OIL POLLUTION

SOUTHERN END OF LAKE MICHIGAN

SEPTEMBER 17-26, 1967

SUMMARY REPORT

OCTOBER 5, 1967

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SUMMARY OF INVESTIGATIONS

September 18 newspaper accounts indicated that oil pollution had interfered with water sports in Lake Michigan and with swimming at several of the beaches on Sunday, September 17. A few complaints were received by the FWPCA and the Chicago Program Office made observations of the Lake and beaches between Jackson Park Beach and the Indiana Harbor Ship Canal. No oil pollution was observed at Jackson Park Beach at that time but Coast Guard personnel stated that oil had been observed earlier Monday at Jackson Park but had washed away. Oil pollution was reported to have been heaviest on Sunday.

On the same day, Monday, September 18, Chicago Program Office personnel took two Chicago American reporters from the Calumet Park Coast Guard Station directly across the Lake to Indiana Harbor and up the Indiana Harbor Canal, departing at 9 a.m. On the way, they observed small patches of oil. Upon arrival at Indiana Harbor, they observed minor oil films of less magnitude than normally observed and the stream was cleaner than usual. On the return trip, a few patches of oil were observed on the Lake. Also, some patches of fine silt-like material were observed near the Commonwealth Edison plant. No samples were taken on this trip.

The following day, newspapers reported heavy "slugs" of congealed oil on a number of beaches. Patches of oil were also reported off Howard, Devon, Belmont and Fullerton and between 31st and 50th Streets. Coast Guardsmen used four boats and a plane from the Traverse City air Station to sight and chart the oily concentrations which "ranged in size from small patches covering a few feet to huge slicks estimated at 300 feet wide and 1,500 feet long." The U. S. Coast Guard also called the FWPCA to report that they had observed a large oil slick on Lake Michigan starting at Indiana Harbor and extending northward for about five miles.

The Coast Guard vessel had been dispatched and samples were collected. Two men from the Coast Guard were sent to the Indiana Harbor area to see if they could locate the source of oil pollution.

The Coast Guard requested analysis by FWPCA of twelve oil samples which they had collected. They were advised that the only analysis the Chicago Program Office could provide would be a comparison between samples. If the oil found on the Lake was compared to the oil from either a production or waste source, identification could be made by infrared spectra to determine if the two samples were the same oil. The laboratory is not equipped to make a complete identification of a specific type of oil.

The FWPCA also continued its investigation. Field men from the Calumet Area Surveillance Unit who collect samples in this area every week reported that the oil in Indiana Harbor and the Canal on Tuesday and Wednesday, September 19 and 20, was worse than they had ever seen previously even though they always see oil in this area.

Patches of oil were observed on the Lake and increased in frequency as the crew approached the Indiana Harbor Canal. These oil patches consisted of very thin films of oil gradually increasing to one large oil slick near the mouth of the Indiana Harbor. Passing into the Indiana Harbor Canal, the wake of the boat was chocolate colored with less than the usual amount of foam. At the edge of the wake a very black border of oil was observed. Oil spread completely across the Harbor.

Visible oil covered the entire Indiana Harbor Canal, and unusual amounts of surface oil were visible on the Lake George Channel. They also observed that bottom dredging was occurring in the Canal upstream from the Forks and portions of the dredged materials were displaced from the operation and floating down the Canal. They also observed oil pollution upstream from the dredging site as well as in the Lake George branch of the Canal.

Over the next several days, newspapers continued to report the oil slick as being the worst case of pollution ever seen in Lake Michigan. Many suggestions were made as to possible sources of the oil pollution but no single source has been identified at this time. The coast Guard and FWPCA both continued with their investigations and collected samples from the Lake, beaches and in the Indiana Harbor Area. These sampling points are shown in Figure 1 and the analytical results are discussed in detail under Laboratory Results and Findings.

Several meetings were held by the FWPCA and by the U. S. Coast Guard with each other, with the U. S. Corps of Engineers and with water pollution representatives of Illinois, Indiana and Chicago to discuss possible solutions to the problems. One of the points brought out by the Chicago Water Department and verified by the U. S. Weather Bureau was that from September 11 to September 20, the winds were of low velocity and predominantly from the south to southeast. This lent support to the view of the Chicago Program Office of FWPCA that much of the oil pollution had originated in the Indiana Harbor area and had been blown out into the Lake by prevailing southerly winds.

