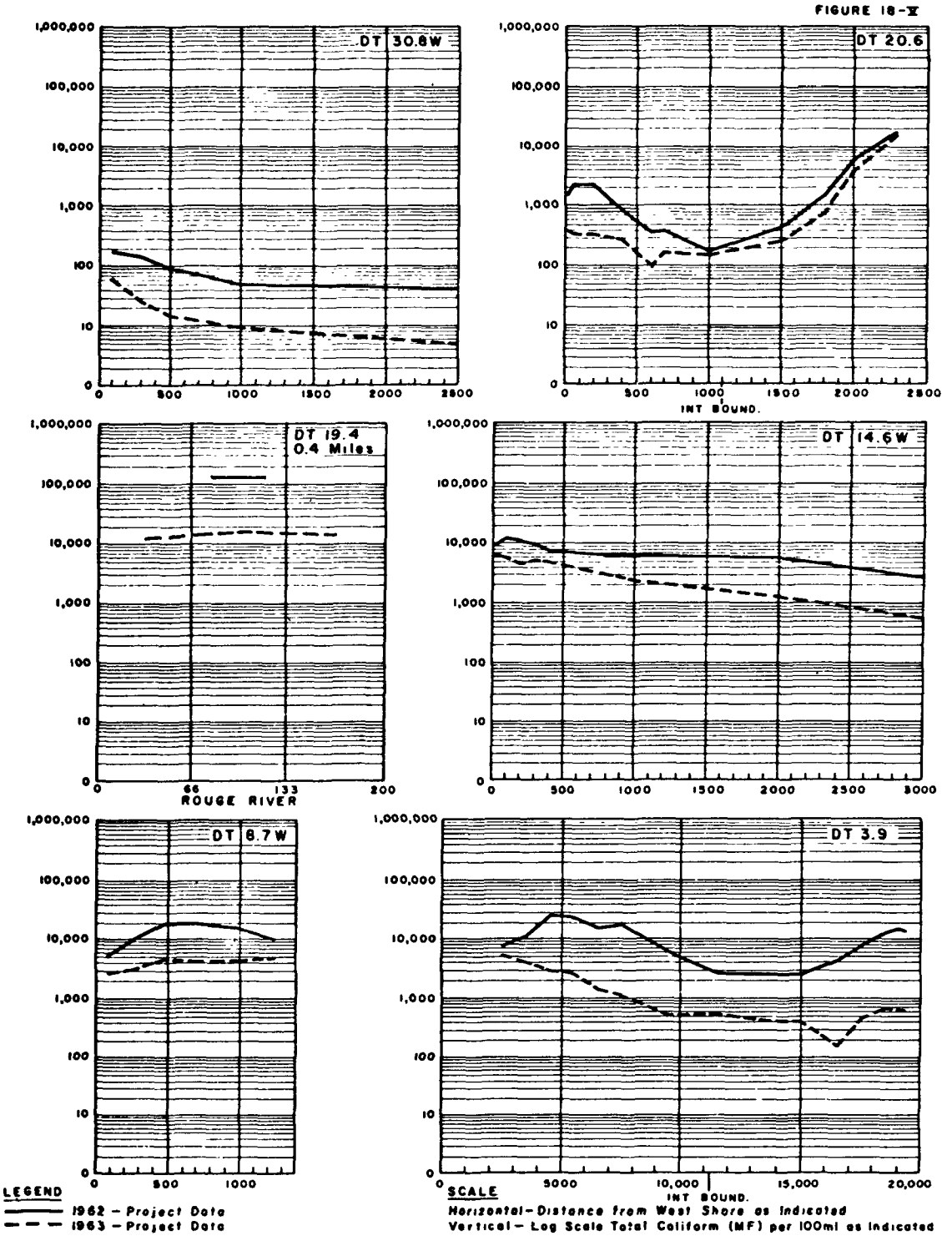
Another approach to evaluation of trends in water quality is the study of changes in levels of certain measures of water quality during this survey. Figures 18-V, 19-V, and 20-V compare 1962 average values for total coliform organisms, phenols, and chlorides with 1963 values.

Figure 18-V, depicting geometric mean total coliform values for the two years, show significantly lower coliform values in the Detroit River during 1963 than 1962 in United States waters (especially near the United States shore). Phenol concentrations in the Detroit River (shown in Figure 19-V) were consistently higher in 1963 than 1962. Chloride concentrations in the lower Detroit River were higher in 1963 except at the mouth, where they were lower near the United States shore and higher on the Canadian. There was very little change in chloride concentrations in the upper Detroit River in the two years.

Comparison of the Rouge River findings during these two years shows a decrease in average total coliform densities and phenols in 1963 and no change in chloride concentrations during this period.

(Figures 18-V, 19-V, and 20-V follow)

FIGURE 18-X



DETROIT RIVER-LAKE ERIE PROJECT

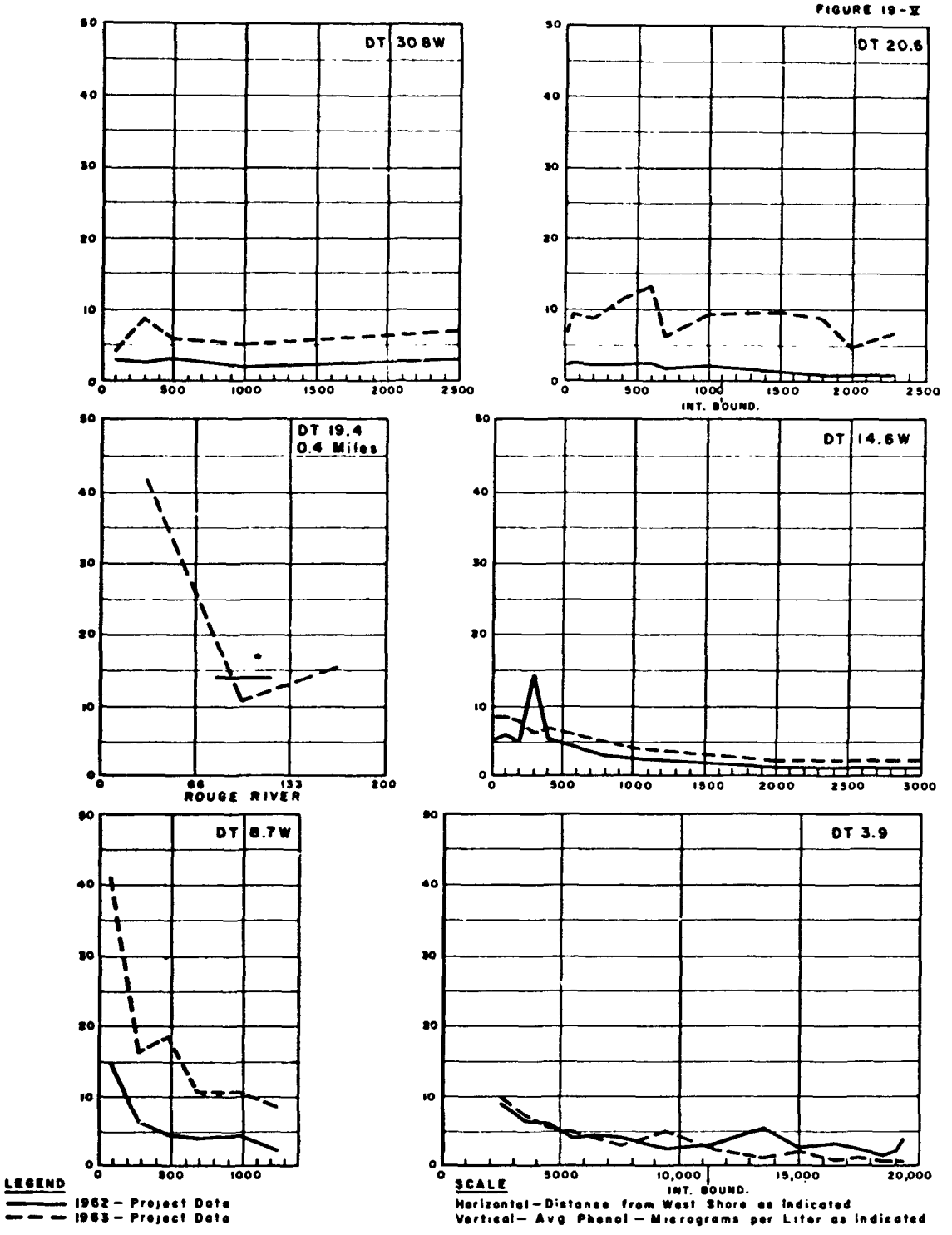
GEOMETRIC MEAN COLIFORM CONCENTRATIONS

1962-1963

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 19-X



DETROIT RIVER–LAKE ERIE PROJECT

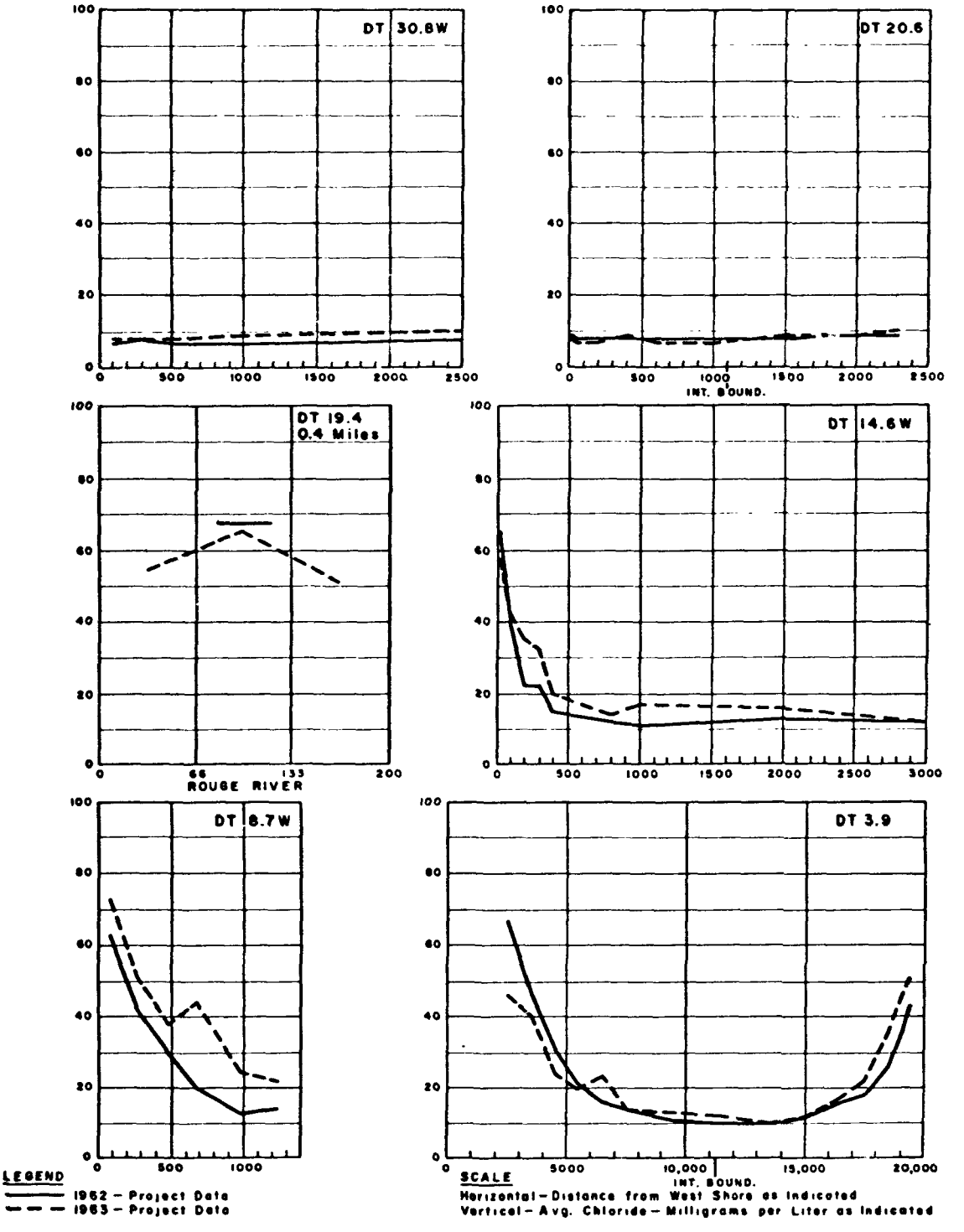
AVERAGE PHENOL CONCENTRATIONS

1962–1963

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 20-X



DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE CHLORIDE CONCENTRATIONS

1962-1963

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

Richard D. Vaughan

SOURCES AND CHARACTERISTICS OF WASTES

Municipal

In addition to study of operating records of sewage treatment plants (see Figures 11-I through 15-I), 4-day surveys were made in cooperation with the Michigan Department of Health during which waste flows were measured and hourly bacteriological samples and 12-hour composite chemical, biochemical, and physical samples were collected and analyzed. Summer and fall surveys were made at the Detroit and Wyandotte Treatment plants and a single survey conducted at the remaining installations.

The location of the sewage treatment plant outfalls in the Detroit River is shown in Figure 7-II. Table 6-V summarizes the results of the surveys while Table 7-V lists the waste loadings in some quantitative unit, such as pounds or gallons. Table 8-V summarizes treatment efficiency in removing certain waste constituents.

(Tables 6-V, 7-V, and 8-V follow.)

TABLE 6-V. SUMMARY OF RESULTS OF DOMESTIC WASTE SURVEYS
DETROIT RIVER

liform Organisms er 100 ml		Fecal Coliform Organisms per 100 ml			Fecal Streptococci Organisms per 100 ml		
minimum	geom. mean	maximum	minimum	geom. mean	maximum	minimum	geom. mean
14,000,000	36,200,000	42,000,000	5,600,000	16,100,000	580,000	175,000	391,000
L 10	79	-	L 10	-	6,840	L 10	122
5,600,000	27,000,000	48,500,000	2,000,000	10,500,000	2,200,000	600,000	1,170,000
L 10	411	68,000	L 10	-	12,000	L 10	175
9,800,000	31,600,000	45,200,000	3,800,000	13,300,000	1,390,000	387,000	780,000
L 10	245	68,000	L 10	-	9,420	L 10	148
2,000,000	67,500,000	100,000,000	42,000,000	65,000,000	16,000,000	4,300	690,000
L 10	31	-	L 10	-	140	10	45
6,000,000	101,000,000	152,000,000	6,900,000	43,800,000	2,000,000	660,000	1,030,000
5,000,000	41,000,000	65,500,000	7,500,000	23,100,000	22,000,000	490,000	1,310,000
9,000,000	84,200,000	126,000,000	24,400,000	54,400,000	9,000,000	331,000	860,000
-	-	-	-	-	-	-	-
0,000,000	34,100,000	24,500,000	6,600,000	12,500,000	1,660,000	420,000	845,000
L 10	14	-	L 10	-	30	L 10	12
3,600,000	5,840,000	7,600,000	1,200,000	3,400,000	500,000	240,000	300,000
L 10	21	-	L 10	-	L 10	L 10	L 10
1,000,000	11,600,000	84,700,000	4,400,000	14,600,000	24,000,000	37,200	1,030,000
L 10,000	7,890,000	42,000,000	L 5,000	4,800,000	1,800,000	2,800	297,000

TABLE 7-V. SUMMARY OF WASTE LOADINGS - DOMESTIC WASTE SURVEYS

DETROIT RIVER

de	ABS	Iron	Copper	Cadmium	Nickel	Zinc	Lead	Cyanide
ay	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
00	20,800	25,200	870	-	1,600	-	502	L 45
-	-	-	-	-	-	-	-	-
00	20,800	25,200	870	-	1,600	-	502	L 45
00	1,160	202	13.1	5.6	5.6	58.1	9.4	5.6
-	-	-	-	-	-	-	-	-
00	1,160	202	13.1	5.6	5.6	58.1	9.4	5.6
40	146	38	3.0	4.7	1.9	7.6	1.5	3.9
78	6.7	1.5	-	-	0.01	0.1	-	0
01	-	-	-	-	-	-	-	-
00	22,100	25,400	886	-	1,610	-	512	L 55

TABLE 8-V. SUMMARY OF TREATMENT EFFICIENCY - DOMESTIC WASTE SURVEYS
DETROIT RIVER

uble sphates	Total Phosphates	Chlorides	ABS	Iron	Copper	Cadmium
removal	% removal	% removal	% removal	% removal	% removal	% removal
18	-	33	0	31	47	-
-	0	-	-	-	-	-
18	0	33	0	31	47	-
0	-	0	0	44	0	0
-	15	-	-	-	-	-
0	15	0	0	44	0	0
0	-	0	7	21	22	0
0	-	10	0	31	0	0
-	-	0	-	-	-	-

Detroit (Belle Isle Sewage Treatment Plant)

Results from the survey revealed a plant influent of low density and treatment removal efficiencies within accepted limits for this type of facility. While BOD removal was low (25%), the low density in the influent (60 mg/1) makes it difficult to achieve a higher degree of removal. Total coliform and fecal streptococcus densities in the effluent were high (7,890,000 and 297,000), but must be expected in a plant not chlorinating its effluent.

Detroit (Main Sewage Treatment Plant)

The plant effluent contained waste constituents at levels normally not associated with domestic wastes. Among these constituents are oil and grease, phenols, copper, iron, chromium, nickel, zinc, and lead. Average phenol effluent concentration during the two surveys was 303 micrograms/1, far in excess of the 20 micrograms/1 value recommended by the International Joint Commission. Effluent oil concentration averaged 30 mg/1, which is double the International Joint Commission recommended effluent concentrations of 15 mg/1. Oil and phenol waste loadings to the Detroit River during this survey were high (15,500 gallons/day and 1,260 lbs/day respectively).

Ammonia-nitrogen concentration in the effluent was high (7.7 mg/1), as were ammonia loadings (31,500 lbs/day). All forms of nitrogen averaged 12 mg/1, representing

a loading to the River of over 51,000 lbs/day. Phosphate effluent concentration averaged 36 mg/l in the total form and 14 mg/l in the soluble form, representing a discharge to the Detroit River of 145,000 and 65,000 lbs/day.

Suspended solids, settleable solids, and BOD values in the plant effluent are high at 140, 60, and 109 mg/l. Treatment efficiency for these substances is low, although long term records show that higher efficiency has been achieved at other times. Settleable solids removal during the survey was poor at 54%. The average suspended solids loading of 607,000 lbs/ day is high. BOD loadings to the Detroit River of 500,000 lbs/day represent a population equivalent of approximately 3 million.

Bacteria removal during the survey was excellent and density in the effluent very low with geometric means for total and fecal coliform and fecal streptococcus under 125 organisms per 100 ml during the first survey and all under 500 organisms per 100 ml during the second. While averages during the survey do not correspond with mean monthly averages during the study period (see Figure 11-I, they indicate that effective bacterial control can be accomplished. During the eight days of the survey period 14 per cent of the samples collected exceeded 2400 organisms per 100 ml and 4.5% exceeded 20,000 organisms per 100 ml.

During this same period 15% of the fecal streptococcus samples exceeded 2,400 organisms per 100 ml and 1% exceeded 10,000, indicating that fecal streptococci were not as effectively reduced by chlorination as were coliforms.

Wayne County Sewage Treatment Plant (Wyandotte)

Results of the surveys indicate waste constituents at levels normally not associated with domestic sewage. These include phenols, oil and grease, iron, chromium, copper, cadmium, nickel, zinc, and lead.

Average concentrations of suspended solids and settleable solds were high (95 and 32 mg/l) during the two surveys and loadings to the River significant (17,000 and 5,600 lb/s day). Average BOD in the effluent during the first survey was high (120 mg/l) and the loadings significant (22,100 lbs/day). This discharge represents a population equivalent of 132,000. Treatment efficiency in this type of plant for BOD and suspended solids removal was in the expected range of 35% and 61% respectively.

Average phenol concentration in the effluent was 71 micrograms/l, far above the International Joint Commission recommended effluent level of 20 micrograms/l, and oil and grease average effluent values of 20 micrograms/l slightly above the International Joint Commission recommended limit of 15 mg/l.

Average ammonia nitrogen effluent concentration during the two surveys was high (16 mg/1) and loading to the River also great (2,900 lbs/day). Total nitrogen compounds, as nitrogen, averaged 19 mg/1 in the effluent, representing loadings of over 3,400 lbs/day. Phosphates were in the effluent in average concentrations of 40 mg/1 in the total form, and 28 mg/1 in the soluble form. This represents waste discharges of phosphates to the River of over 7,200 and 5,000/day respectively.

Bacteriological control was excellent during the first survey when chlorination of the effluent was practiced. Geometric mean densities for total coliforms, fecal coliforms and fecal streptococci during the first survey was less than 100 organisms per 100 ml. Study of plant operation records (Figure 11-I) reveals these results are not typical, but it is encouraging to note that results of this magnitude can be obtained. During the survey 35 of the total coliform results exceed 2,400 organisms per 100 ml and none exceed 10,000 organisms per 100 ml. During the second survey effluent chlorination was not practiced and geometric means for total coliforms, fecal coliforms and fecal streptococci exceeded one million.

The cyanide concentration from the Wyandotte plant reached maximum values during the first survey of

0.11 mg/l, and the average loading to the River was 3 lbs/day.

Wayne County Sewage Treatment Plant (Trenton)

Results of the Trenton survey revealed high concentrations of oil and grease, and phenols in the plant effluent (41 mg/l and 24 micrograms/l). Values of both constituents exceeded International Joint Commission recommended effluent levels of 15 mg/l and 20 micrograms, respectively.

Average suspended and settleable solids in the effluent were high, at 80 and 14 mg/l, but treatment efficiency was within the range expected for this type of installation. Average suspended solids discharged to the Detroit River were 1,600 pounds per day. BOD in the effluent averaged 83 mg/l, representing a loading of 1,780 pounds per day or a population equivalent of over 10,000. Treatment efficiency in BOD removal was 33 percent.

Bacteriological control during the survey was excellent, with all samples examined averaging less than 15 organisms per 100 ml Examination of plant records (Figure 11-I reveals that these values were not typical, however.

Wayne County Sewage Treatment Plant (Grosse Ile)

This survey revealed phenols and oil and grease

effluent concentration in excess of International Joint Commission recommended effluent limits.

Suspended and settleable solids for the effluent averaged 63 and 9 mb/l respectively, and the removal efficiency for suspended solids, 59% was within expected limits for this type of installation. BOD averaged 80 mg/l in the effluent, which represents a population equivalent of 650.

Bacterial control during the survey was excellent, with effluent geometric means for all organisms examined under 25 per 100 ml.

The following table lists present loadings of iron, oil, phenols, and suspended solids, and the reductions which would be effected if IJC recommended effluent limitations and a suspended solids limitation of 35 mg/l were met at all the domestic sewage treatment plants in the Detroit area:

Pollutant	Present Loading	Loading after Reduction	Per Cent Reduction
Oil and Grease	16,000 gallons/day	8,420 gal/day	47
Phenols	1,270 pounds/day	90 pounds/day	93
Iron	25,400 pounds/day	25,400 lbs/day	0
Suspended Solids	626,000 pounds/day	159,000 lbs/day	74.6

Approximately 99 per cent of the iron from domestic sources being discharged to the Detroit River originates from the Detroit Sewage Treatment Plant. The average iron concentration of 5.5 mg/l meets IJC recommended effluent limitations, but is still a substantial loading to the River.

The main treatment plant of the City of Detroit is the major domestic source of almost all waste constituents. For example, Detroit discharges 99 per cent of the iron from domestic sources, 99 per cent of the phenols, 97 per cent of the oil, 95 per cent of the BOD, 97 per cent of the suspended solids, 98 per cent of the settleable solids, and 99 per cent of the toxic metals. It also constitutes 95 per cent of the total volume of wastes discharged and serves 91 per cent of the people served by sewage treatment plants discharging wastes to the Detroit River.

INDUSTRIAL

Industry in the Detroit area differs from that in many other metropolitan areas in that manufacturing is primarily centered around a single industry--motor vehicle production--and the production of raw materials, parts, and accessories that go into the manufacture of transportation equipment. Production of synthetic organics and heavy chemicals from the extensive underground salt deposits of the

region is another large segment of the industry of the area. One paper plant on the Rouge River manufactures paper tissues by the sulfite process. There are also pharmaceutical, rendering, petroleum refining and metal-finishing industries in the Detroit area. Figures 5-II and 6-II show the location of all the industries investigated in the study.

Investigation of these sources of industrial wastes was accomplished jointly by the Michigan Water Resources Commission and the U. S. Public Health Service, Individual surveys were made of each industry, discharging wastes directly to the Detroit River and certain of its tributaries. In addition, outfall grab samples were collected throughout the duration of the Project. Results from both were considered in formulating conclusions and recommendations for improvement of waste treatment.

Tables 9-V and 10-V summarize survey results for 35 industries on the Detroit River. Table 9-V contains average concentrations of selected waste constituents, while Table 10-V summarizes waste loadings in some quantitative unit, such as pounds or gallons per day. In the computation of waste loadings contributed by each industry, only the increase over values found in the plants' raw water supply was used. In most cases, values found during the intensive surveys were used as reported, while some were modified by additional grab samples collected from plant effluents.

(Tables 9-V and 10-V follow)

TABLE 9-V. SUMMARY OF RANGES OF AVERAGE RESULTS OF INDUSTRIAL WASTE EFFLUENT CONCENTRATIONS - DETROIT RIVER

anides mg/l	Copper mg/l	Cadmium mg/l	Nickel mg/l	Zinc mg/l	Lead mg/l	Chromium mg/l
0	0.31	0.08-0.17	.01-.02	.02-.63	.03-.09	.01-.02
0-2	0.15	.01-.06	<.01-.01	.01-.11	.02-.04	.01-.07
.-.04	.03-.09	<.01	<.01-.01	.06	.03-.06	.01
)-.08	.04-.13	<.01-.03	<.01-.03	<.01-.22	.02-.27	<.01-.14
0	.08-3.05	<.01	<.01-.02	.16-.39	.06-.27	<.01-.01
-	-	-	-	.11-.14	.09-.13	<.01
)-.74	.02-2.2	<.01	<.01-.15	.02-.12	<01-.14	<.01-.74
0	<.01-.02	<.01	<.01-.01	<.01-.04	.06-.90	<.01-.04
0	.26-.37	<.01	<.01	.02-.75	.03-.06	<.01-.19
-	.07-.08	<.01	.01-.02	<01-.07	.03-.21	<.01-.26
-	6.3-9.15	<.01	<.01	1.2-7.05	<01-.08	.93-1.5
1.14	.03-.07	<01-.05	<.01-.09	.06-2.38	.12-1.59	<.01
..06	<.01-.09	<.01-.03	.01-.03	<.01-.05	.02-.03	<.01-.01
..01	.04-6.1	<01-0.1	<.01-.32	.34-4.1	.04-.35	<.01-2.3
0	.01-.04	<.01	<.01	.05-5.9	<.01-.05	<.01
23	<.01-.01	<.01	.02-.03	.04-.05	<.01-.06	<.01
-	.03-.04	<.01	.01-.02	.06-.24	<.01-.01	<.01-.01
-	.03-.05	<.01	.01	.06-.07	.16-.25	<.01-.01
-	<.01-.50	<.01	<.01-.02	<.01-4.7	<.01-.13	<.01-.80
0	<.01-.08	<.01-.02	<.01-.03	1.10	.01-.07	.04-.06

TABLE 9-V. (CONT.) SUMMARY OF RANGES OF AVERAGE RESULTS OF INDUSTRIAL WASTE EFFLUENT CONCENTRATIONS - DETROIT RIVER

yanides mg/l	Copper mg/l	Cadmium mg/l	Nickel mg/l	Zinc mg/l	Lead mg/l	Chromium mg/l
-	.10-1.25	<.01	<.01-.01	.07-.86	<.01-.06	<.01-.80
-	.06	<.01	<.01	.06	.09	<.01
0-.01	.04-1.48	<.01	.01-.04	.04-.32	.02-.68	.01-.14
0-.01	<.01-.04	<.01-.02	.01-.02	.05-.20	.09-1.6	<.01
.01-.1	.04-2.75	<.01	<.01-8.	09-1.36	.05-.96	<.01-.04
)-1.12	<.01-.66	<.01-.01	<.01-.21	.01-3	<.01-.74	<.01-.11
-	.02-.04	<.01	.01	.04-.42	.01-.02	<.01
0	<.01-.14	<.01-.01	<.01-.02	<.01-.18	.08-.64	<.01-.18
.01	.04-.08	<.01	.01-.03	.04	<.01	<.01
-	<.01	<.01-.01	<.01-.05	<.01-.08	<.01-.17	<.01-.03
-	<.01	<.01-.02	<.01-.01	<.01-.03	<.01-.02	<.01-.05
-	<.01-.05	<.01	.02-.08	.01-.29	<.01-.05	<.01
2-.96	<.01-.24	<.01-.01	<.01-.02	<.01-.36	<.01-.13	<.01-.07
0-.07	<.01-.41	<.01	<.01-.02	<.01-.38	<.01-.08	<.01-.09
-	.16-.23	<.01	<.01-.01	.08-.44	.10-.13	<.01-.01

TABLE 10-V. SUMMARY OF AVERAGE DAILY LOADING OF INDUSTRIAL WASTES ADDED BY EACH INDUSTRY TO DETROIT RIVER

dmium lbs.	Nickel lbs.	Zinc lbs.	Lead lbs.	Chro-mium lbs.	Phos-phates lbs.
4.1	0	11	1	0	-
0	0	0	0	0	-
0	0	0	0	0	-
0	0	2.8	1.5	0.4	-
0	0	2.0	0.9	-	-
0	0	0	1.0	0	5.5
0	36	275	50	260	-
0	0	0	0	0	-
0	0	230	0	0	-
.1	36	520.8	54.4	260.4	5.5
0	0	0	0	0	-
0	0	32	0.25	10	-
0	0	750	123	0	-
0	0	0	0	0	-
0	0.4	66	0.9	29	-
0	0	650	0	0	22.5
0	0.4	1,432	124.15	39	22.5
0	0	0	0	0	-
0	0	0	0	0	-
0	0.1	0.7	2	0	-
0	0	11	0.5	1.3	-

TABLE 10-V. (CONT.) SUMMARY OF AVERAGE DAILY LOADING OF INDUSTRIAL WASTES ADDED BY EACH INDUSTRY TO DETROIT RIVER

Nickel lbs.	Zinc lbs.	Lead lbs.	Chro-mium lbs.	Phos-phates lbs.
0	6	0.4	0	-
0	9	0	0	-
-	-	-	-	-
0	42	280	0	-
4	12	34	8	-
0	2.8	1.2	0	-
-	-	-	-	-
9	300	325	3	-
0	0.5	3	0.8	-
0.8	0.4	0	0	10,000
0	0	0	0	-
0	0	0	0	-
0	0	0	0	-
0	0	0	0	-
0	7	0	0	14
1	10	7	6	14
0	1.8	0.4	0	-
15.0	403.2	653.5	19.1	10,028
51	2,360	832	318	10,100

Tables 11-V through 13-V list the industries by name and location which discharge wastes directly to the study waters of the Detroit River and Rouge River. The tables include information on production (where available), waste water volume, significant waste constituents, and treatment and control employed for the process wastes. The tables do not include data on sewage from plant employees, as in all but a few minor cases the sewage is discharged to municipal sewers and is considered in the discussion of domestic wastes. Industries which discharge process wastes to municipal sewerage systems are also not included, since satisfactory disposal of these wastes is the responsibility of the municipality involved and is considered in the section on domestic wastes. The total quantity of waste water released by the Detroit and Rouge River industries in 1.1 billion gallons per day. Undoubtedly, significant additional waste discharges are caused by accidental spills of industrial wastes not reflected in effluent measurements.

Tables 11-V, 12-V, and 13-V follow.)

TABLE 11-V. SOURCES OF INDUSTRIAL WASTES - ROUGE RIVER

Industry	Volume (MGD)	Product	Production	Significant Waste Constituents	Waste Treatment or Control
Allied Chemical Corporation					
General Chemicals Division	9.11	sulfuric acid, aluminum sulphate.	- -	acid	ponds, pH monitors.
Plastic Division	0.48	coal tar, pitch, oil.	-	phenols, NH_3	dephenolizers, settling, oil separators.
Semet-Solvay Division	5.9	high-grade coke and by-products	-	phenols	dephenolizer, oil separator
Solvay Process Division	15.2	soda ash	1,000 ton/day	suspended solids, chlorides, phenols	lagoons
American Agricultural Chemical Company	1.15	fertilizer, gelatin, fluoride salts	-	acid	none
Darling and Company	1.13	fats and meat meal	-	BOD, coliform, N, suspended solids, oil	sedimentation
Ford Motor Company	400	steel, castings, coke, glass, automobiles	-	phenols, CN, NH_3, iron, oil	oil separator, sedimentation, sub-surface injection.
Peerless Cement Company	8.1	Portland cement	3 [illegible] million barrels/year	suspended solids	none
Scott Paper Company	43.8	high-grade paper tissue	240 tons/day	BOD, pH, Susp. solids, phenols.	screening, clarifiers
TOTAL	433.72				

TABLE 12-V. SOURCES OF INDUSTRIAL WASTES - UPPER DETROIT RIVER

Industry	Volume (MGD)	Product	Production	Significant Waste Constituents	Waste Treatment or Control
Allied Chemical Corporation					
Solvay Process Division	6.4	soda ash	1,000 tons/day	suspended solids, chlorides, phenols	lagoons
Anaconda-American Brass Company	5.3	copper	-	toxic metals, acid	neutralization, settling
Great Lakes Steel Corporation					
Blast Furnace Division	90	coke, pig iron, coke by-products	-	iron, susp. sol., phenols, oil, NH_3, cyanides	clarifiers, dephenolizer
Parke Davis and Company	8.1	pharmaceuticals	-	none	none
Revere Copper and Brass Company	2.9	brass and copper	-	oil, toxic metal	oil separators
U.S. Rubber Company	42	tires	-	none	oil skimmers
TOTAL	154.7				

TABLE 13-V. SOURCES OF INDUSTRIAL WASTES - LOWER DETROIT RIVER

Industry	Volume (MGD)	Product	Production	Significant Waste Constituents	Waste Treatment or Control
Chrsyler Corporation Amplex Division	0.32	gears	-	none	none
Chemical Products Division	0.27	chemical adhesives, brake linings, soluble oils	-	none	none
Engine Plant	1.1	engines	55,000/mo.	oil	air flotation and oil skimmer, chemical coagulation
Dana Corporation	0.38	auto and truck frames, trilevel RR car carriers	-	phenols, acid, oil, iron	none
E.I. duPont deNemours and Company	1.4	sulfuric acid, oleum	-	acid	none
Firestone Tire and Rubber Company	1.0	wheel rims	11,400,000 lbs./mo.	acid, iron, oil, suspended solids	oil separator, ponds, diffuser pipes
Fuel Oil Corporation	12,240*	ship washing	18 ships/yr.	oil, suspended solids	oil separator
Great Lakes Steel Corporation Hot Strip Mill	72	sheet steel	-	oil, iron, suspended solids	oil skimmers and settling basins
Rolling Mill	72	strip, sheet and bar steel	-	oil, phenols, acid, iron, suspended solids	oil separators

* gallons per hour when washing ship.

TABLE 13-V – Continued

Industry	Volume (MGD)	Product	Production	Significant Waste Constituents	Waste Treatment or Control
Koppers Company, Incorporated	0.8	naphthaline, paraffin epoxy resins	-	phenols, oil	none
McLouth Steel Corporation Girbraltar Plant	1.6	cold rolled steel	80,000 tons/mo.	acid, iron, suspended solids, oil	oil skimmers, lagoons
Trenton Plant	65.7	stainless steel	2,530,000 tons/yr.	iron, suspended solids, oil	chemical coagulation, settling neutralization, oil separators
Mobil Oil Corporation	1.1	gasoline, naptha, kerosine, oils	-	phenols, oil, chlorides, suspended solids	oil separator, ponds
Monsanto Chemical Company	18	phosphates and detergent	-	phosphates, suspended solids	lagoons
Pennsalt Chemicals Corporation East Plant	97	chlorine, caustic, NH_3, hydrogen peroxide, acid, ferric chloride	-	NH_3, chlorine, chlorides, suspended solids	none
West Plant	6.8	organic chemicals	-	phenols, chlorides, suspended solids, oil, oxidizing agents	lagoons, oil skimmers
Shawinigan Resins Corporation and Monsanto Saflex Division	0.4	polyvinyl butyral Ethyl acetate	500,000 lbs/week	acid, BOD, suspended solids	lagoons, neutralization

TABLE 13-V – Continued

Industry	Volume (MGD)	Product	Production	Significant Waste Constituents	Waste Treatment or Control
Wyandotte Chemicals Corporation					
North Plant	57	soda ash, bicarb of soda, lime, calcium carbonate, cellulose	-	phenols, chlorides, suspended solids, nitrogen	lagoons
South Plant	54.7	chlorine, lime, glycol, cement, soda, dry ice	-	chlorides, suspended solids, phenols	lagoons, oil separator
Propylene Oxide Plant	1.0	propylene oxide	65 tons/day	chlorides, suspended solids	lagoons
TOTAL	452.57				

Rouge River Industries

Nine plants on the Rouge River use this watercourse as the receiving stream for their wastes. Their principal products are steel, fabricated metals, heavy chemicals, pulp and paper, cement, and meat-rendering products. (See Table 11-V.) These plants produce a total waste volume of 484 million gallons per day. 83% of this volume originates from the Ford Motor Company. Principal wastes are iron, oxygen-demanding materials, bacteria, suspended solids, oil, pickling liquor, phenols, chlorides, cyanides, toxic metals, and ammonia. With the exception of the American Agricultural Chemical Company and Peerless Cement, the industries provide some form of treatment to restrict discharge of wastes to the Rouge River.

Upper Detroit River Industries

Six industries (shown in Table 12-V) discharge wastes directly to the Detroit River above the Rouge River outlet. The Allied Chemical Corporation, Solvay Process Division, discharges a portion of its wastes through the Schroeder Avenue storm sewer and one outfall located on Zug Island immediately below the outfalls of the Great Lakes Steel Corporation, Blast Furnace Division. These six plants manufacture copper and brass products, pharmaceuticals, rubber tires, soda ash, coke, and iron.

Significant waste constituents originating from these industries consist of chlorides, iron, suspended solids, phenols, ammonia, and oil. All, with the exception of Parke Davis, provide some form of treatment.

Lower Detroit River Industries

Twenty-one industries (shown in Table 13-V) release wastes directly to the Detroit River below the Rouge River. Four are large steel manufacturing complexes, four produce automobile machinery, nine manufacture synthetic organic and heavy chemicals, others make industrial adhesives and petroleum products, and one is engaged in the vessel-washing business. Waste constituents include acids, oxidizing agents, suspended solids, phosphates, oil, ammonia, phenols, oxygen-demanding materials, iron, and chlorides. Common waste treatment methods are oil separation, oxidation for phenol control, and ponding for sedimentation and controlled waste discharge. Industries that do not provide any means of treatment are Chrysler Corporation (Amplex and Chemical Products Divisions), Dana Corporation, duPont, Koppers Company, and the Pennsalt Chemical Corporation East Plant.

In the Detroit area the principal waste constituents discharged directly to adjacent waters are suspended solids, BOD, oil, phenols, acid, ammonia, chlorides,

iron, and toxic ions in plating and metal finishing wastes such as cyanide, chromium, copper, cadmium, nickel, zinc, and lead.

Size of Loadings

Table 14-V summarizes waste loading by area of contribution for several waste constituents. Waste loadings represent amounts added by each industry in excess of those in the raw water supply used by the industry.

Table 15-V shows those concentrations of waste materials released to the Rouge River which either exceed the IJC recommendations for control of boundary water. quality or exceed reasonable limits for effective waste control. In the case of suspended solids, the judgment was based on the fact that effective sedimentation of wastes should remove essentially all of the readily settleable material and reduce the remaining suspended solids to a level not to exceed 35 mg/l.

(Tables 14-V and 15-V follow)

TABLE 14-V. INDUSTRIAL WASTE LOADINGS BY AREA - DETROIT RIVER

Area	BOD (lbs)	BOD (PE)	OIL (gallons)	IRON (lbs)	Susp. Solids (lbs)
Rouge River	145,000	871,000	933	19,000	108,000
Upper Detroit River	5,260	31,400	735	5,150	222,000
Lower Detroit River	19,700	118,000	1,680	58,200	534,000
Total	169,960	1,020,400	3,348	82,350	864,000

Area	Cyanides (lbs)	Phenol (lbs)	Chlorides (lbs)	Ammonia (lbs)	Toxic Metals (lbs)	Acid (lbs)
Rouge River	900	810	307,000	5,280	2,040	50,000
Upper Detroit River	10	373	470,000	2,910	1,950	0
Lower Detroit River	119	225	1,940,000	336	1,200	185,900
Total	1,029	1,408	2,717,000	8,526	5,190	235,900

TABLE 15-V. INDUSTRIAL EFFLUENTS CONTAINING HIGH

CONCENTRATIONS OF WASTE MATERIALS AND VALUES OF PHENOLS, pH, OIL, AND IRON EXCEEDING IJC EFFLUENT RECOMMENDATIONS

Rouge River	Phenols (µg/l)	pH	Oil (mg/l)	Chlorides (mg/l)	Susp.Sol. (mg/l)	Sett.Sol. (mg/l)	Iron (mg/l)	BOD (mg/l)
Allied Chem. Corp.								
Solvay Process Div.								
Waste Pond No. 3	750	11.1		100,000	234	44		
" " No. 2	415	11.0		115,000	216			
Sewer No. 1	45							
" No. 3	55				166			
Plastics Div.	8,750							950
Darling & Co.			50		110			830
Scott Paper Co.	73				97			372
Peerless Cement					331	272		
Ford Motor Co.								
Gate 11			23			51		
Tailrace	375							
Roulo Creek		4.6			171	133	28	
Foundry	2,248				102	87		

The principal wastes from the Allied Chemical Corporation plants are chlorides, phenols, and suspended solids from the two Solvay Process plants which typify wastes produced in making soda ash. These plants produce their own coke for firing the ovens which accounts for the phenolic compounds. The Plastic Division plant produces phenolic waste from the distillation of crude tar in making carbolic oils and pitch. Darling and Company, a meat-rendering plant, produces wastes similar to those from a slaughterhouse with ineffective control measures. The effluent is high in organic content - 7,000 pounds per day BOD.

The Ford Motor Company Rouge Plant is one of the largest of its kind in the world and has in the past been able to manufacture an automobile from the basic raw materials of iron ore, sand, and crude rubber. Their waste products exhibit the vastness of the operation. Ford Motor Company, by far the largest water user in the Rouge River, releases large quantities of wastes, as seen in Table 10-V. The following listing gives the percent of industrial waste constituents discharged to the Rouge River which originates from the Ford Motor Company:

Industrial Waste Constituent	% from Ford
Iron	100
Cyanides	100
Ammonia	95
Toxic Metals	98
Suspended Solids	58
Oil	97.5
Phenols	92.5
Acid	100

It is easily seen that the wastes from the Ford Motor Company contribute significantly to the polluted condition of the Rouge River. The iron, at times as high as 60,000 pounds per day, accounts for the reddish hue of the River, which continues even after dilution with the Detroit River; and excessive quantities of untreated pickle liquor waste, 50,000 pounds per day acid, discolor and corrode the hulls of boats moored in the waters. Iron sludge that settles to the bottom impairs the aquatic life of the area by smothering habitats for reproduction, and in order to maintain the ship channels, the Corps of Engineers must remove large quantities of iron deposits annually in their maintenance dredging program. Ford's phenol discharge of 750 pounds per day exceeds the limits set by the Michigan Water Resources Commission by 150 pounds

per day. Cyanides and toxic metals in amounts of 900 and 2,000 pounds are released to the Rouge River daily. Roulo Creek and Tailrace outlets discharge 95% of the toxic ions. Copper, at 1,500 pounds per day, is the principal toxic metal in the effluent. Ford Motor Company discharges 900 gallons of oil per day which can often be observed as a thin film on the water surface of the Rouge River. Evidence indicates that the oil skimmer stretched across Roulo Creek is not functioning properly as an oil removal device. Probably the oil released to Roulo Creek is largely in the soluble form and does not rise to the surface. High concentrations of iron and oil were found in the sludge deposits of the Ford Motor Company slip. The oil, as well as other pdlutants, seriously interferes with the use of the Rouge River for anything but waste disposal.

Scott Paper Company also releases large quantities of waste products, which include oxygen-demanding materials in the amount of 135,000 pounds per day BOD (equivalent to a population of over 800,000). These wastes impose a large burden on the oxygen resources of the Rouge River. Paper pulp passing the traps also contributes to a share of the sediment problem in the Rouge River.

(Table 16-V follows)

TABLE 16-V. INDUSTRIAL EFFLUENTS CONTAINING HIGH

CONCENTRATIONS OF WASTE MATERIALS AND VALUES OF PHENOLS, pH, OIL AND IRON EXCEEDING IJC EFFLUENT RECOMMENDATIONS

Upper Detroit River	Phenols (µg/l)	pH	Oil (mg/l)	Chlorides (mg/l)	Susp.Sol. (mg/l)	Sett.Sol. (mg/l)	Iron (mg/l)	BOD (mg/l)
Revere Copper and Brass Co.								
Outfall No. 1			146		115	81		
Outfall No. 2						44		
Allied Chem. Corp.								
Solvay Process Div. Cone Effluent	445	11.0		185,000	11,500	11,500		
Great Lakes Steel								
Blast Furnace Div.								
Outfall No. 2	1,150				95	95	20	
" No. 3					172	172	35	
" No. 4	68		37		185	180	16	
" No. 4A	410					82		
" No. 5					144	143	49	
" No. 6	1,250					42		
" No. 7					176	174		
" No. 8	176				240	220		
Parke-Davis								
Outfall No. 1						15		
" No. 2						15		
" No. 3						27		

Table 16-V summarizes effluent waste concentrations in the upper Detroit River considered high. Average concentrations and loadings for this area are found in Tables 9-V or 10-V.

The Great Lakes Steel Corporation, Blast Furnace Division, releases a large percentage of the waste materials that enter the upper Detroit River, as shown by the following listing:

Industrial Waste Constituent	% from Great Lakes Steel
Iron	99
Oil	50
Phenols	99
Suspended Solids	45
Toxic Metals	51
Ammonia	100

Almost all of the eight outfalls contained phenols above the recommended limit of 0.020 mg/l, and suspended solids were concentrated enough to discolor the River in a trail close to the shoreline. The suspended solids were primarily made up of readily settleable material. Approximately 1,000 pounds per day of toxic metals are lost to the Detroit River with 700 pounds of this being zinc.

The Allied Chemical-Solvay Process outfall,

located below the Blast Furnace complex, discharged 54% of the suspended solids and 96% of the chlorides to this reach of the River. This one outfall, although small in flow, contained the largest concentration of wastes observed during the study even though the flow passed through a sedimentation pond.

The Revere Copper and Brass Company waste effluent discharged 360 gallons of oil per day, which represents over half the amount of oil released in the upper River.

The waste effluents from Parke Davis, Anaconda-American Brass Company, and U. S. Rubber Company have only limited effect on water quality. However, the U.S. Rubber Company discharges 650 pounds per day of zinc to the Detroit River.

Table 17-V lists those industries in the lower Detroit River whose effluent discharge is considered to contain certain waste constituents in high concentrations.

(Table 17-V follows, constituting 3 pages)

TABLE 17-V. INDUSTRIAL EFFLUENTS CONTAINING HIGH CONCENTRATIONS OF WASTE MATERIALS AND VALUES OF PHENOLS, pH, OIL, AND IRON EXCEEDING IJC EFFLUENT RECOMMENDATIONS

Lower Detroit River	Phenols (µg/l)	pH	Oil (mg/l)	Chlorides (mg/l)	Susp.Sol. (mg/l)	Sett.Sol. (mg/l)	Iron (mg/l)	BOD (mg/l)
Chrysler Corp.								
Engine Div.	81							
Dana Corp.								
Outfall No. 1			47				57	
Outfall No. 3	138		23					320
E. I. duPont de Nemours & Co.		2.3				24		
Firestone Tire & Rubber Co.								
Ash Pit					365	301		
Outfall No. 3		2.5					470	
Fuel Oil Corp.			347					590
Great Lakes Steel Corp.								
Hot Strip Mill								
Sewer No. 1					90	75		
Rolling Mill								
Outfall No. 1						44		
Pickle Liquor		1.7					2240	
Outfall No. 2			32		119	74	50	
Outfall No. 3		4.0				49	67	
Outfall No. 4			28			28		
Outfall No. 11			165			27		
Outfall No. 7						26		

TABLE 17-V. INDUSTRIAL EFFLUENTS CONTAINING HIGH

CONCENTRATIONS OF WASTE MATERIALS AND VALUES OF PHENOLS, pH, OIL, AND IRON EXCEEDING IJC EFFLUENT RECOMMENDATIONS (Cont.)

Lower Detroit River	Phenols (µg/l)	pH	Oil (mg/l)	Chlorides (mg/l)	Susp.Sol. (mg/l)	Sett.Sol. (mg/l)	Iron (mg/l)	BOD (mg/l)
Koppers Co.								
Sewer No. 2	1360					29		
Sewer No. 3						41		
Monsanto Chem. Co.								
Mobil Oil Co.	12500		82	1500				120
Pennsalt Chem. Corp.								
East Plant								
Outfall No. 1						42		
Outfall No. 2					113	113		
Outfall No. 3								
Outfall No. 4					147	124		
Wye St.				788	18.0			
Perchloron Plant				19750	741			
West Plant	6550				137	99		
Wyandotte Chem. Corp.								
North Plant								
Outfall No. 1				3165	706	606		
Outfall No. 2					119	50		
Outfall No. 2A	585							
Outfall No. 3	76			2780	114			
Outfall No. 4	292							
Outfall No. 4A	35				107			

TABLE 17-V. INDUSTRIAL EFFLUENTS CONTAINING HIGH

CONCENTRATIONS OF WASTE MATERIALS AND VALUES OF PHENOLS, pH, OIL, AND IRON EXCEEDING IJC EFFLUENT RECOMMENDATIONS (Cont.)

Lower Detroit River	Phenols (µg/l)	pH	Oil (mg/l)	Chlorides (mg/l)	Susp.Sol. (mg/l)	Sett.Sol. (mg/l)	Iron (mg/l)	BOD (mg/l)
Wyandotte Chem. Corp.								
South Plant								
Outfall No. 1						39		
" No. 2				3194	275	144		
" No. 3				1977	590	225		
" No. 4					189	103		
Propylene Oxide Plant		11.8			163			
McLouth Steel Corp.								
Gibraltar Plant		3.6		1835				
Trenton Plant								
Outfall No. 1						27	64	
" No. 2						34		
" No. 3					608	600		
" No. 4						26	35	
Shawinigan Resins Corp.								1900

During stream sampling activities in the lower Detroit River many visual observations and laboratory determinations were made by Project personnel which indicate the effect of specific industries upon water quality in the River. These include:

1. The Great Lakes Steel Hot Strip Mill effluent contains oil which leaves a film on the water surface. Significant quantities of suspended iron can be seen discoloring and hugging the shoreline below the outfalls.

2. Thick mats of oil have been observed on the water surface near the Great Lakes Steel Rolling Mill and traced to their oil separator outfalls. Pickle liquor wastes containing 158,000 pounds per day sulfuric acid and 40,000 pounds per day dissolved iron are released at the downstream edge of the steel works, and the effects of this can be observed in the vicinity of Mud Island and Ecorse Channel where the oxidized iron exhibits a noticeable red color to the water.

3. Detroit River water is discolored by calcium chloride and calcium carbonate wastes of the Wyandotte Chemical Company North Works.

4. Increased chloride concentrations were found at shoreward sampling stations in reaches below both

Wyandotte factories and the Pennsalt East Plant. In fact, these three factories contribute approximately 27 per cent of the chloride flow in the Trenton Channel.

5. Lower densities of coliform bacteria and attached aquatic alga at shoreward stations in the vicinity of the two Grosse Ile bridges were presumably caused by the loss of strong oxidizing agents from the Wyandotte and Pennsalt Chemical Plants.

6. Patches of oil and floating solids in Monguagon Creek originated from the Pennsalt West Plant.

7. Nearly one-half of the Trenton Channel was discolored by the suspended iron passing over the effluent weirs of the McLouth Steel Trenton Plant clarifiers. In fact, results of samples collected three times a day, tested for suspended solids and iron by the McLouth Steel personnel, and furnished to the Michigan Water Resources Commission at their request, demonstrate ineffective waste control in that both constituents exceed the Michigan Water Resources Commission prescribed limits approximately one-half the time. The most recent records do reveal better and more consistent operation of existing waste facilities. From the standpoint of removal of suspended solids, this is evidenced by the fact that during the last two months available operating records, the limitations imposed by the

Michigan Water Resources Commission were exceeded only 2 per cent of the time. Iron concentration in the effluent exceeded Commission requirements less than 1 per cent of the time during this period.

8. There were profuse growths of aquatic weeds in the lower Trenton Channel near the phosphate-enriched outfall of the Monsanto Chemical Plant.

9. Sludge deposits and layers of accumulated sediments were in boat slips and other areas where the velocity of flow is retarded sufficiently to permit settling.

10. Globules of oil and iron deposits in the Frank and Poet Drain near the town of Gibraltar were presumably caused by the wastes of the McLouth Steel Gibraltar Plant.

11. Concentrated iron deposits were found in the vicinity of the waste pickle liquor outlet of the Firestone Tire and Rubber Company.

12. Foaming problems in the lower Trenton Channel were traced to accidental spills of detergent from Monsanto Chemical Company.

13. These industries and also the Mobil Oil Corporation release phenols which exceed the IJC effluent recommendations.

14. Toxic metals in amounts of 325 and 700 pounds per day are emptied into the River by the Great Lakes Steel Hot Strip Mill and McLouth Steel Trenton Plant. Lead is the principal metal from the Strip Mill, while zinc and lead comprise most of metal lost from McLouth.

15. Shawinigan Resins discharges 7,000 pounds of BOD daily to the lower Detroit River, which places a demanding load on the oxygen resources of the River. However, a settling lagoon was installed by this company after the survey which may change the amount of BOD discharged from this plant.

16. There was an increase in hardness of approximately 25 mg/l between the upper and lower Detroit River, with the principal contributors being the soda ash plants at Pennsalt Chemical Corporation, Wyandotte Chemical, and Allied Chemical Corporation.

These factors and many others which go undetected severely limit the use of the water resources in the down-river area.

The following table lists reductions in industrial waste loadings in the Detroit River that could be achieved if excessive concentrations of certain constituents were reduced by effective treatment or management to meet International Joint Commission effluent

recommendations and a suspended solids effluent limit of 35 mg/l.

Waste Constituent	Present Loading/day	Loadings after Reduction/day	Per cent Reduction
Iron	82,300 lbs.	24,800 lbs	70
Oil	3,340 gals.	1,900 gals	43
Phenols	1,400 lbs.	80 lbs.	94
Suspended Solids	864,000 lbs.	150,000 lbs.	83

In the Rouge River a reduction of the load reaching the Rouge River, of 50 per cent of the suspended solids, 37 per cent of the iron, 94 per cent of the phenols, and 2 per cent of the oil would result. In order to effect an additional reduction in oil loadings to the Rouge, an internal plant program would have to be inaugurated to prevent oil from reaching plant drains.

In the upper Detroit River suspended solids could be reduced 98 per cent, phenols 96 per cent, and oil 64 per cent.

In the lower Detroit River suspended solids would be reduced 81% to 97,000 pounds per day; iron 87% to 7,600 pounds per day; oil 57% to 723 gallons per day; and phenols 91% to 20 pounds per day.

Industries which are under restrictions by the Michigan Water Resources Commission because of excessive

discharges of wastes are McLouth Steel - Gibraltar (pH), McLouth Steel - Trenton (iron and suspended solids), Mobil Oil Corporation (phenols and oil), Ford Motor Company - Rouge Plant (phenols), Pennsalt Chemical Corporation - West Plant (phenols), Fuel Oil Corporation (oil), Darling and Company (coliform bacteria, BOD), Scott Paper Company (phenols, BOD, suspended solids), E. I. duPont deNemours and Company (pH), Firestone Tire and Rubber Company (iron, pHO, and Great Lakes Steel Corporation - Hot Strip Mill (suspended solids, oil).

OTHER WASTE SOURCES

Stormwater Overflow

The majority of the sewered areas in the study area utilize combined sewers in which storm and sanitary wastes are carried. During periods of significant rainfall, these sewers discharge, without treatment, a combination of stormwater and domestic sewage directly to the receiving stream. As indicated by the water use inventory in this report, over 100 such points of overflow are located along the Detroit River and represent a significant source of waste during wet conditions.

Due to the magnitude of the effect of this waste an extensive evaluation was undertaken by the Project and is discussed under "Special Studies" in this section of the report.

Pollution from Boats

In the Public Health Service report for the 1962 conference it was stated that over 125,000 pleasure boats were registered in the Detroit area, and the water use inventory of this report lists numerous marina facilities and describes the magnitude of the commercial shipping industry in this area. All boats, when used in the waters under study, represent potential sources of pollution from human wastes.

Estimates of the magnitude of these sources have not been made because the following information was unavailable or inadequate:

1. Number of boats in the water at any one time or at any one location.

2. Length of average cruise, to ascertain probability of use of waste disposal facilities.

3. Number or percentage of vessels having adequate waste treatment facilities.

The State of Michigan recently adopted legislation amending the Public Acts of 1931 to prevent the discharge of garbage to a river or inland lake of Michigan or within 3 miles of the shoreline of any part of the Great Lakes or connecting waters thereof in Michigan unless it has passed through a disposal unit approved by

the U. S. Public Health Service. The legislation authorizes a fine of not more than $1,000 or imprisonment for not more than one year, or both.

The U. S. Corps of Engineers has certain responsibilities relating to discharge of deleterious material into navigable waters from boats, and these are described in the section IV of this report.

Shorefront Homes

Estimates of the number of unsewered shorefront homes that discharge sewage directly or from improperly functioning septic tanks to the Detroit River were made in the 1962 conference report. The majority of these homes are located on Grosse Ile, and a special study was performed to determine the effect of this source of pollution on water quality and use. A report of this survey is made under "Special Studies" in this section of the report.

SPECIAL STUDIES

During this Project a number of special studies or investigations were made to collect additional information which might furnish insight into the relationship of sources of wastes to water quality in the receiving streams. Descriptions of the nine studies follow.

Richard D. Vaughan

Stormwater Overflow

Combined sewers carrying both domestic waste and surface runoff are used in the Detroit metropolitan area as well as most of the large metropolitan areas of this nation. During periods of significant rainfall these sewers discharge a combination of raw sewage and storm runoff directly to the receiving stream (in this case the Detroit River) without treatment of any kind. The effect of this operation upon water quality in the Detroit River and possible interference with water use downstream was of great concern to Project personnel, and special studies to provide appropriate facts were undertaken.

The problem was attacked in two ways: First, a cooperative study with State of Michigan regulatory agencies was set up to measure the frequency, duration, volume, and strength of the overflows at the point of overflow. Secondly, a special stream sampling program on the Detroit River was established to collect bacteriological samples during and after heavy rainfall. These were compared with dry weather values found at each sampling location.

Characteristics of Overflows from Combined Sewers

Special samplers were designated and fabricated and placed at the point of overflow in the Conners Creek

sewer system, which serves approximately 25 per cent of the City of Detroit. The samplers were completely automatic, activating and deactivating at the beginning and end of an overflow. The samples were collected by Project personnel and analyzed at Public Health Service laboratory facilities. Determinations made include total coliform, fecal coliform, and fecal streptococcus on individual samples; and a limited number of phosphates, nitrogen compounds, suspended solids, and BOD and phenol determinations on composite samples representing an entire storm.

Water level recorders were installed at each location and extra rainfall gages installed to provide adequate precipitation data. A control study was also made in similar manner at the Allen Creek drainage system in the City of Ann Arbor to determine similar characteristics of discharge from separate storm sewers.

A special factual summary of the results of this investigation was prepared by the Michigan Department of Health. This report lists average and extreme bacteriological results and the duration of each overflow. The report estimates the volume of overflow discharged into the Detroit River following each storm. Generally speaking, accumulated precipitation of 0.3 inch will cause an overflow at the Conners Creek installation and 0.2 inch will cause

an overflow at the Conant-Mt. Eliot relief sewer.

Additional summaries of the results of this investigation were made to emphasize certain findings. Table 43-V lists pertinent facts concerning the number of overflows at Detroit during the first year's operation of the sampler (excluding the 10-day period of raw sewage by-pass at the Conners Creek pumping station) and the duration of overflows. Figure 47-V summarizes 20-year rainfall records for the Detroit area by showing the number of days per year rain of specific intensity and accumulation could be expected.

Table 44-V summarizes bacteriological results at the separate storm overflow at Ann Arbor.

Table 45-V shows the average composite results of BOD, solids, nutrients, and phenols at the three installations, while Table 46-V summarizes bacteriological results at the three stations by two-month intervals.

(Table 43-V; Figure 47-V; Table 44-V constituting two pages; Table 45-V; and Table 46-V follow.)

TABLE 43-V. OVERFLOWS FROM COMBINED SEWERS
CONNER GRAVITY SYSTEM
CITY OF DETROIT

Location of Installation	Number of Overflows		
	1st Year of Operation*	2nd Year of Operation**	Total
Conners Creek	23	10	33
Jefferson & Leib	31	16	47

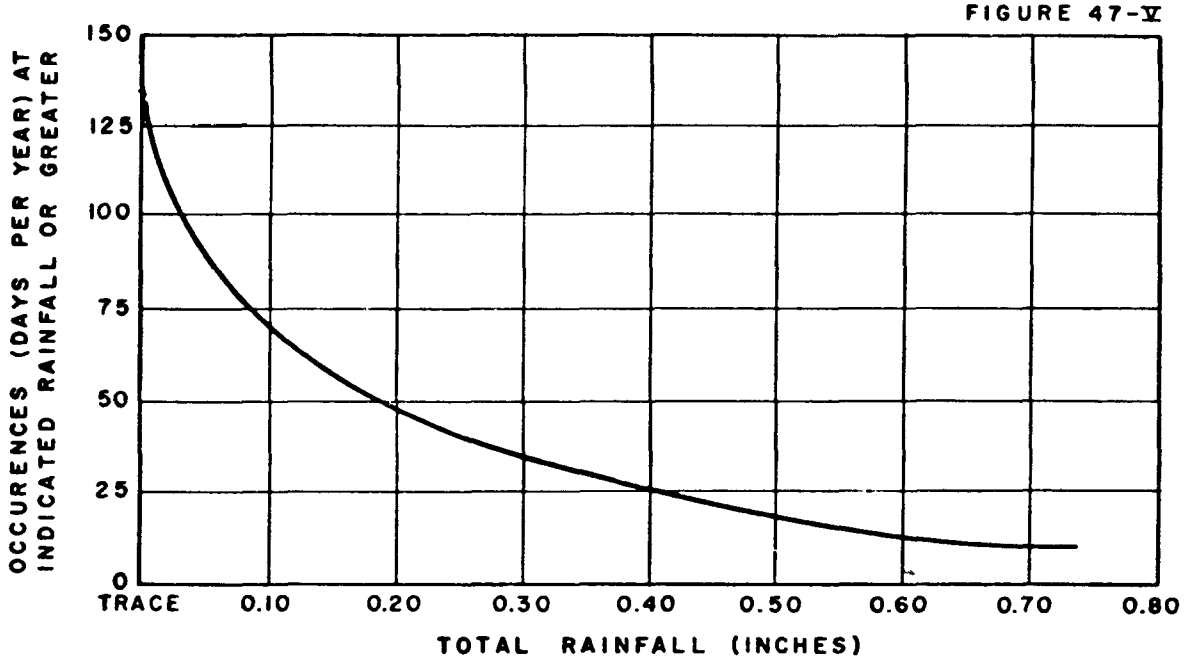
Location of Installation	Mean Overflow Duration	Total Accumulated Overflow Time***
Conners Creek	9.85 hours	325 hours
Jefferson & Leib	6.70 hours	314 hours

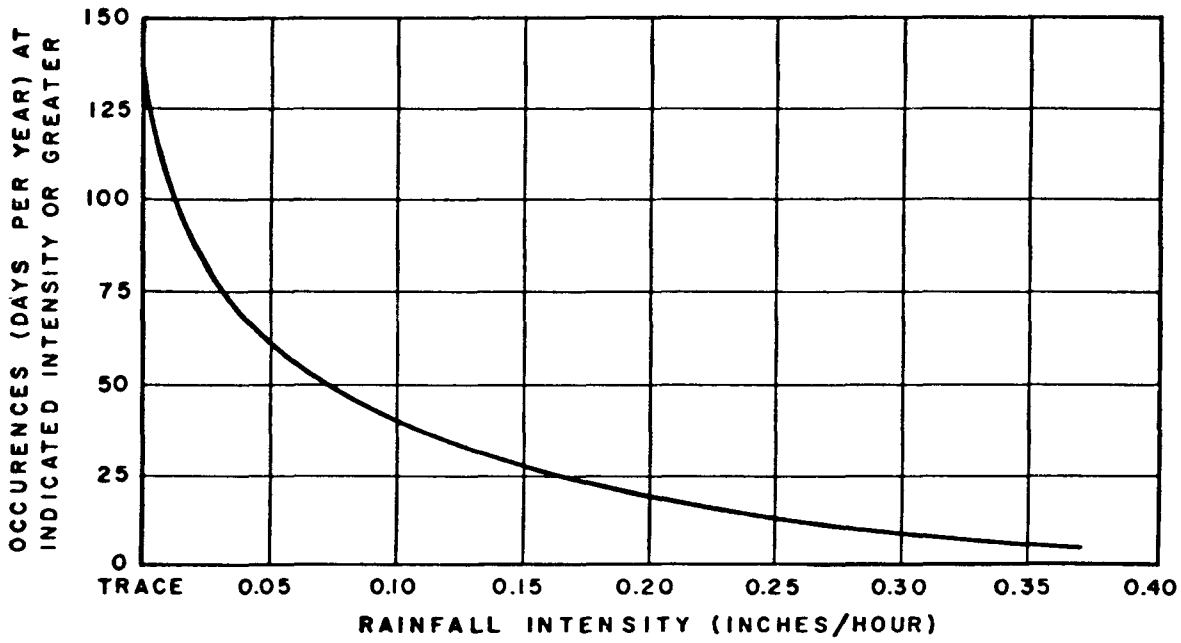
*At the Conners Creek installation, the first year is considered to extend from the installation date of May 10, 1963, straight through to May 10, 1964; the first year of operation of the Leib installation is considered to extend from the installation date of June 15, 1963 to June 15, 1964, with the exception of the period from December 10, 1963 to March 17, 1964, when it was not in service.

**May 10, 1964 through August 31, 1964 for Conners Creek; June 15, 1964 through August 31, 1964 for Leib.

***Through August 31, 1964.

FIGURE 47-V





BASED ON 20 YEAR RECORDS AT DETROIT CITY AIRPORT

DETROIT RIVER - LAKE ERIE PROJECT

EXPECTED FREQUENCY OF RAINFALL
CITY OF DETROIT

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

TABLE 44-V. SUMMARY OF BACTERIOLOGY RESULTS
ANN ARBOR STORM SEWER INSTALLATION

Date of Overflow	Duration of Overflow (Min)	Total Rainfall inches*	Number of Samples	Total Coliform Organisms/100ml			Fecal Coliform Organisms/100ml		
				Geom. Mean	Minimum	Maximum	Geom. Mean	Minimum	Maximum
1964									
4/2-3	-	.75	2	340,000	180,000	640,000	17,000	9,000	32,000
4/21	24	.40	5	116,000	70,000	200,000	10,100	10,000	10,400
4/28	38	.40	8	355,000	210,000	520,000	7,400	4,000	14,000
5/8	11	.25	3	880,000	460,000	2,800,000	73,000	58,000	87,000
5/8	G105	.90	21	139,000	42,000	2,800,000	28,700	10,000	87,000
6/7	16	.25	4	2,100,000	1,030,000	3,200,000	39,000	26,000	56,000
6/7	-	1.0	1	5,500,000	-	-	86,000	-	-
6/12	27	.50	6	4,010,000	3,300,000	5,900,000	78,100	16,000	250,000
6/15	30	.55	7	187,000	120,000	280,000	24,100	14,000	38,000
6/19	4	.60	2	10,200,000	5,500,000	19,000,000	133,000	56,000	320,000
7/2	39	.50	8	2,200,000	120,000	5,100,000	125,000	30,000	240,000
7/2	25	.45	6	4,100,000	2,800,000	5,100,000	G1,500	G1,500	14,000
7/3	14	.45	3	390,000	250,000	840,000	60,000	26,000	142,000
7/20	22	.35	5	3,900,000	2,500,000	6,800,000	435,000	290,000	830,000
7/25	29	.30	6	15,000,000	2,900,000	32,000,000	560,000	14,000	4,300,000
8/3	3	.30	2	1,700,000	500,000	5,800,000	270,000	120,000	600,000
8/11	5	.25	2	5,800,000	4,100,000	8,100,000	680,000	210,000	2,200,000
8/11	33	.40	12	1,200,000	170,000	3,900,000	350,000	20,000	1,700,000
8/11	27	.35	10	220,000	L10,000	1,500,000	165,000	L10,000	1,000,000
8/17	3	.35	2	34,300,000	24,000,000	49,000,000	747,000	360,000	1,550,000
8/22	15	.35	6	920,000	610,000	2,000,000	340,000	300,000	380,000
8/28	33	.55	12	8,500,000	3,500,000	22,000,000	570,000	200,000	1,300,000

*PHS raingage - Ann Arbor water treatment plant

TABLE 44-V. SUMMARY OF BACTERIOLOGY RESULTS ANN ARBOR STORM SEWER INSTALLATION (CONTINUED)

Date of Overflow	Fecal Streptococci Organisms/100ml			Composite Results per Overflow				
	Geom. Mean	Minimum	Maximum	Susp. Solids (ppm)	Phenols (ppb)	Phosphates (ppm)	Ammonia N. (ppm)	Organic N. (ppm)
1964								
4/2-3	31,000	25,300	38,500	-	12	-	-	.02
4/21	12,400	7,100	19,700	91	25		.74	.47
4/28	20,100	11,500	32,800	-	7	-	.40	.88
5/8	323,000	264,000	413,000	949	11	2.4	.60	.30
5/8	73,000	36,000	140,000	2,062	1	2.7	.55	.34
6/7	193,000	125,000	336,000	-	-	-	.67	.51
6/7	326,000	-	-	-	-	-	-	-
6/12	124,000	80,000	210,000	-	-	-	-	-
6/15	42,500	30,000	66,000	-	-	-	-	-
6/19	116,000	90,000	150,000	-	-	-	-	-
7/2	190,000	140,000	262,000	-	-	-	.44	.41
7/2	180,000	142,000	237,000	-	-	-	.59	.52
7/3	-	96,000	96,000	-	-	-	-	-
7/20	600,000	310,000	1,000,000	1,544	-	9.5	.45	.49
7/25	670,000	360,000	1,840,000	1,320	10	4.3	.68	.00
8/3	475,000	340,000	660,000	-	-	-	-	-
8/11	260,000	200,000	330,000	-	-	-	-	-
8/11	190,000	130,000	330,000	904	7	2.1	-	.28
8/11	120,000	110,000	400,000	1,066	9	2.0	-	.28
8/17	362,000	320,000	410,000	-	-	-	-	-
8/22	310,000	240,000	400,000	-	-	-	-	-
8/28	330,000	120,000	550,000	-	-	-	-	-

TABLE 45-V. SUMMARY OF COMPOSITE RESULTS COMBINED AND SEPARATE SEWER INSTALLATIONS

Location of Installation	Type of Sewers	Range of Composite Results					
		BOD (mg/l)	Susp. Solids (mg/l)	Phenols (ug/l)	NH_3N (mg/l)	Org. N. (mg/l)	Total PO_4 (mg/l)
Ann Arbor	Separate	29 - 51	91 - 2060	1 - 25	.4 - .7	.00 - .88	.28 - 9.5
Conners Creek	Combined	-	14 - 422	11 - 125	1.3 - 5.1	.16 - .52	1.8 - 13
Leib & Jefferson	Combined	46 - 217	86 - 422	12 - 35	3.2 - 5.9	.21 - 1.09	4 - 24

TABLE 46-V. SUMMARY OF BACTERIOLOGY RESULTS AT SAMPLER INSTALLATIONS BY TWO-MONTH INTERVALS

Period	Analysis	Ann Arbor Range of Geometric Mean (Organisms/100ml)	Detroit Range of Geometric Mean (Organisms/100ml)	Ann Arbor Geometric Mean of all Storms (Organisms/100ml)	Detroit Geometric Mean of all Storms (Organisms/100ml)	Ratio of Combined (Detroit) To separate (Ann Arbor) Overflows
April-May	Tot.Col.	116,000- 880,000	575,000-23,600,000	279,000	3,350,000	14:1
	Fec.Col.	7,400- 73,000	187,000- 3,570,000	19,300	1,040,000	54:1
	Fec.Strep.	12,000- 323,000	276,000- 1,490,000	44,900	510,000	12:1
June-July	Tot.Col.	187,000-15,000,000	1,340,000-45,000,000	2,670,000	20,100,000	8:1
	Fec.Col.	24,100- 560,000	470,000-10,500,000	105,000	3,230,000	31:1
	Fec.Strep.	42,500- 670,000	185,000- 980,000	201,000	453,000	2:1
Aug-Sept	Tot.Col.	220,000-34,300,000	3,200,000-45,000,000	2,550,000	17,200,000	7:1
	Fec.Col.	165,000- 747,000	500,000-16,500,000	395,000	5,810,000	15:1
	Fec.Strep.	120,000- 362,000	410,000- 790,000	270,000	545,000	2:1
Oct-Nov	Tot.Col.	-	900,000-18,200,000	-	1,280,000	-
	Fec.Col.	-	900,000-17,400,000	-	1,250,000	-
	Fec.Strep.	-	-	-	-	-

Careful study of the data and individual results provided the basis for the following conclusions:

1. Total coliform, fecal coliform, and fecal streptococcus densities in the overflow from combined sewers many times approached values found in raw sewage. Coliform counts of over 100,000,000 per 100 ml were found during summer months.

2. Bacterial densities in the combined overflows varied greatly with the season or time of the year. The highest densities were found during warmer weather and lowest results in the winter.

3. Total coliform densities in the separate system at Ann Arbor regularly exceeded 1,000,000 per 100 ml. Average total coliform densities in the overflows from the Detroit combined system were approximately 10 times higher than those in Ann Arbor's separate system. Fecal coliform densities in the combined sewer effluent were found to be approximately 30 times greater than similar values in the separate system, while comparable fecal streptococcus levels were at least twice as high.

4. In the Detroit area rainfall sufficient to cause overflows from all combined sewers (0.3 inch) can be expected to occur approximately 33 days each year. Rainfall sufficient to cause overflows from certain parts

of the system (0.2 inch) can be expected to occur about 45 days each year.

5. Although the average duration of overflow from combined sewers was found to be 8.2 hours, discharges have occurred for continuous periods in excess of 24 hours. Two such overflows occurred during the month of August 1964.

6. Suspended solids concentration in the discharge from the separate storm installation at Ann Arbor was higher than in the combined overflows at Detroit.

7. Phenol, BOD, phosphate, ammonia and organic nitrogen concentrations were two to five times higher in the combined overflow than in separate storm discharge.

8. Bacteriological results from the combined installations showed a slight tendency for higher values during the first sample but thereafter were relatively constant throughout the duration of the overflow.

9. Bacteriological results at the Ann Arbor separate system were also comparatively constant during a storm, always remaining within one order of magnitude. Small changes in quality and flow were more noticeable at this installation, however.

10. Calendar year 1963 was the driest on record for the City of Detroit according to rainfall records of

the U. S. Weather Bureau. Even during this year, the Conners Creek pumping station was observed to overflow 12 times during a 6-month period in 1963. During the first year of operation of the automatic sampler, the Conners Creek installation overflowed and collected samples 23 separate times. Both figures exclude the period of raw sewage bypass from this station by the City of Detroit.

11. The volume of overflow at the Detroit installation during the survey varied from 40 million gallons to 509 million gallons. The greatest volume was observed during the overflow of longest duration. This volume, which originates from only 25 per cent of the City of Detroit, is approximately the same as the daily discharge of partially treated sewage from all sewage treatment plants into the Detroit River.

12. Volume figures in the joint report indicate a discharge into the Detroit River of 4-1/4 billion gallons from the combined sewers serving the Connor system during the first year of operation of the sampling stations.

13. Overflow from the combined sewers occurred 3-4% of the time during the survey period. Rate of discharge per hour from the combined sewers varies with the intensity of the storm, making an exact ratio of sewage from the Conners gravity system to the discharge to the

Detroit River impossible. Within the limits observed during the study, 50-80% of the raw sewage collected is spilled over into the River during the overflow. Thus approximately 2% of the total raw sewage contributed to the Detroit area plants reaches the Detroit River each year. This is over 5 billion gallons of raw sewage flowing into the River each year. Furthermore, this is a conservative estimate, since the Connor system is designed for more storage capacity than many other combined sewers in the Detroit and downriver collection systems.

Effect of Overflows from Combined Sewers on Detroit River

Several times special field investigations were made to determine the effect of overflows from combined sewers upon the Detroit River during or following rainfall. This was accomplished by collecting bacteriological samples above and below combined sewer outfalls during and following rainfall and comparing results from these analyses with dry weather data. Nine storms during which overflows occurred, in the period April 23, 1963, through August 15, 1964, were studied. Total coliform, fecal coliform, and fecal streptococcus determinations were made on samples collected during this period. Five ranges from the head to the mouth of the Detroit River were selected for this special sampling program to minimize the

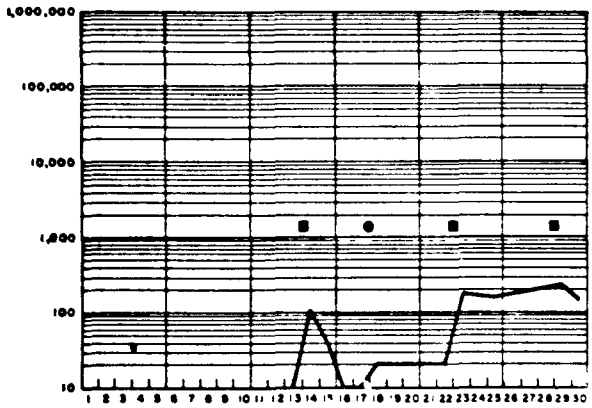
impact on the laboratory and get the most significant results with minimum effort.

Figure 48-V depicts the change in bacteriological densities during July, 1963, following three storms of sufficient magnitude to cause overflow from combined sewers.

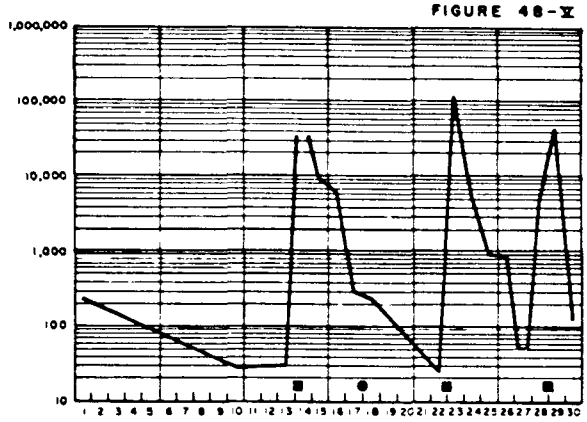
Figure 49-V shows the increase in total coliform densities from the headwaters to the mouth during a typical overflow. The value at the station nearest the United States shore is shown in Figures 48-V and 49-V.

(Figures 48-V and 49-V follow.)

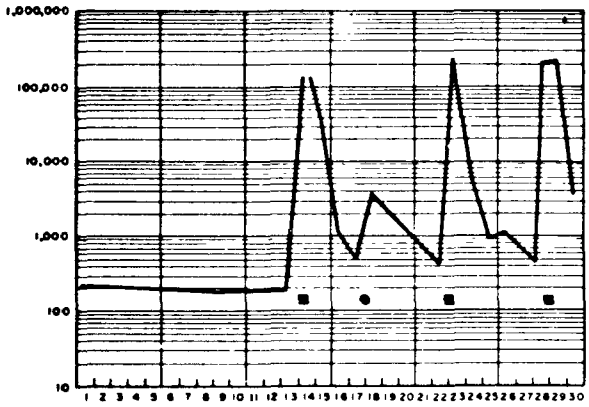
FIGURE 48-V



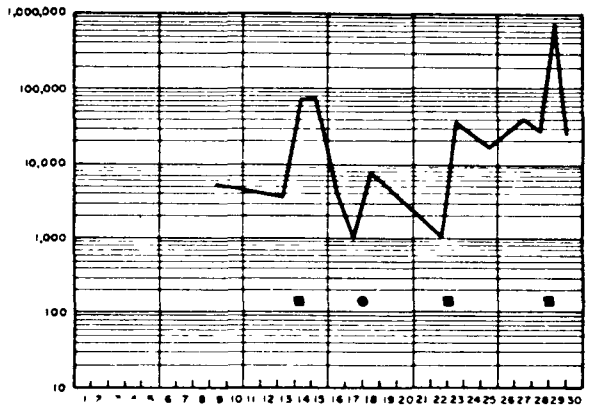
DT 30.8W—100 FEET



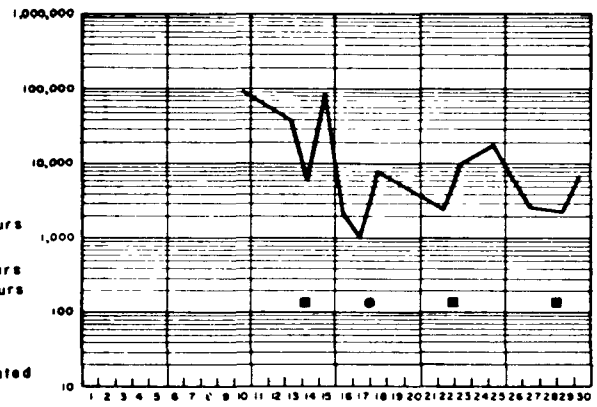
DT 28.4W—100 FEET



DT 20.6—50 FEET



DT 14.6W—100 FEET



DT 3.9—2500 FEET

RAINFALL ACCUMULATIONS (Detroit City Airport)

July 14 —— 0.67 Inches
July 17 —— 0.16 Inches
July 22 —— 1.33 Inches
July 28,29— 0.52 Inches

OVERFLOW DURATIONS

July 14 Leib-Jefferson-6 Hours, Conners Creek-12 Hours
July 17 Leib-Jefferson-4 Hours; Conners Creek-None
July 22 Leib-Jefferson-4 Hours, Conners Creek-7 Hours
July 28,29— Leib-Jefferson-3 Hours, Conners Creek-13 Hours

SCALE

Horizontal—Dates During July, 1963 as Indicated
Vertical—Log Scale Total Coliform (MF) per 100ml as Indicated

LEGEND

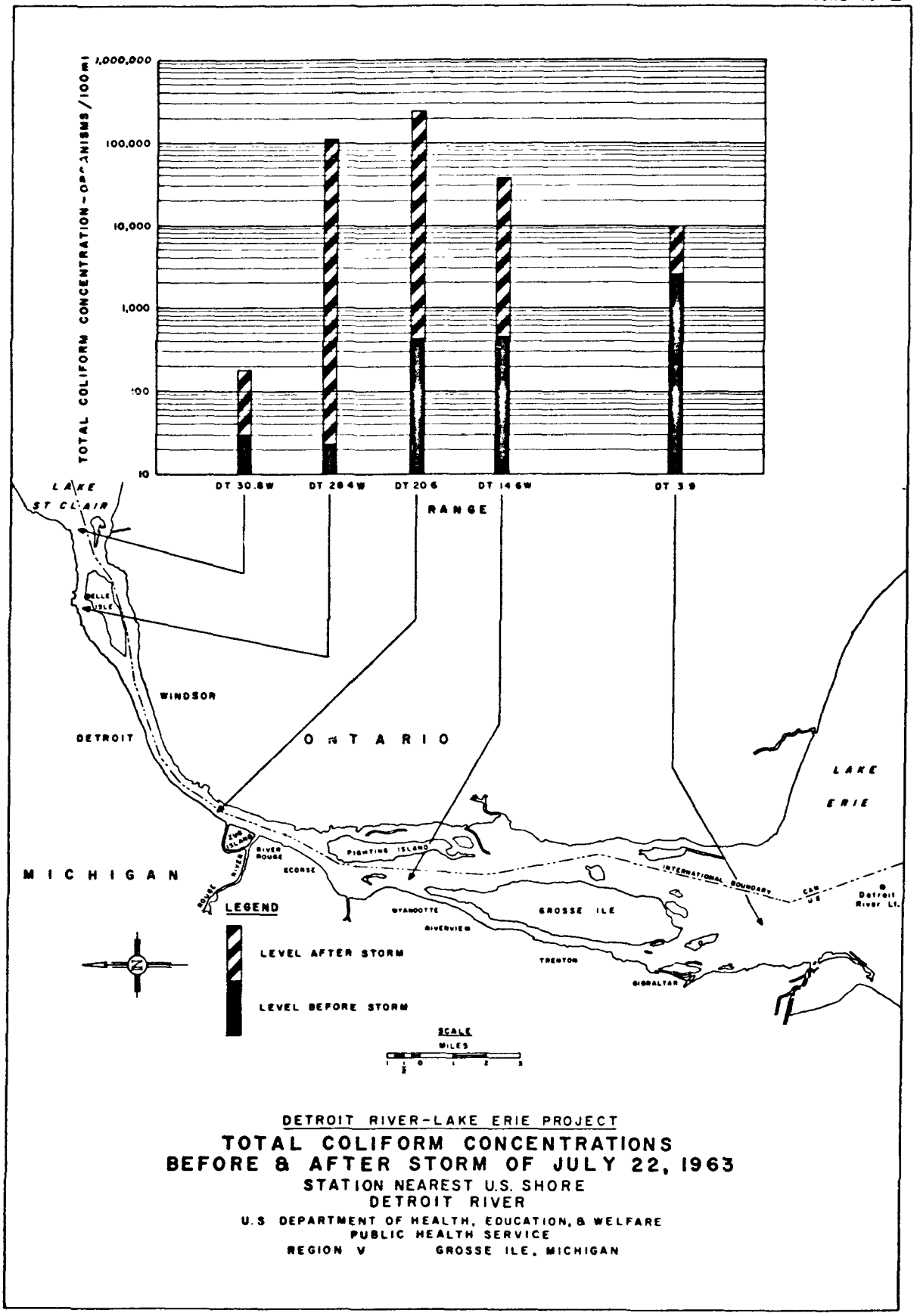
■ Overflow at Both Conners Creek and Leib-Jefferson
● Overflow at Leib-Jefferson Only

DETROIT RIVER—LAKE ERIE PROJECT

SUMMARY OF STORM EFFECTS DURING JULY 1963

STATION NEAREST U.S. SHORE
DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



DETROIT RIVER-LAKE ERIE PROJECT

TOTAL COLIFORM CONCENTRATIONS BEFORE & AFTER STORM OF JULY 22, 1963

STATION NEAREST U.S. SHORE
DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

These Figures, together with Project and municipal data, support the following conclusions:

1. Coliform, fecal coliform, and fecal streptococcus densities increased in the Detroit River, following an overflow from combined sewers, 10 to 50 times over the values found during dry weather conditions.

2. Coliform densities in the Detroit River following an overflow often exceeded 300,000 per 100 ml and at times exceeded 700,000 per 100 ml.

3. All high bacteriological values in the Detroit River during or following an overflow were found below Conners Creek. Bacteriological densities above this point stayed fairly constant during wet and dry conditions. Conners Creek represents the most upstream location of many combined sewer outfalls which extend to the mouth of the River.

4. Analysis of the City of Detroit sampling records reveals individual analyses exceeding 800,000 coliforms per 100 ml in the Detroit River on the day following significant rainfall.

5. High bacteriological densities following overflows were found at both the City of Wyandotte water intake and the new City of Detroit intake near Fighting Island. The Wyandotte values exceeded 100,000 per ml and

the Fighting Island values 10,000 per 100 ml.

6. The effect of overflows on water quality in the Detroit River has been observed as long as 4 days after the rain subsided.

7. Each of the nine storms individually investigated produced a severe effect on water quality in the Detroit River as evidenced by increased bacterial contamination. This effect was also noticed in statistical evaluation of regular data by wet or dry conditions.

8. The length of the effect of overflows of combined sewers upon water quality in the Detroit River varies from 1 to 4 days after the beginning of the actual discharge.

9. The greater the rain the longer the period of overflow and more severe the effect on the Detroit River.

10. While bacteriological analysis was used to compare normal conditions with those found during or following an overflow, other observations were made by field personnel in the area during heavy rains which indicated the deleterious effect of the overflows upon water quality in the River. Field notes on these occasions described debris and garbage as well as excrement floating down the Detroit River.

11. Analysis of rainfall, overflow, and stream quality records reveals that during a 9-month period in 1963 (March-November) overflows from combined sewers affected water quality in the Detroit River during part or all of 88 days. This represents 32 per cent of the days in the 9-month period. This phenomenon occurred during the year of lowest accumulated rainfall and could represent an even greater effect on Detroit River water quality during a year of normal rainfall.

GROSSE ILE POLLUTION SURVEY

Several studies were made in waters adjacent to Grosse Ile to determine the effect of local waste sources on the quality of water of beach and residential areas at the southerly end of Grosse Ile. In addition to chemical and bacteriological analyses, limited tracer studies were made to determine the flow patterns for the given conditions of test. Information collected during this study is presented in Figure 21-V and Table 18-V.

(Figure 21-V and Table 18-V follow.)