REPORT OF WIND CONDITIONS

AT SOUTH DISTRICT WATER FILTRATION PLANT, 79th STREET, 2,000' FROM SHORE

Date		
11	SSE	10 mph
12	SSE	15 mph
13	SSE	16 mph
14	SSE	16 mph
15	SSE	15 mph
16	SSE	8 mph
17	SSE	8 mph
18	SSE	11 mph
19	SSE	10 mph
20	S	15 mph

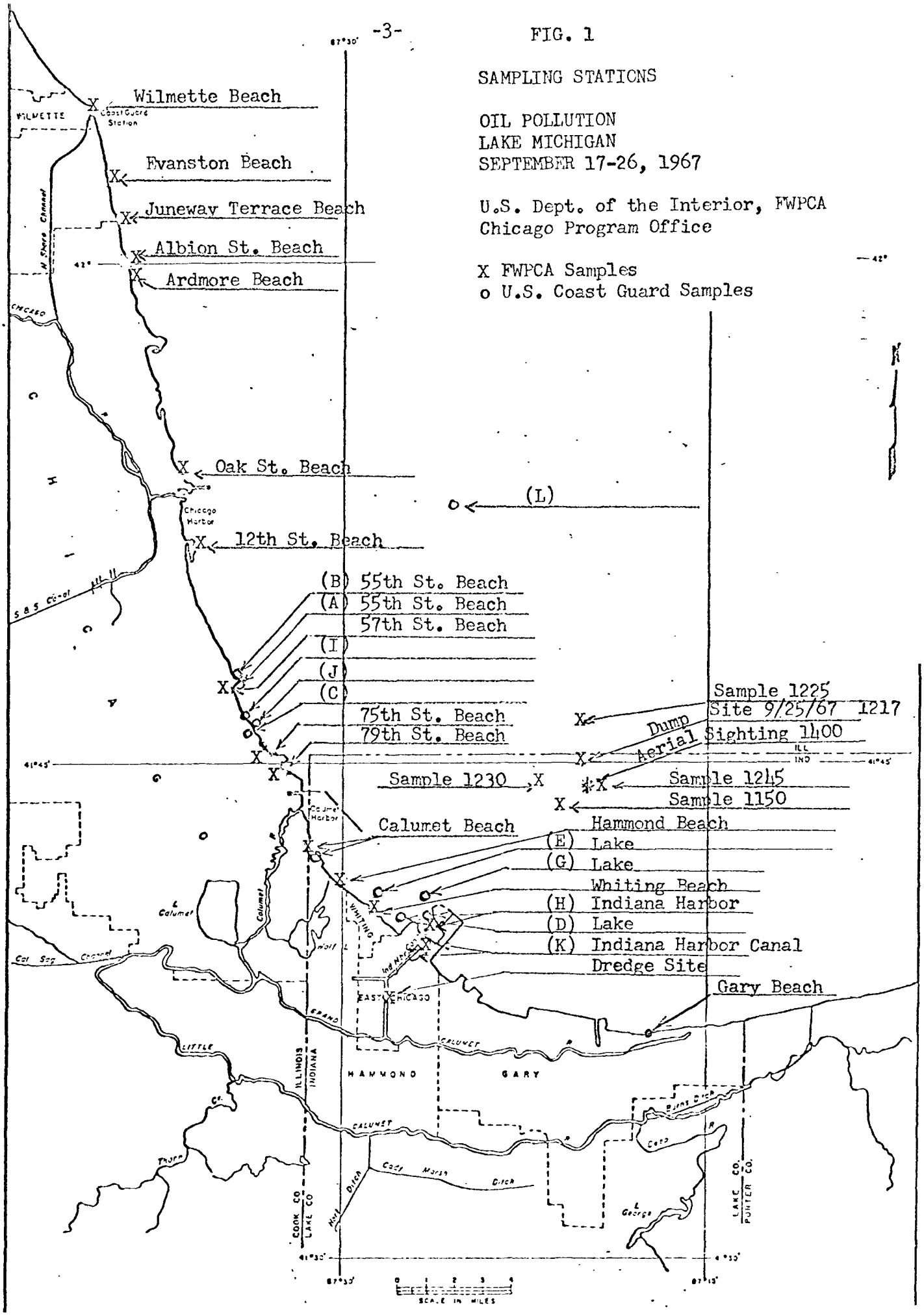
FIG. 1

SAMPLING STATIONS

OIL POLLUTION
LAKE MICHIGAN
SEPTEMBER 17-26, 1967

U.S. Dept. of the Interior, FWPCA
Chicago Program Office

X FWPCA Samples
o U.S. Coast Guard Samples



AT MIDWAY AIRPORT

Date	Wind Direction	Wind Speed (Knots)
14	S to SE	10
15	SE	10
16	E	8
17	E	7
18	E	7
19	S	5
20	S	10
21	NW (Wind Shifted from S to NW) (around noon)	12

AT MEIGS FIELD

14	SE	10
15	S	12
16	E	10
17	ENE	10
18	ESE	10
19	S	10
20	SW	15
21	NW	12

The Coast Guard expressed interest in the possible use of chemical dispersants to emulsify the oil and "eliminate" the oil slicks. The FWPCA was definitely opposed to the use of any such material. Emulsification of the oil creates a worse problem in that emulsified oil is more hazardous to biological life than the presence of oil on the surface. In addition, such emulsions eventually break and the oil returns to the surface of the water. An alternative process which would receive favorable consideration by FWPCA would be the use of shredded polyeurethane foam to absorb the oil. The oil-soaked foam could then be trapped and lifted from the surface of the water.

A meeting was held on Friday, September 22 between the FWPCA and the Corps of Engineers. The FWPCA presented their proposal for placing a boom across the Indiana Harbor Channel to control oil discharged into Lake Michigan. It was recognized that this would not control all of the oil discharged but it was felt that it would eliminate a large portion of the floating oil. Skimmers would be used behind this boom to remove the oil which would accumulate in the harbor. The problems involved with installing and operating such a boom were discussed. The Corps of Engineers indicated their interest in this proposal and stated they would take it up with higher authority. The problem of dredging in the Indiana Harbor Canal was also discussed. FWPCA analysis of bottom sediments in Indiana Harbor Canal prior to the dredging operation indicated that the material at 11 sampling points sampled in June 1967 ranged from 17 to 48% of carbonaceous oxygen demanding material with an oil and grease content