FIGURE 21-V

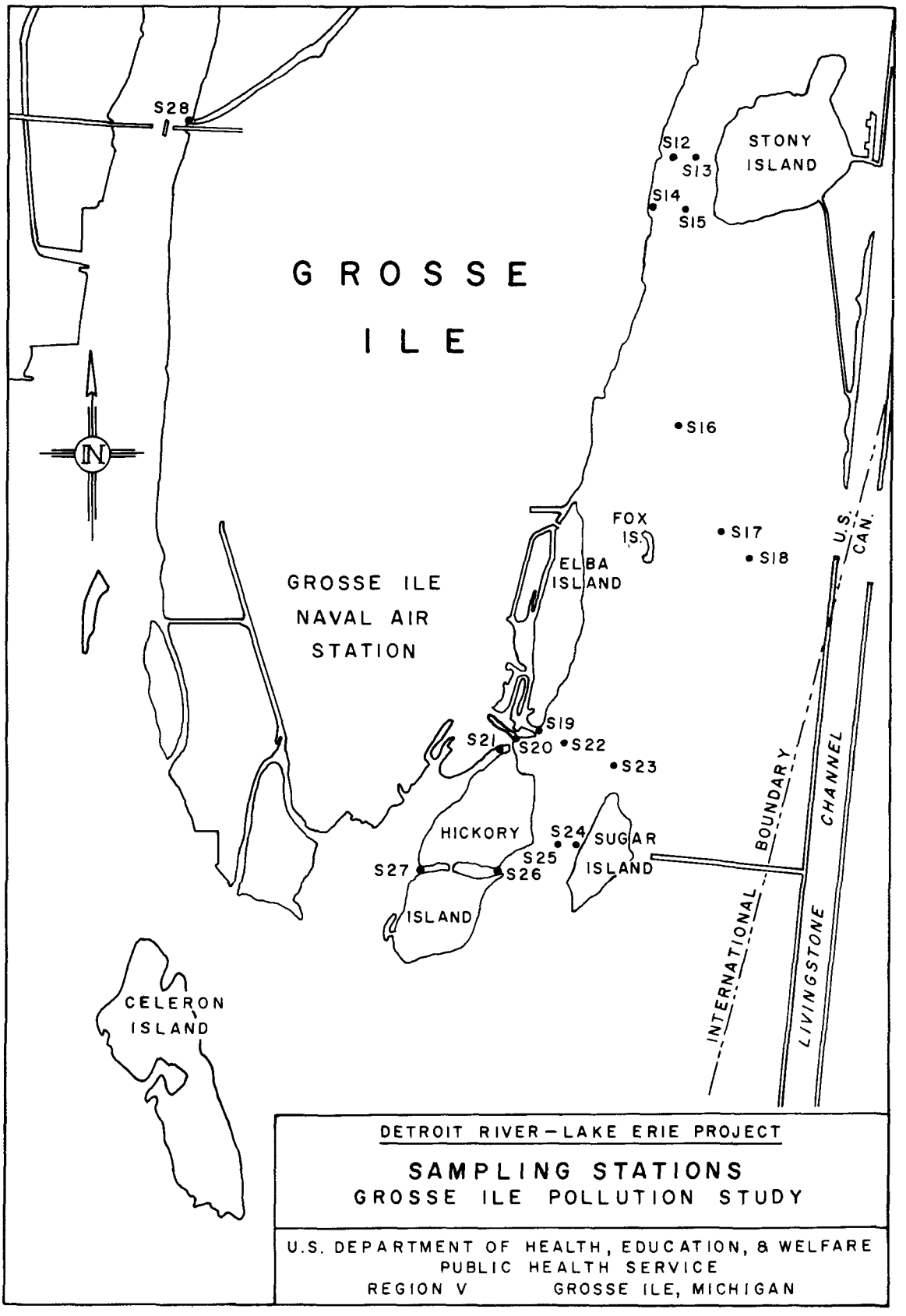

S28
S12
S13
S14
S15
STONY ISLAND
GROSSE ILE
N
S16
FOX IS.
S17
S18
U.S.
CAN.
ELBA ISLAND
GROSSE ILE NAVAL AIR STATION
S19
S21
S20
S22
S23
HICKORY
S24
SUGAR ISLAND
S25
S27
S26
ISLAND
BOUNDARY
CHANNEL
INTERNATIONAL
LIVINGSTONE
CELERON ISLAND
DETROIT RIVER—LAKE ERIE PROJECT
SAMPLING STATIONS
GROSSE ILE POLLUTION STUDY
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V
GROSSE ILE, MICHIGAN

TABLE 18-V. SUMMARY OF RESULTS OF GROSSE ILE POLLUTION STUDY

(Note: See Figure 20-V for location of sampling stations.)

Location	Range of Observed Values				
	Temp °C	Chlorides mg/l	Total Coliform Org/100 ml	Fecal Coliform Org/100 ml	Fecal Strep. Org/100 ml
DT 9.3E - 100'	18.0-20.0	16-20	1,900-3,200	95-160	10-20
DT 9.3E - 200'	18.5-20.0	7-17	700-5,000	60-105	10-20
DT 9.3E - 500'	19.0-20.0	14-20	800-2,200	72-440	10-20
DT 9.3E - 1200'	19.0-20.0	8-22	2,800-22,000	280-6,150	10-30
No. 12	18.5-20.0	19-25	3,000-26,000	40-155	20-30
No. 13	18.5-20.0	12-27	2,000-4,000	400-600	10-60
No. 14	18.0-19.5	10-27	1,000-8,000	50-1,200	50-300
No. 15	19.0-20.0	9-22	2,700-22,000	405-12,100	<10
No. 16	19.0	15-24	3,600-25,000	180-7,500	20-60
No. 17	19.0-20.0	9-27	9,000-11,000	405-2,200	5-30
No. 18	19.0-20.0	11-16	3,900-5,000	<70-1,500	10-15
No. 19	18.0-20.0	16-31	4,100-16,000	205-2,400	70-120
No. 20	18.0-20.0	14-26	1,800-6,300	270-315	90-180
No. 21	17.5-20.0	17-25	3,600-8,600	430-540	60-170
No. 22	19.0-20.0	9-17	2,400-19,000	300-9,500	30-60
No. 23	18.5-19.5	7-17	1,400-10,000	140-4,000	10-80
No. 24	18.0-20.0	8-18	1,200-4,000	20-3,600	10-25
No. 25	18.5-20	15-19	<1,000-12,000	570-6,000	30-120
No. 26	18.5-20.0	16-25	1,400-5,600	350-1,120	20-60
No. 27	18.5-20.00	17-26	900-2,400	120-270	70-120
Thorofare Canal on West River Road	17.5-21.0	8-27	21,000-24,000	1,100-9,600	130-2,700

Richard D. Vaughan

A study was made on the east side of Grosse Ile in the area between Stony Island and Grosse Ile, extending to Hickory Island and Sugar Island. On 3 days, samples were collected at the points indicated on Figure 21-V and on the western half of Range 9, 3E.
A tracer study was made by placing dye at the midpoint between Stoney Island and Grosse Ile in line with the abandoned bridge connecting the Island and at a location adjacent to the shore at the extension of Bellevue Road. The results of the 3-day study are summarized in Table 18-V.

At the time the tracer study was made, the rising water level likely had an influence on the flow pattern noted. As observed by the dye tracings, the current was retarded in part as a result of the rising water level. This is indicated by the shifting of the dye to a position below Stoney Island rather than proceeding directly down the thread of the stream; however, one would expect some movement in this direction as a result of the changing flow and cross-sectional area. The dye placed near the septic tank outfall at the end of Bellevue Road moved along the shoreline in the shallow waters, and its apparent movement was retarded by the heavy weed growth in those areas.

Other tests of the flow pattern in this area have indicated that some of the flow from the Livingstone

Channel passes below Power House Island and proceeds to discharge into Lake Erie between Hickory and Sugar Islands. Dye introduced above Power House Island indicated that the flow proceeded in the direction between Hickory and Sugar Island.

During the limited period of study, the coliform count on the beach adjacent to Sugar Island indicated that water quality was unsafe for swimming. In two of the three instances, the coliform count was higher at the mid-point between sugar and Hickory Islands than on the beach. Coliform counts below Elba Island were generally higher than coliform counts found in the thread of the stream, indicating that the residential areas adjacent to and above Elba Island contribute to impairing water quality. The water of the samples taken in the thread of the stream bed did not meet acceptable standards for swimming. Major improvement in waste water treatment for residential areas on Grosse Ile would improve the water along some of the residential shoreline, but may not improve the quality of water adjacent to beach areas to an acceptable level. The water quality on Sugar Island can be improved if the water upstream in the Detroit River is improved, as well as various local sources of pollution.

The continuing effort of the State of Michigan

regulatory agencies to bring about pollution abatement and reduce the threat to the public health caused by this condition is recognized. This project is also aware of the plan to install sewers and a primary sewage treatment plant on the island.

INVESTIGATION OF BACTERIOLOGICAL REGROWTH

Review of the literature regarding coliform bacteria results in streams brought attention to the matter of bacterial regrowth and die-off. Some rivers seemed to exhibit a marked increase in total coliform bacteria within a few hours after discharge occurred to the stream, while other rivers did not have this characteristic. In order to evaluate adequately the coliform bacteria results of the Detroit River-Lake Erie Project, it was therefore necessary to determine the pattern of bacterial regrowth and die-off in the Detroit River.

The purpose of this survey was threefold: First, to pinpoint and define sources of bacterial contamination going into the Detroit River; second; to determine channeling of wastes in the River; and, third, to calculate the pattern of regrowth and die-off of coliform bacteria in the Detroit River. In view of the fact that the City of Detroit chlorinates its waste effluent

to protect downstream sources of water supply, it became especially important to evaluate this third factor, since experiences elsewhere have shown that there is a significant increase in coliform organisms when chlorinated sewage is diluted with river water.

The survey was conducted August 12 through August 15, 1963, from a point 300 feet above the Detroit Sewage Treatment Plant outfall to Point Hennepin at the north end of Grosse Ile. The results were as follows:

1. No significant regrowth or die-off of coliform bacteria occurs in the Detroit River from the Rouge River to Point Hennepin.

2. The first day's sampling indicated a regrowth immediately below the Rouge River; however, during the remainder of the study a slight die-off occurred.

3. Bacterial pollution discharged at the Rouge River and the Detroit Sewage Treatment Plant remained in American waters as far downstream as Point Hennepin.

4. Approximately 62 per cent of the bacterial pollution discharged at the Rouge River and the Detroit Sewage Treatment Plant followed the channels closest to the American shore. The remaining 39 per cent was distributed in other channels east of Grosse Ile.

Richard D. Vaughan

CITY OF DETROIT RAW SEWAGE BYPASS

In May, 1963, the City of Detroit submitted a request to the Michigan Water Resources Commission for a temporary increase in use of the waters of the Detroit River. This temporary use arose from the need to replace badly worn 40-year-old sluice gates at Fairview Pumping Station, requiring the bypassing of raw sewage to the Detroit River for approximately 10 days in December. The commission ruled that the City of Detroit could proceed with planning for the proposed bypass and that, upon the recommendation of the Michigan Department of Conservation's waterfowl specialist, the bypass be restricted to a 10-day consecutive period between the dates November 10 to November 30. The Commission also decided that all affected parties should be notified by the City of Detroit just before the operation would begin. Accordingly, the Michigan Department of Health issued a permit to the City for the temporary bypassing of untreated sewage.

Consequently, the City of Detroit began operations to replace the sluice gates by turning off the pumps at the pumping station at 0800 , Tuesday, November 12 The field crews of the Project began to measure the effect of the untreated sewage on the water quality of the Detroit River by sampling night and day beginning 0100 Tuesday

morning. Sampling activities continued through the weekend and into the next week until the sluice gates had been replaced and operations returned to normal. The City completed the construction work and the station was placed back in service at 0810, Friday, November 22. Operations went according to regulations specified by the Michigan Department of Health in their permit to the City. Project sampling activities to measure the effect of the bypass continued until the effect had diminished.

During the operation the precise amount of sewage being bypassed to the River was not known since the City was apparently able to route an estimated 50 mgd around the Fairview Pumping Station. It is probable that 75 mgd was discharged directly to the River. Although it was assumed that the bypassing operation would occur constantly throughout the day and night, this was not the case. Erratic discharge of this material especially at night and during the early morning hours required a revision of the Project sampling schedule to take this into account.

Project files contain detailed accounts of the results of the sampling during this 10-day period. The first effects of the bypassing on water quality in the receiving stream were detected at 3 a. m. on the second day,

approximately nine hours after the initial discharge of bypassed sewage.

In summary, bacteriological results at the head of the Detroit River indicated very low densities (less than 100 organisms per 100 ml) throughout the entire operation, indicating that this range was not affected by the operation. In the upper part of the River significant rises in coliform and fecal streptococcus organisms were noted, especially near the United States shore. The effects of pollution were noted in a band along the shore, which increased in width from 300 feet just below Conners Creek at Range DT 28.4 to about 500 feet 8 miles downstream at a point just above the Rouge River. Coliform counts in this area increased from 10 to 100 times normal dry weather values with counts observed in the range of 10,000 to 100,000 organisms per 100 ml.

Below the Rouge a similar increase in coliform density over normal dry weather condition was noted, with the width of the polluted water increasing to approximately 1,000 feet. On the Canadian side of Fighting Island no increase in bacterial densities was observed, and the data indicate the bypassing had no effect on water quality in this area.

Further downstream at Range DT 14.6 an increase

was noted in coliform and fecal streptococcus densities on the second day of the bypass in a band about 3,000 feet in width. Results in the Trenton Channel indicated dispersal of increased coliform densities throughout the entire channel, while results at the mouth of the Detroit River showed a 7,000 foot band of increased coliform density (10,000-30,000 organisms per 100 ml) near the United States shore.

The Rouge River and Conners Creek were also monitored and geometric mean values of 10,500,000 per 100 ml observed at Conners Creek and 52,000 per 100 ml at the Rouge.

An effort was made to determine the effect of the bypassing on the beaches of Lake Erie. Beaches from the mouth of the Detroit River to below the Raisin River were sampled. Although high coliform denisities were observed at several of the beaches, the only beach which definitely showed the effect of the bypass was Maple Beach, located near the mouth of the Detroit River, while Dewey Beach possibly showed a slight effect of the operation.

Figure 22-V depicts the area in the Detroit River affected by this bypassing operation. Table 19-V summarizes pertinent results of the sampling conducted during this survey.

(Figure 22-V; and Table 19-V constituting 2 pages follow.)

FIGURE 22-V

DETROIT RIVER-LAKE ERIE PROJECT

AREA AFFECTED BY CONNERS CREEK RAW SEWAGE BYPASS

DETROIT RIVER

US DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

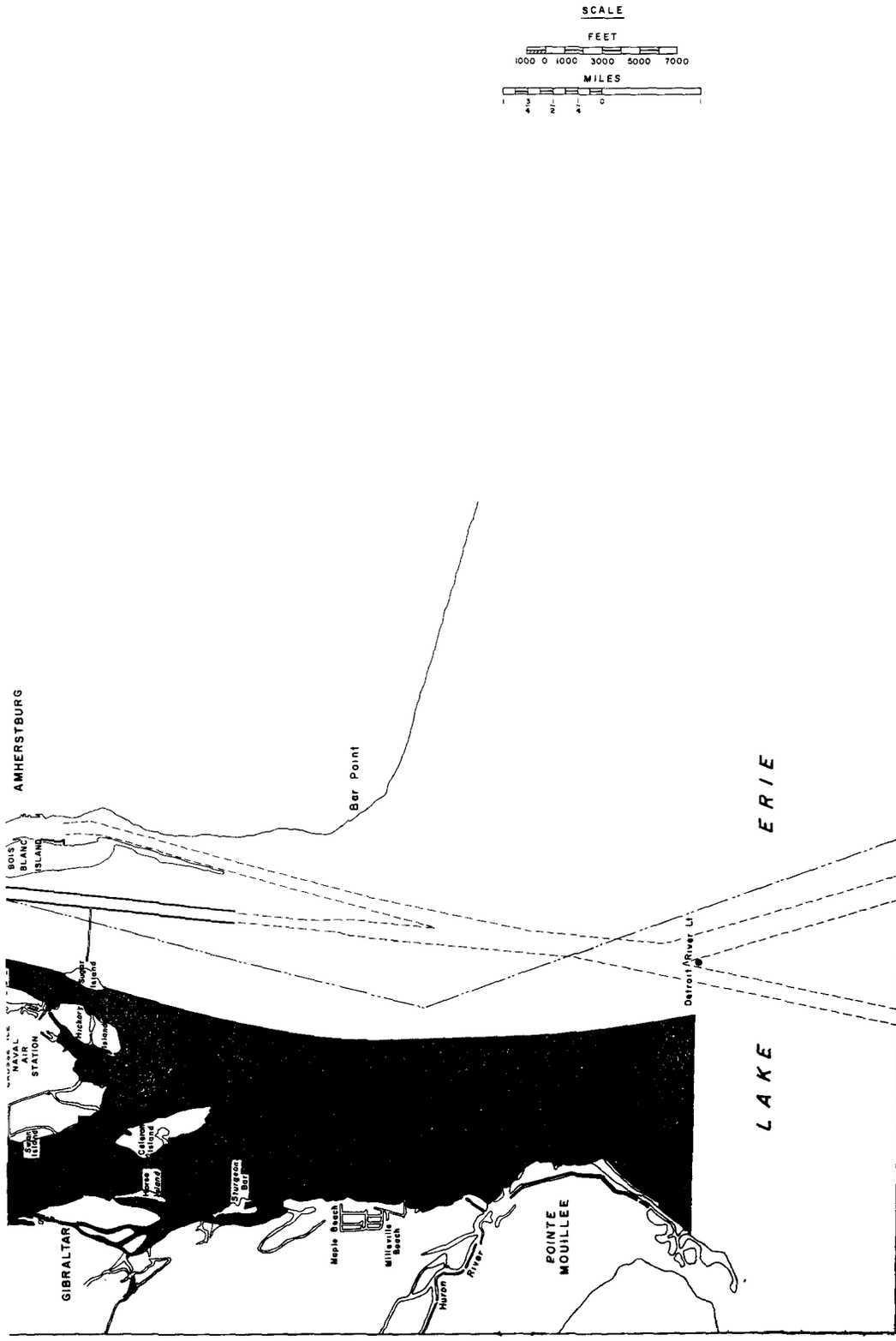


TABLE 19-V. SUMMARY OF AVERAGE RESULTS OF

CITY OF DETROIT RAW SEWAGE BYPASS

NOVEMBER 12-22, 1963

Range	Feet	Total Coliform Avg./100 ml	% Fecal Coliform	Fecal Streptococci Avg./100 ml	Typical Coliform Value Before Bypass	Typical Coliform Value After Bypass
DT 30.8W	100'	10	20	2	20	20
	300'	11	18	5	30	6
	500'	15	7	5	20	14
	1,000'	19	52	5	30	30
	2,500'	10	29	5	6	15
DT 28.4W	100'	25,000	41	200	10	410,000
	300'	2,800	48	27	20	59,000
	700'	59	20	3	70	100
	1,300'	61	28	2	30	330
DT 26.8W	52'	380,000	36	540	270	510,000
	169'	340,000	38	460	240	390,000
DT 20.6	5'	79,000	40	360	110	180,000
	50'	17,000	48	71	90	250,000
	200'	57,000	33	330	50	140,000
	400'	10,000	35	39	50	710,000
	600'	1,100	35	58	28	5,100
	700'	440	38	11	44	2,400
	1,000'	80	37	6	12	370
	1,500'*	200	57	4	360	300
	1,800'*	470	40	8	2,900	310
	2,000'*	3,100	45	86	10,000	2,000
	2,300'*	8,400	60	21	34,000	6,200
DT 17.4W	100'	12,000	35	30	1,200	80,000
	200'	13,000	63	23	100	41,000
	400'	17,000	37	310	100	150,000
	800'	9,400	40	56	100	36,000
	1,200'	1,000	37	13	20	1,300
	1,600'	130	40	2	20	200
	2,200'*	100	28	3	80	100

* Canadian Stations

TABLE 19-V - Continued.

Range	Feet	Total Coliform Avg./100 ml	% Fecal Coliform	Fecal Strepcococci Avg./100 ml	Typical Coliform Value Before Bypass	Typical Coliform Value After Bypass
DT 14.6W	20'	15,000	47	66	700	27,000
	100'	22,000	40	120	900	17,000
	200'	18,000	50	79	300	180,000
	300'	17,000	73	120	500	63,000
	400'	31,000	39	180	700	220,000
	800'	15,000	43	140	2,500	34,000
	1,000'	28,000	40	190	900	33,000
	2,000'	1,800	80	22	600	11,000
	3,000'	2,700	44	5	1,300	7,000
DT 8.7W	80'	6,400	24	5	2,700	21,000
	280'	9,100	34	9	3,500	22,000
	480'	21,000	37	60	4,900	270,000
	680'	18,000	52	93	5,400	320,000
	980'	23,000	42	66	5,500	290,000
	1,240'	17,000	36	120	4,300	310,000
DT 3.9	2,500'	27,000	35	10	23,000	57,000
	3,500'	24,000	33	6	7,700	89,000
	4,500'	19,000	27	230	2,500	210,000
	5,500'	12,000	37	53	600	170,000
	6,500'	22,000	35	190	2,200	99,000
	7,500'	8,400	55	55	1,500	67,000
	9,500'	4,700	41	39	400	35,000
	11,500'*	2,600	42	22	1,100	8,700
	13,500'*	1,700	51	54	600	7,600
	15,000'*	1,000	46	24	460	2,300
	16,500'*	850	53	34	2,300	1,800
	17,500'*	2,500	56	30	8,400	1,100
	18,500'*	5,700	50	160	9,900	12,000
	19,000'*	8,200	40	160	7,700	23,000
	19,300'*	9,700	49	160	9,900	24,000

* Canadian Stations

The City of Detroit requested permission to shut down the Detroit River outfall and bypass treated effluent into the Rouge River in order to allow inspection and renovation of the regular outfall. Permission was granted by State agencies with the provision that an experimental testing period be undertaken to determine any deleterious effect this action might have upon the re-' ceiving waters and the users thereof. The scheduled commencement date of this experimental period was July 27, 1964.

After learning of this proposed action through minutes of meetings of the Michigan Water Resources Commission, a brief surveillance of the action was planned by personnel of this Project. On July 23 regular sampling operations revealed extremely high total and fecal coliform densities in the Rouge River and in the lower part of the Detroit River during dry weather. This was especially pronounced at station DT 14.6, where coliform densities of over 200,000 organisms were found at all stations and a count of 620,000 organisms per 100 ml was found near the Wyandotte water intake. A total coliform density of 3,700 organisms per 100 ml was found at the new City of Detroit water intake near Fighting Island. Results in the Rouge River near its mouth exceeded 2 million total

coliform organisms per 100 ml. Fecal coliform densities were similarly high, exceeding 200,000 organisms in the Rouge and over 50,000 in the Detroit River, at station DT 14.6 near Wyandotte. Fecal streptococcus densities in the Rouge and Detroit Rivers were low on this date with all but one result below 1,000 organisms per 100 ml. (The exception was 1,950 on the Rouge.)

The Michigan Water Resources Commission and the Michigan Department of Health were notified on July 24 when the results were read in the Project laboratory. The City of Wyandotte, a downstream user of water, was also notified on this date. Investigation of the alternate bypass on the Rouge River revealed on July 23 and 26 that the discharge through this outfall had already begun.

Project sampling continued over the weekend and similar results obtained. Telephone calls were received from the Michigan Department of Health and the Michigan Water Resources Commission with information that the City of Detroit was notified of the Project's concern and had instigated sampling over the weekend. The results of their sampling caused them to suspend bypassing operations Monday morning.

On Thursday, July 30, the waters were sampled, and coliform densities dropped to normal dry weather levels.

During the period of actual partial bypass (July 19-27) two rains occurred--July 20 and July 25. The first was very light, and any effect should have been dissipated within 24 hours. The second could have affected water quality on July 25 and possibly July 26 but certainly not on July 23 and 24, when the City of Detroit sampled.

Checking with the City of Wyandotte revealed consistently high coliform densities during the period July 19-27, 1964, with results exceeding 110,000 organisms per 100 ml. The results at the intake during the 3 days following the cancellation of the bypass indicated a sharp reduction to less than 1,000 organisms per 100 ml.

It is interesting to note that the highest individual coliform value at station DT 14.6 near Wyandotte (620,000 per 100 ml) was recorded during this bypass in a period of dry weather. Values at the station in the Detroit River immediately above the Rouge River remained low during and after this period except for samples collected on August 3, following a heavy rain.

Evaluation of this experience emphasizes the necessity for careful study of the effects of bypassing on water quality and the desirability for designing sewage treatment facilities in order to properly cope with this situation.

Richard D. Vaughan

BOTTOM DEPOSITS

Analysis of bottom materials to determine the effects or extent of water pollution is a field in which there is little basis for quantitative interpretation. "Standard Methods" gives only passing mention of recommended procedures for field and laboratory, and considerable difficulty is involved in working with a solid-liquid mixture rather than a liquid. For these reasons, bottom deposits were treated only in a general way, to show differences in bottom composition in various areas of the Lake.

Time is also a factor with bottom materials. They may remain undistrubed under water year after year, long after the original waste source has ceased to exist. Therefore, the current bottom condition cannot be conclusively identified with existing effluents. It can be definitely stated, however, that the condition of the bottom is caused by the settling of waste materials, and if suspended solids continue to enter the river they will settle in the same areas as before and cause the same problems.

A sampling technique was developed to enable a boat crew to collect the samples while drifting over the area. A special drag-type sampler was used to scoop up

the top 0.2 to 0.3 feet of material. The results are qualitative for each site, and no attempt was made to determine thickness of settled deposits.

Only one sample was taken at each location, and the locations were widely spaced to cover a variety of conditions in each area. By grouping the results by area, certain trends were noted. These areas were selected according to the bottom material quality shown by observations and chemical analysis. Each area was then rated as good, fair, or poor, according to the overall indications for that area.

Good condition: Natural bottom conditions of sand, gravel, mud or silt without oil, grease or odor, and without abnormally large amounts of waste-associated materials.

Fair condition: Natural bottom condition with some evidence of deposited material, slight oil or odor, and moderate amounts of waste-associated materials.

Poor condition: Bottom deposits or organic or other material having oily appearance and odor of oil or sewage; large amounts of waste-associated materials, such as greases, phenols, total nitrogen, phosphates, and iron; high percentages of volatile materials and a pH higher or lower than surrounding areas.

Solids settled over the natural bottom disrupt or eliminate fish and other aquatic life. In shallow water, they are offensive to swimmers and boaters, and when fluctuating water levels expose beds of these materials, the resulting appearance and odors destroy the aesthetic value of the waterways.

Since most of the bottom material in the poor condition areas is light and easily disturbed, there is a constant problem when this material is resuspended in the water during stormy weather or from the passage of large boats. Resuspended bottom materials in the poor condition areas increase turbidity, oxygen demand, algae growth, and taste and odor problems, which decrease the quality of the water for riverside or lakeside recreation, fishing, swimming, water skiing, and industrial and municipal water supply. This increased turbidity is frequently observed in the Detroit River and Lake Erie during stormy weather. Figure 23-V shows the Detroit River classified according to the type of material deposited on its bottom. Tables 20-V through 25-V summarize the results of the bottom deposit studies of the Rouge River and separate areas of the Detroit River.

(Figure 23-V; and Tables 20-V through 25-V follow.)

FIGURE 23-V

DETROIT RIVER-LAKE ERIE PROJECT

CLASSIFICATION OF BOTTOM CONDITION AS INDICATED BY BOTTOM DEPOSITS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

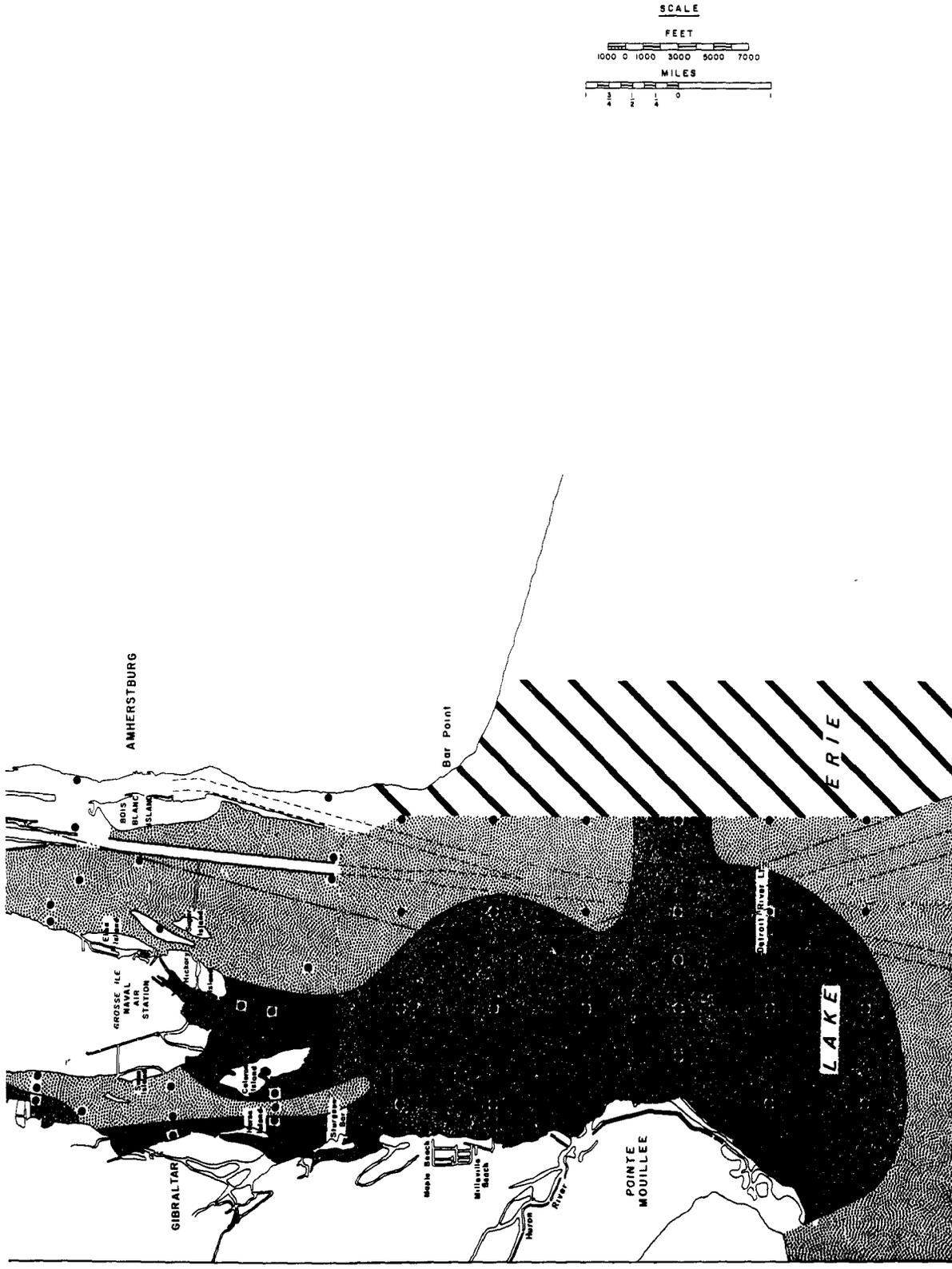


TABLE 20-V. SUMMARY OF BOTTOM MATERIALS - DETROIT RIVER

MILE 30.8 TO MILE 25

	No. of Samples	Max.	Min.	Med.	Mean	Remarks
pH						
AM	13	7.7	7.1	7.4	7.4	
CAN	5	8.0	7.2	7.3	7.4	
% IRON						Low values.
AM	13	6.89	0.01	1.26	1.52	
CAN	5	4.13	0.007	1.02	1.32	
% OIL AND GREASE						Generally good except one high value from southern tip of Belle Isle
AM	13	2.10	0.003	0.02	0.28	
CAN	5	0.44	0.01	0.09	0.15	
% TOTAL VOLATILE SOLIDS						High values found at Peach Island Light and below Conners; all others low.
AM	11	12.2	1.6	7.1	6.6	
CAN	3	12.6	4.6	9.0	8.7	

CONCLUSION: Bottom conditions generally good except for areas downstream from Conners and the sewage treatment plant on Belle Isle.

TABLE 21-V. SUMMARY OF BOTTOM MATERIALS - DETROIT RIVER

MILE 25 TO MILE 19.5

	No. of Samples	Max.	Min.	Med.	Mean	Remarks
pH						10.1 just downstream from Allied Chemical at Zug Island.
AM	10	10.1	7.4	7.7	8.0	
CAN	4	7.8	7.4	7.6	7.6	
% IRON						Low values except for one 11% value at Zug Island.
AM	7	11.01	0.01	0.56	2.35	
CAN	4	4.13	0.02	0.28	1.17	
% OIL AND GREASE						Low to medium values.
AM	10	0.60	0.00	0.14	0.17	
CAN	4	0.50	0.02	0.18	0.22	
% TOTAL VOLATILE SOLIDS						Both high and low values found on both sides of river.
AM	8	17.0	8.2	8.2	10.2	
CAN	4	20.2	8.4	10.3	12.8	

CONCLUSION: Bottom conditions generally good except for the Zug Island area particularly below Allied Chemical outfall.

TABLE 22-V. SUMMARY OF BOTTOM MATERIALS - ROUGE RIVER

	No. of Samples	Max.	Min.	Med.	Mean	Remarks
pH	6	7.3	6.8	7.0	7.0	
% IRON	4	8.60	1.72	2.74	3.95	Fairly high
% OIL AND GREASE	6	4.20	1.00	1.75	2.18	Very high
% TOTAL VOLATILE SOLIDS	6	25.6	11.1	20.9	19.9	Very high

CONCLUSION: Bottom condition in the Rouge River is very poor.

TABLE 23-V. SUMMARY OF BOTTOM MATERIALS - DETROIT RIVER

MILE 19.5 TO MILE 15

	No. of Samples	Max.	Min.	Med.	Mean	Remarks
pH						
AM	13	8.1	7.2	8.0	7.8	
CAN	5	7.8	7.1	7.5	7.5	
% IRON						Variable, bu generally high on American side and low er on Canadi- an side.
AM	9	11.45	0.05	1.13	3.62	
CAN	3	2.06	0.01	0.04	0.70	
% OIL AND GREASE						High down- stream from Rouge on American sid-.
AM	13	3.20	.02	0.37	0.77	
CAN	5	0.32	0.006	0.07	0.11	
% TOTAL VOLATILE SOLIDS						
AM	11	17.3	9.9	13.0	13.5	
CAN	4	14.0	8.0	9.5	10.3	

CONCLUSION: Bottom condition is poor on the American side and fair on Canadian side.

TABLE 24-V. SUMMARY OF BOTTOM MATERIALS - DETROIT RIVER

MILE 15 TO MILE 8.7

	No. of Samples	Max.	Min.	Med.	Mean	Remarks
pH						9.0 downstream from Wyandotte Chemical and 11.2 downstream from Firestone Steel Products.
Trenton Channel	25	11.2	7.0	7.7	7.8	
East of Grosse Ile	11	8.0	7.2	7.6	7.6	
% IRON						High in Trenton Channel; low on east side of Grosse Ile.
Trenton Channel	22	30.96	0.01	3.13	5.68	
East of Grosse Ile	11	8.94	0.01	1.38	2.96	
% OIL AND GREASE						High in Trenton Channel and below Firestone and Wye Street sewer; low on Canadian side.
Trenton Channel	25	2.11	0.04	0.15	0.41	
East of Grosse Ile	11	0.38	0.03	0.09	0.11	
% TOTAL VOLATILE SOLIDS						High values in Trenton Channel; low on East side of Grosse Ile.
Trenton Channel	25	38.0	3.1	6.4	8.2	
East of Grosse Ile	11	12.9	1.1	4.0	4.9	

CONCLUSION: Poor bottom conditions prevail in Trenton Channel. Fair to good in waters east of Grosse Ile.

TABLE 25-V. SUMMARY OF BOTTOM MATERIALS - DETROIT RIVER

MILE 8.7 TO LAKE ERIE

	No. of Samples	Max.	Min.	Med.	Mean	Remarks
pH						
Trenton Channel	13	7.9	7.3	7.6	7.6	High values on Canadian side.
East of Grosse Ile	11	9.8	7.2	7.4	7.8	
% IRON						
Trenton Channel	12	9.63	0.004	2.83	3.26	High Trenton Channel; low on east side of Grosse Ile.
East of Grosse Ile	10	4.82	0.005	1.72	1.75	
% OIL AND GREASE						
Trenton Channel	13	2.45	0.06	0.39	0.53	Higher values in Trenton Channel.
East of Grosse Ile	10	0.64	0.02	0.21	0.26	
% TOTAL VOLATILE SOLIDS						
Trenton Channel	12	17.3	2.1	7.8	8.0	High in Trenton Channel; low on east side of Grosse Ile.
East of Grosse Ile	11	12.9	1.4	5.4	5.8	

CONCLUSIONS: Bottom condition is poor in the Trenton Channel as far south as Pointe Mouillee. Bottom conditions east of Grosse Ile vary from fair to good.

In addition to the indices shown on these tables, analyses of the bottom deposit supernatant were made for phenol, phosphate, nitrate, and ammonia concentrations. All of these factors, including field observations, were taken into consideration in characterizing bottom conditions.

From the head of the Detroit River to mile point 25 at the south end of Belle Isle, the bottom was in good condition on the Canadian side and fair to good on the American. One sampling point rated poor was just below Conners Creek.

From Belle Isle to the Rouge River conditions on both sides of the Detroit River were fair with better bottom in midriver. An area rated poor began just above Zug Island and extended southward along the United States shore.

All stations sampled on the Rouge River indicated poor condition.

Below the Rouge River to mile point 15 at the head of Grosse Ile, all points along the United States shore were poor. Those in faster moving water were somewhat better.

From mile point 15 to the Grosse Ile County Bridge, the bottom condition of the Trenton Channel

(west of Grosse Ile) was poor. East of Grosse Ile, the bottom condition in United States waters was fair, and generally fair to good in Canadian waters.

From the County Bridge to the mouth of the Detroit River, the bottom condition was poor in the Trenton Channel and below Grosse Ile poor along the United States shore. The waters were generally fair on the east side of Grosse Ile.

Organic material in a state of decomposition, having a dark color, oil or sewage odor, and oily appearance, was found in isolated places in the Detroit River above Zug Island. These occurrences could be attributed to storm water overflows or other organic deposits.

Around Zug Island and the Rouge River, bottom material was in very poor condition, and this situation prevailed along the United States shore to Ecorse and throughout the Trenton Channel to Lake Erie. Bottom materials on the Canadian side of the river and east side of Grosse Ile were in fair to good condition.

Samples taken of the mud-water interface in the turning basin at the Ford Motor Company plant and in the Ford slip revealed high concentrations (500 mg/1) of both oil and iron.

HYDROLOGIC STUDIES

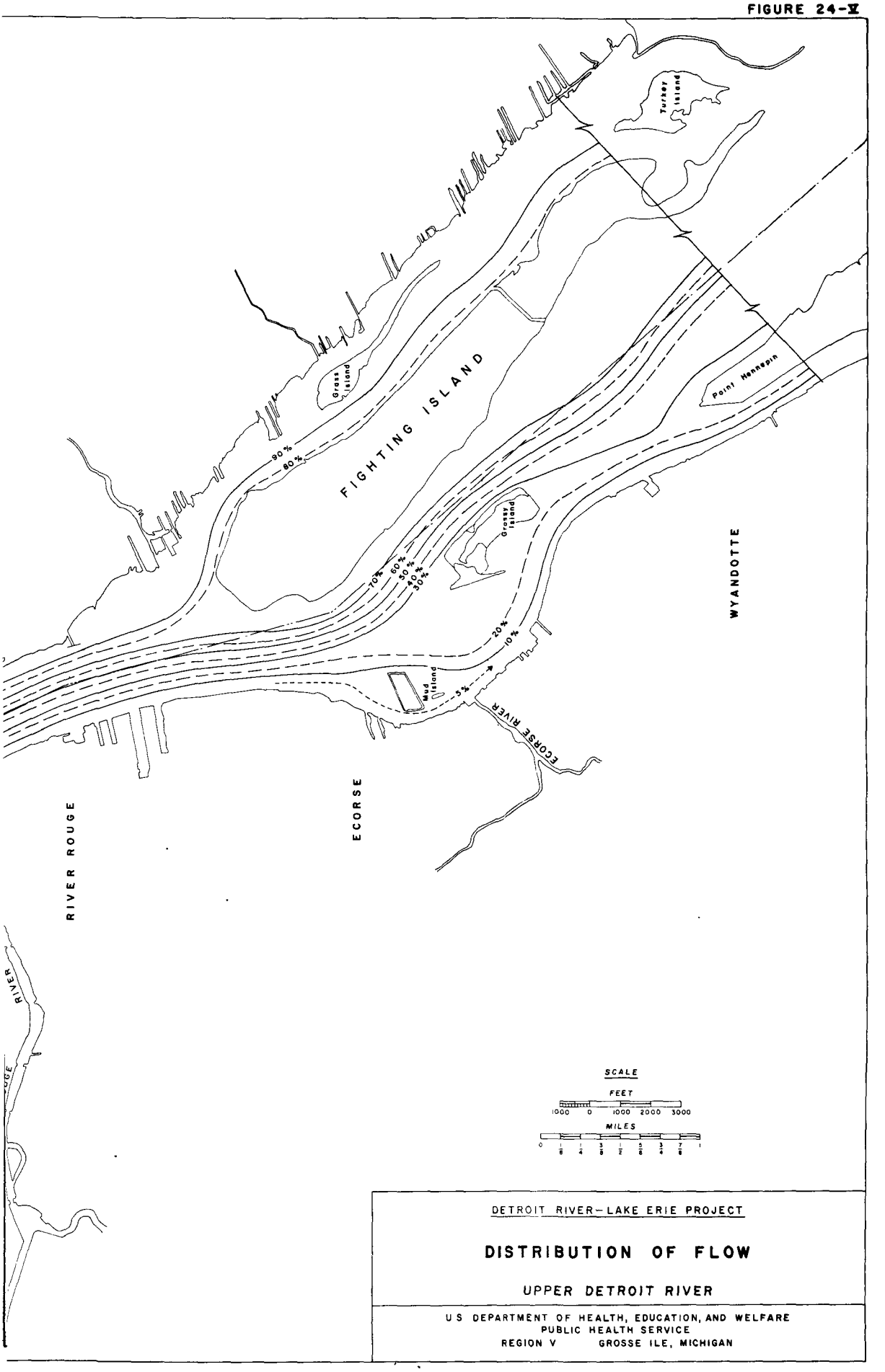
Richard D. Vaughan

Several investigations of hydraulic and hydrologic characteristics were made on the Detroit River to provide insight into the relationship between sources of wastes and areas affected by pollution. Flow distribution in the Detroit River was determined at several locations and routes of wastes traced from their source to downstream areas of water use. Dispersion patterns of domestic and industrial waste effluents were determined and plotted.

Flow Distribution: In Figures 24-V and 25-V flow distribution across the upper and lower Detroit River is shown. These figures depict streamlines or distribution of per cent of flow across the Detroit River at varying ranges. The numbers shown adjacent to the streamlines represent the per cent flow west of the particular line. The per cent flow in United States waters varied from approximately 70 per cent at the head and opposite Fighting Island to less than 40 per cent at several locations, including the mouth. Velocities varied in the main part of the River between one and four feet per second, causing turbulent flow, resulting in the creation of a homogeneous mass of water in a vertical plane due to mixing. Horizontal mixing was much less pronounced due to large masses of water moving downstream at high velocities.

(Figures 24-V and 25-V follow.)

FIGURE 24-V



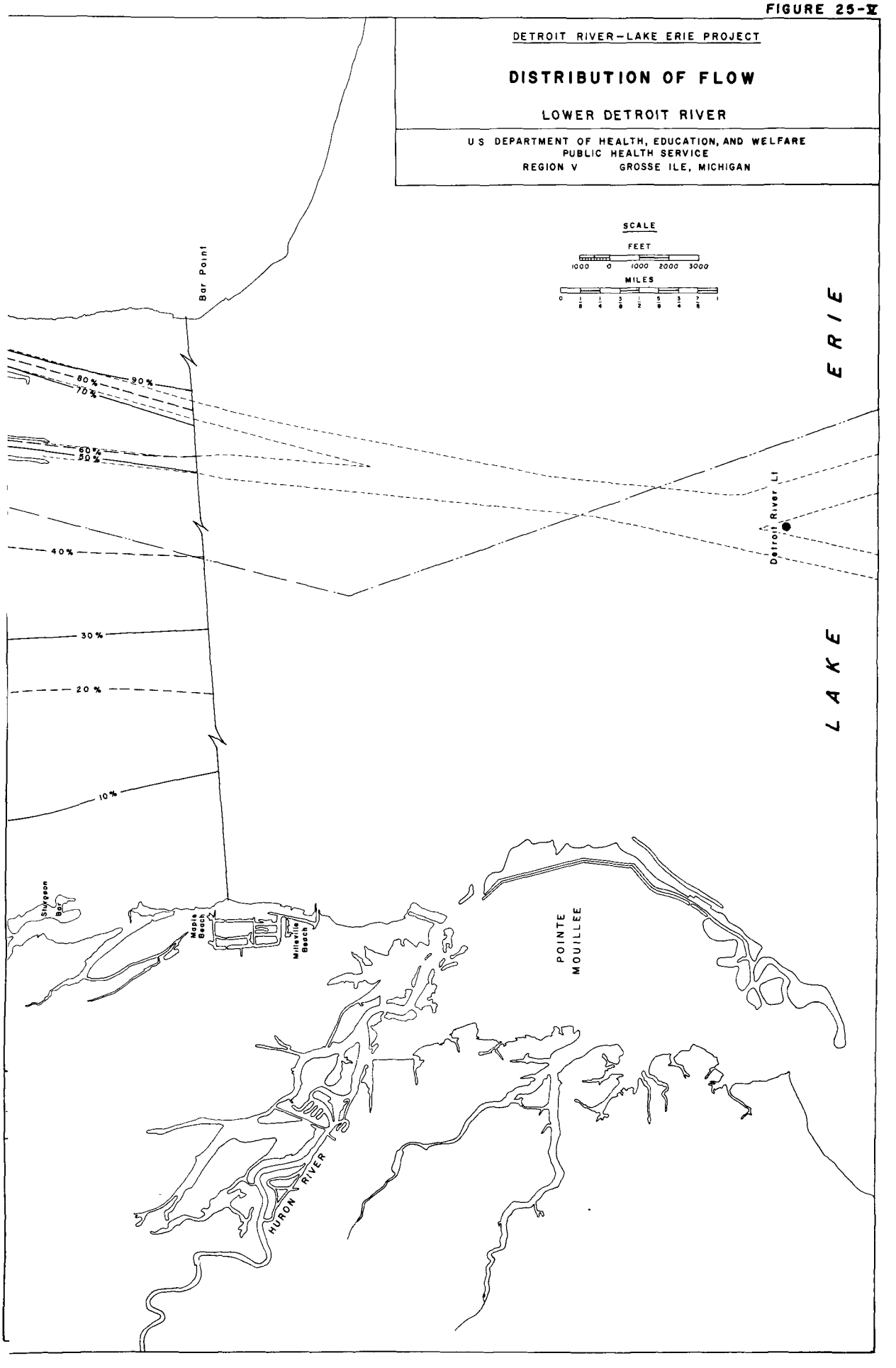
DETROIT RIVER–LAKE ERIE PROJECT

DISTRIBUTION OF FLOW

UPPER DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 25-V

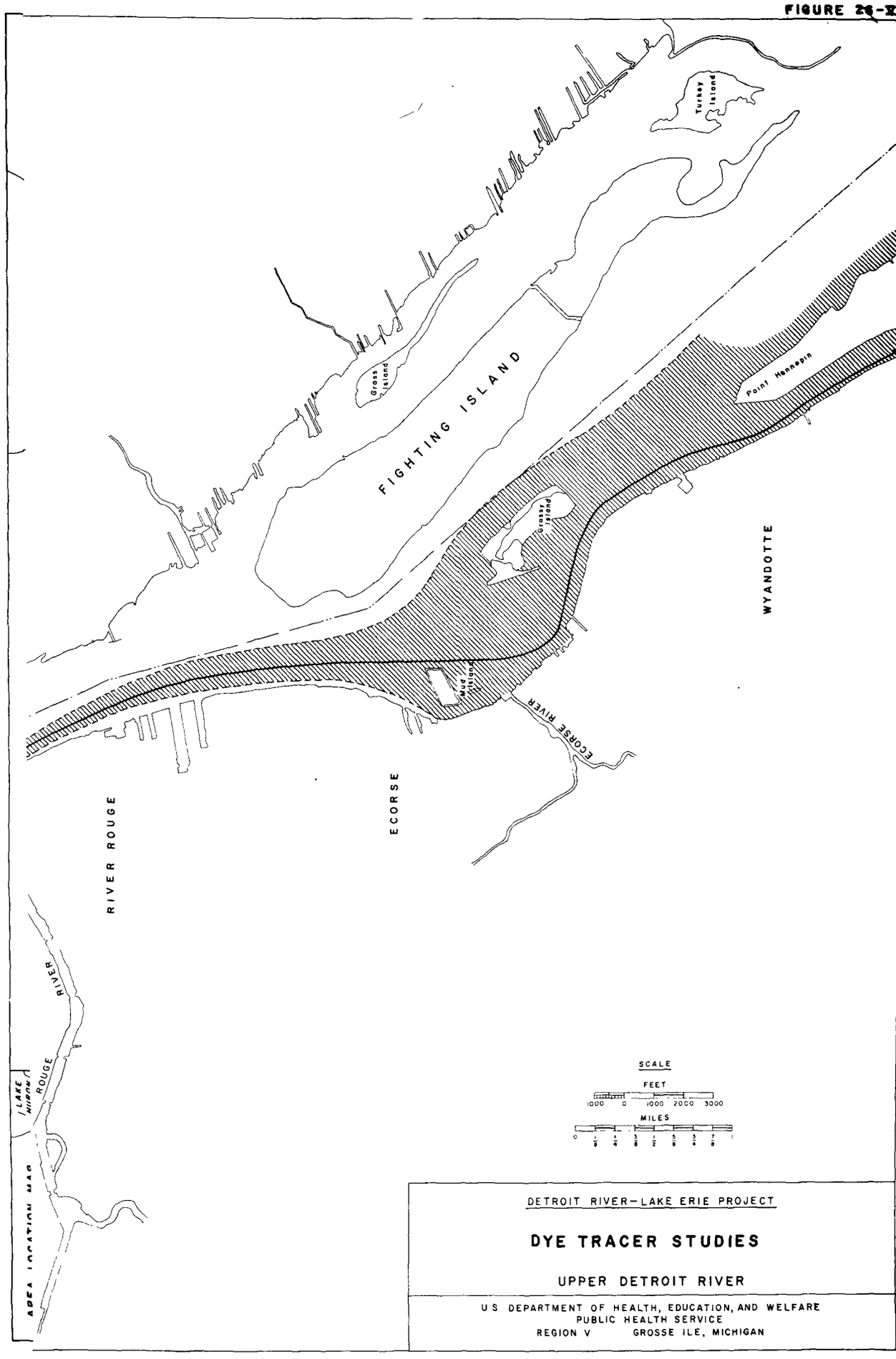

DETROIT RIVER–LAKE ERIE PROJECT
DISTRIBUTION OF FLOW
LOWER DETROIT RIVER
U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN
SCALE
FEET
1000 0 1000 2000 3000
MILES
0 1/8 1/4 3/8 1/2 5/8 3/4 7/8 1
Bar Point
90%
80%
70%
60%
50%
40%
30%
20%
10%
Detroit River Lt
LAKE ERIE
Sturgeon Bay
Maple Beach
Millville Beach
POINTE MOUILLEE
HURON RIVER

Dry Tracer Studies

Rhodamine-B fluorescent dye was placed in the effluent of four domestic sewage treatment plants and traced downstream. Floats were placed in the River to assist in tracing the dye, which soon became invisible and had to be located with a fluorometer. Figures 26-V and 27-V depict the results of these surveys in the upper and lower Detroit River by plotting the extent of dye as a shaded area and the major concentration of the dye was a solid heavy line with direction arrows. No attempt was made to draw any conclusions regarding the expected concentration of wastes from the observed concentration of dye at any point. In addition to placing dye in sewage plant effluents several tracer runs were made after release of dye in several areas of the Detroit River from its head to its mouth.

(Figures 26-V and 27-V follow.)

FIGURE 26-X



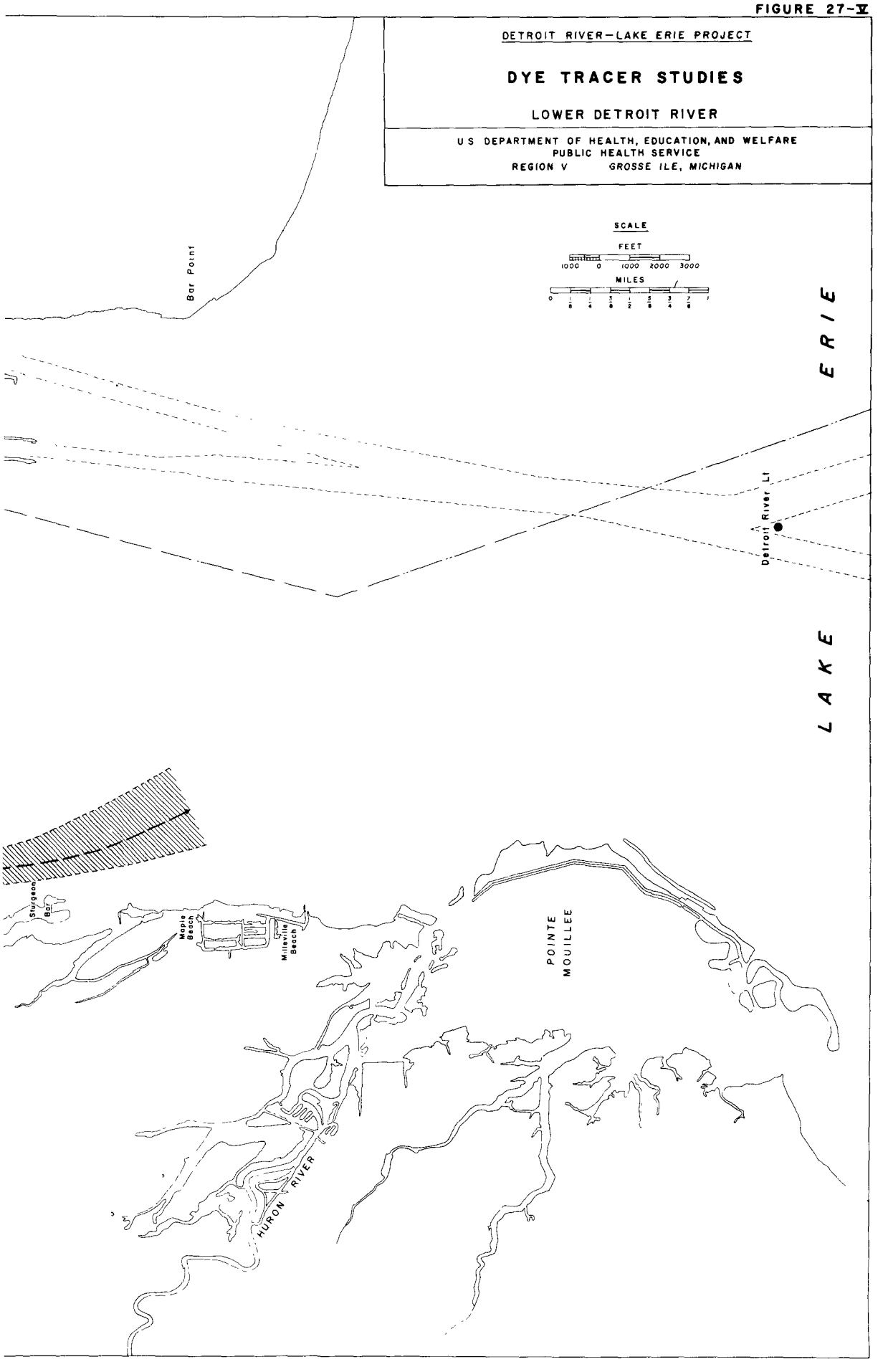
DETROIT RIVER–LAKE ERIE PROJECT

DYE TRACER STUDIES

UPPER DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 27-V


DETROIT RIVER—LAKE ERIE PROJECT
DYE TRACER STUDIES
LOWER DETROIT RIVER
U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN
SCALE
FEET
1000 0 1000 2000 3000
MILES
Bar Point
LAKE ERIE
Detroit River Lt
Sturgeon Bar
Maple Beach
Milleville Beach
POINTE MOUILLEE
HURON RIVER

One tracer study was made at the Belle Isle Sewage Treatment Plant, and the results (Figure 26-V) showed that the dye stayed in the main channel of the River, dispersing gradually to a 1,000-foot width at the Ambassador Bridge. The main path of this dye passed through one of the regular sampling points at Range Dt 20.6, 700 feet from the United States shore. This is a logical explanation for the sudden peak in coliform densities noted at this location in earlier discussions. (See Figure 1-V and Figure 15-V.) This same bacterial load was missed at the sampling station immediately below the outfall due to the narrow band of pollution traveling between two regular sampling stations.

Three tracer studies were made at the main sewage treatment plant of the City of Detroit, and the path shown in Figure 26-V is the concensus of the three studies. The three studies did show approximately the same results under different conditions of wind, but during dry weather. The dye shifted gradually to midchannel and traveled to the west edge of the Fighting Island Channel but was most concentrated near the United States shore. The dye appeared to miss the new southwest water intake of the City of Detroit, but a heavy concentration of the dye passed over the City of Wyandotte water intake. Further downstream,

the dye was traced to the east as well as the west side of Grosse Ile at Point Hennepin, although the main concentration of the dye was observed in the Trenton Channel. In general the dye was found almost exclusively in American waters and was most concentrated approximately 700 feet from the United States shore.

Tracer studies were made at the Wayne County Sewage Treatment Plants at Wyandotte and Trenton. The dye was traced down the Trenton Channel and between Horse Island and Celeron Island at the lower end of the channel. The dye was most intense near the mainland shore. In both studies dye was found in Marinas along the shore.

Using the results of the flow distribution, tracer studies from domestic waste plants, and special dye studies at various locations in the Detroit River. Figure 28-V was constructed to show the expected routing or dispersion of industrial or domestic waste discharged into the river at different geographic zones. Use of this figure can be illustrated by the following example:

> The wastes from the industries in zone 1 are expected to be dispersed in the River to the west of the zone line beginning at the upper end of zone 1. Opposite the Ecorse River, wastes from zone 1 are dispersed throughout the

entire United States section of the River, while wastes from zone 4 hug a narrow band near the United States shore.

Using Figures 28-V, 24-V, and 25-V, it is possible to predict the downstream areas where wastes from specific sources are felt and also possible to predict areas where water quality improvement would result after improved waste treatment at specific sources.

Table 26-V shows the percentage of the Detroit River affected by the discharge of industrial and domestic wastes from the Michigan mainland. The zone numbers correspond to those shown in Figure 26-V.

(Figure 28-V follows.)

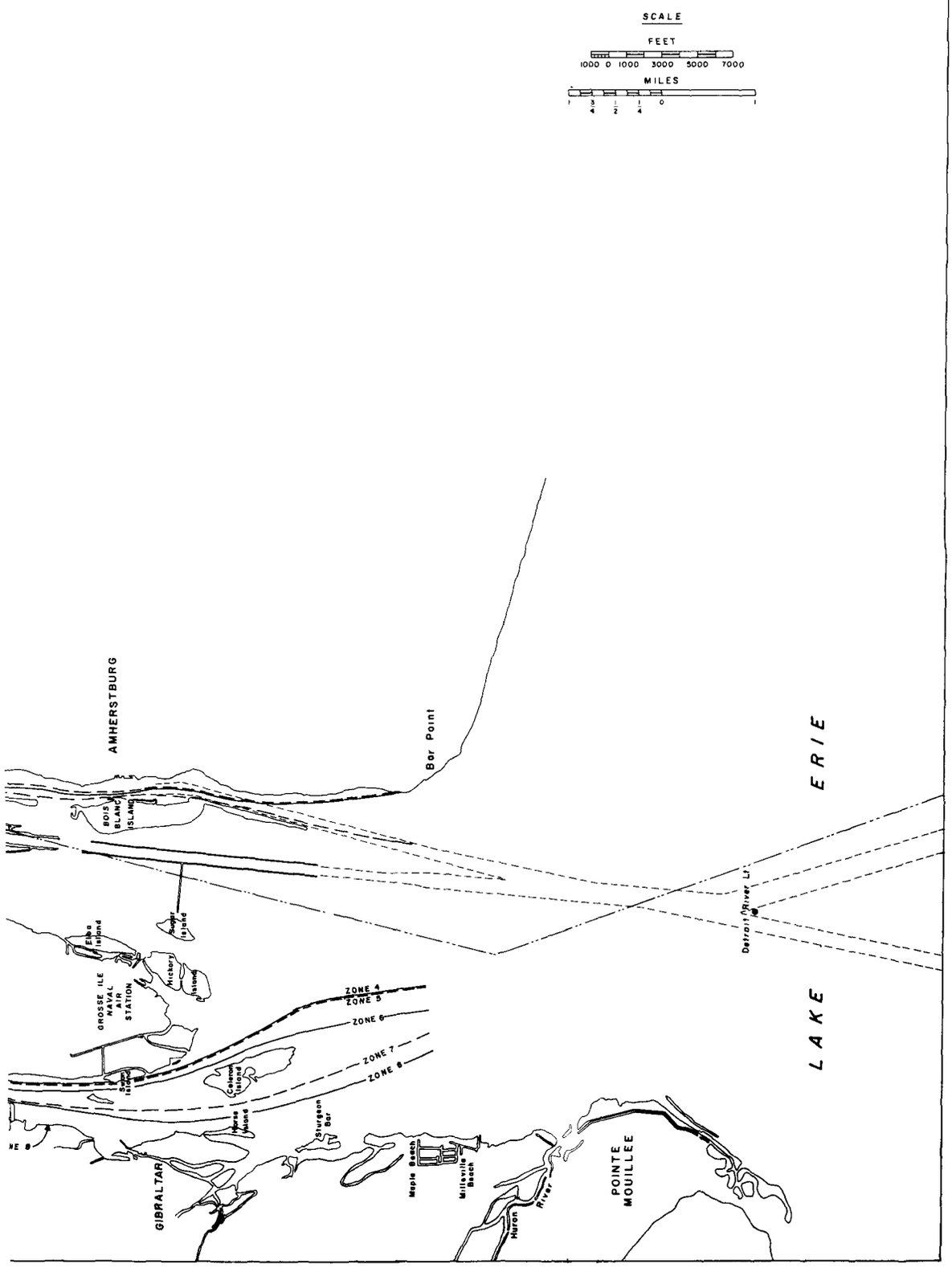
FIGURE 28-V

DETROIT RIVER-LAKE ERIE PROJECT

ZONES OF WASTE DISPERSION AFTER DISCHARGE

U.S. WATERS
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



The outflow of the Rouge River was traced into the Detroit River and downstream a short distance. The Rouge River and effluent from the submerged outfall of the Detroit Sewage Treatment Plant are clearly identifiable by color as two distinct water masses at their junction near the mouth of the Rouge River. However, these two water masses become intermixed due to turbulence and diffusion and for all practical purposes act as a single water mass passing downstream. Dye releases from the Detroit Sewage Treatment Plant outfall were therefore used to trace the downstream movement of this combined flow. These flow measurements were performed during dry weather and represent normal or even below normal discharge from the Rouge River.

It is conceivable and even probable that following a heavy rainfall with subsequent overflows from combined sewers on the Rouge River that its increased discharge would have a more pronounced effect on the dispersion of the combined water masses towards Canadian waters and have a more deleterious effect on water quality at the southwest intake of the City of Detroit.

STREAM LOADINGS

When concentrations of waste constituents in the Detroit River are compared with corresponding discharge values for each section of the River sampled, quantitative

loadings may be computed. These are usually reported in units such as pounds, gallons, or numbers. An average concentration of a waste constituent weighted to discharge may also be computed. This procedure allows the presentation of one value at each range or cross=section representative of existing concentrations and amounts of waste present. Stream loadings are useful in presenting a concise picture of what is happening in the river from the headwaters to the mouth. They may also be used in comparison with loadings from domestic and industrial waste effluents.

A special problem is involved when numbers of coliform organisms are presented. Their values are so high that they are awkward to work with and comprehend. To allow a better understanding of these values, the bacterial population equivalent (BPE) has been employed.

This is a value equivalent to the daily bacterial contribution from one human being in raw sewage. The value used for one BPE is 200 billion coliform bacteria per day per capita. Use of the BPE should give the reader of this report a better understanding of the magnitude of increases and decreases in numbers of coliform organisms in the Detroit River and assist in the evaluation of the effect of waste sources upon these numbers.

Tables 27-V through 38-V show stream loadings for phenols, chlorides, and total coliform organisms at several ranges in the Detroit River during 1962 and 1963 sampling seasons. The total loadings for the United States and entire River are shown as well as per cent flow of each section sampled.

Table 39-V shows the increase in stream loadings for these same waste constituents by listing the values in the upper and lower section of the Detroit River. In this particular table the loadings in the upper River were adjusted to the same volume of the River found in United States waters at the mouth. This gives a more valid indication of increase in loadings due to waste discharge, since almost all wastes discharged into the Detroit and Rouge Rivers remain in United States waters.

Table 40-V compares the increase in waste loadings in waste loadings in the Detroit River with loadings found in the domestic and industrial waste surveys.

Table 41-V is included to show bacterial loadings and weighted average total coliform concentrations during wet and dry conditions.

(Tables 26-V through 41-V, inclusive follow.)

TABLE 26-V. INDUSTRIAL AND MUNICIPAL WASTE DISPERSION - PERCENTAGE OF DETROIT RIVER

Cross-Sectional Location	Waste Source - Zones							
	1	2	3	4	5	6	7	8
Ambassador Bridge	25							
Dt 19.0 (Rouge R.)	50	30						
Dt 17.4W	70	50	40	10				
Dt 14.6W	70	60	50	20	5			
Dt 12.0	70	70	60	23	20	5		
Dt 8.7	80	80	70	23	23	15	7	
Dt 3.9	100	100	80	25	25	20	15	10

Note: Percentage flow values are computed from the west (American) shore

TABLE 27-V. STREAM LOADING FOR DETROIT RIVER

DT 30.8W

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
20	.33	7	20,000	12
100	1.57	32	90,000	50
200	3.39	52	202,000	120
300	3.58	42	206,000	110
400	3.92	90	202,000	74
500	6.41	150	330,000	110
700	12.86	400	690,000	180
1,000	34.76	570	1,734,000	380
2,000	24.96	290	1,446,000	240
2,500	3.16	67	180,000	24
U.S. Water	94.94	1,700	5,100,000	1,300
Entire Range	100	1,800	5,400,000	1,300
Weighted Average - U.S. Water		2.4 µg/l	7 mg/l	80 org/100ml
Weighted Average - Entire Range		2.4 µg/l	7 mg/l	79 org/100ml

1963

100	3.59	55	110,000	30
300	6.24	370	384,000	85
500	14.80	410	554,000	50
1,000	51.19	1,690	2,990,000	65
2,500	24.18	1,325	2,222,000	40
U.S. Water	94.94	3,850	6,260,000	270
Entire Range	100	4,050	6,660,000	271
Weighted Average - U.S. Water		6.0 µg/l	10 mg/l	18 org/100ml
Weighted Average - Entire Range		6.0 µg/l	10 mg/l	15 org/100ml

* Location of sampling station in feet from west shore

TABLE 28-V. STREAM LOADING FOR DETROIT RIVER

DT 28.4 W

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
100	7.41	40	200,000	650
200	5.52	15	136,000	131
300	5.82	25	134,000	133
400	12.21	70	284,000	210
700	20.26	45	500,000	300
1,000	16.48	55	370,000	174
1,300	13.08	30	290,000	82
1,500	19.22	70	426,000	220
U.S. Water	100	350	2,340,000	1,900
Entire Range	100	350	2,340,000	1,900
Weighted Average - U.S. Water		1.2 µg/l	8 mg/l	320 org/100ml
Weighted Average - Entire Range		1.2 µg/l	8 mg/l	320 org/100ml

1963

100	10.17	50	154,000	127
300	11.92	210	498,000	133
700	34.60	350	408,000	42
1,300	43.31	740	980,000	78
U.S. Water	100	1,350	2,040,000	380
Entire Range	100	1,350	2,040,000	380
Weighted Average - U.S. Water		4.6 µg/l	7 mg/l	70 org/100ml
Weighted Average - Entire Range		4.6 µg/l	7 mg/l	70 org/100ml

* Location of sampling station in feet from west shore

TABLE 29-V. STREAM LOADING FOR DETROIT RIVER

DT 25.7

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
50	.56	15	46,000	340
100	2.37	140	194,000	740
300	5.19	50	372,000	570
600	9.06	120	660,000	440
1,000	17.32	155	1,294,000	470
2,000	18.04	220	1,294,000	340
U.S. Water	52.54	700	3,860,000	2,900
Entire River	100	1,300	7,540,000	9,200
Weighted Average - U.S. Water		1.4 µg/l	7 mg/l	170 org/100ml
Weighted Average - Entire River		1.3 µg/l	8 mg/l	390 org/100ml

1963

50	.56	18	38,000	250
100	2.37	112	152,000	530
300	5.19	247	352,000	560
600	9.06	791	564,000	190
2,000	37.36	2,282	2,574,000	170
U.S. Water	54.54	3,450	3,680,000	1,700
Entire River	100	6,250	7,660,000	36,700
Weighted Average - U.S. Water		7.2 µg/l	8 mg/l	150 org/100ml
Weighted Average - Entire River		6.7 µg/l	8 mg/l	1,740 org/100ml

* Location of sampling station in feet from west shore

TABLE 30-V. STREAM LOADING FOR DETROIT RIVER

DT 20.6

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
5	.08	1	8,000	40
20	.21	4	18,000	220
50	.71	15	60,000	530
100	1.94	55	146,000	1,870
200	3.57	85	284,000	3,210
300	4.47	85	360,000	1,750
400	5.08	120	440,000	1,610
500	5.28	155	450,000	520
600	5.62	140	480,000	550
700	11.24	220	894,000	910
1,000	11.88	270	1,000,000	790
U.S. Water	50.08	1,150	4,140,000	12,000
Entire River	100	1,850	8,480,000	82,000
Weighted Average - U.S. Water		2.7 µg/l	8 mg/l	1,000 org/100ml
Weighted Average - Entire River		1.8 µg/l	8 mg/l	3,600 org/100ml

1963

5	.18	6	6,000	13
50	1.79	783	58,000	130
200	6.77	419	330,000	1,040
400	10.00	1,629	948,000	3,800
600	8.31	750	350,000	707
700	11.29	793	780,000	1,440
1,000	11.74	1,070	820,000	1,370
U.S. Water	50.08	5,450	3,300,000	8,500
Entire River	100	10,100	6,440,000	30,900
Weighted Average - U.S. Water		11.6 µg/l	7 mg/l	730 org/100ml
Weighted Average - Entire River		10.8 µg/l	8 mg/l	1,460 org/100ml

* Location of sampling station in feet from west shore

TABLE 31-V. STREAM LOADING FOR DETROIT RIVER

DT 19.0

1963

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
100	1.74	452	564,000	3,100
200	2.72	504	774,000	9,600
300	4.03	600	1,186,000	12,800
400	12.33	2,030	3,076,000	35,600
800	15.43	340	2,150,000	3,570
1,000	15.06	1,124	1,190,000	2,330
U.S. Water	51.31	5,050	8,940,000	67,000
Entire River	100	6,380	12,780,000	81,500
Weighted Average - U.S. Water		10.5 µg/l	19 mg/l	5,700 org/100ml
Weighted Average - Entire River		7.2 µg/l	14 mg/l	3,870 org/100ml

* Location of sampling station in feet from west shore

TABLE 32-V. STREAM LOADING FOR DETROIT RIVER

DT 17.4 W

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
100	1.21	67	212,000	2,200
200	4.41	243	710,000	10,600
400	10.74	590	1,450,000	18,700
600	11.87	555	1,320,000	19,000
800	10.85	750	1,270,000	16,400
1,000	10.86	390	1,202,000	13,900
1,200	10.98	250	1,004,000	8,000
1,400	10.98	265	950,000	6,800
1,600	14.38	390	1,222,000	4,400
U.S. Water	86.28	3,500	9,340,000	100,000
Entire Range	100	3,800	10,340,000	110,000
Weighted Average - U.S. Water		5.2 µg/l	14 mg/l	6,600 org/100ml
Weighted Average - Entire Range		4.8 µg/l	13 mg/l	5,900 org/100ml

1963

100	1.21	148	226,000	650
200	4.41	442	792,000	3,660
400	16.67	895	1,670,000	7,600
800	28.22	1,545	4,190,000	14,200
1,200	22.40	520	1,656,000	3,500
1,600	13.37	200	886,000	1,390
U.S. Water	86.28	3,750	9,420,000	31,000
Entire Range	100	3,920	10,260,000	32,100
Weighted Average - U.S. Water		5.9 µg/l	15 mg/l	2,100 org/100ml
Weighted Average - Entire Range		5.3 µg/l	14 mg/l.	1,920 org/100ml

* Location of sampling station in feet from west shore

TABLE 33-V. STREAM LOADING FOR DETROIT RIVER

DT 14.6W

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
20	.35	15	190,000	80
100	1.55	80	450,000	4,850
200	2.66	103	470,000	7,150
300	2.93	340	546,000	3,950
400	4.74	201	530,000	9,750
600	6.93	283	690,000	14,100
800	5.58	148	550,000	9,520
900	3.62	121	326,000	5,300
1,000	3.62	79	328,000	5,800
1,100	12.18	231	1,350,000	17,300
2,000	2.20	11	120,000	1,900
2,300	34.98	20	110,000	1,450
3,000	13.76	518	4,600,000	36,700
U.S. Water	95.10	2,150	10,260,000	117,850
Entire Range	100	2,300	11,560,000	130,000
Weighted Average - U.S. Water		2.8 µg/l	14 mg/l	6,881 org/100ml
Weighted Average - Entire Range		2.8 µg/l	15 mg/l	7,000 org/100ml

1963

20	.35	22	150,000	770
100	1.55	98	482,000	5,400
200	2.66	155	688,000	3,800
300	2.93	138	694,000	4,100
400	8.70	241	734,000	5,880
800	11.16	470	1,350,000	10,000
1,000	11.52	613	2,464,000	7,200
2,000	28.28	40	252,000	350
3,000	27.95	673	4,126,000	8,000
U.S. Water	95.10	2,450	10,940,000	45,500
Entire Range	100	2,510	11,360,000	45,600
Weighted Average - U.S. Water		3.5 µg/l	16 mg/l	2,800 org/100ml
Weighted Average - Entire Range		3.4 µg/l	15 mg/l	2,720 org/100ml

* Location of sampling station in feet from west shore

TABLE 34-V. STREAM LOADING FOR DETROIT RIVER

DT 12.0W

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
122	15.36	200	2,252,000	3,000
322	24.24	255	2,048,000	14,500
490	19.76	240	1,086,000	3,200
670	20.77	205	926,000	26,600
880	19.87	200	868,000	25,700
U.S. Water	100	1,100	7,180,000	73,000
Entire Range	100	1,100	7,180,000	73,000
Weighted Average - U.S. Water		4.8 µg/l	31 mg/l	14,000 org/100ml
Weighted Average - Entire Range		4.8 µg/l	31 mg/l	14,000 org/100 ml

1963

122	15.36	483	1,730,000	2,200
322	24.24	875	1,870,000	3,300
670	60.40	1,242	2,840,000	10,500
U.S. Water	100	2,600	6,440,000	16,000
Entire Range	100	2,600	6,440,000	16,000
Weighted Average - U.S. Water		12.9 µg/l	31 mg/l	3,500 org/100ml
Weighted Average - Entire Range		12.9 µg/l	31 mg/l	3,500 org/100ml

* Location of sampling station in feet from west shore

TABLE 35-V. STREAM LOADING FOR DETROIT RIVER

DT 9.6W

1963

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
100	5.32	63	740,000	840
300	14.18	168	1,500,000	3,700
500	17.72	105	1,278,000	5,100
900	62.78	1,064	3,082,000	11,360
U.S. Water	100	1,400	6,600,000	21,000
Entire Range	100	1,400	6,600,000	21,000
Weighted Average - U.S. Water		6.6 µg/l	30 mg/l	4,300 org/100ml
Weighted Average - Entire Range		6.6 µg/l	30 mg/l	4,300 org/100ml

* Location of sampling station in feet from west shore

TABLE 36-V. STREAM LOADING FOR DETROIT RIVER

DT 9.3E

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
100	.01	1	0	17
200	.01	1	0	13
500	.01	2	30,000	200
800	.32	10	28,000	600
1,200	.85	15	84,000	1,550
1,500	1.14	10	96,000	2,300
2,000	1.90	130	164,000	3,650
2,500	3.79	45	330,000	6,970
3,000	3.87	21	318,000	5,160
3,300	5.52	25	270,000	5,440
3,600	5.39	40	540,000	7,100
U.S. Water	22.81	300	1,860,000	33,000
Entire Range	100	800	8,180,000	150,000
Weighted Average - U.S. Water		1.7 µg/l	11 mg/l	8,000 org/100ml
Weighted Average - Entire Range		1.3 µg/l	11 mg/l	8,200 org/100ml

1963

100	.01	1	-	-
500	.18	12	40,000	120
1,200	1.58	43	184,000	540
2,000	3.36	86	466,000	1,270
3,000	17.68	258	1,210,000	3,070
U.S. Water	22.81	400	1,900,000	5,000
Entire Range	100	1,270	9,000,000	34,000
Weighted Average - U.S. Water		2.5 µg/l	11 mg/l	1,400 org/100ml
Weighted Average - Entire Range		2.6 µg/l	13 mg/l	2,100 org/100ml

* Location of sampling station in feet from west shore

TABLE 37-V. STREAM LOADING FOR DETROIT RIVER

DT 8.7W

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
80	5.35	225	744,000	1,400
280	12.71	220	1,208,000	5,700
480	15.69	480	1,086,000	12,300
680	21.91	250	1,048,000	19,200
980	32.89	500	1,040,000	24,100
1,240	11.45	125	414,000	5,300
U.S. Water	100	1,800	5,540,000	68,000
Entire Range	100	1,800	5,540,000	68,000
Weighted Average - U.S. Water		7.9 µg/l	24 mg/l	13,000 org/100ml
Weighted Average - Entire Range		7.9 µg/l	24 mg/l	13,000 org/100ml

1963

80	4.49	382	716,000	750
280	11.75	477	1,320,000	500
480	15.93	415	1,336,000	1,300
680	23.04	500	2,280,000	7,300
980	28.54	573	1,456,000	8,300
1,240	16.25	253	752,000	850
U.S. Water	100	2,600	7,860,000	19,000
Entire Range	100	2,600	7,860,000	19,000
Weighted Average - U.S. Water		12.7 µg/l	38 mg/l	4,100 org/100ml
Weighted Average - Entire Range		12.7 µg/l	38 mg/l	4,100 org/100ml

* Location of sampling station in feet from west shore

TABLE 38-V. STREAM LOADING FOR DETROIT RIVER

DT 3.9

1962

Feet*	% Flow	Phenols lb./day	Chloride lb./day	Coliform BPE
1,500	2.40	155	1,710,000	5,260
2,500	3.38	300	2,290,000	9,200
3,500	3.13	210	1,444,000	10,700
4,500	3.76	240	1,180,000	30,300
5,500	4.33	155	920,000	32,700
6,500	3.38	180	522,000	18,400
7,500	4.70	208	660,000	28,600
8,500	5.71	207	700,000	16,200
9,500	5.08	130	604,000	1,550
10,500	3.53	60	390,000	3,200
11,500	4.62	155	480,000	3,890
U.S. Water	44.02	2,000	10,900,000	160,000
Entire River	100	3,800	18,560,000	250,000
Weighted Average - U.S. Water		4.5 µg/l	24 mg/l	14,000 org/100ml
Weighted Average - Entire River		3.7 µg/l	18 mg/l	11,000 org/100ml

1963

2,500	5.78	526	2,468,000	8,250
3,500	3.13	210	1,148,000	3,110
4,500	3.76	202	850,000	3,450
5,500	4.33	200	796,000	3,480
6,500	3.38	135	710,000	2,370
7,500	7.55	134	730,000	1,720
9,500	8.70	503	1,266,000	2,200
11,500	7.39	320	972,000	1,420
U.S. Water	44.02	2,230	8,940,000	26,000
Entire River	100	3,550	16,600,000	50,000
Weighted Average - U.S. Water		5.5 µg/l	22 mg/l	2,700 org/100ml
Weighted Average - Entire River		3.8 µg/l	18 mg/l	2,320 org/100ml

* Location of sampling station in feet from west shore

TABLE 39-V. SUMMARY OF CHANGE IN WASTE LOADINGS BETWEEN UPPER AND LOWER DETROIT RIVER U.S. WATERS ONLY

	Upper Detroit River	Upper * Detroit River Adjusted	Lower Detroit River	Difference**
Total Coliform Organisms BPE/day	700	440	77,000	76,560
Chlorides lbs/day	5,560,000	3,520,000	10,080,000	6,560,000
Phenols lbs/day	2,500	1,600	2,100	500
Suspended Solids lbs/day	3,900,000	2,500,000	8,600,000	6,100,000
Settleable Solids lbs/day	3,200,000	2,100,000	7,200,000	5,100,000
Iron lbs/day	106,000	67,000	260,000	193,000
Total Phosphate lbs/day	114,000	72,000	217,600	145,600
Ammonia Nitrogen lbs/day	73,700	46,700	133,200	86,500
Nitrate Nitrogen lbs/day	112,000	70,900	109,000	38,100
Organic Nitrogen lbs/day	91,200	57,800	72,600	14,800

* Upper Detroit River loadings have been adjusted for equal discharge to Lower Detroit River at mouth.

** Difference is from Lower Detroit River and adjusted Upper Detroit River.

TABLE 40-V. COMPARISON OF INCREASE IN STREAM LOADING WITH KNOWN WASTE SOURCE LOADINGS

	Increase in Detroit River*	Sum of Loadings from Waste Surveys*
Chlorides - lbs/day	6,560,000	3,320,000
Phenols - lbs/day	500	2,680
Suspended Solids - lbs/day	6,100,000	1,490,000
Settleable Solids - lbs/day	5,100,000	966,000
Iron - lbs/day	193,000	107,000
Total Phosphates - lbs/day	145,600	162,000
Ammonia Nitrogen - lbs/day	86,500	42,800
Nitrate Nitrogen - lbs/day	38,100	697
Total Nitrogen - lbs/day	143,200	60,700

*U.S. Waters

TABLE 41-V. BACTERIAL LOADINGS AND WEIGHTED AVERAGE CONCENTRATIONS

DURING WET AND DRY CONDITIONS - DETROIT RIVER

UNITED STATES WATERS

	DRY		WET	
Range	$\bar{X}_w$**	B.P.E.	$\bar{X}_w$**	B.P.E.
Dt 30.8W	55	876	31	480
Dt 25.7	482	1,690	40	6,710
Dt 20.6	537	6,400	27,500	311,000
Dt 19.0*	2,800	34,000	702,000	7,670,000
Dt 17.4W	3,140	46,200	12,700	210,000
Dt 14.6W	3,360	56,100	16,800	275,000
Dt 12.0W	6,990	34,400	8,530	41,400
Dt 9.6W*	2,430	11,700	10,100	50,400
Dt 9.3E	3,690	11,100	3,300	17,200
Dt 8.7W	5,340	26,500	18,400	90,800
Dt 3.9	5,150	57,100	14,400	141,000

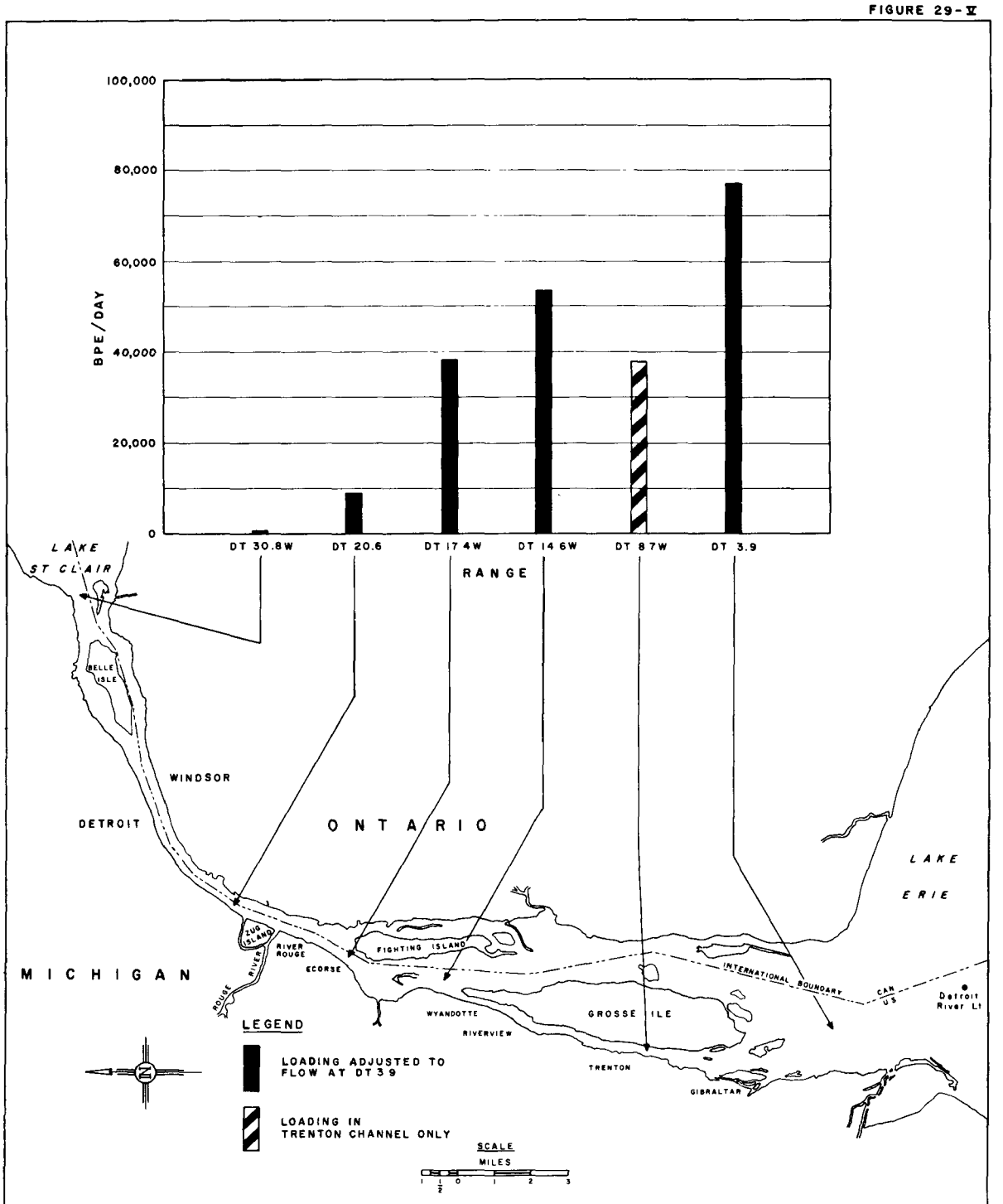
* Results from 1963 data
** Mean adjusted to flow at cross-section

Figures 29-V through 37-V depict stream loadings at several key locations in the Detroit River for total coliform organisms, phenols, chlorides, phosphates, total nitrogen, ammonia, suspended solids, iron, and nitrates respectively.

Figures 38-V through 46-V depict average concentrations for these same constituents weighted to flow for the entire range.