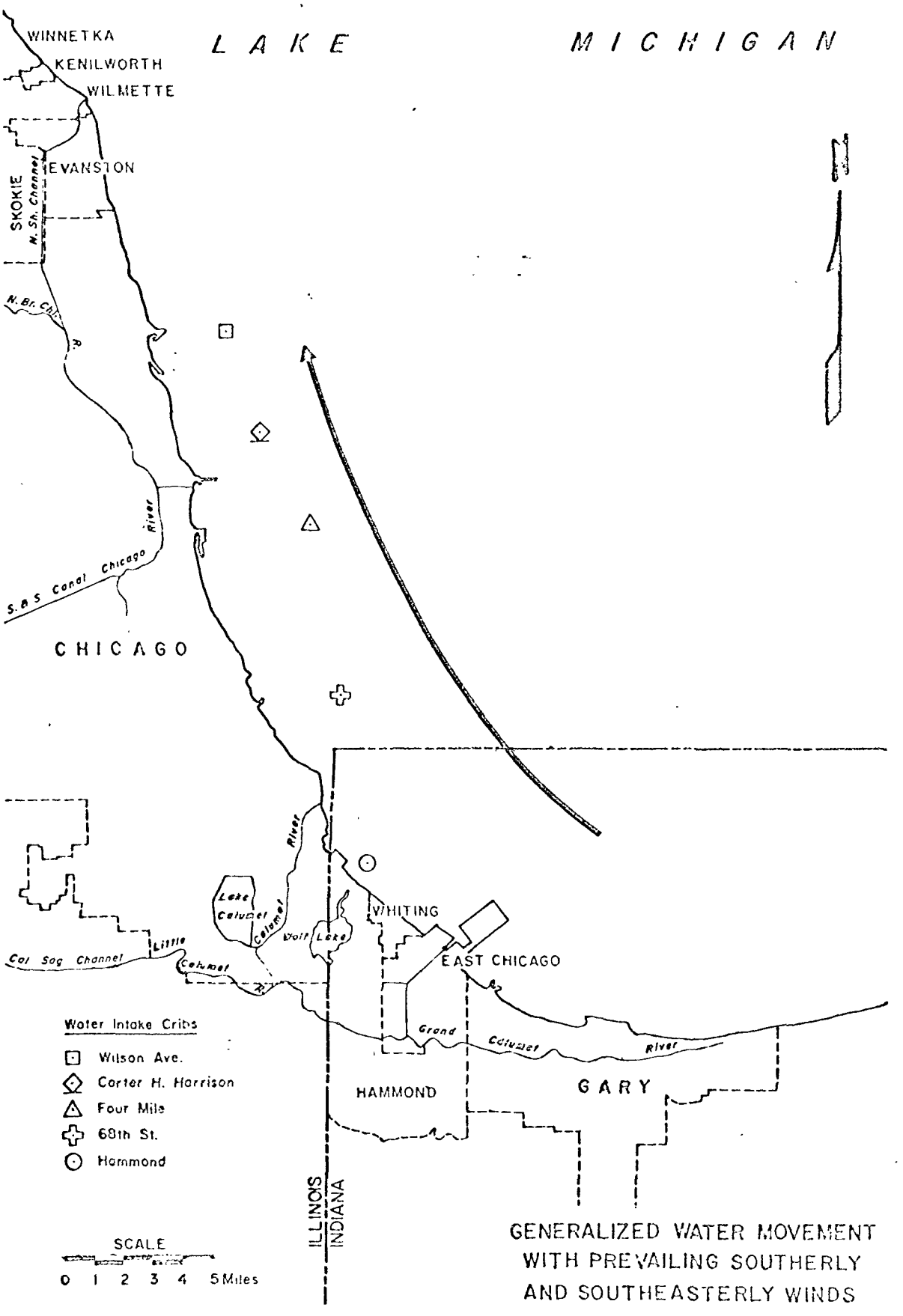

LAKE MICHIGAN
WINNETKA
KENILWORTH
WILMETTE
EVANSTON
SKOKIE
N. Sh. Channel
N. Br. Chi. R.
S. B. S. Canal
Chicago River
CHICAGO
Lake Calumet
Calumet River
Wolf Lake
Little Calumet
Cal Sag Channel
WHITING
EAST CHICAGO
Grand Calumet River
HAMMOND
GARY
ILLINOIS
INDIANA
Water Intake Cribs
Wilson Ave.
Carter H. Harrison
Four Mile
68th St.
Hammond
SCALE
0 1 2 3 4 5 Miles
GENERALIZED WATER MOVEMENT
WITH PREVAILING SOUTHERLY
AND SOUTHEASTERLY WINDS

Figure 2

between 3 and 17%. See Table 1. FWPCA officials were alarmed at this figure and felt that this material should not be placed in the Lake. Corps of Engineers representatives said that if the dredging operation was to be halted it would mean cancellation of a contract with a severe penalty and would have to be taken up with a higher level of authority within their organization. They requested that we complete our analysis comparing dredged material with the materials found on the beaches as rapidly as possible so that if this dredging operation was one of the major contributors to oil pollution it could be eliminated within the minimum possible time.

The beach conditions observed on September 22 were as follows:

1. Gary Beach - clean.

2. Hammond Beach had a moderate number of globules of this tar-like material. (One piece about 1 inch in diameter and from 1/4" to 1" in thickness per square yard).

3. Whiting Beach. (See 5.)

4. Calumet Park-Inner 100th Street. (See 5.)

5. 75th Street Beach. (Whiting, Calumet and 100th Street had one globule of thin, tar-like oil about 1 inch to 1 1/2 inches in diameter per four square yards.)

6. 79th Street Beach was the same as Hammond Beach.

7. There were a large number of globules of thin tar-like material all over 57th Street Beach, ranging in size from 1/2 inch to 3 or 4 inches in diameter and from 1/4" to 1" in thickness.

8. There was no evidence of this material or oily material at the 12th Street Beach.

9. Oak Street Beach was the same as 12th Street Beach.

10. The conditions at Ardmore Street Beach (5800 N) were similar to those observed at 57th Street Beach. The amount of the tarry material present was somewhat less but the size of the globules were larger.