(Figures 29-V through 46-V, inclusive, follow)

FIGURE 29-V



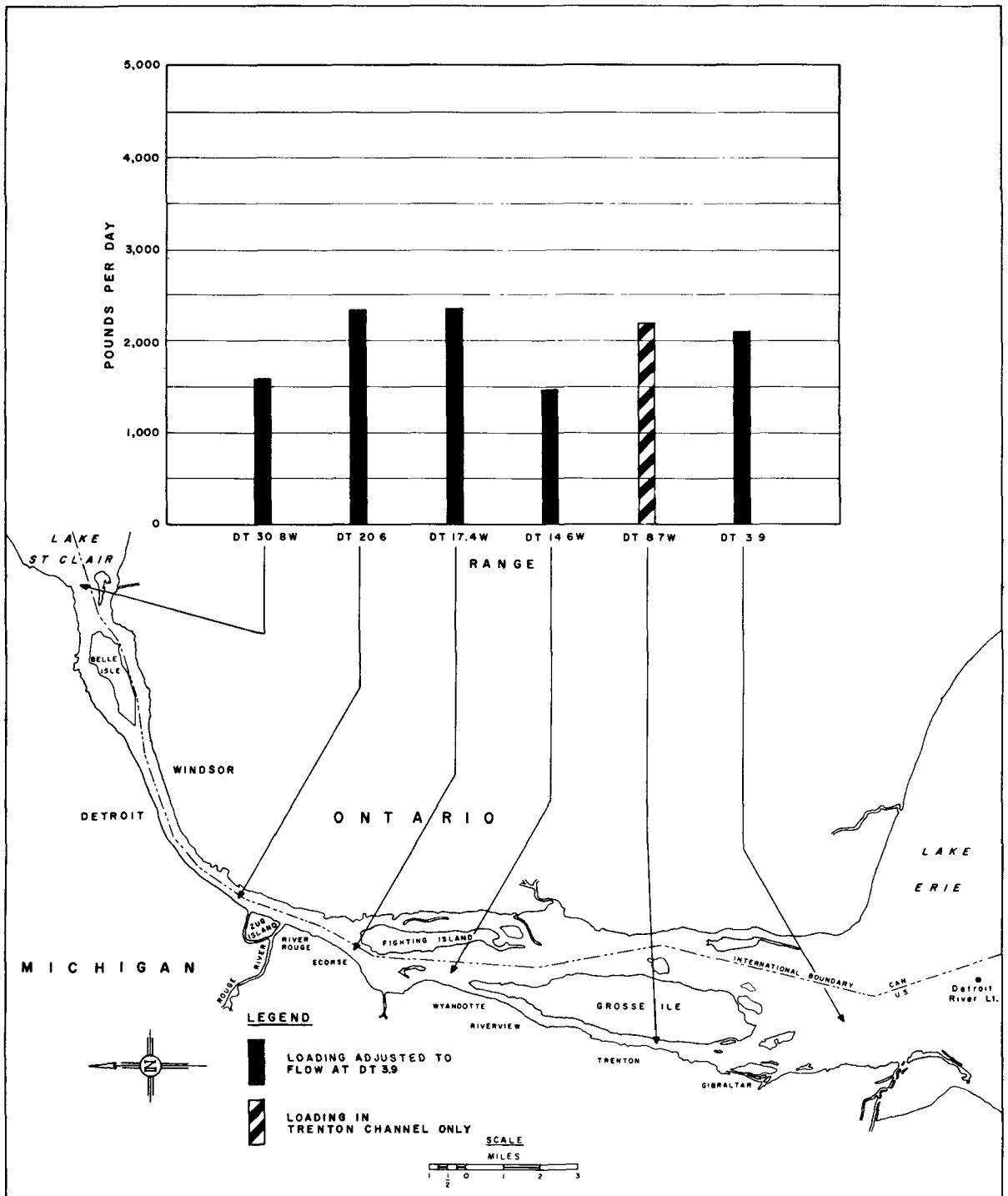
DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
COLIFORM ORGANISMS

U.S. WATERS
DETROIT RIVER

U.S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 30-V

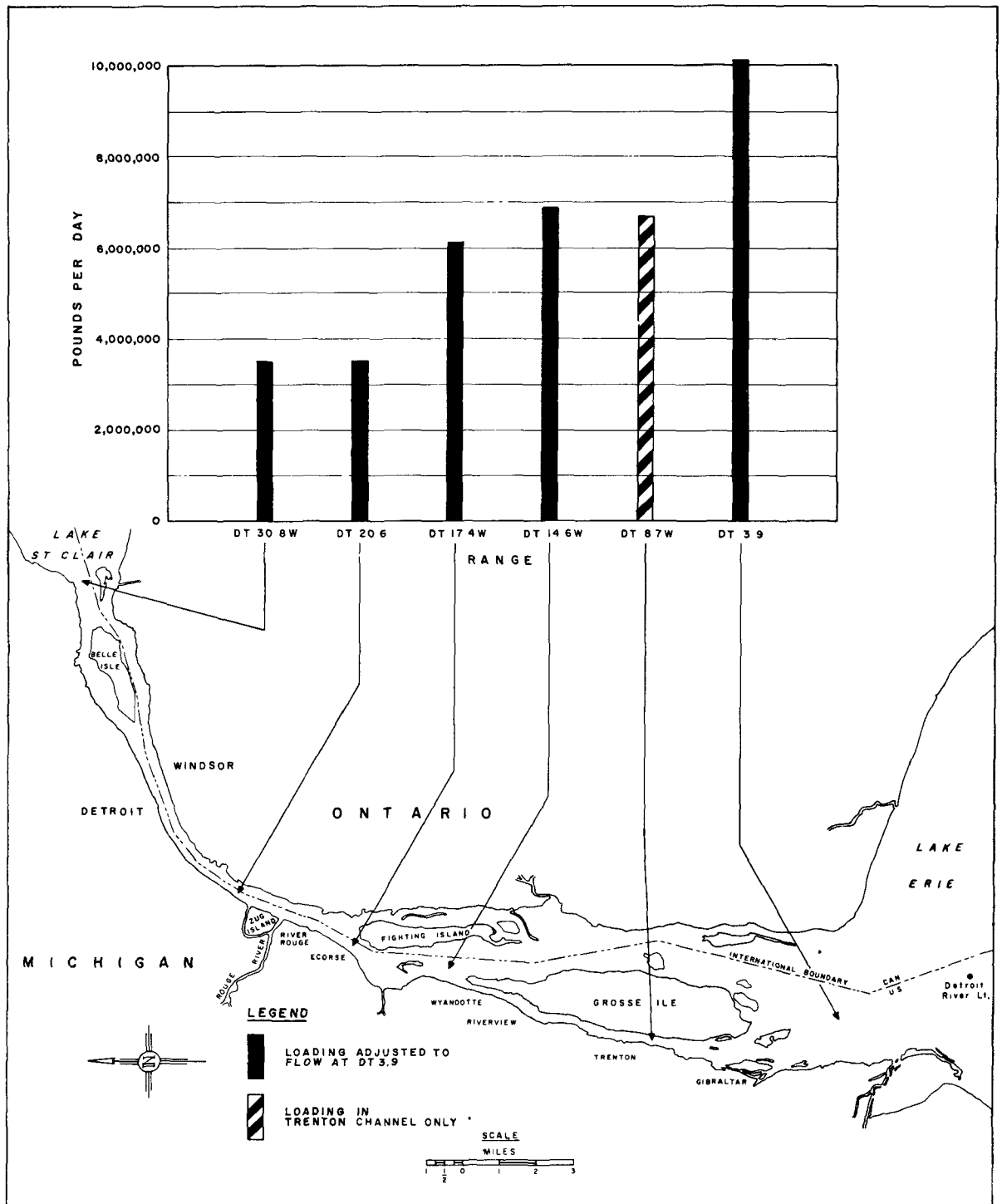


DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
PHENOLS
U.S. WATERS
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 31-V



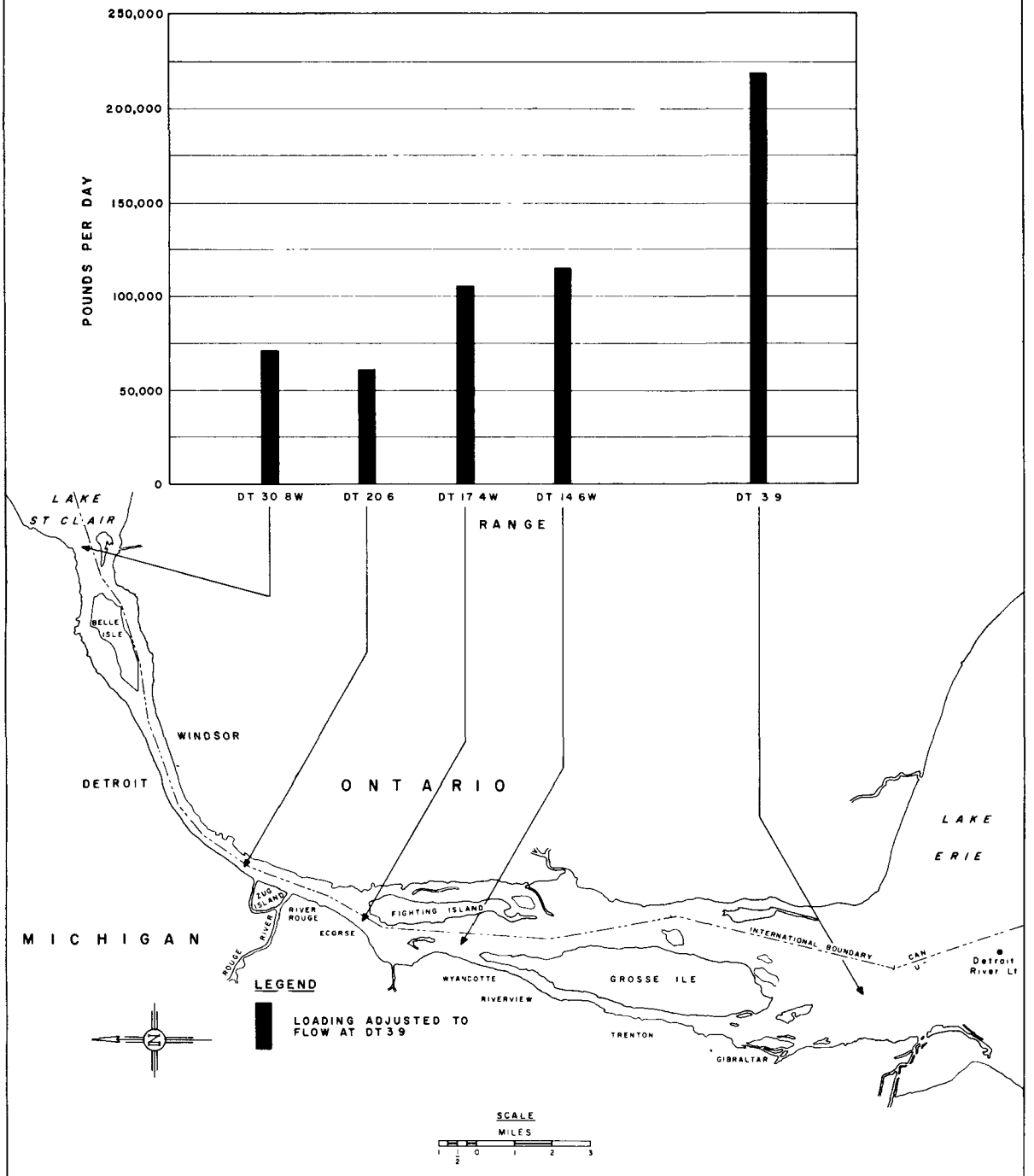
DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
CHLORIDES

U.S. WATERS
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 32-V



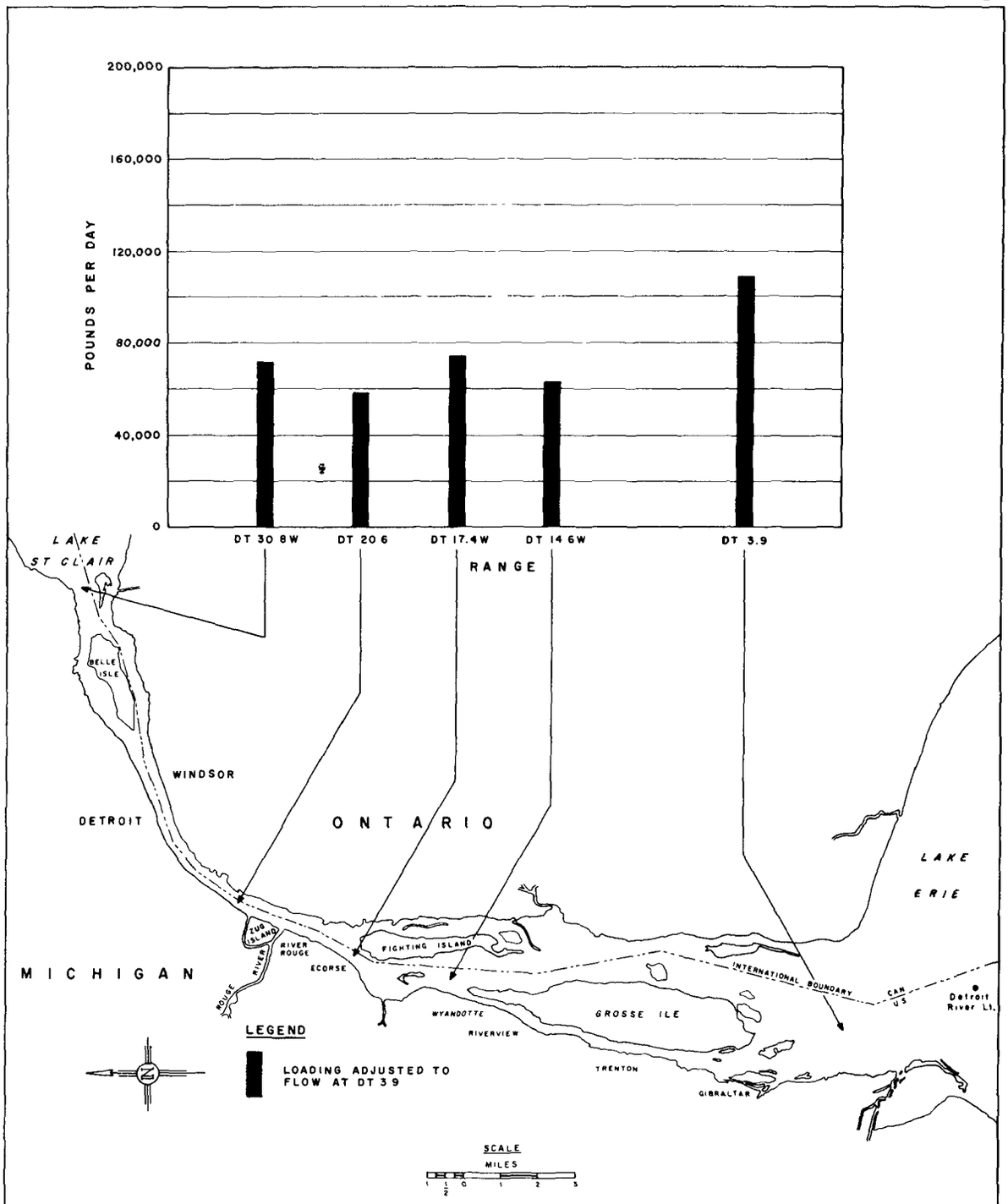
DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
PHOSPHATES (PO_4)

U.S. WATERS
DETROIT RIVER

U.S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 33-V

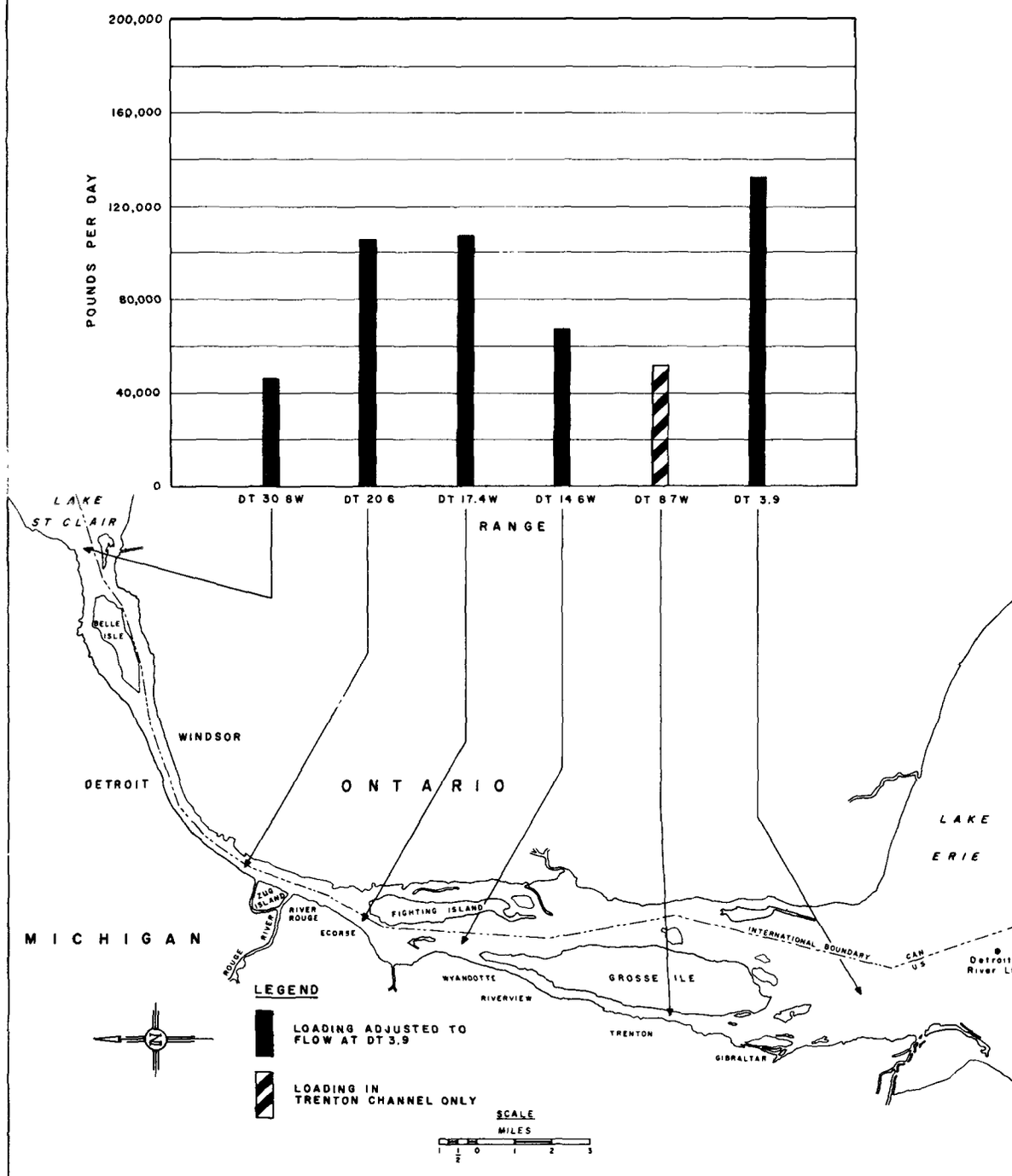


DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
NITRATES (N)
U.S. WATERS
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 34-V

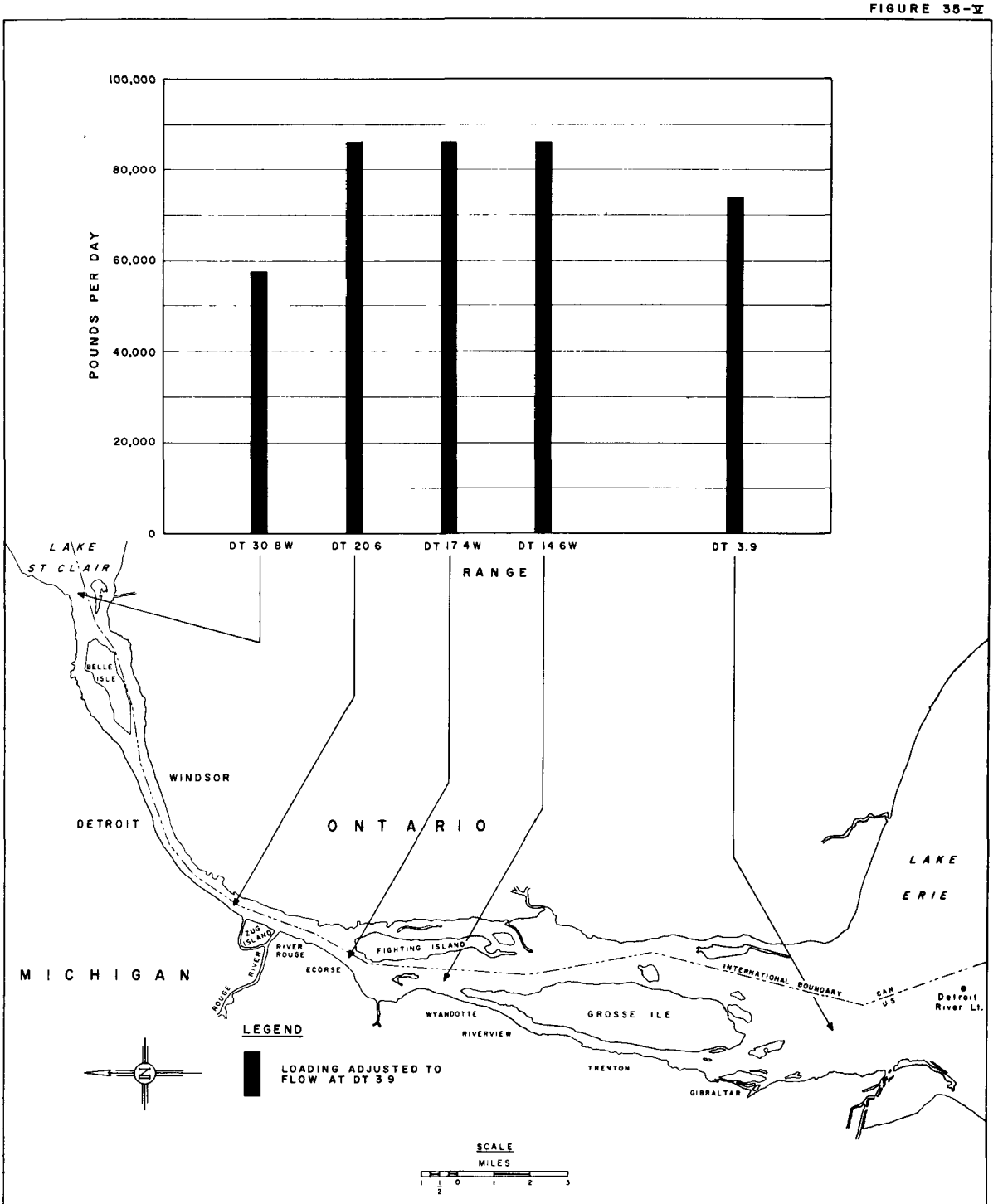


DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
AMMONIA (N)
U.S. WATERS
DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 35-V

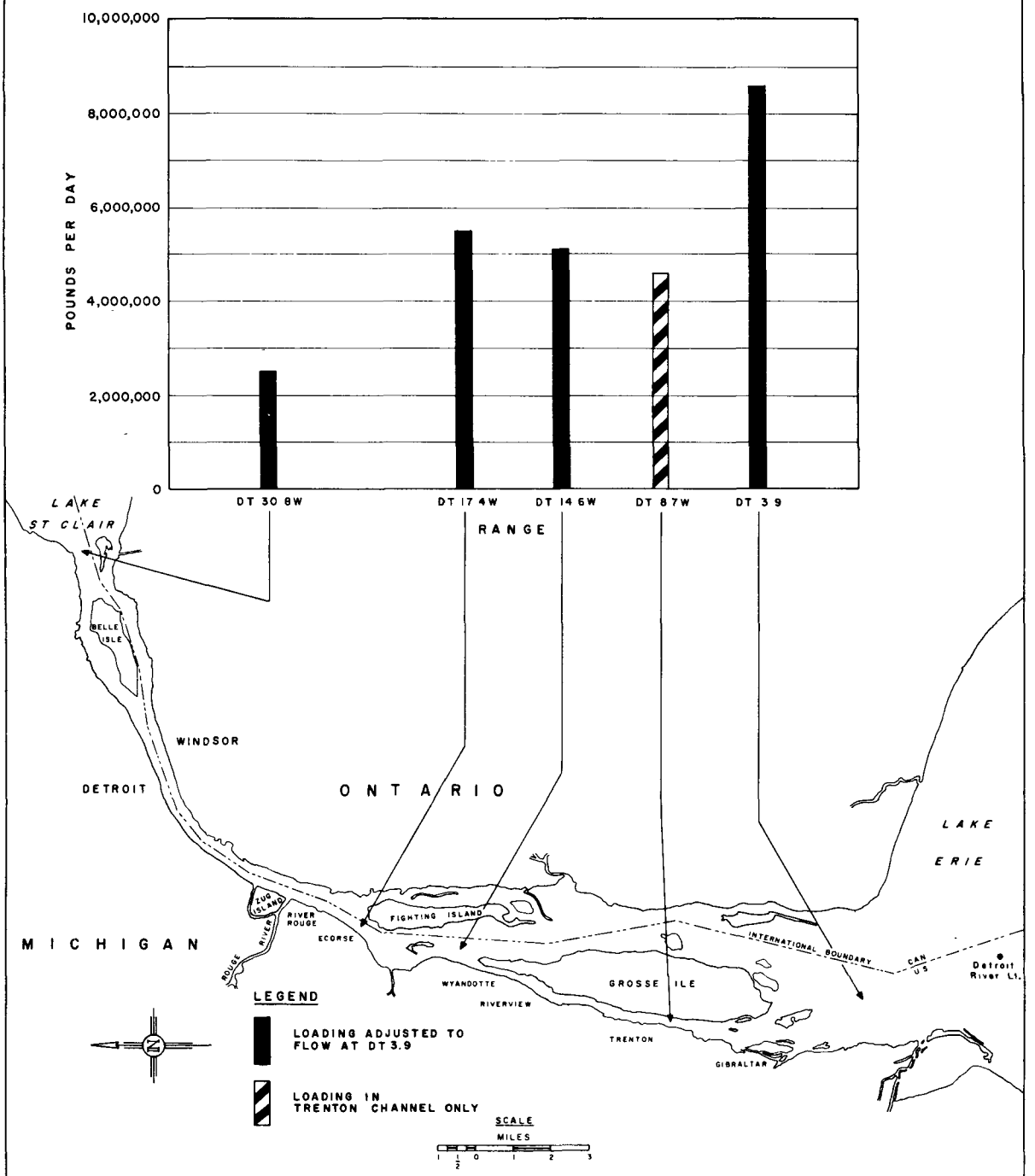


DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
ORGANIC NITROGEN
U.S. WATERS
DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 36-V

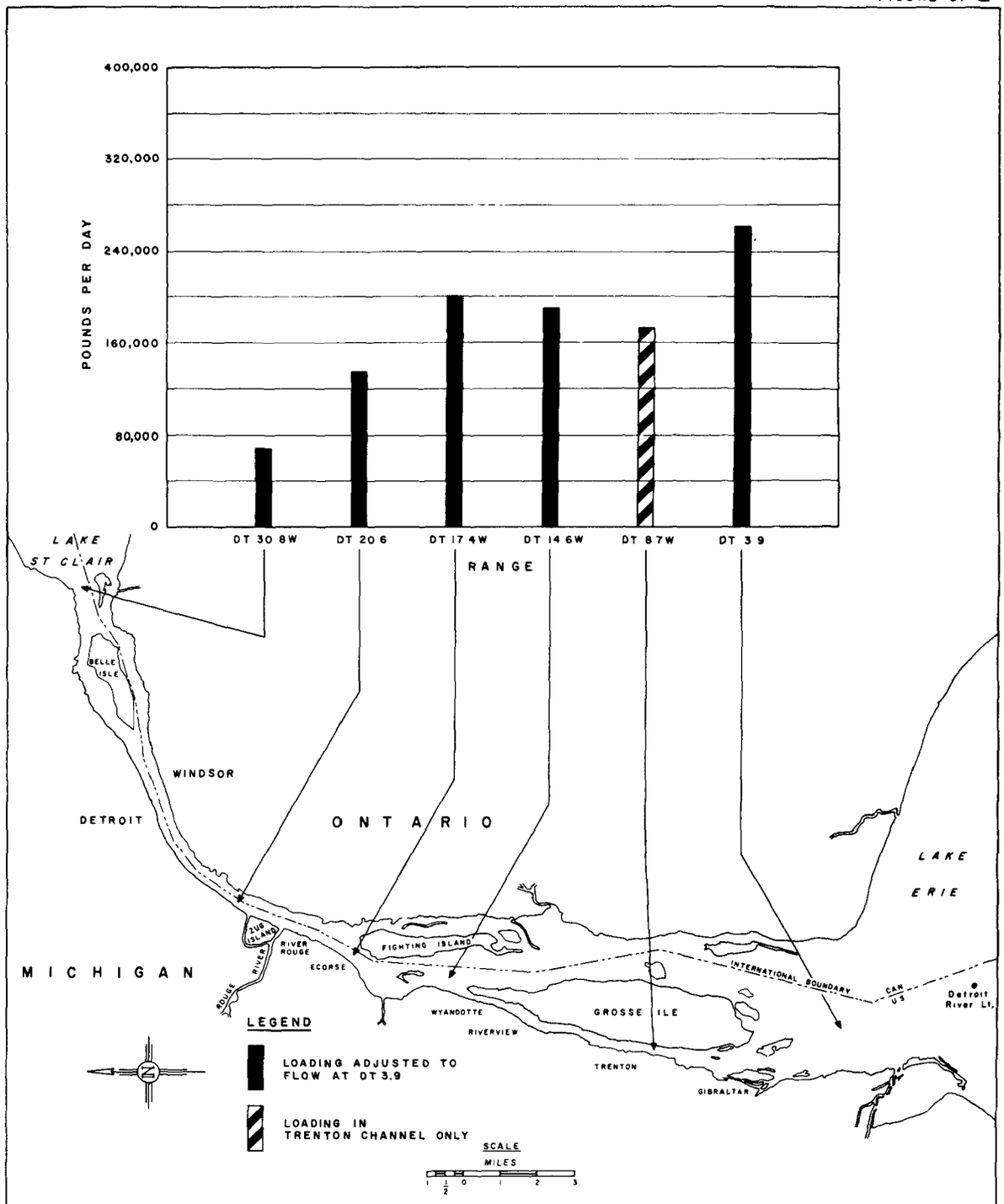


DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS
SUSPENDED SOLIDS
U.S. WATERS
DETROIT RIVER

U S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 37-V



DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE DAILY STREAM LOADINGS

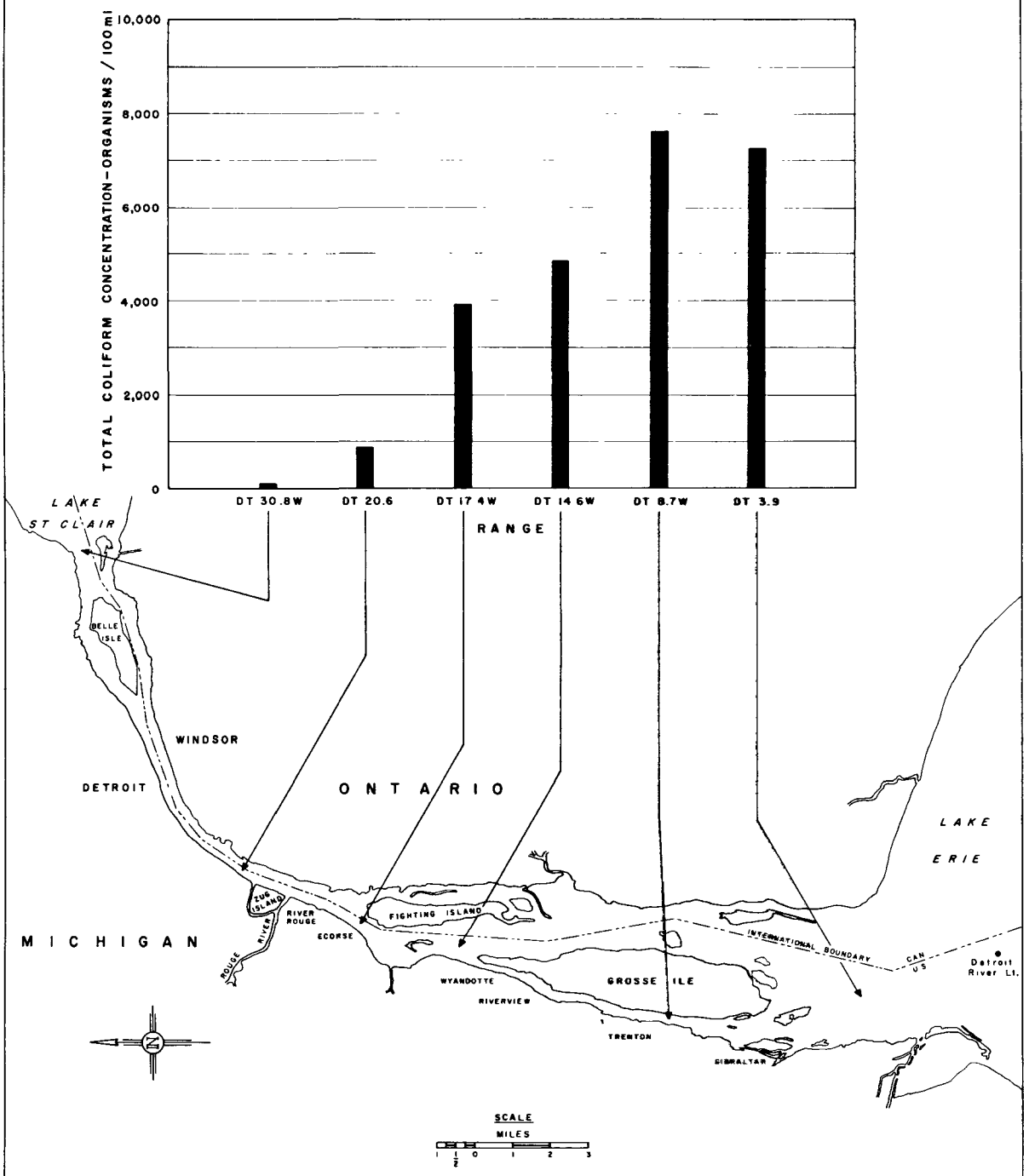
IRON

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 38-V



DETROIT RIVER-LAKE ERIE PROJECT

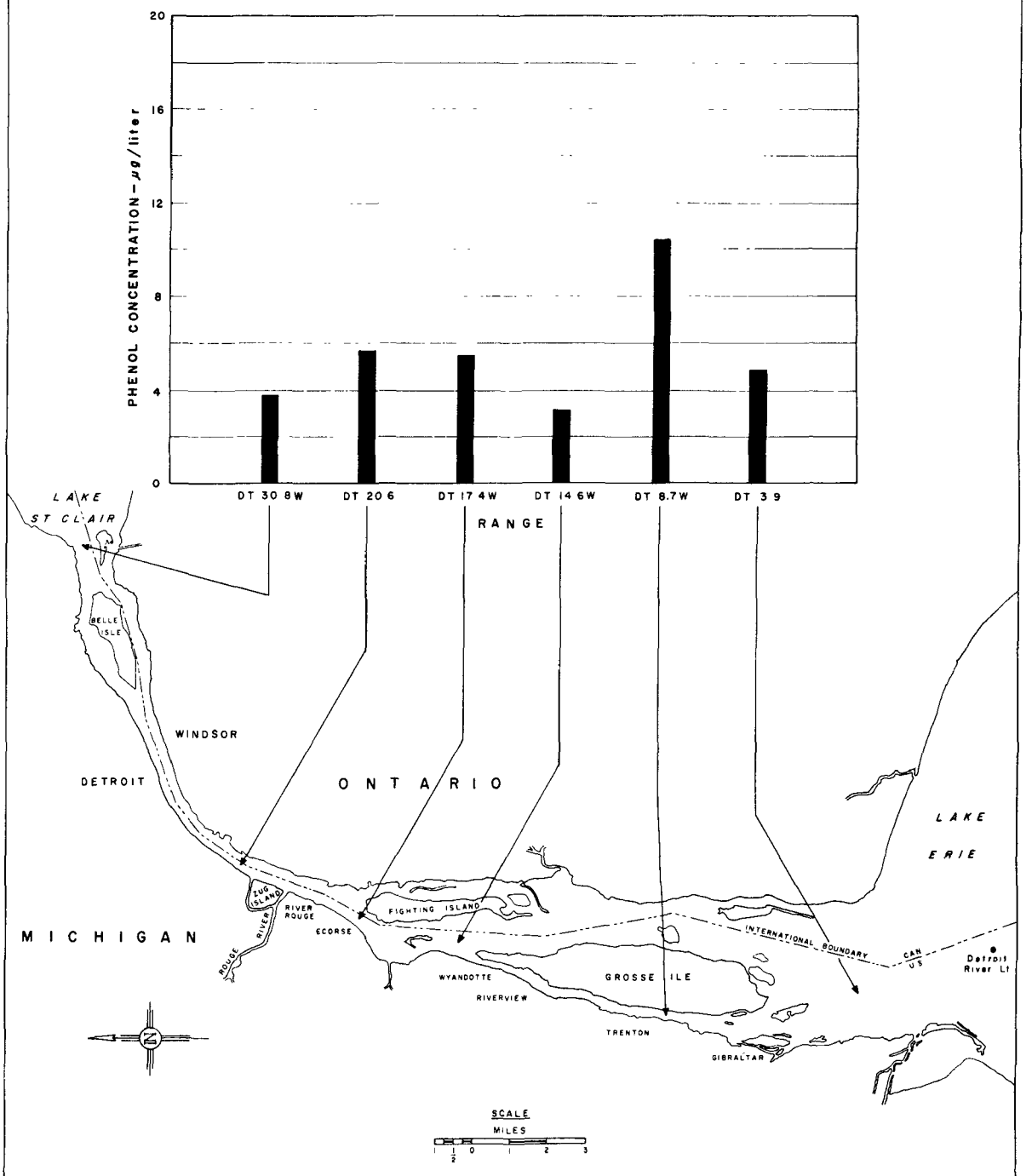
GEOMETRIC MEAN COLIFORM CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 39-V



DETROIT RIVER-LAKE ERIE PROJECT

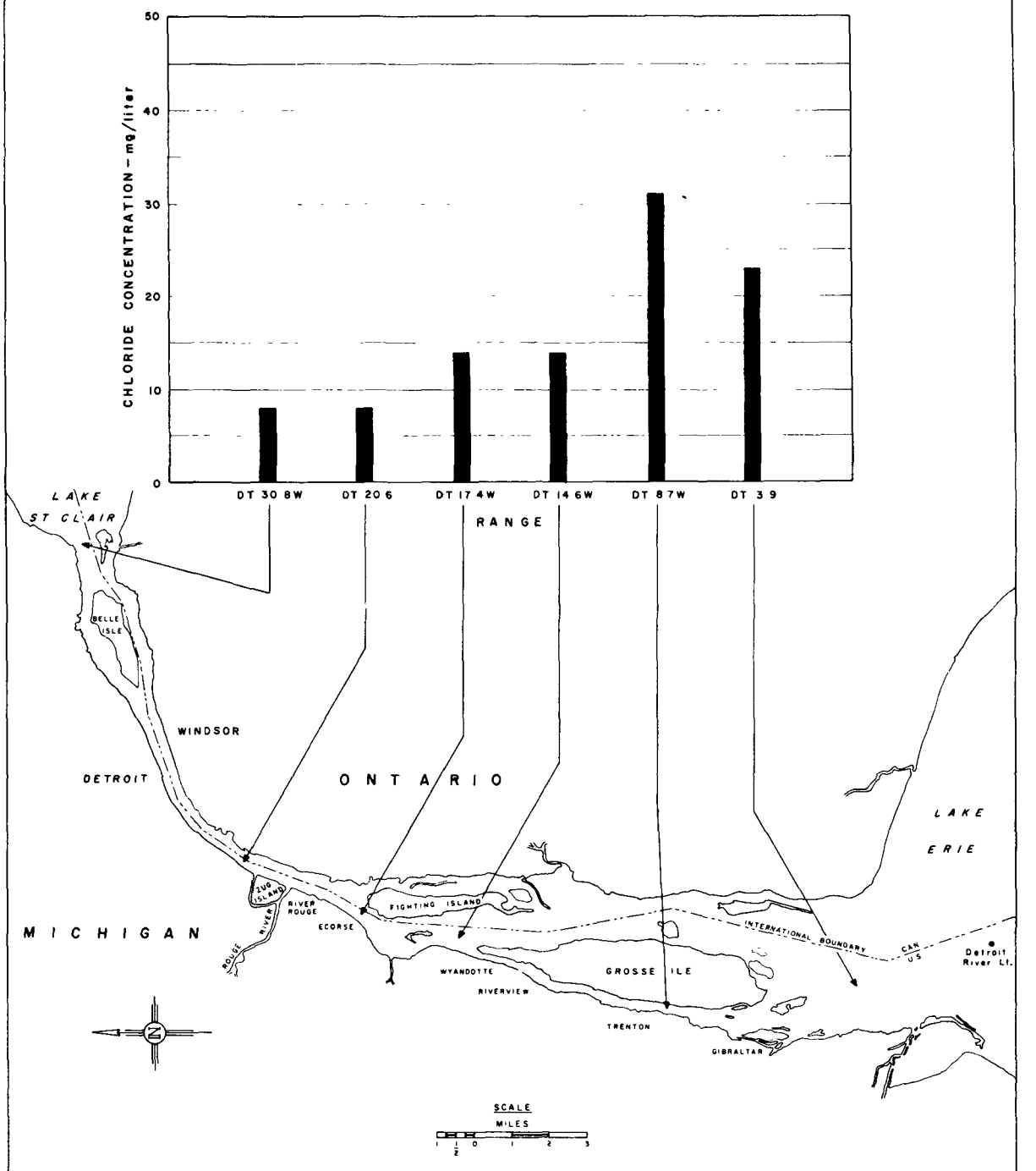
AVERAGE PHENOL CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 40-V



DETROIT RIVER-LAKE ERIE PROJECT

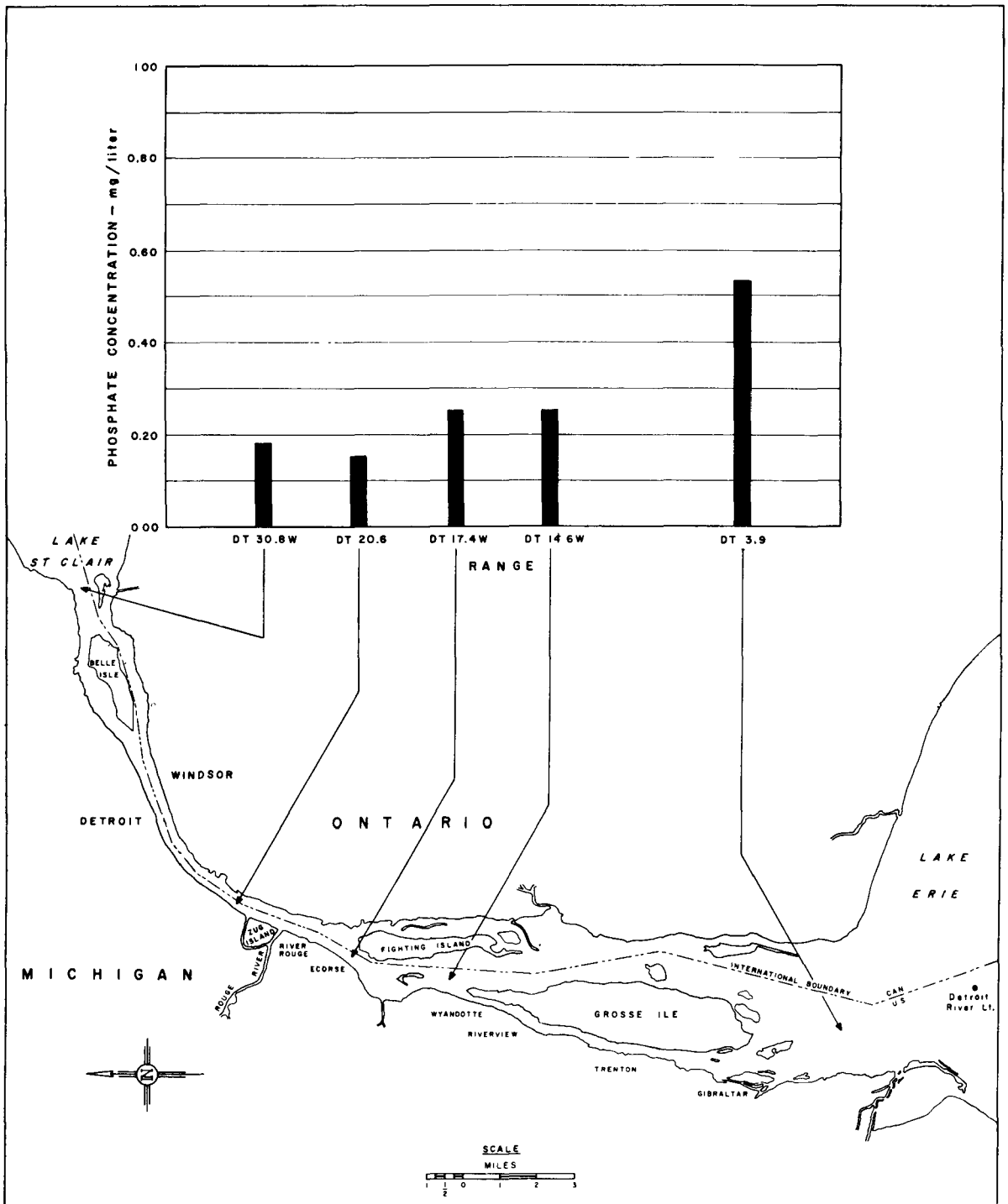
AVERAGE CHLORIDE CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 41-V



DETROIT RIVER-LAKE ERIE PROJECT

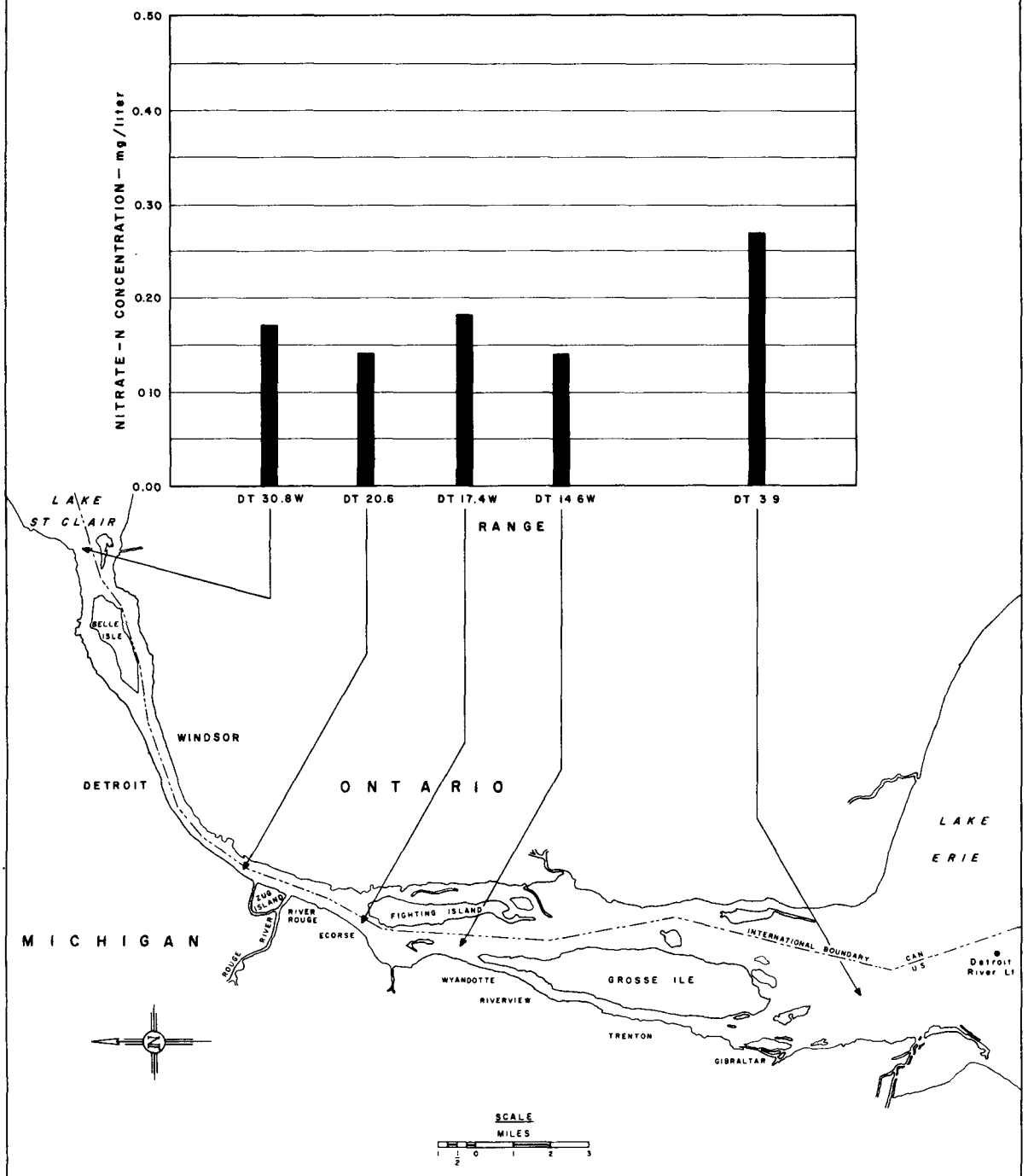
AVERAGE PHOSPHATE CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 42-V



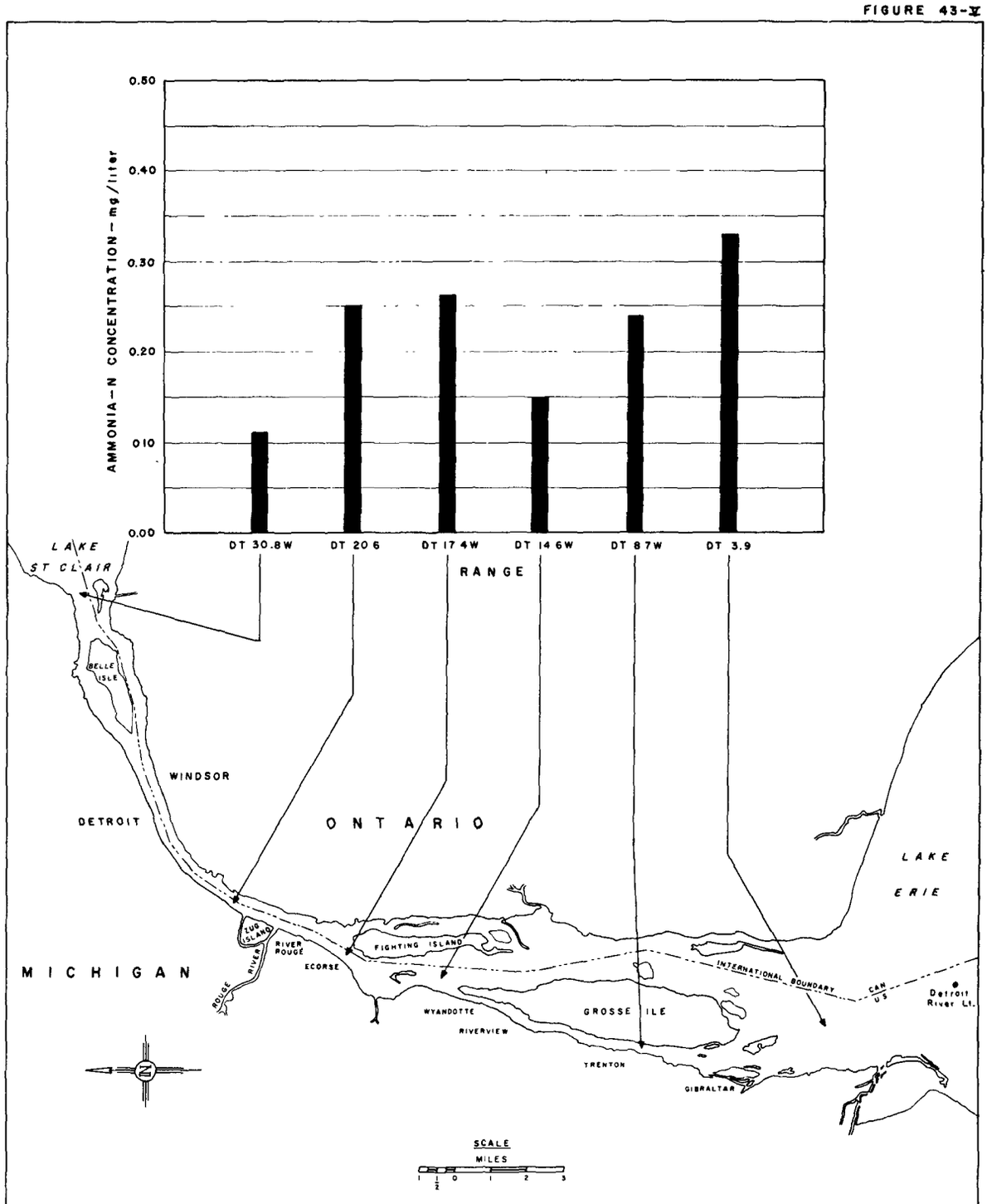
DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE NITRATE-N CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS
DETROIT RIVER

U. S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 43-V



DETROIT RIVER-LAKE ERIE PROJECT

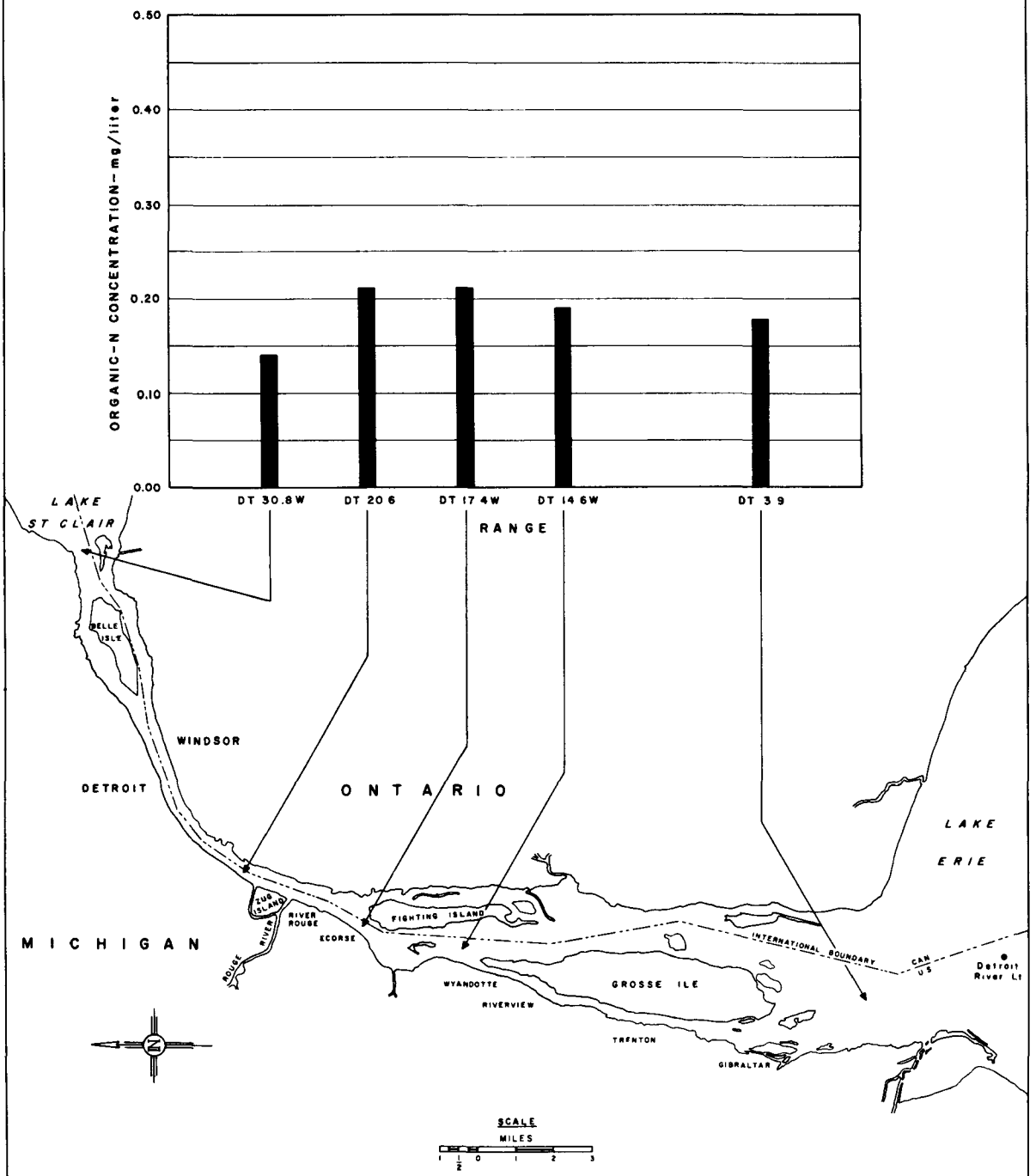
AVERAGE AMMONIA-N CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 44-V



DETROIT RIVER-LAKE ERIE PROJECT

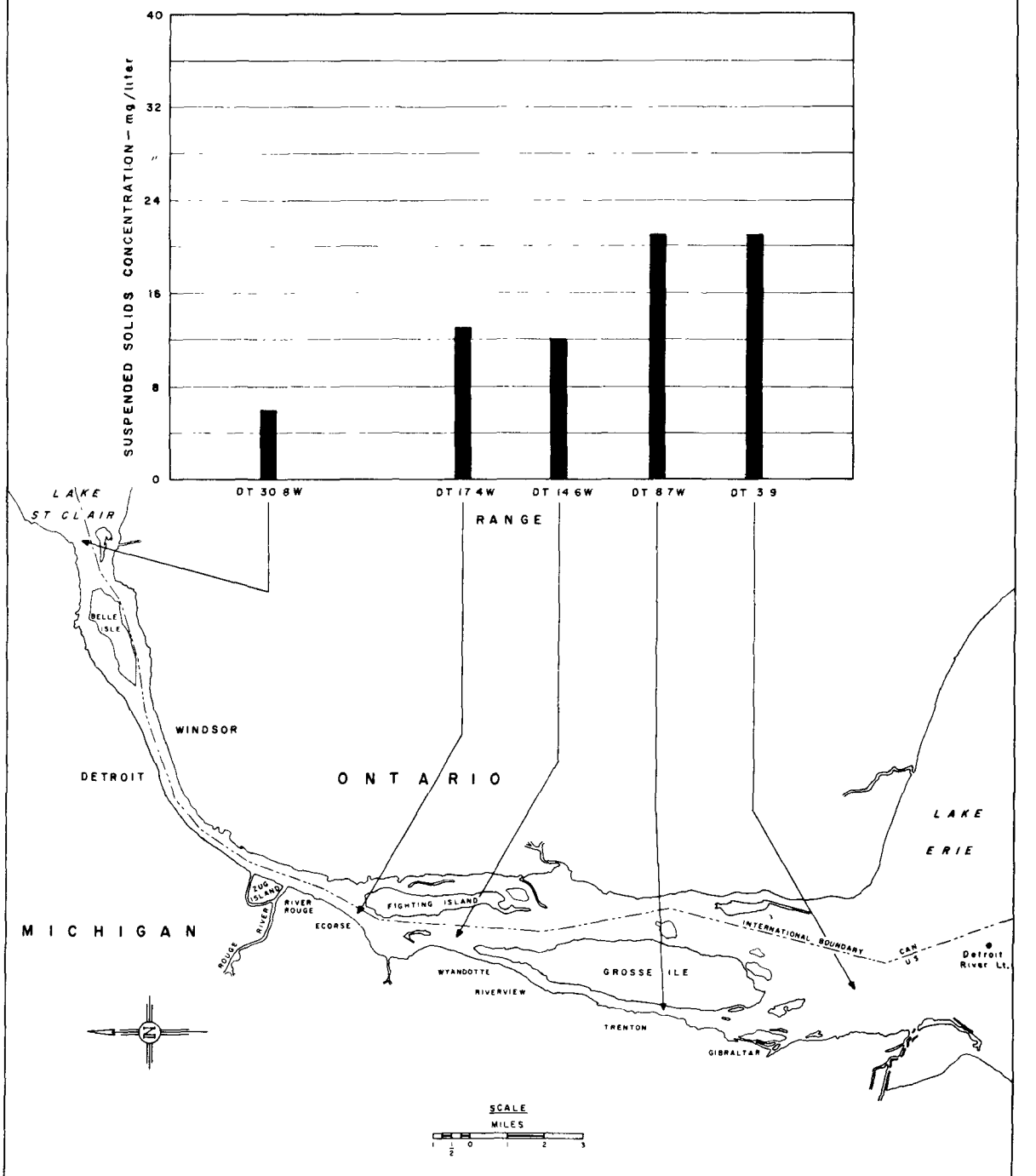
AVERAGE ORGANIC-N CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 45-V



DETROIT RIVER-LAKE ERIE PROJECT

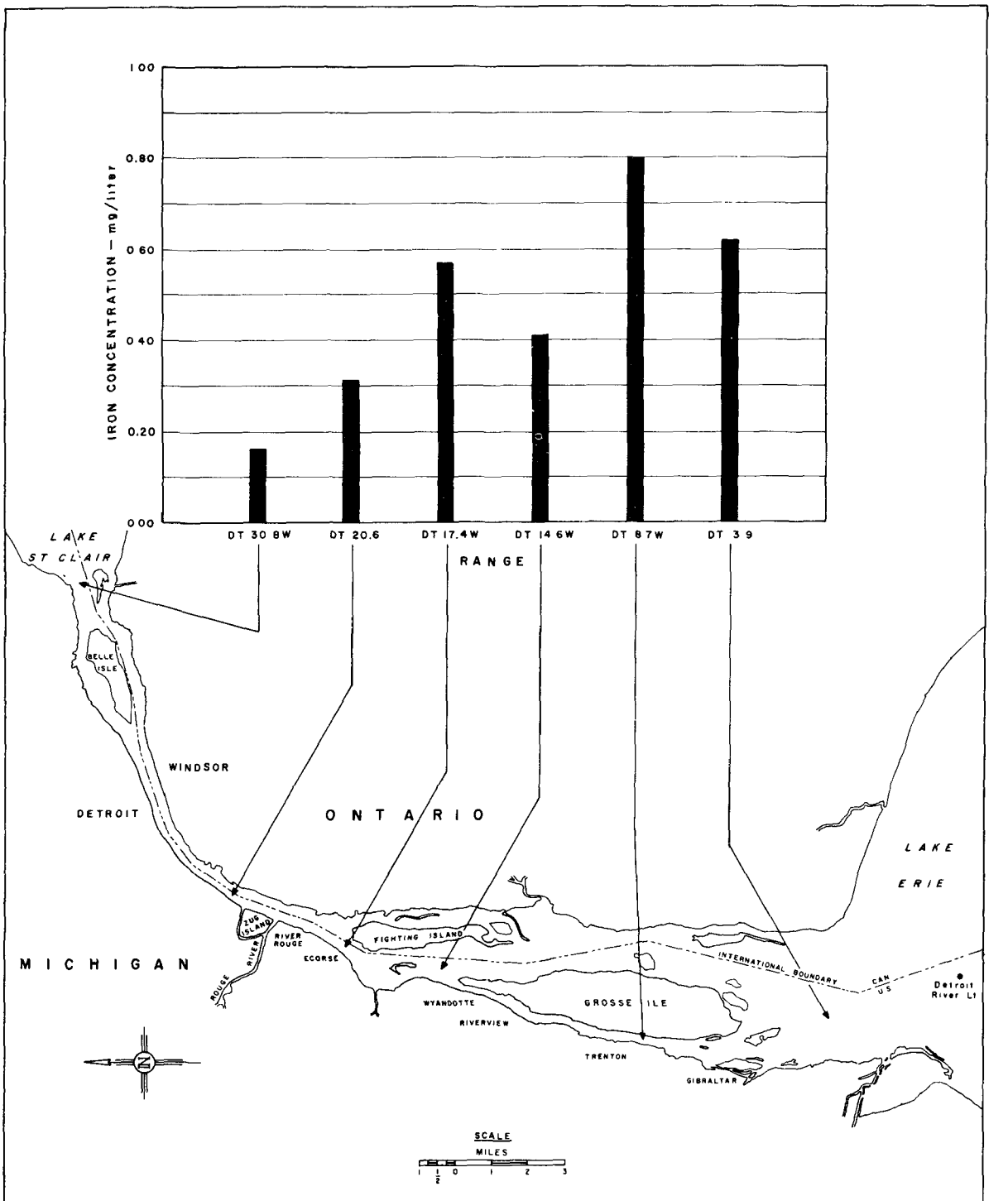
AVERAGE SUSPENDED SOLIDS CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 46-V



DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE IRON CONCENTRATIONS ADJUSTED TO FLOW AT CROSS-SECTION

U.S. WATERS

DETROIT RIVER

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

As shown by the graphs, there was a noticeable increase in weighted average concentration in the Detroit River coliform densities, from 46 to 7,250 organisms per 100 ml. Chlorides increased from 8 to 23 mg/l and phenols showed great variability from 3.8 micrograms/l to 10.5 micrograms/l just below the Rouge to 4.9 micrograms/l at the mouth. The increase in essential plant nutrients was noticeable as the loadings of total nitrogen or phosphate double between the headwaters and the mouth. Iron showed a significant increase in both weighted average concentrations and loadings.

A reasonable portion of the increase in stream loadings is accounted for in the loadings computed from domestic and industrial waste surveys.

Summaries of Detroit River tributary stream loadings and weighted average concentrations for nitrogen compounds, phosphates, total coliform organisms, phenols, and chlorides are shown in Table 42-V. The tributaries covered in this summary are the Rouge River, Ecorse River, and Monguagon Creek.

(Table 42-V follows.)

TABLE 42-V. SUMMARY OF DETROIT RIVER TRIBUTARY STREAM LOADINGS AND WEIGHTED AVERAGE CONCENTRATIONS

Tributary	Chlorides	Phenols[b]	Total Coliforms[a]	Phosphates	Nitrates	Ammonia Nitrogen	Organic Nitrogen	Total Nitrogen
Rouge River								
Weighted Avg. - mg/l	59	15	47,000	0.228	0.50	0.75	0.18	1.43
Loading - lbs/day	1,160,000	250	20,000	4,240	9,320	14,320	3,380	27,020
Ecorse River								
Weighted Avg. - mg/l	142	7.6	154,000	0.11	-	1.21	0.34	-
Loading - lbs/day	42,000	2.5	193	0.6	-	9.5	2.1	-
Monguagon Creek								
Weighted Avg. - mg/l	360	1,494	700	0.128	-	3.03	0.62	-
Loading - lbs/day	24,600	102	1.1	8.3	-	195	39	-

a - Weighted average in organisms per 100 ml and loading in BPE/day.

b - Phenol concentrations are in $\mu g/l$

Study of the tributaries revealed the Rouge River to be a major contributor of coliform organisms, phenols, and chlorides. Further study of the records revealed a dramatic bacterial improvement in the Rouge in 1963 with a 42 per cent reduction in coliform loadings. Phenol loadings, on the other hand, increased 54 per cent, and chlorides stayed constant. The Ecorse River is a small contributor of highly concentrated bacterial waste, while Monguagon Creek is a major contributor of phenolic wastes with 102 pounds per day. The Rouge River is a significant source of phosphates, ammonia, nitrates, and organic nitrogen.

The variable phenol values found at the head of the Detroit River posed an investigative problem. Records of the Detroit Field Unit of the International Joint Commission were studied, and it was found that the weighted average concentration in the St. Clair River was 9 micrograms/l, and loading was 8,700 pounds per day. Known sources of phenolic waste are located in the upper part of the St. Clair River at Sarnia, Ontario and are believed to be the major source of this waste constituent.

TABLE 47-V. SUMMARY OF RESULTS OF
INTENSIVE ROUGE RIVER SURVEY NUMBER ONE*

January 14-31, 1963

Unit	Station / Constituent	T11	T13	T14	T15	T16	T17	T18	T19	T20	T21	T24	T25
organisms/100 ml	Total Coliform	490	267	216	1,900	2,300	3,200	3,900	8,900	110,000	90,000	1,000,000	3,430,000
organisms/100 ml	Fecal Coliform	108	53	56	670	1,100	2,100	1,400	3,600	67,000	-	400,000	1,400,000
organisms/100 ml	Fecal Strep.	34	21	29	133	173	200	263	340	10,600	48,000	42,000	136,000
µg/l	Phenols	22	8	2	79	73	98	87	50	28	-	28	41
mg/l	Iron	1.39	.23	.31	.43	.59	.41	.35	.35	.48	-	.75	.52
mg/l	Suspended Solids	4	3	3	20	25	24	29	31	14	0	18	55
mg/l	ABS	.50	.12	.12	.21	.21	.22	.22	.31	.66	-	4.54	6.14
-	pH	7.7	7.8	7.8	7.1	7.1	7.1	7.0	6.9	7.5	-	7.6	7.4
mg/l	Chlorides	34	13	13	40	40	41	41	42	86	206	185	152
°C	Temperature	0.5	0.3	0.2	5.3	5.2	5.4	5.7	5.9	6.1	-	0.3	3.7

* Average values found during survey for all constituents except bacteria for which geometric means are shown.

mg/l	Dissolved Oxygen	13.8	13.7	14.1	9.5	9.8	10.3	10.3	9.3	9.0	6.2	-	1.7
µmhos x 4	Conductivity	75	53	48	85	93	97	94	98	151	330	338	303
mg/l	BOD	4.2	2.1	1.9	2.8	3.5	3.0	3.6	5.3	11.1	-	36.4	103.3
mg/l	Copper	.01	.01	.04	.01	<.01	.01	.01	<.01	.01	-	.14	.78
mg/l	Cadmium	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	-	.05	<.01
mg/l	Nickel	.01	.01	.03	.02	.01	.01	.01	.01	.04	-	.02	.29
mg/l	Zinc	.02	.02	.02	.09	.09	.11	.10	.09	.05	-	.05	.09
mg/l	Lead	.02	.01	.03	.01	.01	.01	.01	.01	.02	-	.02	.01
mg/l	Chromium	.01	.01	.01	.02	.02	.03	.02	.03	.02	-	.03	.08

TABLE 48-V. SUMMARY OF RESULTS OF INTENSIVE ROUGE RIVER SURVEY NUMBER TWO[a]

June 16-19, 1963

Unit	Constituent \ Station	T11	T13	T15	T16
Organisms/100 ml	Total Coliform	40,000	590	20,000	6,800
Organisms/100 ml	Fecal Coliform	13,000	230	5,500	2,500
Organisms/100 ml	Fecal Strep.	900	46	450	170
mg/l	BOD	5.1	2.5	3.3	13.2
mg/l	COD	28	7	18	15
µg/l	Phenols	3.7	8.7	2.7	2.5
-	pH	7.2	8.0	7.2	7.2
°C	Temperature	20.1	17.8	20.5	22.0
mg/l	Chloride	65	22	42	33
mg/l	Ammonia	1.07	.42	.53	.63
mg/l	Org N	.26	.41	.29	.36
mg/l	Suspended Solids	13	0	14	16
mg/l	Settleable Solids	12	-	10	12
mg/l	Iron	2.06	-	2.21	-
mg/l	Cyanides	0	0	0	0
mg/l	ABS	.14	-	.11	-
mg/l	Copper	*	-	*	-
	Nickel	.01	-	.02	-
	Zinc	.01	-	*	-
	Lead	.02	-	*	-
	Chromium	.01	-	*	-
	Cadmium	*	-	*	-

* Not detected at the sensitivity of the test, .01 mg/l

\- No determination made

a Average values found during survey for all constituents except bacteria for which geometric means are shown.

TABLE 49-V. SUMMARY OF RESULTS OF
INTENSIVE ROUGE RIVER SURVEY NUMBER THREE

September 24 - October 1, 1963

	Geometric Mean Coliform Densities Org/100 ml	Maximum Coliform Densities Org/100 ml	Minimum Coliform Densities Org/100 ml
T10	55,000	440,000	5,000
T11	60,000	450,000	10,000
T12	54,000	450,000	10,000
T13	810	5,000	200
T14	770	4,800	120
T15	21,000	1,300,000	1,200
T16	3,200	17,000	800
T17	1,300	19,000	140
T18	1,100	8,000	20
T19	1,600	51,000	40
T20	90,000	2,100,000	5,000
T21	3,300	61,000	400
T22	4,100	53,000	300
T23	8,500	48,000	1,000
T24	3,900	24,000	1,000
T25	8,000	41,000	2,000
T26	6,100	360,000	2,000
T27	3,300	13,000	900

Phenol concentrations averaged 98 micrograms/l during the first survey at a point 1.8 miles upstream from the mouth and decreased noticeably to a range of 2 - 22 micrograms/l, due primarily to dilution with Detroit River water from the old channel of the Rouge River. During the summer survey (No. 2) phenol values were much lower than the winter, ranging from 2.5 to 8.7 micrograms/l.

Coliform densities at the mouth averaged 490 organisms per 100 ml during survey number 1 but increased to exceptionally high values in the upper reaches of this tributary, with geometric mean values exceeding 35 million per 100 ml. No doubt the occasional bypass of raw sewage by the City of Dearborn described by the Michigan Department of Health accounted for a great deal of these high values. During the second survey conducted during the summer of 1963, the geometric mean coliform density at the mouth was 40,000 per 100 ml and decreased at upstream stations. During survey number 3, coliform densities were typified by sudden increases at two locations in the River.

During this survey a significant increase was found in the Rouge River coliform densities between Greenfield and Schaefer Roads (3,300 to 90,000 per 100 ml). Investigation showed this increase was due to discharge of highly

concentrated bacterial wastes from a rendering plant operated by Darling and Company. The sudden increase (3,200 to 56,000 per 100 ml) in bacterial densities at the mouth of the Rouge was attributable to the sporadic discharge of raw sewage into the River from an overloaded pumping station operated by the City of River Rouge. This information was turned over to appropriate State of Michigan agencies, and in both cases corrective action was taken to eliminate these sources of pollution.

BOD and dissolved oxygen values during survey number 1 indicated that the oxygen-consuming wastes were also attributable to the bypass during construction repairs by the City of Dearborn.

Iron concentrations were high, averaging over 1 mg/l at the mouth during surveys number 1 and number 2. Iron concentrations in the Rouge below points of discharge of industrial waste containing iron averaged over 2 mg/l during survey number 2.

Average values of suspended solids ranged from 4 to 55 mg/l, with higher values upstream and higher values at the mouth during the summer survey. Settleable solids observed during the second survey varied from 60 to 90% of the suspended solids found in the River, with the largest values at the mouth.

Of the toxic metals, nickel, zinc, lead, and chromium were consistently found throughout the length of the Rouge River in concentrations ranging from 0.01 to 0.11 mg/l. ABS was found at the mouth at a concentration of 500 micrograms/l, which was somewhat higher than found in the Detroit River.

The Rouge River is itself polluted to the extent of interference with water uses--including recreation and navigation. It is also a major source of pollution in the lower Detroit River. Most significant of the measures of Detroit River water quality affected by the Rouge are coliform, iron, suspended and settleable solids, and phenol concentrations.

Ecorse River

An intensive survey was conducted on the Ecorse River July 15-18, 1963. The regular sampling station at the mouth indicated high coliform densities, expecially during or following rainfall. Several combined sewer outfalls are located along the North Branch of the Ecorse River, and discharge from these sewers was suspected of contributing to the high bacterial densities found at the mouth. No rain occurred during the survey, and the flow of the Ecorse was negligible (less than 1 cfs).

Results of sampling indicated high coliform, chloride, and suspended solids concentrations at the mouth of the river and both branches. Coliform and fecal streptococci densities in the North Branch were significantly higher than those found in the South Branch. Shown below is a brief summary of a range of average values found during this survey.

Constituent	Mouth ECORSE RIVER	NORTH BRANCH	SOUTH BRANCH
Coliform (org/100 ml)	660,000	18,000-65,000	1,700-31,000
Fecal Strep (org/100 ml)	25,000	1,200-5,400	430 - 1,300
Chlorides (mg/l)	89	120 - 144	106 - 249
Suspended Solids (mg/l)	25	81	173
Settleable Solids (mg/l)	5	46	127
ABS (micrograms/l)	900	-	-

These results indicate pollution from domestic waste sources, probably through overflows from combined sewers, although this could not be verified due to lack of rainfall during the survey period. The densities found probably represent a residual effect from the overflows in this small river plus small undetectable amounts of domestic waste flowing into the River in dry weather.

Monguagon Creek

An intensive survey was conducted on Monguagon Creek July 14-18, 1963. Flow in the Creek is greatly influenced by approximately 11 cfs of industrial waste from the Pennsalt Chemical Company's West Plant. Upstream from this outfall the flow in Monguagon Creek was 0.5 cfs, and downstream it was 12 cfs.

The sampling showed phenol, suspended or settleable solids, nitrogen compounds, and chlorides in the water. Shown below is a summary of average values at the mouth as well as above and below the Pennsalt outfall.

	MOUTH	BELOW PENNSALT	ABOVE PENNSALT
Flow (cfs)	12.0	12.0	0.5
Phenols (micrograms/l)	1,050	1,230	6
Suspended Solids (mg/l)	131	100	46
Settleable Solids (mg/l)	116	69	26
Chlorides (mg/l)	343	339	210
Ammonia (mg/l)	3.03	2.97	0.49
Org-N (mg/l)	0.62	0.38	0.27
Coliform (organisms/100 ml)	490	190	7,700

The decrease in coliform density below the outfall was due to dilution with low coliform water as well as the bactericidal effect of the industrial waste.

Study of waste loadings shown on the following page revealed the Pennsalt Chemical Company as the major contributor of all constituents mentioned (except bacteria). In fact, the increase in stream loadings below this one source varied from 96 to 99%. All values shown are in pounds per day.

Constituent	Mouth	Below Pennsalt	Above Pennsalt
Phenols	65	80	0.02
Suspended Solids	8,470	6,470	270
Chlorides	22,200	21,900	566

This survey reveals that Monguagon Creek is a major source of phenolic contribution to the Detroit River, and generally speaking, water quality conditions at the mouth of this Creek are representative of the effluent of the Pennsalt-West Chemical Plant.

INTERFERENCES WITH WATER USE

Municipal Water Supply

Three municipal water intakes are located in the Detroit River. Two are located in the lower section of the River below the Rouge and are seriously affected by pollution. The other intake is located near the head of the Detroit River and is relatively free from damaging effects of pollution; it is not discussed here.

Southwest Water Intake - City of Detroit

This intake, located near Fighting Island, usually receives high quality water during dry weather conditions, but following overflows from combined sewers upstream the water contains more than 10,000 coliform organisms per 100 ml. Project data indicate geometric mean coliform densities of approximately 800 organisms per 100 ml during dry conditions and 4,000 organisms per 100 ml during wet conditions. Maximum values exceeding 50,000 coliform organisms per 100 ml have been observed in waters adjacent to this intake following heavy rainfall. The geometric mean coliform density of 9 samples collected at the intake during the

summer and early fall of 1964 was 2,240 organisms per 100 ml, with a maximum value of 6,400 organisms per 100 ml and 67% of the samples by the Public Health Service for raw water, but do not compare favorably with water quality in the upper Detroit River.

Analysis of data collected by Wayne County Road Commission personnel during summer months reveals a geometric mean of 1,930 organisms per 100 ml at the intake before its use. Samples collected during fall and winter months indicated water of better bacteriological quality.

Breakdown of these results reveals 64 per cent of the samples collected during summer months with values greater than 1,000 per 100 ml, 39 per cent greater than 2,400 per 100 ml and 17 per cent greater than 5,000 per 100 ml. The maximum observed value during this period was 240,000 per 100 ml. No records of raw water results were available after the plant opened in May, 1964. This plant serves an estimated population of 200,000.

The effects of pollution upon this water use vary greatly because of its location outside the main-stream of the normal flow of grossly polluted water down the Detroit River. This is fortunate, but changes in weather conditions such as wind and rain can pose a

threat to the health and welfare of the users of this supply, particularly when rainfall causes overflows from combined sewers.

City of Wyandotte Water Intake

Raw water records at this intake have been described elsewhere in this report. (See Figure 15-1.) Monthly geometric mean coliform densities during the last four years frequently exceeded 10,000 per 100 ml. During the past two years monthly geometric mean coliform densities were lower but still exceeded 5,000 per 100 ml quite often during the summer months.

The maximum monthly coliform density exceeded 110,000 during 35 of 48 months during the period 1960-63. Both maximum and geometric mean values are minimized due to the maximum dilution at the plant, which allows specific reporting only for coliform densities equal to or less than 110,000 per 100 ml. If the true values were known (rather than merely greater than 110,000 per 100 ml) the monthly geometric means and maximum values would undoubtedly be higher.

Project data showed water quality at this point to have a geometric mean coliform density of approximately 3,000 per 100 ml during dry conditions and 40,000 per

100 ml during wet conditions. The maximum coliform value observed by Project personnel during the survey at this location exceeded 600,000 per 100 ml.

Such bacteriological levels exceed requirements for a safe and dependable raw water supply. Improvement in operation at the City of Detroit Sewage Treatment Plant has lowered the values during record years to those reported above, but more remains to be done. Pollution in the raw water used as a municipal source by 44,000 persons constitutes an interference with this water supply and a threat to the health and welfare of the consumer.

To add to this already difficult problem, ammonia concentrations in the intake interfere with chlorination so essential to the production of drinking water from this supply. Furthermore, phenol concentrations at the intake have produced unpleasant tastes and odors in the drinking water.

These statements should not be interpreted as criticms of the operation of the Wyandotte water treatment facilities. It merely means that because of pollution, the raw water supply available at this location does not meet accepted levels of bacterial quality and is lower in quality than that which would be expected at a

municipal water intake

INDUSTRIAL WATER SUPPLY

Attempts to acquire information from industries in the study area relative to interference to their water supply due to pollution were generally fruitless.

The Detroit Edison Company, an industry using cooling water only, with several plants located from the head of the Detroit River to its lower reaches, answered inquiries to the effect that no serious problem existed. The Company did report minor troubles at an installation in the Rouge River due to organic matter, and at an installation below Conners Creek following overflow from the nearby combined sewer. In both cases, a Company representative stated that the problem was easily solved by increase in chlorine dosage. This industry was asked for information relative to water treatment costs at their plants, but declined to provide it.

RECREATION

Because of pollution, all bathing areas below Belle Isle on the Detroit River have been described as unsafe for swimming and other water-contact

sports by State and local health authorities. This restriction affects the lower 26 (out of 31) miles of the Detroit River.

Numerous complaints concerning the effects of pollution were received from boat owners and operators of marina facilities along the lower Detroit River. These were verified by visits to the installations where observation revealed docking facilities fouled with oil and filled in with sludge. Many owners reported significant expense incurred in periodic cleaning or dredging of their docking area to remove accumulated material.

Ownership and operation of sports watercraft is big business on the Detroit River, with over 125,000 vessels registered during a recent year. Pollution affecting boating is due to the discharge of oil and settleable suspended solids from municipal and industrial outfalls on the Detroit River.

Swimming and water skiing still occur in the restricted area, and such practice represents a threat to the health and welfare of the user. The restriction, on the other hand, represents an interference with a legitimate water use for those who need the warning.

FISH AND WILDLIFE PROPAGATION

Although there is no evidence of reduction in total numbers of pounds of fish caught by sports fishermen in the Detroit River, the creel census records of various agencies indicate a change in the predominant types of fish present in the waters from game or sport fish to those of the rough variety, such as carp, often inedible.

Bottom conditions along the lower section of the Detroit River, caused by pollution, represent unfavorable environmental conditions for the propagation of a great variety of game fish and interfere with this water use by limiting the variety to those species capable of survival and propagation in polluted waters.

During the past four years no major duck kill due to pollution has been experienced in the Detroit River. This admirable accomplishment is the result of effective oil pollution control by the Michigan Water Resources Commission with the cooperation of the Michigan Conservation Commission. Major kills have occurred as recently as 1960, however, when over 10,000 birds succumbed. Constant vigilance during critical seasons is required to prevent a recurrence of such a

tragedy.

NAVIGATION

Interference with navigation occurs at the junction of the Rouge and Detroit Rivers, where sludge deposits require extensive annual dredging operations by the Corps of Engineers to keep navigable waters in use. The deposits of suspended solids originate partly in the discharge from several industries along the Rouge. This fact is recognized by both the industries and the Corps who make a charge for this service to the polluter involved. Deposition of suspended solids also occurs at harbor facilities and at the mouth of the Detroit River in the navigation channels.

SECTION VI

PRESENTATION OF RESULTS:

LAKE ERIE

DESCRIPTION OF WATER QUALITY

The Michigan waters of Lake Erie constitute approximately 1 per cent of its total surface area, and all the determinations in this report are limited to those waters. A series of maps on which the contours of various measures of water quality are described will be presented, along with tables giving the results of sampling. Both will be accompanied by interpretation. The sampling stations in Lake Erie, along its bathing beaches and on its tributaries, are shown in Figure 2-I.

Bacteriological

Bacteriological densities in Lake Erie from the mouth of the Detroit River to a distance from 2 to 3 miles below this point indicate that the water is polluted to the extent that it cannot safely be used for recreational purposes. Following heavy rainfall in the Detroit area, bypassing of excess waste from the Detroit treatment plant extends the zone of polluted water south -

ward to just north of Stony Point. Both the International Joint Commission objective (2,400 coliform organisms per 100 ml) and the standard commonly used for recreational use of water (1,000 per 100 ml) are exceeded in the zone of Lake Erie influenced by the Detroit River. A similar, less extensive zone radiates from the mouth of the Raisin River. This zone of polluted water also extends farther out into the Lake following heavy rainfall.

Figure 1-VU depicts geometric mean coliform values in the Lake as contours. Most of the Michigan area of the Lake had average coliform densities under 500 organisms per 100 ml. Two areas of high density are evident from Figure 1-VI. The first extends below the mouth of the Detroit River south to just above Stony Point, while the other radiates out into the Lake a short distance from the Raisin River; each is apparently caused by separate waste contributions from the two tributaries, and they do not appear to be associated with each other. Geometric mean coliform densities greater than 5,000 organisms per 100 ml were observed at the mouth of the Detroit River as it entered Lake Erie.

(Figure 1-VI follows.)

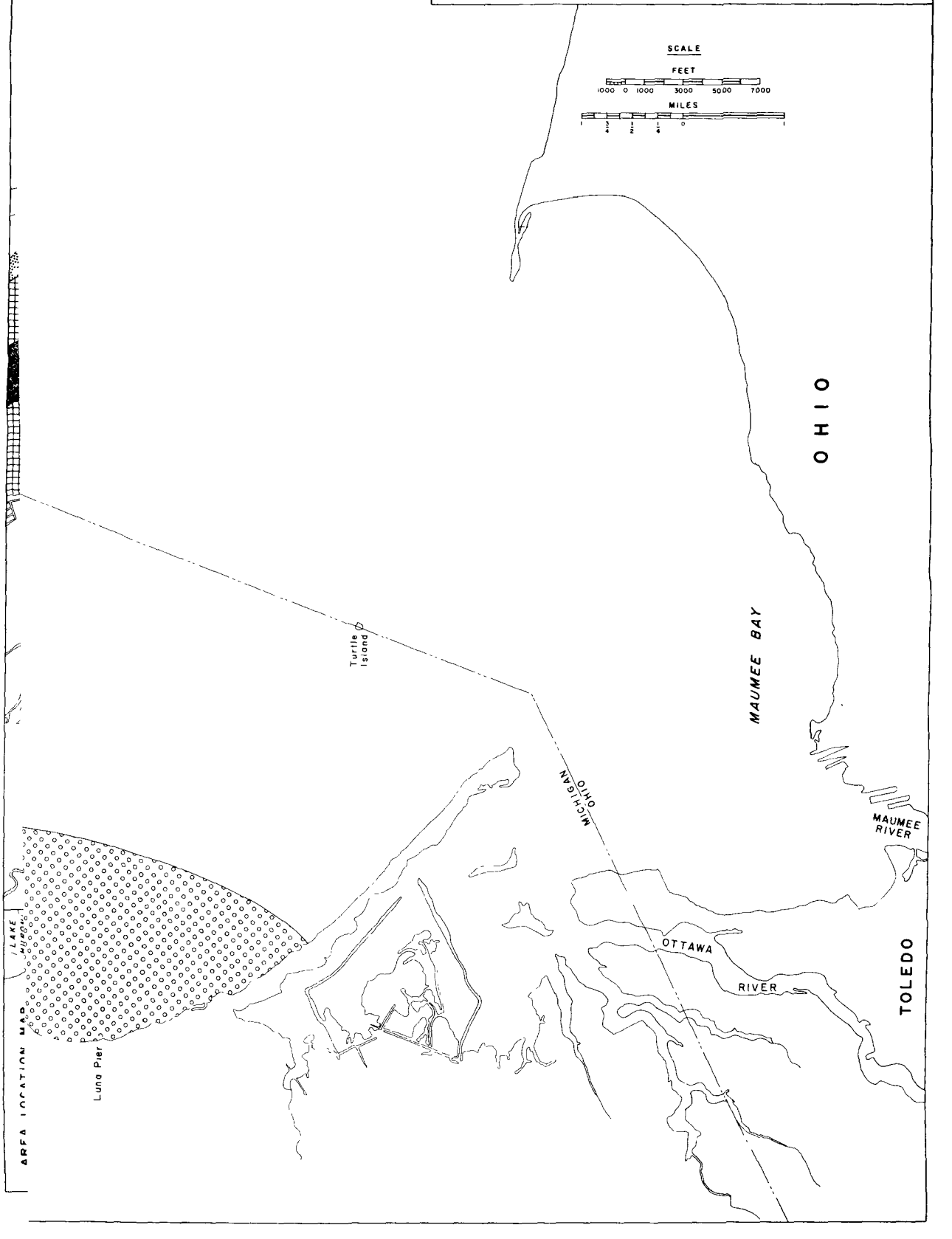
FIGURE I-XI

DETROIT RIVER-LAKE ERIE PROJECT

GEOMETRIC MEAN COLIFORM CONCENTRATIONS

MICHIGAN WATERS OF LAKE ERIE

U.S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



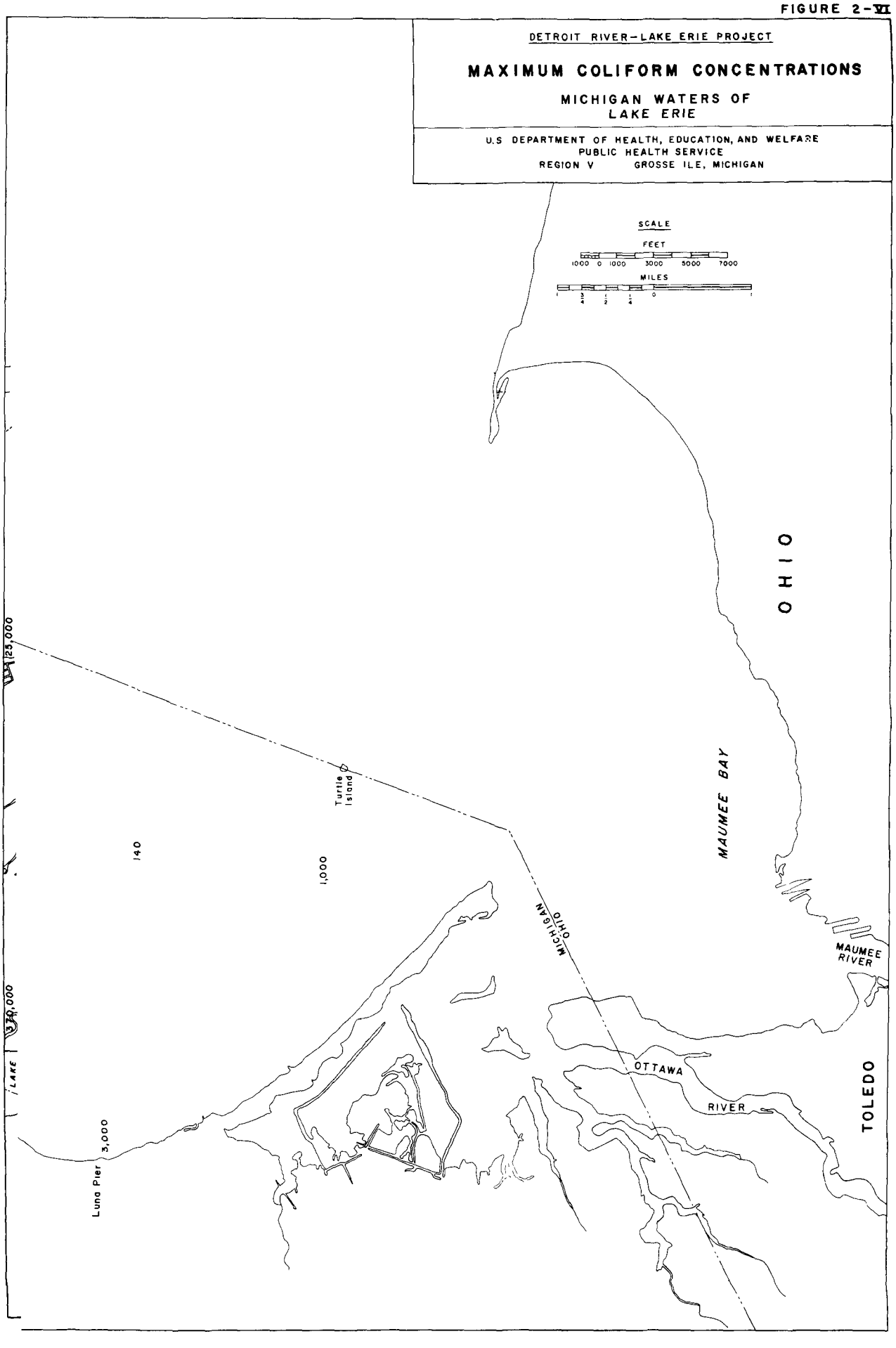
An area of geometric mean coliform density exceeding the International Joint Commission objective (2,400 organisms per 100 ml) extended down into Lake Erie for a distance of 2 to 3 miles.