11. Albion Street Beach (6600 N) was the same as at Ardmore.

12. Juneway Terrace Beach (7800 N) was clean.

Table 1a

ANALYSES OF BOTTOM SEDIMENTS
Indiana Harbor Canal
June 14, 1967
Results expressed as mg/kg

Sample No.	1		2		3		4		5	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
% T. Solids	39.6		37.8		67.8		59.0		54.5	
% T. Vol. Solids		19.7		20.2		9.2		9.5		16.0
NH_3-N	216	545	235	622	48	71	103	175	142	260
NO_3-N	3.0	7.6	3.0	7.9	3.0	4.4	5.0	8.5	3.0	5.5
Org-N	630	1591	576	1525	390	575	367	622	908	1665
T. Sol. PO_4	6	15	6	16	2	3	5	8.5	6	11
T. PO_4	1550	3920	3390	8970	1670	2460	444	752	2110	3880
Phenol (µg/kg)	1620	4090	1490	3941	480	708	1390	2355	1350	2480
Oil & Grease	51000	128800	64400	170200	37600	55400	22000	37100	62100	114000
T. Fe	51000	128800	52000	137500	19000	28000	32000	54200	45000	82500
Sulfide	686	1730	1530	4050	904	1332	730	1238	847	1552
Cu	57	144	66	175	18	27	28	49	50	92
Cd	197	498	*	*	*	*	*	*	171	314
Ni	200	506	82	217	27	40	90	153	175	321
Zn	247	624	2940	7790	852	1258	1510	2560	1050	1930
Pb	370	934	399	1058	169	250	212	360	543	1000
Cr	48	121	67	72	27	40	36	61	*	*
Cyanide	0.22	0.56	0.27	0.71	0.49	0.72	NF	NF	0.22	0.40
COD	173000	437000	182000	482000	115000	169900	84300	143000	174000	319500

* - Not Detected
NF = None Found

Table 1b

ANALYSES OF BOTTOM SEDIMENTS
Indiana Harbor Canal
June 14, 1967
Results expressed as mg/kg

Sample No.	6		7		8		9		10	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
% T. Solids	55.1		29.0		29.0		28.2		33.8	
% T. Vol. Solids		8.1		16.2		20.2		18.3		17.0
NH_3-N	49	89	76	262	129	445	184	653	167	495
NO_3-N	3.0	5.4	2.0	6.9	2.0	6.9	1.0	3.5	1.0	3.0
Org-N	950	1721	872	3010	668	2305	936	3320	1053	3120
T. Sol. PO_4	3	5.5	5	17	2	6.9	2	7.1	2	5.9
T. PO_4	2050	3720	7840	27000	4380	15100	4050	14350	7840	23200
Phenol (µg/kg)	950	1721	1690	5830	1660	6420	1930	6850	1620	4800
Oil & Grease	22100	40100	37800	129700	32300	111300	31200	111500	27100	80200
T. Fe	47000	85200	60000	207000	45000	155000	73000	259000	85000	251500
Sulfide	304	551	457	1575	910	3140	336	1190	272	805
Cu	13	24	29	100	30	104	15	53	12	36
Cd	125	227	250	863	359	1240	1170	4150	2530	7490
Ni	133	242	200	690	325	1120	875	3100	2050	6070
Zn	795	1440	1610	5560	1310	4520	664	2355	568	1980
Pb	169	307	289	997	338	1163	360	1279	462	1365
Cr	6	11	34	117	50	173	38	135	23	68
Cyanide	0.19	0.34	0.15	0.52	NF	NF	NF	NF	NF	NF
COD	74300	134800	67400	232500	130000	449000	124000	440000	119000	352000

NF = None Found

Table 1c

ANALYSES OF BOTTOM SEDIMENTS
Indiana Harbor Canal
June 14, 1967
Results expressed as mg/kg

Sample No.	11		12		13		14		15	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
% T. Solids	39.7									
% T. Vol. Solids		12.5								
NH_3-N	62	156								
NO_3-N	1.0	2.5								
Org-N	684	1722								
T. Sol. PO_4	2	5								
T. PO_4	4160	10490								
Phenol (µg/kg)	1220	3080								
Oil & Grease	14900	37600								
T. Fe	77000	194000								
Sulfide	472	1190								
Cu	16	40								
Cd	656	1652								
Ni	750	1890								
Zn	4190	10580								
Pb	294	741								
Cr	19	48								
Cyanide	NF	NF								
COD	89900	226500								

NF = None Found

13. There was a fair amount of oil present at Evanston Beach (Dempster St.)

14. Wilmette Beach was clean (Lake Ave.).

FWPCA crews again worked in the entire Calumet Area on Monday, September 25, 1967. An FWPCA engineer was on a United States Coast Guard vessel which followed a tug and two barges out into Lake Michigan to dump dredgings from the Indiana Harbor Canal. He observed the dumping operation, took photographs and collected samples prior to dumping. A sample was taken in the wake of the barge to detect leaking, if any. Samples were taken during the period from 12:15 to 12:45 p.m.