Maximum coliform densities at several locations showed a similar pattern (Figure 2-VI). Again two zones of high values were found, in the same locations described above. The maximum observed outside the two zones of especially polluted water was 42,000 organisms per 100 ml, while maximum values exceeding 100,000 organisms per 100 ml were observed near the mouths of the Detroit and Raisin Rivers.

Average fecal coliform densities in Lake Erie ranged from 5 to 30 per cent of the total coliform density; geometric mean fecal streptococcus densities in Lake Erie were under 80 organisms per 100 ml at all locations.

(Figure 2-VI follows.)

FIGURE 2-VI


DETROIT RIVER-LAKE ERIE PROJECT
MAXIMUM COLIFORM CONCENTRATIONS
MICHIGAN WATERS OF
LAKE ERIE
U.S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN
SCALE
FEET
1000 0 1000 3000 5000 7000
MILES
OHIO
MAUMEE BAY
MAUMEE RIVER
TOLEDO
OTTAWA
RIVER
MICHIGAN
OHIO
Turtle Island
140
1,000
Luna Pier
3,000
LAKE
125,000
130,000

All bathing beaches along Lake Erie showed geometric mean coliform densities less than 1,000 organisms per 100 ml, except Maple Beach (B1) which is located in the influence of the polluted Detroit River. The relatively low means at the Sterling State Park beaches are misleading due to high maximums which appear under certain relatively frequent conditions of wind and weather. Since these values are masked in median or geometric mean values, a special survey was made on this beach, described later in this section of the report. Average fecal coliform densities at the beaches ranged, without a noticeable pattern, from 23 to 72 per cent of the total coliform values. Fecal streptococcus geometric means at the beaches ranged from 13 to 430 organisms per 100 ml. Bathing beaches from Otter Creek to the Ohio State line had geometric mean coliform densities less than 350 organisms per 100 ml; maximum coliform densities at these locations did not exceed 3,000 organisms during the survey.

Coliform densities were highest at the mouths of the tributaries. Table 3-VI shows geometric mean coliform densities in excess of 1,500 organisms per 100 ml at the mouths of all Lake Erie tributaries. (Tables 1-VI, 2-VI, and 3-VI follow.)

TABLE 1-VI. SUMMARY OF AVERAGE RESULTS IN MICHIGAN LAKE ERIE

Station	pH	Phenols µg/l	Chloride mg/l	Alkalinity mg/l	Geometric Mean Coliform org/100ml	Geometric Mean Fecal Strep org/100ml	Geometric Mean Fecal Coli org/100ml	Phosphates mg/l	Nitrates mg/l	Nitrites mg/l	Ammonia Nitrogen mg/l	Organic Nitrogen mg/l
L2	8.07	2	14	79	2,000	16	360	.17	.15	.003	.09	.13
L3	8.12	2	25	79	6,000	23	1,620	.35	.12			
L4	8.08	3	44	85	3,500	12	550					
L5	7.95	2	18	79	3,700	15	670	.32	.24	.003	.34	.12
L6	8.14	1	20	79	1,600	80	320		.24			
L7	8.13	1	19	80	1,900						.34	.18
L8	8.22	2	24	82	640			.20	.15	.003	.24	.12
L9	8.25	2	18	119	330			.12	.12	.002	.39	.14
L10	8.44	2	21	83	130			.22	.26			
L11	8.36	6	22	80	69			.14	.10	.002	.05	.08
L12	8.33	1	25	79	200			.24	.39	.003	.13	.23
L14	8.46	4	25	81	160	5	21	.13	.53	.001	.18	.23
											.34	.37
L15	8.46	1	20	78	88			.11	.34			
L17	8.41	2	22	78	36			.25	.19	.001	.12	.12
L20	8.58	1	23	81	55			.33	.14			
L21	7.63	0	35	84	5,000	29	1,250	.78	.32	.006	.27	.17
L22	8.13	1	46	84	260	9	13	.24	.44	.001	.23	.17
L23	8.32	2	29	84	130	8	22					
L24	8.19	5	24	81	84	5	25	.29	.44	.001	.17	.15
											.43	.54
L25	8.30	16	26	85	48	5						
L26	8.19	-	25	84	19			.31	.15	.030	.10	.25
											.41	.47
L27	8.44	2	29	81	88	7	5					
L28	8.44	2	24	86	69	7	7	.11	.49	.002	.16	.33
											.58	.62

TABLE 2-VI. SUMMARY OF AVERAGE RESULTS
MICHIGAN LAKE ERIE BATHING BEACHES

Station	pH	Phenols µg/l	Chloride mg/l	Alkalinity mg/l	Geometric Mean Coliform org./100 ml	Geometric Mean Fecal Strep org./100 ml	Geometric Mean Fecal Coli org./100 ml
B1	8.42	2	65	93	2,000	79	680
B3	8.51	2	44	85	960	13	320
B4	8.50	2	41	86	480	60	180
B5	8.51	3	33	79	490	53	152
B7	8.63	3	28	78	340	130	180
B8	8.66	4	27	79	480	77	200
B10	8.61	4	28	76	480	69	254
B14	8.60	3	25	87	360	50	83
B17	8.59	3	25	76	430	90	206
B18	8.51	2	25	83	500	51	190
B21	8.50	3	27	83	990	37	178
B22	8.43	4	26	85	460	430	207
B23	8.68	3	24	82	860	200	490
B25	8.74	2	25	81	300	190	111
B27	8.68	1	32	83	210	190	67
B29	8.81	1	24	87	170	53	123
B31	8.73	2	27	93	350	170	170

TABLE 3-VI. SUMMARY OF AVERAGE RESULTS TRIBUTARIES TO MICHIGAN LAKE ERIE

Tributary	pH	Phenols µg/l	Chloride mg/l	Alkalinity mg/l	Geometric Mean Coliform org./100 ml	Geometric Mean Fecal Strep org./100 ml	Geometric Mean Fecal Coli org./100 ml
Huron River	8.37	3.1	36	145	13,000	560	5,700
Swan Creek	8.19	4	94	106	4,100	150	1,350
Stony Creek	8.22	2	26	186	1,700	370	610
Sandy Creek	8.19	3	82	188	5,600	730	1,800
Raisin River	7.93	7	27	125	30,000	85	13,200
Plum Creek	7.77	16	31	221	49,000	2,500	21,500
LaPlaisance Creek	8.05	2	40	130	2,400	180	1,630

Highest counts were at Plum Creek, averaging 49,000 coliform organisms per 100 ml, and at the Raisin River, averaging 30,000. Fecal coliform densities were also high here, ranging from 32 to 68 per cent of the total values. Fecal streptococcus densities in Plum Creek averaged 2,500 organisms per 100 ml, while those at all other tributaries averaged under 1,000. Maximum coliform densities exceeding 25,000 organisms per 100 ml were found in all tributaries. The maximum value found in Plum Creek exceeded 1 million organisms per 100 ml.

CHEMICAL AND PHYSICAL

Phenols

With few exceptions IJC objectives for average phenol concentrations (2 micrograms/l) were met during the survey. There is no evidence that phenols in the Michigan waters of Lake Erie constitute interference with water use at this time.

Average phenol concentrations in the Lake and along shore ranged from 1 to 16 micrograms/l with 5 out of 23 stations exceeding the IJC limit (2 micrograms/l). The few locations with high phenol concentrations showed no apparent pattern, and were not located in the vicinity of either the mouth of the Detroit or Raisin Rivers.

Maximum phenol values appeared, generally, at the same stations, with one maximum value as high as 88 micrograms/l at station L 11.

All beaches had average phenol concentrations less than 5 micrograms/l with most equal to or less than 2 micrograms/l. Plum Creek, averaging 16 micrograms/l, and the Raisin River, at 7 micrograms/l, were the only tributaries with phenols exceeding 4 micrograms/l. Phenol concentrations near the City of Monroe intake averaged 2 micrograms/l.

Chlorides

Average chloride concentrations in the Michigan water of Lake Erie ranged from 18 to 44 micrograms/l, with the higher values alongshore and near the mouth of the Detroit River. Average chloride concentrations in Lake Erie are shown as contours in Figure 3-VI. The influence of the Trenton Channel of the Detroit River on chloride concentrations in Lake Erie is clearly shown in this figure, and is felt as far south as Stony Point. A maximum value of 82 micrograms/l was observed near the mouth of the Detroit River. A maximum value of 74 micrograms/ l was noted near the mouth of the Raisin River.

(Figure 3-VI follows)

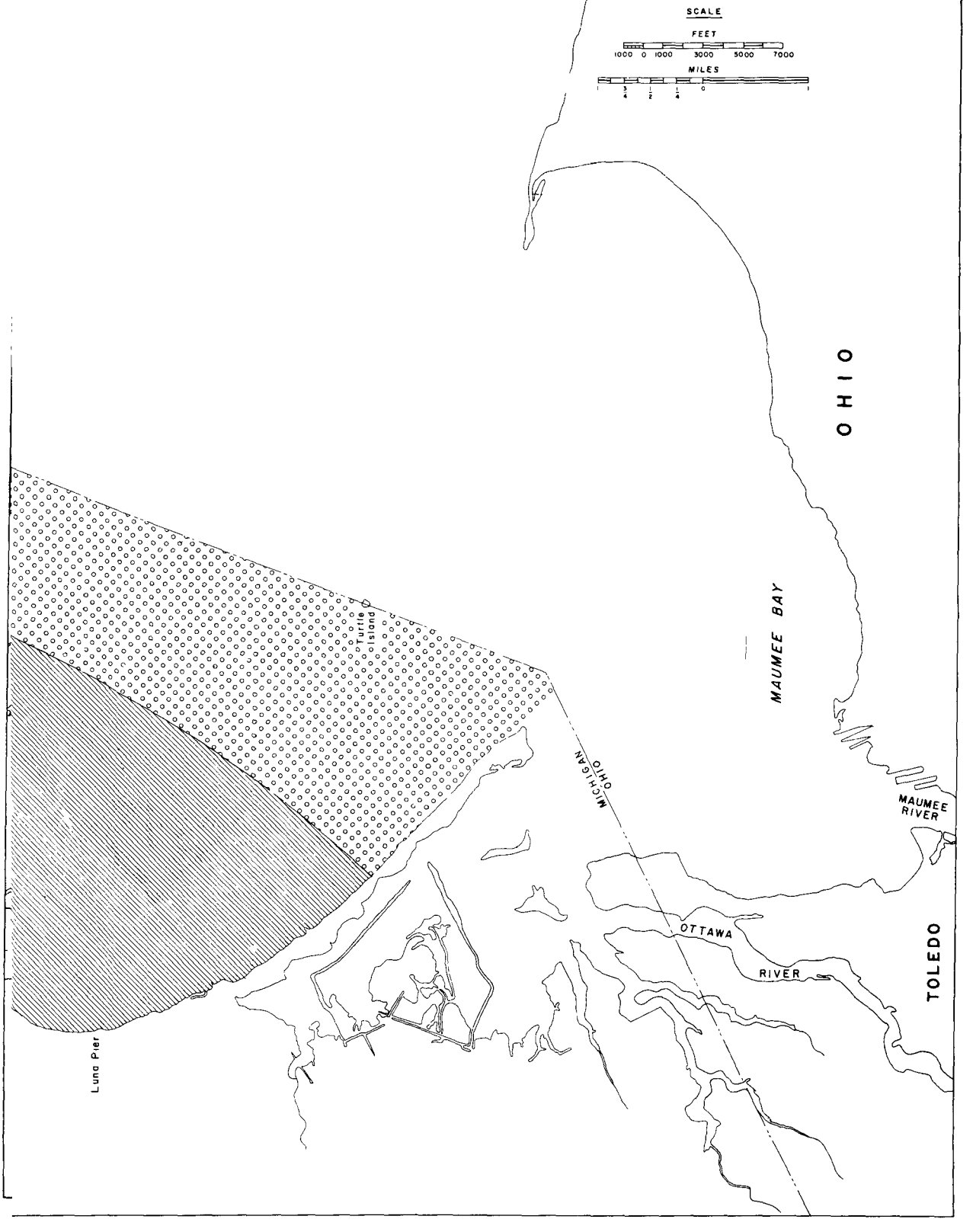
FIGURE 3-VI

DETROIT RIVER–LAKE ERIE PROJECT

AVERAGE CHLORIDE CONCENTRATIONS

MICHIGAN WATERS OF LAKE ERIE

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



Harbor Beaches, just north and south, respectively, of the mouth of the Raisin River. Suspended and settleable solids in the Raisin River, itself, averaged 20 and 9 mg/l respectively.

Suspended solids in Lake Erie, in the vicinity of the mouths of the Raisin and Detroit Rivers and near the shores, having reached levels which constitute damaging pollution. The solids settle on the Lake bottom, as sludge or bottom deposits, causing damage to aquatic life. By blanketing the bottom, sludge deposits are killing eggs and essential fish-food organisms, and destroying spawning beds.

Cyanides

No cyanide was found in Lake Erie or at its beaches, except one concentration of 0.03 mg/l at Sterling State Park. Cyanides in the Raisin River averaged 0.03 mg/l at its mouth.

Cyanide concentrations found in the Raisin River and in Lake Erie near the mouth of the Raisin indicate a potential interference with water use from the standpoint of fish and wildlife propagation. This condition appears to be limited to a small area of the Lake immediately adjacent to the mouth of the Raisin River.

Iron

An area adjacent to and south of the mouth of the Raisin River has iron concentrations ranging between 0.21 and 0.64 mg/l. Iron concentrations in the northern part of the Michigan waters of Lake Erie were low (0.01 mg/l).

Iron concentrations in Lake Erie exceed the IJC objective (.03 mg/l) in the waters adjacent to and south of the mouth of the Raisin River. They represent potential interference with water supply and aquatic life.

Toxic Metals

These metals consist of cadmium, chromium, copper, lead, nickel, and zinc.

All except cadmium were detected in the Michigan waters of Lake Erie above the 0.01 mg/l level. The occurrence of metals seemed to be greater in the waters south of Stony Point.

Copper, chromium, and zinc ranged from 0.01 to 0.07 mg/l, with the higher values adjacent to the mouth of the Raisin River. Lead ranged from 0.01 to 0.12 mg/l, with the higher values again in the vicinity

of the mouth of the Raisin. All nickel concentrations were 0.02 mg/l or less, and, as mentioned before, cadmium was not detected at the sensitivity of the test (0.01 mg/l). Toxic metals were found above minimum detectable concentrations in the area extending outward 2 to 4 miles from the mouth of the Raisin River.

At this time toxic metals in Lake Erie do not cause interference with water use. However, maximum values of chromium and lead found near the mouth of the Raisin River indicate potential future problems.

ABS

All concentrations of alkyl benzene sulfonate found in the Michigan waters of Lake Erie were less than 25 micrograms/l, far less than the amount which is expected to cause foaming (500 micrograms/l). There is no interference with water use from this constituent.

Dissolved Oxygen

Levels of DO in most of the Michigan waters of Lake Erie are sufficient at this time to prevent interference with water use. At the mouth of the Raisin River, however, and to some extent in the influence of the Detroit River, significant decrease in oxygen content has

occurred. If oxygen-consuming materials continue to be added to the Lake from the Detroit and Raisin Rivers, DO deficits will occur and cause serious problems.

Figure 4-VI depicts oxygen saturation contours for Lake Erie. These are average values calculated on the basis of both surface and depth samples. The difference between surface and depth samples ranged between 5 and 20 per cent during fall surveys, and as much as 90 per cent during spring and early summer surveys, in the deeper sections of the Lake. The lowest actual dissolved oxygen concentrations were found, as expected, during summer months, in areas adjacent to the mouths of the Raisin and Detroit Rivers.

(Figure 4-VI; and Tables 4,-VI, 5-VI, and 6-VI follow.)

FIGURE 4-VI

DETROIT RIVER–LAKE ERIE PROJECT

AVERAGE % SATURATION DISSOLVED OXYGEN

MICHIGAN WATERS OF LAKE ERIE

US DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

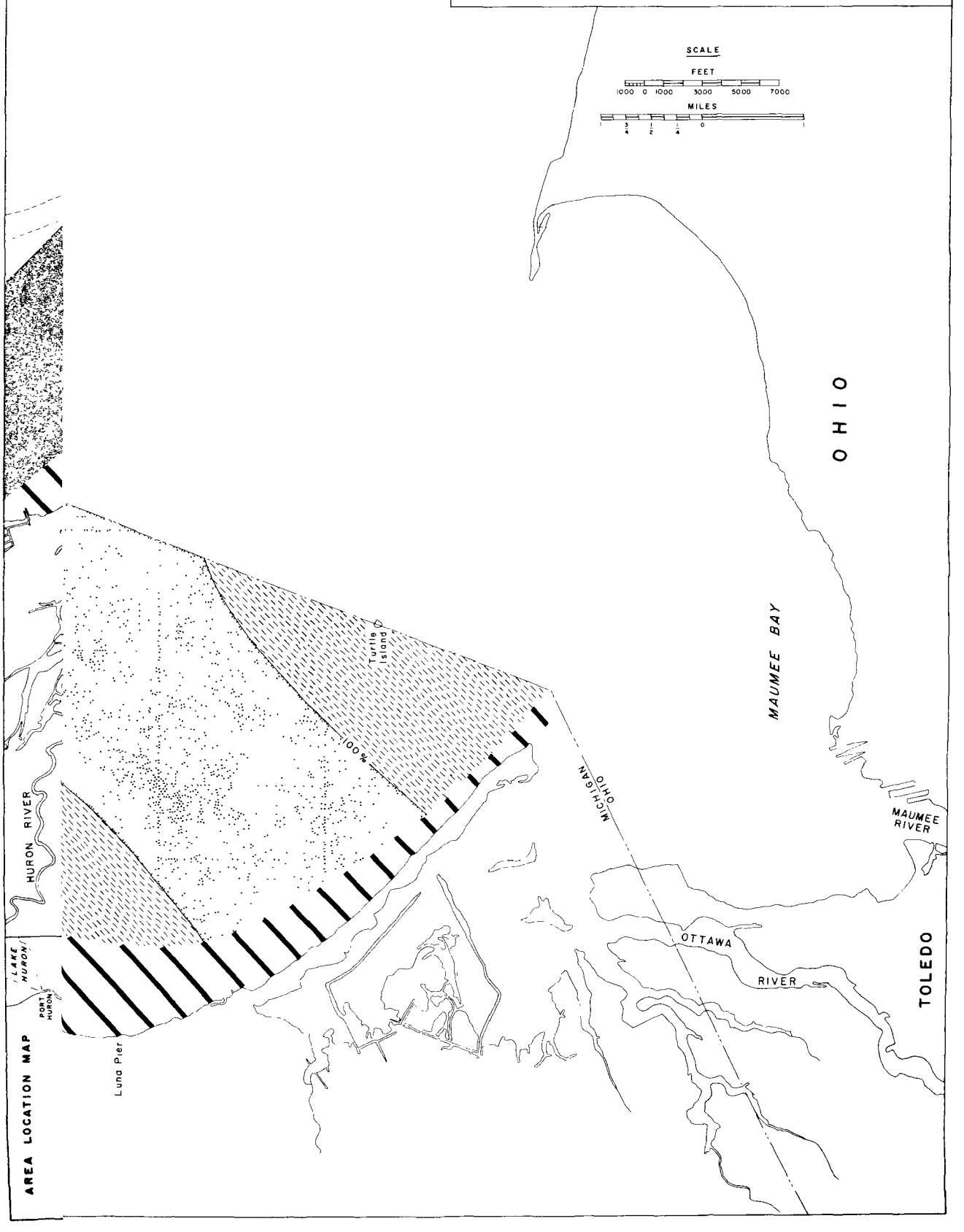


TABLE 4-VI. SUMMARY OF MAXIMUM VALUES FOUND IN MICHIGAN LAKE ERIE

Station	pH	Phenols µg/l	Chloride mg/l	Alkalinity mg/l	Coliform org./100 ml	Fecal Strep org./100 ml	Fecal Coli % of Total
L2	8.4	6	44	82	56,000	45	42
L3	8.7	8	58	80	110,000	88	45
L4	8.7	9	82	89	75,000	60	45
L5	8.6	15	44	80	97,000	58	55
L6	8.8	5	48	80	30,000	85	20
L7	9.1	4	48	81	42,000	-	-
L8	9.2	7	37	87	100,000	--	-
L9	8.7	7	55	157	23,000	-	-
L10	8.9	6	37	85	3,000	-	-
L11	9.0	58	47	82	2,500	-	-
L12	8.8	6	46	81	36,000	-	-
L14	9.0	28	41	84	6,400	L 10	25
L15	8.8	8	30	82	7,400	-	-
L17	8.8	9	35	78	1,200	-	-
L20	9.0	5	28	82	1,000	10	-
L21	8.0	0	58	84	57,000	310	40
L22	8.7	3	74	84	81,000	55	5
L23	8.8	2	39	86	1,700	75	25
L24	8.8	17	36	84	2,400	L 10	30
L25	8.8	30	34	87	4,700	L 5	-
L26	8.6	-	31	85	140	-	-
L27	8.8	2	34	84	2,700	20	5
L28	9.0	4	27	86	2,000	20	10

TABLE 5-VI. SUMMARY OF MAXIMUM VALUES FOUND AT MICHIGAN LAKE ERIE BATHING BEACHES

Station	pH	Phenols µg/l	Chloride mg/l	Alkalinity mg/l	Coliform org./100 ml	Fecal Strep org./100 ml	Fecal Coli % of Total
B1	9.0	14	82	93	25,000	2,000	100
B3	9.2	5	80	88	240,000	850	70
B4	9.0	8	80	89	190,000	200	100
B5	9.0	8	75	82	42,000	380	58
B7	9.1	10	71	81	62,000	2,000	95
B8	9.1	13	79	81	37,000	1,400	100
B10	9.2	15	78	78	33,000	2,500	100
B14	9.2	8	37	99	86,000	420	40
B17	9.2	7	31	80	96,000	500	80
B18	9.3	8	30	88	230,000	250	80
B21	9.4	9	49	87	72,000	160	40
B22	9.3	14	42	90	3,100	3,700	85
B23	9.3	10	36	86	51,000	1,800	90
B25	9.4	8	31	86	8,000	3,500	100
B27	9.3	4	149	87	2,200	2,100	60
B29	9.5	3	30	90	2,000	740	100
B31	9.4	13	37	103	3,000	1,500	90

TABLE 6-VI. SUMMARY OF MAXIMUM VALUES FOUND ON TRIBUTARIES TO MICHIGAN LAKE ERIE

Tributary	pH	Phenols µg/l	Chloride mg/l	Alkalinity mg/l	Coliform org./100 ml	Fecal Strep org./100 ml	Fecal Coli % of Total
Huron River	9.1	14	47	163	140,000	2,800	75
Swan Creek	8.5	12	193	109	26,000	400	45
Stony Creek	8.5	8	38	190	32,000	1,100	95
Sandy Creek	8.8	8	180	198	460,000	6,100	82
Raisin River	8.8	36	33	153	530,000	560	100
Plum Creek	8.1	175	94	234	1,200,000	9,200	60
LaPlaisance Creek	8.7	6	59	145	44,000	400	95

A band of low DO, less than 50 per cent saturation, extended out from the Raisin River for a distance of 1/2 to 3/4 mile. In this small area there was occasional complete depletion of DO. The zero DO values were concentrated in the mouth of the Raisin River hydrologically speaking, especially since within one mile of the average values recovered to 100 per cent saturation.

A second area of relatively low DO was found immediately below the mouth of the Detroit River in a finger extending southward for a distance of 4 to 6 miles. Average values here were under 85 per cent saturation; the minimum value was 5.8 mg/l, just off Pointe Mouillee.

Excluding these two areas, the lowest value in Lake Erie was at Station L17: 5.6 mg/l at 24 feet. The corresponding surface sample was 11.9 mg/l. An area of exceptionally high DO was found in the Brest Bay area where averages exceeded 120 per cent saturation. Such high values in natural waters are normally associated with algal growth and subsequent production of oxygen.

Temperature

Temperature values in the Michigan waters of Lake Erie reached a high of 24.5°C, or 76 degrees F. On some days during fall and winter months temperatures varied only 1 degree throughout the Lake; during spring and early summer surveys, however, differences throughout the Lake as great as 6 degrees were observed. Average temperatures in the Lake during the spring and summer tended to be slightly higher than those in the Detroit River; during the fall no difference between the two bodies of water was observed. Differences at specific stations between surface and depth samples were less than 1 degree C during fall and winter months, but increased to 3 and 4 degrees during the spring and early summer at the deeper stations on Lake Erie.

Temperature levels in the Michigan waters of Lake Erie do not at present interfere with water use.

Nitrogen Compounds

Over 85 per cent of the Michigan waters of Lake Erie contain inorganic nitrogen in concentrations above the level which produces undesirable algal blooms. These growths represent serious interference with water use,

and contribute to the premature nutritive enrichment, or aging, of the Lake.

Figure 5-VI shows average nitrate concentrations as contours in the Michigan waters of Lake Erie. The fluming effect from the mouth of the Detroit River noticeable in the dispersion of other pollutants was not present in the distribution of nitrates. These did radiate out from the mouth of the Raisin River, however.

Immediately surrounding the mouth of the River average values were greater than 0.50 mg/l; around Sterling State Park average concentrations ranged to 0.35 to 0.50 mg/l. Another area of high nitrate concentration was observed off Pointe Mouillee, with values above 0.35 mg/l average.

(Figure 5-VI follows.)

Daily values in the Brest Bay area reached maximums early in May (0.91 mg/l), minimums in September (0.11 mg/l), and then rose again in October and December (to 0.24 mg/l).

Nitrate values in the Lake averaged between less than 0.0001 mg/l to 0.0009 mg/l, with no noticeable pattern in the distribution of these values.

Nitrates and nitrites in the Lake study area do not, at this time, interfere with water uses.

Ammonia nitrogen average concentrations are shown in Figure 6-VI. Fluming effects from the mouths of both the Detroit and Raisin Rivers were noticeable. A mass of water with concentrations exceeding 0.30 mg/l extended about ten miles into the Lake from the Detroit River. Average concentrations exceeding 0.30 mg/l radiated about 1/2 mile into the Lake from the mouth of the Raisin River, and values exceeding 0.20 mg/l were found for one to two miles farther.

(Figure 6-VI follows.)

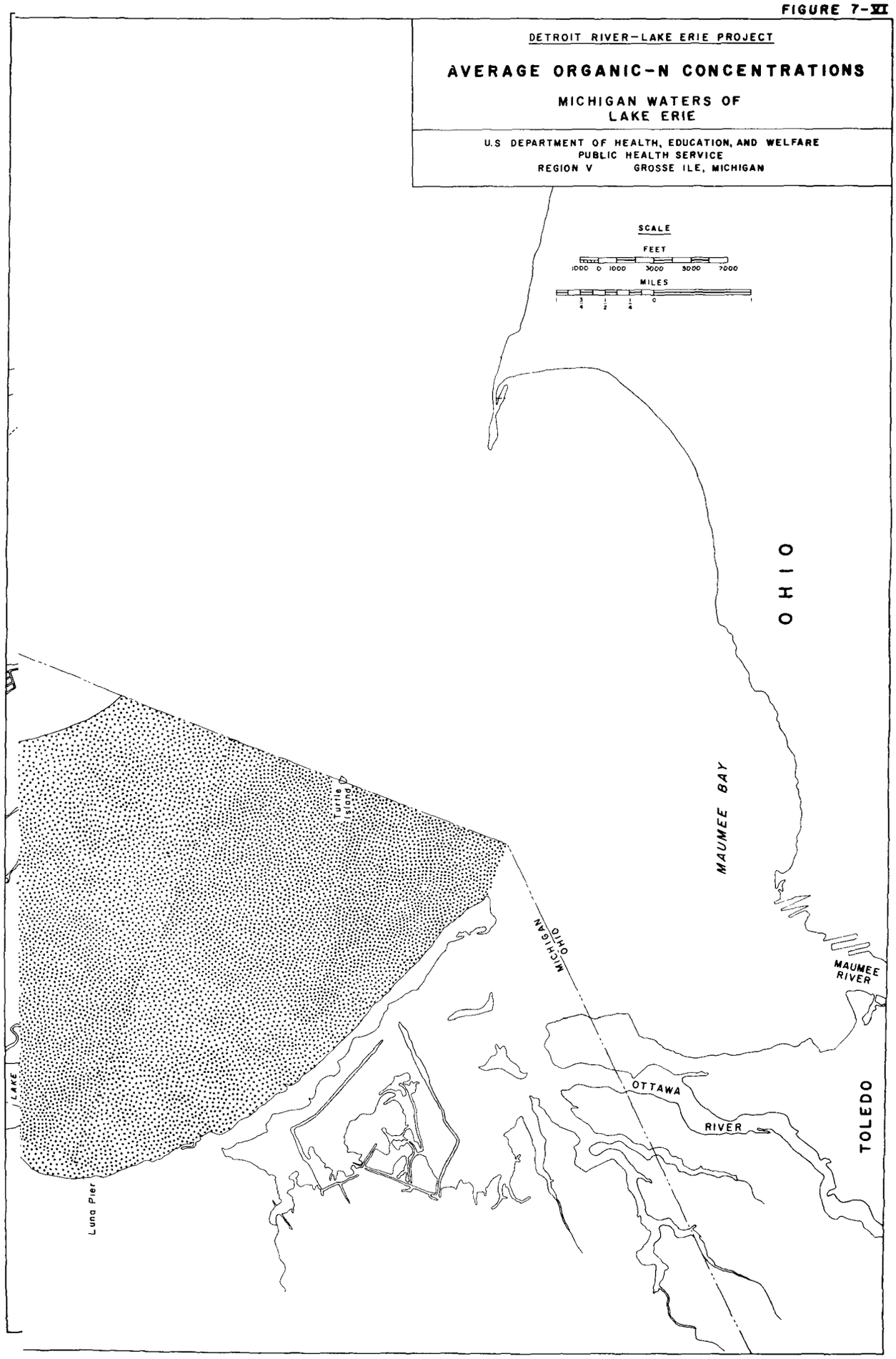
Average ammonia concentrations of 0.20 mg/l and above near the City of Monroe water intake indicate water treatment difficulties and the need for excessive dosage of chlorine to achieve adequate disinfection.

Average concentrations of all organic nitrogen in the Michigan waters of Lake Erie are shown in Figure 7-VI. The northern part of the Michigan waters had values of less than 0.20 mg/l for the most part.

The portion of the Lake extending along the shore from the Raisin River to the Michigan-Ohio State line along the Michigan shore had average organic nitrogen values between 0.20 and 0.30 mg/l. A small area just off the mouth of the Raisin River had values exceeding 0.30 mg/l.

(Figure 7-VI follows.)

FIGURE 7-XI


DETROIT RIVER–LAKE ERIE PROJECT
AVERAGE ORGANIC-N CONCENTRATIONS
MICHIGAN WATERS OF
LAKE ERIE
U.S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN
SCALE
FEET
1000 0 1000 3000 5000 7000
MILES
OHIO
MAUMEE BAY
MAUMEE RIVER
TOLEDO
OTTAWA
RIVER
MICHIGAN
OHIO
Turtle Island
LAKE
Luna Pier

Phosphates

Concentrations of soluble phosphates in almost the entire Michigan portion of Lake Erie exceeded 0.015 mg/l as phosphorus. (To convert soluble phosphates reported as phosphates to those reported as phosphorus, divide by three.) Combined with the high concentrations of nitrogen compounds, the phosphates contribute an excess of nutritive matter to the Lake, accelerating its aging, or eutrophication. Over 85 per cent of the Michigan waters of Lake Erie contain soluble phosphorus in concentrations sufficient to creat nuisance algal blooms and concomitant damages.

Areas of high total phosphate concentration (0.20 - 0.50 mg/l), reported as phosphate, extended from the mouth of the Detroit River into Lake Erie as far south as Stony Point (Figure 9-VI).

(Figure 9-VI follows.)

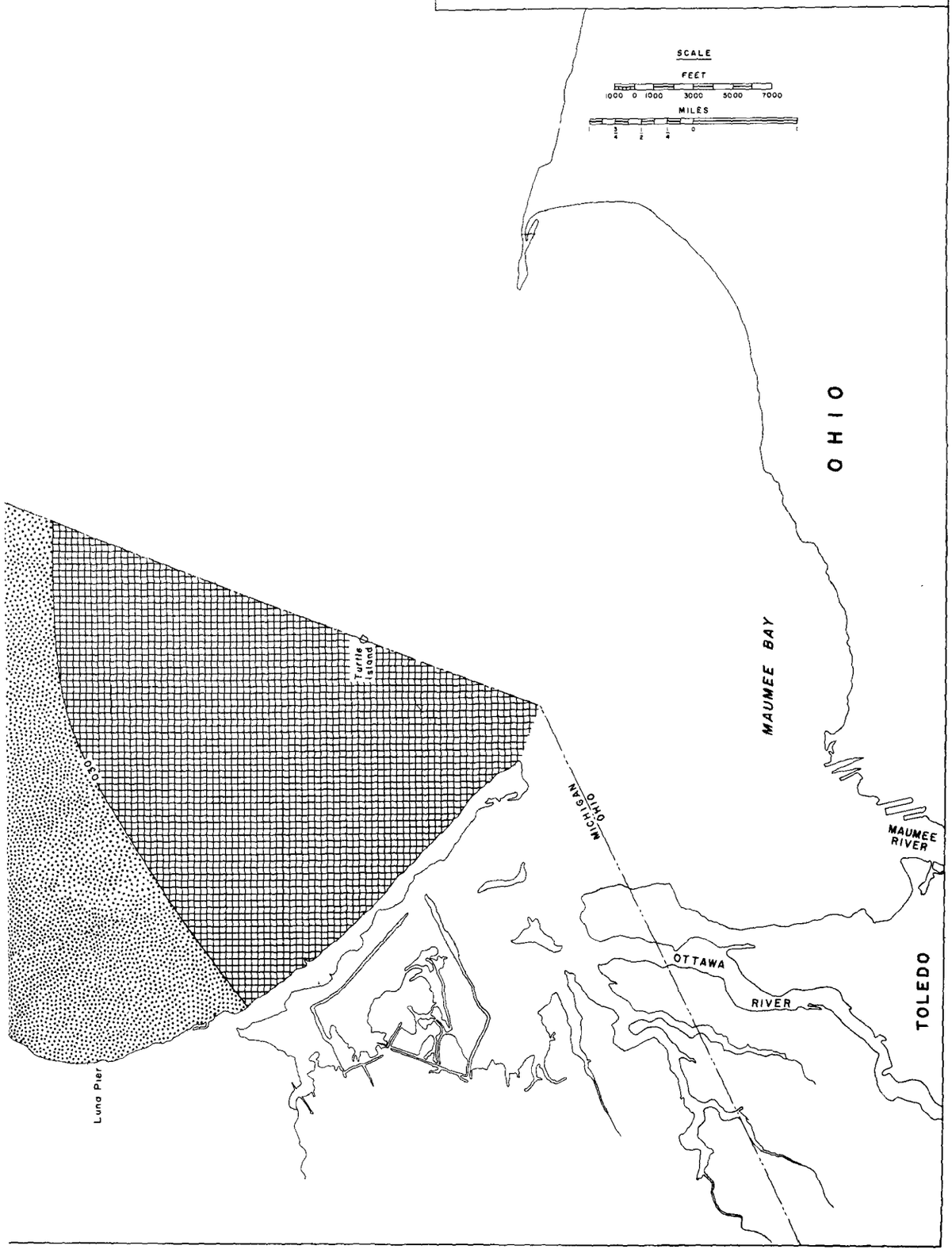
FIGURE 9-XI

DETROIT RIVER-LAKE ERIE PROJECT

AVERAGE TOTAL PHOSPHATE CONCENTRATIONS

MICHIGAN WATERS OF
LAKE ERIE

US DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



Daily average total phosphate concentrations for the entire Lake varied from 0.18 mg/l in the spring to over .30 mg/l in late fall and early winter. Another small zone of high total phosphate concentrations (.30 - .40 mg/l) extended outward from the mouth of the Raisin River about one mile.

Soluble phosphate values (shown in Figure 10-VI) indicated three areas of high concentrations of this constituent. One extended down 6 to 8 miles from the mouth of the Detroit River, with concentrations varying from 0.10 to greater than 0.20 mg/l as phosphate (0.033 to 0.65 mg/l as phosphorus). The second area of high concentration radiated outward 1 to 2 miles from the mouth of the Raisin River. The third area extended upward 3 to 4 miles from the Michigan-Ohio State line near Toledo. Most of the remainder of the Michigan waters of Lake Erie had concentrations of soluble phosphate ranging from 0.05 to 0.10 mg/l as phosphate (0.016 to .033 mg/l as phosphorus).

(Table 10-VI follows.)

Alkalinity

Average alkalinity was very constant throughout the Michigan waters of Lake Erie, ranging from 78 to 86 mg/l. One exception was the concentration of Station L9 of 119 mg/l, with no apparent explanation other than one very high count distorting the average. Alkalinity concentrations at Lake Erie bathing beaches were also consistent and in the same range (76-93 mg/l). Tributary alkalinity concentrations were generally much higher, ranging from 106 mg/l in Swan Creek to 221 mg/l in Plum Creek.

Alkalinity in Michigan Lake Erie was well within a range suitable for all water uses.

BIOLOGICAL

Microscopic Plants and Animals

Waters of the Lake in the study area in contrast to River waters, were found to be rich in plankton, with counts as high as 22,425/ml. The Lake area nearest the shore supported especially dense populations of plant and animal plankters. Plankton was primarily responsible for the observable turbidity of much of the Michigan waters of the Lake.

Collections near the mouth of the Detroit River had phytoplankton counts throughout the season 4 to 7 times lower than those of the Lake, reflecting the plankton-poor water masses passing from the Detroit River and heading eastward into other waters of Lake Erie. Density levels in general increased with distance from the Detroit River mouth. Average values for the whole season were 2,500 organisms/ml for the outshore locations and 4,200 organisms/ml for the inshore stations (see Table 7-VI).

(Table 7-VI follows.)

TABLE 7-VI. ABUNDANCE OF PHYTOPLANKTON - LAKE ERIE STATIONS, 1963

Values in Number of Organisms per Milliliter

Station	Date of Collection										
	April 18	May 9	*June 3	July 5	August 6	Sept. 4	*Oct. 3	*Oct. 10	Nov. 4	Nov. 27	Mean
(Outshore)											
2	1775	925	900	950	525	125	350	625	550	275	700
5	2050	7125	2750	1025	525	100	275	1250	1900	2850	1985
10	4450	6075	7775	3625	1225	575	2100	1200	1675	3600	3230
15	8350	3950	5825	3750	1575	725	1800	775	2525	3525	3280
17	5825	7225	6450	3925	1375	750	2500	1550	1250	1650	3250
Mean	4490	5060	4740	2655	1045	455	1405	1080	1580	2380	2489
(Inshore)											
4	22425	6450	12600	5675	875	225	250	1075	3200	225	5300
8	7825	4845	3575	10325	1600	1000	300	500	2875	2950	3580
12	8975	4250	4800	4500	1900	1100	5025	1125	6025	5175	4288
24	4100	5325	4500	6050	5150	1800	4525	1800	3950	4125	4133
28	4800	4650	7875	5175	4225	1500	3750	1650	2625	5350	4150
14	5525	7200	9250	6775	2550	1625	5875	1450	3800	2900	4695
20	5425	8725	3600	2225	1850	2075	2000	1450	950	4400	3272
Mean	8439	5921	6600	5818	2593	1332	3104	1293	3357	3589	4205

* Variations from date of collection shown:

June 3 - Station 2 on May 20; 4, 5, 8 on May 29; 17, 20 on June 4.
October 3 - Stations 2, 4, 5, 8 on September 30.
October 10 - Stations 12, 15, 28 on October 11; Stations 2, 4, 5, 8 on October 14

The abundance of phytoplankton observed in the Michigan waters of Lake Erie indicates that its capacity to produce plankton is among the highest in the Great Lakes. The heavy crops of algae observed at the inshore stations near Stony Point and Brest Bay could not be maintained throughout the summer season without an adequate supply of inorganic nitrogen and soluble phosphates. Measurements showed inorganic nitrogen and soluble phosphates reported as phosphorus at 0.55 mg/l and 0.036 mg/l, respectively, levels characteristic of organically enriched waters. The nutrient levels at the beginning of the spring growing season required to produce nuisance blooms are only 0.30 mg/l for inorganic nitrogen and 0.015 mg/l for soluble phosphates reported as phosphorus.

The shallowness of the western basin of Lake Erie, coupled with wind and current action, bring about almost uniform vertical distribution of temperature and nutrients, which creates an optimal environment for growth and reproduction of plankters. Atmospheric and photosynthetic oxygen is thoroughly mixed throughout the water mass, so that there is no anaerobic organic decomposition near the bottom. High mid-summer temperatures of 24 degrees C increase the rate of decomposition

of protein materials and convert nitrogen into the form needed for growth of algae. Phosphorus, bound in the cell material of dead and decaying algae and other organic material, is released in the form of soluble phosphates and a portion recycled as a plant nutrient.

In the Brest Bay area, where the nutrient supply is rich and the algae count highest, the phosphates and nitrates are recirculated in the water mass by the clockwise currents. The addition of more nutrients gradually increases the concentration. At times of bloom low levels of nitrates were observed, but this can be explained by the known tendency of phytoplankton to take up nutrients in excess of actual needs.

A considerable portion of the nutrient supply for maintaining the observed phytoplankton abudance in Brest Bay originates from the discharge of inadequately treated domestic wastes and the paper mill wastes to the Raisin River at Monroe. Nutrient measurements substantiate this assumption, as the phosphate and nitrate levels observed in the Raisin River were 0.4 mg/l and 0.6 mg/l, respectively.

Other symptoms of heavy organic enrichment at the inshore stations were the sewage-tolerant species of blue and green algae, and the diatoms characteristic

of highly eutrophic bodies of standing water. These blooms were concentrated in Brest Bay and at the station above Stony Point close to the City of Monroe's water intake. (Taste and odor-producing algae have caused trouble at the City of Monroe's water treatment plant in the past. The intake was moved to its present location in 1950 to obtain waters less prone to tastes and odors.)