Other FWPCA scientists flew over the area to observe the effect of the barge dumping operation. At 1:30 p.m. the tug and barges were observed returning empty about one mile from Indiana Harbor. Flying out over the Lake a bad oil slick and severe discoloration of the water was observed approximately six miles due north of Gary Harbor. The Lake was relatively calm and pollution effects could be readily discerned.

At 2 p.m., the plane flew over the same point six miles north of Gary Harbor and observed that the discoloration of the water still persisted. A radio fix was taken of this point to obtain the coordinates. These coordinates were later checked out against the position of the dredge dumping as fixed by the United States Coast Guard vessel and were found to be at the same point.

Another badly discolored area was observed about three miles north of Gary Harbor. To the east, lighter discolorations were noted over a broad area of the Lake. Pictures were taken of the discolored areas of the Lake. This appeared to be the residual of the large oil slick reported on previous days.

An aerial patrol was made over Indiana Harbor, over the Indiana Harbor Canal, over Gary Harbor, and Calumet Harbor. Pollution was observed to be severe in Indiana Harbor, in the Indiana Harbor Canal, in the Lake George Branch, and in the Calumet River Branch of the Indiana Harbor Canal. Aerial photographs were taken of these pollutional sources.

Two large discharges of heavily discolored water were observed coming from the South Works of U. S. Steel Corporation at 87th Street into Calumet Harbor. The plumes of discolored water continued out through the Harbor opening into Lake Michigan.

A discharge of waste was observed from a sewer outfall immediately west of Gary Harbor, apparently from Gary Works, U. S. Steel Corporation. This discharge appeared to carry about a mile into the Lake.

The beaches from Indiana Harbor to Wilmette were observed from the air. One-hundredth Street Beach at Calumet Park was covered with Cladophora. Some oil was observed on beaches at Jackson Park and in the vicinity of Foster Avenue.

Aerial photographs were made by the FWPCA of the dumping of Indiana Harbor Canal dredging materials into Lake Michigan on Monday, October 2. These photographs show clearly the formation of an oil slick on the surface of the Lake as heavier materials darken the waters just below the surface. Samples were taken at the same time by an FWPCA engineer who accompanied the barges on a U. S. Coast Guard vessel.

Another oil pollution incident occurred on Tuesday, October 3, 1967. The Coast Guard received an oil pollution report from Indiana Harbor at 2:30. A Coast Guard vessel and crew was dispatched to the Indiana Harbor area where an oil slick was observed coming out into Lake Michigan. Following the oil slick back into the canal, a stream of oil was traced to a sewer located between the Five Railroads Bridge and the Pennsylvania Railroad Bridge on the Inland Steel side of the harbor. The Coast Guard collected samples in the canal below the point of discharge and a sample was collected of the discharged oil coming from the sewer at about 3:45 p.m. The crew then proceeded further into the canal to check other possible sources of pollution. No other sources were found. They returned past the outfall at 4 o'clock and at that time no oil discharge was observed.

These samples were to be submitted to the custody of the U. S. Army Corps of Engineers by the U. S. Coast Guard with subsequent arrangement for the FWPCA to obtain representative portions for analysis. However, these samples have not yet been released to the Chicago Program Office of FWPCA.

CONCLUSIONS

As a result of the FWPCA investigation and the results of the analysis of samples collected by the FWPCA and the U.S. Coast Guard, the Chicago Program Office of FWPCA draws the following conclusions:

1. The laboratory findings indicated that the major portion of the extensive oil slick which spread over the southern tip of Lake Michigan in the week of September 17 consisted of No. 6 fuel oil containing some asphaltic products. Some areas of both heavier and lighter oils were found.

2. The data also shows a substantial difference in chemical nature between the heavy oil found in the slick and on the beaches as compared to the dredged materials from the Indiana Harbor Canal collected at the 138th Street site.