The filamentous green algae, Cladophora, and the filamentous slime bacterium, sphaerotilus, mentioned earlier as usually associated with nutrient-enriched waters, were also found at most stations in Lake Erie. Heavy growths of algae were found along the beaches near Bolles Harbor, and in the Brest Bay area, further indicating the polluted condition of these waters and pointing to sources of waste in the Monroe-Raisin River area.

Bottom Organisms

In Lake Erie, a study of the bottom animals revealed particularly polluted areas adjacent to the Raisin River and Sterling State Park (Figure 12-VI, Table 8-VI), and also at the mouth of the Detroit River, extending in the shape of a fan out into the Lake.

(Figures 11-VI and 12-VI and Table 8-VI follow.)

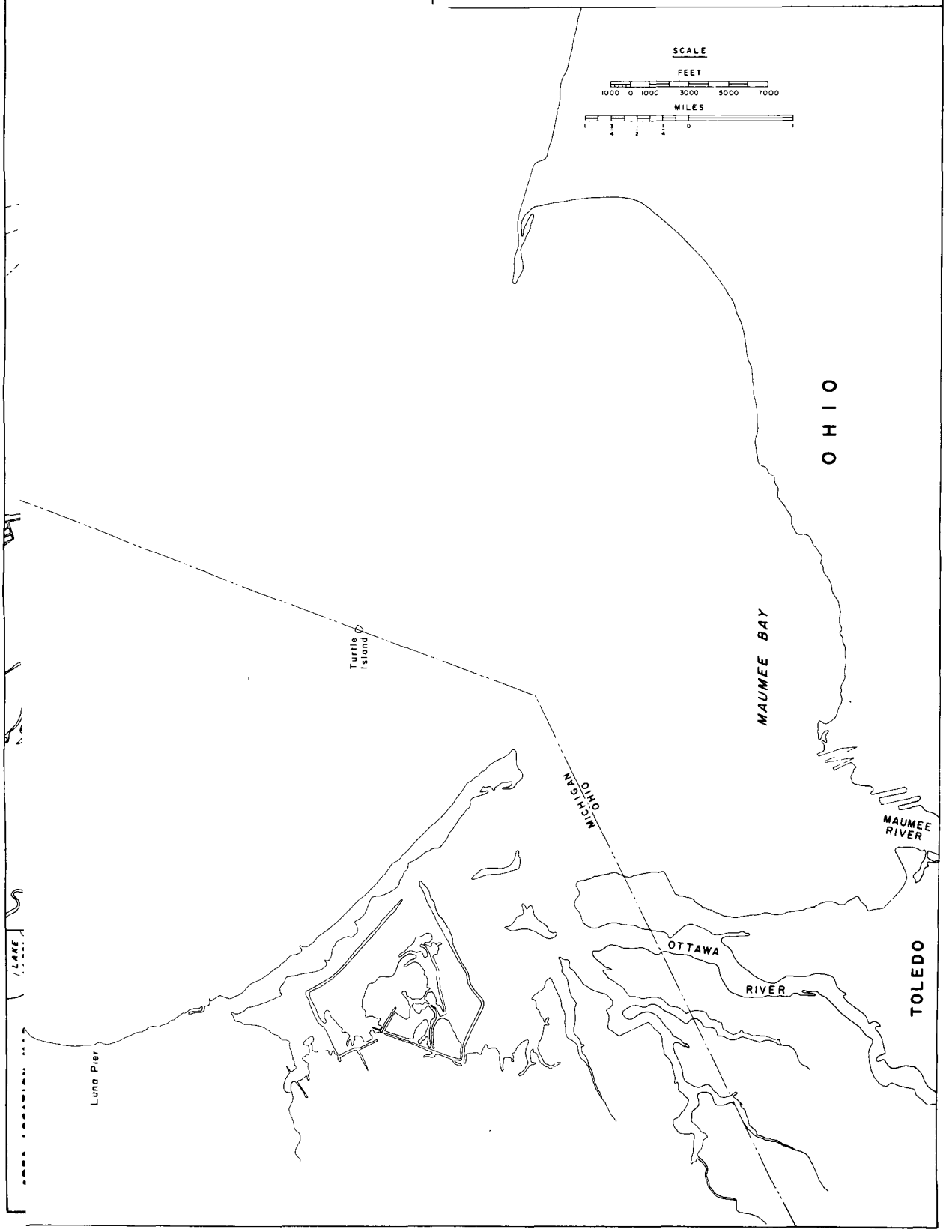
FIGURE II-VI

DETROIT RIVER-LAKE ERIE PROJECT

DISTRIBUTION OF FILAMENTOUS SEWAGE BACTERIA

MICHIGAN WATERS OF LAKE ERIE

U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN



The clustering of these zones close to the mouths of the Detroit and Raisin Rivers points to the greatest sources of pollution. In between the two polluted areas, associations of bottom forms containing sensitive, intermediate, and tolerant specimens indicate that the two general areas of pollution are independent of each other.

Samples from the Detroit River below sources of pollution and from the Lake did not contain a single burrowing mayfly. Among the causative factors involved in the disappearance of this important fish food organism are changes in the Lake floor sediments themselves. Oooze or flocculent sludge and oil laid down by pollution from Detroit and the Monroe area have replaced the more desirable habitats that once supported mayflies and other fish food organisms.

SOURCES AND CHARACTERISTICS OF WASTES

Municipal

In addition to studying the operating records of sewage treatment plants (see Figures 11-I and 14-I) in the area studied by the Project, two 4-day surveys were made of the Monroe Sewage Treatment Plant in cooperation with the Michigan Department of Health. Waste flows

were measured, hourly bacteriological samples and 12-hour composite chemical, biochemical, and physical samples collected, and the results analyzed in the Project laboratory.

Table 9-VI summarizes the results of the two surveys, and Table 10-VI lists waste loadings and observed treatment efficiency of the plant.

The two surveys revealed an influent fairly typical of a weak domestic waste. Exceptions to this general observation included high concentrations of soluble and total phosphates (20 and 40 mg/l respectively), and high concentrations of certain toxic metals including copper, zinc, and lead.

(Tables 9-VI and 10-VI follow.)

TABLE 9-VI. SUMMARY OF RESULTS OF MONROE SEWAGE TREATMENT PLANT SURVEY

Avg. Pb	Avg. CN	Avg. Cl_2 Resid.
mg/l	mg/l	mg/l
0.13	-	-
0.09	-	1.25
-	-	-
-	-	-
0.13	-	-
0.09	-	1.25

TABLE 10-VI. SUMMARY OF WASTE LOADINGS

MONROE SEWAGE TREATMENT PLANT SURVEY

	Copper	Cadmium	Nickel	Zinc	Lead	Cyanide
ay	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
	-	-	0.33	1.65	2.96	-
	-	-	-	-	-	-
	-	-	0.33	1.65	2.96	-

SUMMARY OF TREATMENT EFFICIENCY

MONROE SEWAGE TREATMENT PLANT SURVEY

rides	ABS	Iron	Copper	Cadmium
moval	% removal	% removal	% removal	% removal
0	0	37	-	-
-	-	-	-	-
0	0	37	-	-

over 600 pounds of phosphates, 1,180 pounds of suspended solids, and an oxygen demand equivalent to the raw sewage of a population of 8,100 to the Raisin River.

The table below lists the loadings of iron, oil, phenols, and suspended solids, which would result if International Joint Commission effluent limitations, including a suspended solids limitation of 35 mg/l, were met at the Monroe Plant.

POLLUTANT	PRESENT LOADING	LOADING AFTER REDUCTION	REDUCTION PER CENT
Oil and Grease	52 gallons/day	31 gals./day	40
Phenols	0.97 lbs./day	0.47 lbs/day	51
Iron	31 lbs./day	31 lbs./day	0
Suspended Solids	1,180 lbs./day	856 lbs./day	27

INDUSTRIAL

The sources of industrial wastes studied in the lower Raisin River are six plants near Monroe, Michigan. These plants consist of four paper mills, a manufacturer of automobile bumpers and accessories, and a manufacturer of automobiles.

TABLE 11-VI. SUMMARY OF RANGES OF AVERAGE RESULTS OF INDUSTRIAL WASTE EFFLUENT CONCENTRATIONS

RAISIN RIVER AT MONROE

a-des g/l	Copper mg/l	Cadmium mg/l	Nickel mg/l	Zinc mg/l	Lead mg/l	Chromium mg/l
).03	0-0.09	0-<0.01	<0.01-0.08	0-0.16	0-0.34	0-0.08
0	<0.01-0.70	<0.01-0.05	<0.01-0.04	0.06-1.13	0.07-0.13	<0.01-0.02
..02	0.03-0.76	<0.01-0.07	<0.01-.12	<0.01-0.27	<0.01-0.04	<.01-0.24
0	<0.01-	<0.01	<0.01	<.01-0.03	.07-0.13	.01-0.03
0	.01-0.06	<0.01	0.01-0.02	<0.01-0.07	0.05-0.10	<.01-.01
0	.07-0.14	<.01-.02	<.01-0.01	1.2-4.3	0.07-0.15	.01-0.09

TABLE 12-VI. SUMMARY OF AVERAGE DAILY LOADING OF INDUSTRIAL WASTES BY EACH INDUSTRY TO RAISIN RIVER AT MONROE

mium bs.	Nickel lbs.	Zinc lbs.	Lead lbs.	Chro-mium lbs.	Phos-phates lbs.
0	0	0	0	0	-
0	0	15	0	0	9
0	120	125	0	136	1,046
)	0	93	0	0	0
)	0	0	0	0	0
)	120	233	0	136	1,060

TABLE 13-VI. SOURCES OF INDUSTRIAL WASTES - RAISIN RIVER

Industry	Volume (MDG)	Product	Production	Significant Waste Constituents	Waste Treatment or Control
Consolidated Paper Company					
North Side Division	7.5	liner board and corrugated cardboard	435 tons/day	coliform, suspended solids, BOD	sedimentation
South Side Division	7.0	automotive blackboard, boxboard	368 tons/day	coliform, suspended solids, BOD	sedimentation
West Side Division		Not Operating			
Union Bag-Camp Paper Company					
River Raisin Paper Company Division	4.57	liner board	315 tons/day	suspended solids, BOD	sedimentation
Monroe Paper Products Company	2.2	liner board	88 tons/day	coliform, suspended solids, BOD	sedimentation, chemical coagulation
Monroe Auto Equipment Company	0.016	shock absorbers	-	none	none
Ford Motor Company	130	automobile accessories	-	toxic metals, CN, oil	dilution, chemical coagulation, sewage treatment plant, alkaline chlorination
TOTAL	151.3				

TABLE 14-VI. INDUSTRIAL EFFLUENTS CONTAINING EXCESSIVE CONCENTRATIONS OF WASTE MATERIALS

Industry	BOD (mg/l)	Cyanides (mg/l)	Suspended Solids (mg/l)	Coliform Bacteria MF/100 ml
Raisin River				
Consolidated Paper Company				
North Side				
West Clarifier	310		163	29,000
East Clarifier	327		190	46,000
Bypass			277	62,000
South Side	120		189	2,000,000
Ford Motor Company				
Sewage Treatment Plant				460,000
Main Plant		1.02		
Monroe Paper Products Company	126		99	60,800
Union Bag-Camp Paper Company	305		93	

The total waste volume from these six plants is 151 million gallons per day. Another plant, the Consolidated Paper Company, West Side Works, although not operating during the Project, has since resumed operation on a part-time basis. Waste constituents from these sources include large quantities of oxygen-demanding material which deplete the oxygen resources of the Raisin River beyond recovery. The wastes also contain significant quantities of coliform bacteria, oil, toxic metals, cyanides, and suspended and settleable solids.

The industrial wastes which most seriously degrade the water of the Raisin River originate from the four paper mills, where the treatment is in all cases inadequate. The paper plants all provide partial treatment for removal of settleable solids and one provides chemical coagulation in addition. The Ford Motor Company plant maintains extensive treatment facilities for control of the toxic metallic ions and cyanide-bearing wastes. In addition, a small primary sewage treatment plant treats the domestic wastes from the Ford Works.

With the exception of the Monroe Auto Equipment Company, all treatment facilities are inadequate to prevent interference with water uses in the Raisin River and subsequently in Lake Erie. The Raisin

River, itself, primarily due to the paper mill wastes, is in a continuous state of putrefaction and is literally offensive in appearance.

Wastes in the Raisin River eventually reach the waters of western Lake Erie. The paper mill wastes combined far exceed the assimilative capacity of the Raisin River, discharging wastes equal to the oxygen demand of sewage from a population of 225,000. They also contain excessive densities of coliforms, at times exceeding 1 million organisms per 100 ml. These densities are of particular concern because of the Lake Erie bathing beaches at the mouth of the Raisin. The Ford Motor Company discharges 1,075 pounds of cyanides and 4,080 pounds of toxic metals each day, and, under summer flow conditions, the large discharge from Ford comprises nearly the entire flow in the lower Raisin River. The oil from Ford, although low in concentration due to dilution in the waste canal, is large in quantity--870 gallons/day. These wastes may severely hinder the propagation of aquatic life in the Raisin River and the nearby lake waters.

Below is a tabulation of the industrial waste loadings in the Raisin River which would result if excessive concentrations of certain constituents were

reduced to meet International Joint Commission effluent recommendations and a suspended solids effluent limit of 35 mg/l.

POLLUTANT	PRESENT LOADING	LOADINGS AFTER REDUCTION	PER CENT REDUCTION
Iron	35 pounds/day	35 pounds/day	0
Oil	870 gals/day	870 gals./day	0
Phenols	22 pounds/day	7,400 lbs./day	70
Suspended Solids	23,500 lbs./day	7,400 lbs/day	68

STORMWATER OVERFLOW

All along the Lake Erie shorefront are pumping stations designed to receive surface drainage and automatically discharge it, untreated, into Lake Erie during or following rainfall and heavy surface runoff. Sampling of the discharge of these stations revealed that sewage from direct discharge or from improperly operating septic tank installations reaches the stations along with surface storm runoff.

The City of Monroe has separated its sewers, but a portion of the sanitary sewers still receives roof

runoff from residences and commercial establishments. This places a burden on the sewage treatment plant and any waste load above 10 MGD is bypassed to the Raisin River, receiving chlorination only. In addition, a flood relief pumping station on the Raisin River interceptor functions when unusually high rainfall or flood stage of the river inundates the sanitary sewer to the plant. Both of these operations contribute untreated wastes to the River.

Coliform data from the mouth of the Raisin River were evaluated with respect to rainfall in the Monroe area. In the lower part of the River steady industrial and municipal waste contributions overshadowed any noticeable effect of rain on bacterial water quality. The effect of rainfall on the River above known sources of pollution, however, was strongly adverse, as in late August, 1963, when heavy rains caused the flood pumping station to operate for one hour, and coliform densities jumped to 10 and 20 times the normal levels. In times of moderate rainfall slight rises in coliform densities were noticed in the upper Raisin River, for relatively short periods of time.

SHOREFRONT HOMES

Estimates of the number of unsewered shorefront homes that discharge sewage directly, or from improperly functioning septic tanks, to Lake Erie or its tributaries were made in 1962 conference transcript. Consultation with personnel of the Monroe County Health Department revealed several tributaries, including Plum Creek and Sandy Creek, which receive such wastes directly and via county surface drains. Much of the Lake Erie shoreline from Maple Beach to below the Raisin River, outside of the sewered area of the City of Monroe, is so affected. Surface drainage polluted with sewage reaches the Raisin River above the City of Monroe through county drains which permit discharge into the river during wet and, in some reported cases, dry conditions.

Individual reports will be made on the effects of this type of pollution in the Maple-Milleville Beach and Sterling State Park Beach areas (see Special Studies). In general it can be stated that these sources of wastes adversely affect water quality at Lake Erie bathing beaches, especially in times of rainfall and specific wind conditions favoring retention of the polluted wake along the shorefront.

POLLUTION FROM BOATS

Commercial and pleasure boats make heavy use of the Michigan waters of Lake Erie. All such craft represent potential sources of pollution from oil and human wastes. The files of this Project contain reports of oil spills which appeared to originate in the middle of the Lake waters under study, undoubtedly from boats.

ENRICO FERMI ATOMIC REACTOR

The Enrico Fermi Atomic Reactor, designed to generate electric energy for domestic and industrial use, is not now in active operation but is expected to produce power sometime in 1965. Both radioactive and domestic wastes are adequately treated, and create no interference with water use.

Domestic wastes from the 150 employees of this installation are treated by a secondary treatment plant. Over 90 per cent of the BOD is removed by this plant, which now operates under its design capacity of 75,000 gallons per day. Operating records are sent to the Michigan Department of Health for review.

The only radioactive wastes originating in the plant are from biweekly steam cleaning of the

reactor sub-assembly, and over 00 per cent consists of sodium 24 with a half-life of 15 hours. Treatment is provided by storage for 9 days in a surge tank. . The effluent is then bled off at a rate determined by the radioactivity remaining in the tank and discharged to Lake Erie through a dilution canal off a lagoon in Swan Creek. Automatic monitoring devices operate continually and prevent discharge of highly concentrated radioactive material to the receiving waters. In the event radioactivity is too high after 9 days storage for discharge into the receiving waters, additional storage equal to three months' capacity is available.

TRIBUTARIES TO LAKE ERIE

Tributaries to Lake Erie are large sources of its pollution. The major source, the Detroit River, has been described in detail in Section V of this report. U. S. waters of the Detroit contribute over 95% of the pollution of the Michigan waters of Lake Erie. Other tributaries considered in this study include the Raisin River, Huron River, Swan Creek, Stony Creek, Sandy Creek, Plum Creek, and LaPlaisance Creek. Table 15-VI summarizes average quantitative loadings for each of these tributaries for total coliform organisms.

(Tables 15-VI and 16-VI follow.)

TABLE 15-VI. AVERAGE COLIFORM LOADINGS
TRIBUTARIES TO MICHIGAN LAKE ERIE

Tributary	Average Coliform Loading BPE*
Detroit River**	77,000
Huron River	317
Swan Creek	10
Stony Creek	51
Sandy Creek	47
Raisin River	4,500
Plum Creek	47

* One BPE = 200 billion coliform organisms

** United States waters

TABLE 16-VI. AVERAGE STREAM LOADINGS
TRIBUTARIES TO MICHIGAN LAKE ERIE

	Detroit River		Huron River		Raisin River	
	Concentration*	Loading*	Concentration*	Loading*	Concentration*	Loading*
Chlorides	23	10,100,000	36	89,200	28.6	141,000
Phosphate	0.53	218,000	1.71	4,240	.36	1,770
Nitrates	0.27	109,000	0.28	694	.13	640
Ammonia	0.33	133,000	0.26	645	.39	1,920
Organic Nitrogen	0.18	72,600	0.13	322	.27	1,330
Suspended Solids	21	8,600,000	4	9,920	9.7	47,800
Settleable Solids	18	7,200,000	-	-	2.9	14,300
Phenols	4.9	2,100	3.1	8	7.1	35
Iron	0.62	260,000	.09	223	0.78	3,840

* Concentration in mg/l, except phenols, which are in ug/l. Detroit River average concentrations are adjusted to flow for the entire United States section at the mouth.

* Loadings in pounds per day.

Table 16-VI summarizes average values and loadings for the Detroit, Huron, and Raisin Rivers, the largest tributaries, for phosphates, nitrogen compounds, phenols, chlorides, suspended solids, cyanides, and iron. Three intensive studies, or surveys, done of the Raisin River are discussed under "Special Studies."

The Huron River is a contributor of wastes high in coliform densities, phosphates, and nitrogen compounds. However, the Project was unable to demonstrate specific adverse effects on the Michigan waters of Lake Erie directly attributable to the Huron. The Huron River discharges into a large marsh at Pointe Mouillee which is subject to backwater from the already polluted waters of the Detroit River. Retention in the Pointe Mouillee marsh prevents the identification of Huron's share of nutrient and coliform loadings. Any change in water quality in Lake Erie due to the Huron is masked by other sources of pollution. After sources of pollution in the Detroit River have been eliminated or substantially controlled, the real contribution of the Huron River may be ascertained.

SPECIAL STUDIES

Several special studies were made in areas where pollution problems were not clearly defined by routine investigation of water quality and waste sources. Included in these activities were three intensive surveys of the Raisin River, a pollution study of the Maple-Milleville Beach area, collection and analysis of bottom deposits in the Lake, determination of distribution of currents in Michigan Lake Erie, a study of rooted aquatic plants, and a special pollution investigation of the Sterling State Park bathing beaches.

RAISIN RIVER INTENSIVE SURVEYS

Three intensive surveys of the Raisin River were conducted by Project personnel during winter and summer months. Figure 13-VI shows the sampling stations on a map of the Raisin River; and Tables 17-VI through 19-VI summarize the results.

(Tables 17-VI through 19-VI follow.)

TABLE 17-VI. SUMMARY OF RESULTS
RAISIN RIVER SURVEY NUMBER 1
NOVEMBER 16 THROUGH DECEMBER 12, 1962

Station	Average Flow (cfs)	Geometric Mean Coliform Densities org./100 ml	Average Phenol µg/l	Average Chloride mg/l	Average Iron mg/l	Average Suspended Solids mg/l	Average Cyanides mg/l
T80 (mouth)	330	1,350	5.8	24.7	.78	5	.07
T81	330	3,030	6.0	24.6	.80	9	.24
T82	160	33,900	6.4	23.8	.46	36	.46
T83	148	101,000	9.6	23.9	.28	10	0
T84	135	3,100	3.8	23.2	.18	5	0
T85	134	4,100	7.0	23.0	.15	5	-
T86	132	4,000	4.6	23.2	.07	5	-
T87	132	3,700	2.6	22.2	.18	6	-
T88	132	3,140	8.6	22.7	.09	4	-
T89	132	547	3.5	21.8	.10	2	-
T90	132	295	4.8	21.5	.17	13	0

	COD mg/l	Phenol µg/l	Chloride mg/l	Iron mg/l	Average Suspended Solids mg/l	Cyanides mg/l
Consolidated Paper Company - North Plant	267	0	32	0.16	99	-
Consolidated Paper Company - South Plant	13-310	0-13	23-90	0.09-0.72	17-234	-
Mason Run (Consolidated North and Union-Bag Camp Company)	504	49	23	1.22	298	-
Ford Motor Company	22-35	0	23-27	0.10-0.25	3-8	1.3

TABLE 18-VI. SUMMARY OF RESULTS
RAISIN RIVER SURVEY NUMBER 2
JUNE 9 THROUGH JUNE 12, 1963

Station	Average Flow (cfs)	Geometric Mean Coliform Densities org./100 ml	Average Phenols µg/l	Average Chlorides mg/l	Average Suspended Solids mg/l
T80 (mouth)	868	120,000	8.6	32.6	8
T81	868	150,000	5.0	26.8	12
T82	704	170,000	23.8	45.2	59
T83	682	57,000	3.6	29.2	37
T84	668	7,800	4.4	41.8	54

Station	Average Flow (cfs)	Average Cyanides mg/l	Average BOD mg/l	Average Copper mg/l	Average Nickel mg/l
T80 (mouth)	868	.03	7.6	.16	.02
T81	868	.30	14.4	.22	.01
T82	704	0	24.8	.06	.03
T83	682	<.01	10.0	.02	.02
T84	668	.01	8.4	.03	.03

Station	Average Flow (cfs)	Average Zinc mg/l	Average Lead mg/l	Average Chromium mg/l	Average Cadmium mg/l
T80 (mouth)	868	.02	<.01	.01	-
T81	868	.04	.01	.02	-
T82	704	.10	.04	<.01	<.01
T83	682	.06	.01	<.01	<.01
T84	668	.01	<.01	<.01	<.01

TABLE 19-VI. SUMMARY OF RESULTS
RAISIN RIVER SURVEY NUMBER 3
AUGUST 26 THROUGH AUGUST 29, 1963

Station	Average Flow (cfs)	Geometric Mean Coliform Densities org./100 ml	Average Phenols µg/l	Average Suspended Solids mg/l
T80	245	30,000	6.8	16
T82	72	200,000	26.0	30
T83	60	420,000	19.8	55
T84	46	430,000	12.0	31
T86	45	17,000	99.8	9
T88	45	16,000	15.0	8
T89	45	720	2.5	3

	Coliform Densities org./100 ml	Suspended Solids mg/l	Settleable Solids mg/l
Mason Run (Consolidated North and Union-Bag Camp Company)	26,000-50,000	108-203	11-115
Consolidated Paper Company - North Plant	6,200-190,000	192-670	0-180
Consolidated Paper Company - South Plant	100-5,000,000	21-637	0-567
Monroe Paper Products	2,000-80,000	43-372	15-359
Monroe Sewage Treatment Plant	20,000-420,000	23-31	0-2

Major waste sources are introduced to the river between station T83 and T84 (Monroe Sewage Treatment Plant and Consolidated Paper Company, South Plant) and between stations T82 and T83 (Consolidated Paper Company, North Plant, Union-Bag Company and Ford Motor Company). Wastes from the Monroe Paper Products enter the river between T88 and T89.

From the upstream stations to station T84 (above most waste sources) coliform densities in the river averaged under 20,000 organisms per 100 ml during all surveys and under 5,000 organisms per 100 ml during two. Below station T84 average values were over 100,000 organisms per 100 ml during all surveys. The backwater effect of the Lake increased volume of low bacterial industrial waste from the Ford Motor Company reduced coliform densities at the mouth to values of 1,350 organisms per 100 ml during winter months and to 30,000 and 120,000 organisms per 100 ml during summer months.

In June, 1963, effluent of the Monroe Sewage Treatment Plant was monitored and had a geometric mean of only 105 coliform organisms per 100 ml during the survey. Nevertheless, an increase between station T84 and T83 of 7,800 to 57,000 organisms per 100 ml was observed. This testifies to the extreme influence of the

effluents from the paper mills along the Raisin River upon its coliform density and bacterial water quality.

High concentrations of suspended and settleable solids were noted in the effluents of all paper mills, but not in that of the Ford Motor Company or Monroe Sewage Treatment Plant. Cyanides from one Ford effluent were excessive, at 1.3 mg/l. Iron concentrations in all effluents were low but the average value at the mouth was high, at 0.78 mg/l. Analysis of toxic metals during survey number two indicated substantial quantities of copper, nickel, and zinc. The following table is a summary of amounts of wastes discharged into the Raisin River between station T89 and the mouth, compared to the increase in stream loadings between those two points.

CONSTITUENT	WASTE SOURCES POUNDS/day	INCREASE IN LOADINGS, POUNDS/DAY
Phenols	24	15
Chlorides	19,600	60,000
Cyanides	1,050	135
BOD	49,000	35,600
Iron	40	1,300
Suspended Solids	23,300	20,600

The two-mile stretch of the Raisin River immediately above its mouth receives large quantities of industrial and domestic wastes, and is not only grossly polluted, but also seriously degrades an area of Lake Erie near its mouth. Waste constituents discharged to the River are high in coliform, suspended solids, and cyanide concentrations, and include large quantities of oxygen-consuming substances, as evidenced by the discharge of 49,000 pounds per day of BOD (equivalent in oxygen-consuming capacity to the untreated wastes of a population of about 225,000). The lower Raisin River is frequently completely devoid of dissolved oxygen, resulting in a continuous state of putrefaction during the summer months. All uses of the Raisin River except waste disposal and navigation have been eliminated by pollution, and deposits of settleable solids at the mouth interfere with these uses to the extent that annual dredging is required to remove bottom material and keep the channels open for ship movement.

Bacterial counts in the lower River are excessively high and represent prohibition of any possible recreational use of the water. The effect of the Raisin River upon Lake Erie is seen in the enrichment of the waters of the western basin and in high coliform levels

at bathing beaches near its mouth (including Sterling State Park).

BOTTOM DEPOSITS

From the mouth of the Detroit River to Pointe Mouillee, extending as far eastward as the Detroit River Light, the bottom is in poor condition. From Pointe Mouillee to Stony Point, in the center of Swan Creek Bay and in the deep water east of Stony Point, the bottom is in fair to poor condition. From Stony Point to the Raisin River, there are poor areas of bottom condition in the center of Brest Bay and in the deeper water directly east of the mouth of the Raisin River. The condition of the bottom is very poor at the mouth of the Raisin River. Below the Raisin River south to Otter Creek the bottom is in fair condition near the shore and poor offshore. From Otter Creek to the south end of the Michigan waters the bottom is fair to good condition.

Along the United States shore near the mouth of the Detroit River there is a large area whose bottom condition is poor. This area, extending from the Trenton Channel past Pointe Mouillee as far east as the Detroit River Light and southerly to the center of Swan Creek,

indicates the contribution of the effluent of the Trenton Channel.

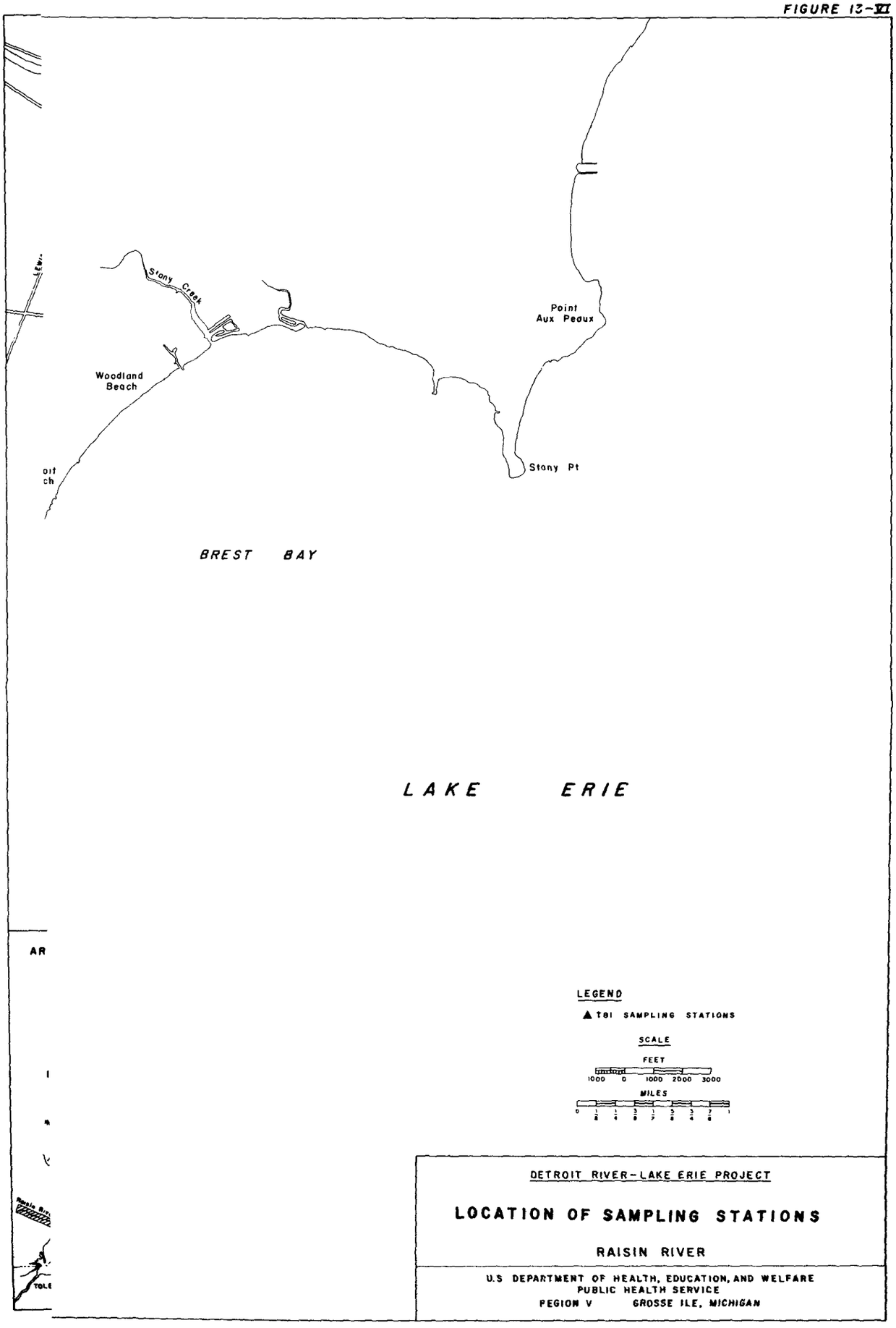
Figure 14-VI shows bottom conditions as contours.

Tables 20-VI through 25-VI summarize bottom deposits in the Raisin River and various segments of Michigan Lake Erie.

In addition to the results shown in these tables, analysis of the bottom deposit supernatant was made for phenol, phosphate, nitrate, and ammonia concentrations and all these factors, including field observations, were considered in evaluating bottom conditions.

(Figure 13-VI, Figure 14-VI; Tables 20-VI through 25-VI follow.)

FIGURE 13-VI



DETROIT RIVER-LAKE ERIE PROJECT

LOCATION OF SAMPLING STATIONS

RAISIN RIVER

U.S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN

FIGURE 14-VI

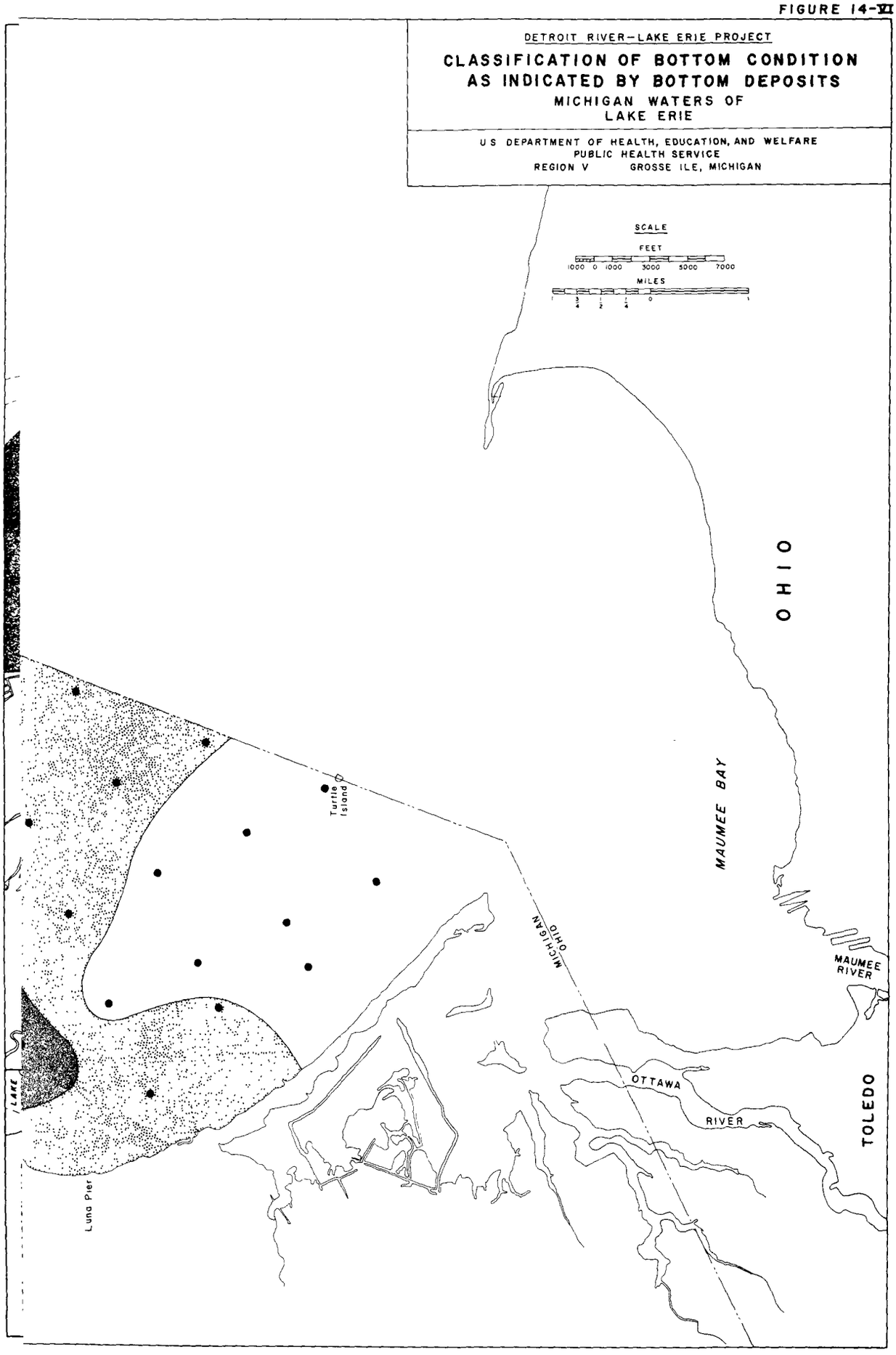

DETROIT RIVER–LAKE ERIE PROJECT
CLASSIFICATION OF BOTTOM CONDITION AS INDICATED BY BOTTOM DEPOSITS
MICHIGAN WATERS OF LAKE ERIE
U S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION V GROSSE ILE, MICHIGAN
SCALE
FEET
1000 0 1000 3000 5000 7000
MILES
OHIO
MAUMEE BAY
MAUMEE RIVER
TOLEDO
OTTAWA RIVER
MICHIGAN
OHIO
Turtle Island
Luna Pier
LAKE

TABLE 20-VI. SUMMARY OF BOTTOM MATERIALS - MICHIGAN LAKE ERIE
MOUTH OF DETROIT RIVER TO POINTE MOUILLEE

	Number of Samples	Maximum	Minimum	Mean	Remarks
pH					Small area of 7.2 near navigation channel.
Inshore	12	7.6	7.2	7.4	
Offshore	13	9.2	6.6	7.5	
% IRON					High (9%) Pointe Mouillee area.
Inshore	10	9.98	<.01	3.86	
Offshore	9	6.11	.28	2.77	
% OIL AND GREASE					Very high near Detroit River Light off Pointe Mouillee.
Inshore	12	1.12	.03	.65	
Offshore	12	1.05	.01	.45	
% TOTAL VOLATILE SOLIDS					Fair condition.
Inshore	12	10.7	1.1	6.07	
Offshore	13	8.1	2.0	5.29	

CONCLUSION: Bottom is in poor condition on the American side extending as far eastward as the Detroit River Light. River is widening and losing velocity throughout this area allowing solids to settle out.

TABLE 21-VI. SUMMARY OF BOTTOM MATERIALS - MICHIGAN LAKE ERIE
POINTE MOUILLEE TO STONY POINT

	Number of Samples	Maximum	Minimum	Mean	Remarks
pH					
Inshore	10	7.7	7.2	7.49	
Offshore	25	7.8	7.4	7.53	
% IRON					
Inshore	10	3.20	.02	1.22	
Offshore	24	4.82	.01	2.13	
% OIL AND GREASE					Low nearshore; higher values in center of Swan Creek Bay and east of Stony Point.
Inshore	10	.60	.01	.26	
Offshore	24	.99	.02	.38	
% TOTAL VOLATILE SOLIDS					Fair as far south as Stony Point and poor (10%) east of Stony Point.
Inshore	10	12.0	5.8	8.8	
Offshore	25	13.2	2.0	7.3	

CONCLUSIONS: Bottom is in fair to poor condition with poor areas in center of Swan Creek Bay, and in deep water east of Stony Point. Both areas favor the settling of solids because of reduction in current velocity.

TABLE 22-VI. SUMMARY OF BOTTOM MATERIALS - MICHIGAN LAKE ERIE
STONY POINT TO RAISIN RIVER

	Number of Samples	Maximum	Minimum	Mean	Remarks
pH					6.7 center Brest Bay.
Inshore	7	7.8	7.2	7.41	
Offshore	27	7.6	6.9	7.3	
% IRON					High west of Stony Point and center of Brest Bay.
Inshore	8	6.30	.002	2.48	
Offshore	24	9.50	.02	2.84	
%OIL AND GREASE					Low nearshore; high in center of Brest Bay.
Inshore	8	1.2	.03	.23	
Offshore	25	1.0	.02	.36	
% TOTAL VOLATILE SOLIDS					High in deep water south of Stony Point and in center of Brest Bay.
Inshore	7	13.4	1.0	6.86	
Offshore	26	18.3	2.8	9.12	

CONCLUSION: A poor area exists in the center of Brest Bay and in deeper water directly east of the Raisin River mouth. Shoreline areas are fair to good.

TABLE 23-VI. SUMMARY OF BOTTOM MATERIALS - MICHIGAN LAKE ERIE
RAISIN RIVER

	Number of Samples	Maximum	Minimum	Mean	Remarks
% IRON	4	6.30	2.30	4.33	High 4% in Raisin and around mouth.
% OIL AND GREASE	4	2.74	2.0	1.06	High in Raisin River.

CONCLUSIONS: Condition of bottom is very poor in the Raisin River.

TABLE 24-VI. SUMMARY OF BOTTOM MATERIALS - MICHIGAN LAKE ERIE
RAISIN RIVER TO OTTER CREEK

	Number of Samples	Maximum	Minimum	Mean	Remarks
pH					7.8 to 8.0 nearshore.
Inshore	4	8.0	7.4	7.6	
Offshore	19	7.7	7.1	7.3	
% IRON					Low values.
Inshore	3	1.24	.003	.47	
Offshore	17	3.1	.006	1.22	
% OIL AND GREASE					Low values throughout.
Inshore	4	.13	.01	.07	
Offshore	19	.86	.02	.15	
% TOTAL VOLATILE SOLIDS					Poor condition
Inshore	3	13.0	4.8	8.3	
Offshore	19	18.3	1.3	6.5	

CONCLUSION: Bottom is in fair condition nearshore and poor offshore.

TABLE 25-VI. SUMMARY OF BOTTOM MATERIALS - MICHIGAN LAKE ERIE
OTTER CREEK TO SOUTH END OF MICHIGAN AREA

	Number of Samples	Maximum	Minimum	Mean	Remarks
pH					7.2 to 7.4; 6.8 to 6.9
Inshore	8	7.8	6.9	7.3	nearshore south of
Offshore	19	7.4	6.8	7.2	Otter Creek.
% IRON					Low except nearshore
Inshore	5	4.82	.004	1.50	south of Otter Creek.
Offshore	15	5.50	.008	2.28	
% OIL AND GREASE					Low values except
Inshore	6	.56	.007	.14	south of Otter Creek.
Offshore	16	.34	.02	.15	
% TOTAL VOLATILE SOLIDS					Good condition - 4 to
Inshore	8	7.2	3.3	4.94	6%.
Offshore	17	30.0	3.1	7.56	

CONCLUSION: Bottom is good to fair except for a poor area nearshore south of Otter Creek.

Richard D. Vaughan

HYDROLOGIC STUDIES

Special hydrologic investigations were made of the Michigan waters of Lake Erie to show the relationship between sources of wastes and areas affected by pollution. Of special interest was the path of dispersion of the waters of the Detroit River into Lake Erie under varying weather conditions. Rhodamine B fluorescent dye and a fluorometer were used in conjunction with surface and subsurface floats or drogues to assist in this determination.

Wind is the primary factor influencing water movement in the open water sections of Lake Erie. The response of surface waters to wind changes is very rapid. Few instances of carryover effect due to differing wind conditions preceding a survey were noted.

The Detroit River outlet into the Lake is a strong factor influencing currents in the immediate area of its debouchment, diminishing rapidly beyond the Detroit River Light. Wind effects are noted as far north as Project sampling range DT 3.9, although the River current is by far the greater influencing force at this point. South of Pointe Mouillee wind forces predominate over Detroit River current.

Seiches and wind affect the shallow areas and mouths of tributaries, causing inward and outward water movement independent of the prevailing current patterns in open-water sections of the Lake. These estuarine-like movements are local in effect, from a current pattern standpoint, but may be much more extensive in terms of water quality, as is the case with the Raisin River.

Vertical temperature profiles, taken regularly during dye vector work, showed nothing suggesting stratification, so that surface current pattern results were assumed to apply to the water mass as a whole. Horizontal surface temperature profiles calculated in the northern section of the study area support fluorometric and dye vector study results closely.

The prevailing wind direction on the Michigan waters of Lake Erie is southwest, occurring 24 per cent of the time on a ten-month basis (March through December). Winds with a southerly component, namely those from the southeast, south, and southwest, account for 50 per cent of the total. During the months of June, July, and August, when recreational water uses are at a peak, southwest winds and winds with a southerly component occur

19 per cent and 49 per cent of the time, respectively. These values are somewhat lower than the ten-month average, possibly because calm and near-calm conditions are more frequent during the summer than during the year as a whole.

Figures 15-VI through 18-VI depict current patterns in the Michigan waters of Lake Erie determined under varying wind conditions. The description of the wind direction (i.3. south wind) indicates the direction from which the wind blows; a south wind comes out of the south and blows toward the north. The large arrows denote the dispersion of Detroit River currents, while the small arrows indicate lake currents considered to be outside of the influence of the Detroit River.

A narrative description of the observed currents under each set of wind conditions follows with an estimate of the frequency of occurrence of the specific wind conditions.

(Figures 15-VI through 18-VI follow.)

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