3. Some of the oil samples collected in Indiana Harbor and the Indiana Harbor Canal on September 19 differed from No. 6 fuel oil but matched an oil sample collected at the south end of 55th Street Beach on September 18. Other samples from the surface in Indiana Harbor matched the heavy oil samples found on the Lake.

4. A floating oil sample collected upstream from the dredging operation on September 22 matched samples collected the same day at Ardmore Street Beach (5800 North) and at the 79th Street boat launching site (7900 South). These samples were nearly identical to the No. 6 fuel oil reference sample.

5. Samples collected from the ground area next to Youngstown Steel Oil Docks, from the fuel oil pipeline, and from the overflow next to a new fill area contained an apparent mixture of asphalt in No. 6 fuel oil.

6. On the basis of the observations made, it is believed that the oil pollution originated in the Indiana Harbor and Indiana Harbor Canal and was swept out into the Lake by the prevailing southerly and southeasterly winds.

RECOMMENDATIONS

Whether or not the September 17 to 20, 1967 oil pollution can be laid at the doorstep of any individual, corporation or ship owner does not alter the fact that oil pollution has been continuing unabated in the Calumet Area both before, during, and after this particular incident.

It is recommended therefore:

1. That all oil pollution be kept out of Lake Michigan.

2. That a boom and curtain be placed across Indiana Harbor to minimize the movement of oil from Indiana Harbor into Lake Michigan with an operating gate to permit navigation.

3. That oil skimmers be placed behind this boom to remove surface oil which accumulates.

4. That a floating adsorbant material such as shredded polyurethane foam be considered as an aid in the adsorption and removal of this oil.

5. That oil skimmed from the harbor be disposed of on land.

6. That the above boom and skimmers be operated by the U.S. Corps of Engineers and operating costs be charged to all persons, corporations, and ship owners using the Harbor and Canal except those who can prove they do not discharge any oil.

7. That each source of oil pollution be identified and a concerted effort be made by Federal, state, and local authorities to require elimination of each source.

8. That all individuals, corporations, and ship owners be required to state their position and establish a date at which they will cease all oil discharges to the waterways.

9. That the use of chemical oil dispersants not be permitted in discharges to streams or as a means of controlling an oil spill.

10. That water quality standards for soluble oil as well as for floating oil be established and that the presence of either soluble oils or floating oil be considered a violation of water quality standards.

11. That the above recommendations be applied to all other harbors or tributaries to Lake Michigan where oil discharges are encountered.

12. That there be an expansion in the FWPCA surveillance activities both in the frequency of surveillance and the area covered by the surveillance activities.

LABORATORY RESULTS AND FINDINGS

Sampling Background

The first samples received by the laboratories were oil samples collected by the Chicago Program Office from the water surface in Indiana Harbor and Indiana Harbor Canal on September 19. Additional samples were received from the U. S. Coast Guard and submitted to the laboratories on September 20. These samples were the oily wastes collected from the surface of Lake Michigan at twelve points located between Indiana Harbor and Chicago Jackson Park Harbor. One sample was collected on September 11 and the others were collected Sept. 18 and 19. The next group of samples received were collected by Chicago Program Office personnel late on Friday afternoon, September 22. One crew visited the site of dredging operations in the Indiana Harbor Canal at 138th Street. Dredging operations had ceased; however, three samples were obtained, two directly from the barge and one from the water surrounding the barge. Concurrently, two other crews visited Lake Michigan beaches from Gary, Indiana to Wilmette, Illinois. Samples of black asphalt-like material were collected from eleven of these beaches and shore line points.

Additional samples were obtained by Chicago Program Office personnel on Saturday, September 23, 1967 at the dredging site in the Indiana Harbor Canal. These samples were as follows: one water sample, one sample from the contents of the dredging bucket and one sample from the dredgings deposited on the barge. In addition, samples of asphalt and No. 6 fuel oil were obtained from the Sinclair Refining Company to use as standard reference samples.

On September 25, the U.S. Coast Guard submitted an additional four samples. These were collected at points located in and near the industrial sites situated in the vicinity of the Indiana Harbor and Indiana Harbor Canal.

Also, on September 25, six water samples were collected at and in the vicinity of the dumping site for dredge material. The dumping site is located in Lake Michigan approximately six miles from Indiana Harbor. Analysis of this set of samples was not completed at the time this report was prepared.

On September 27, the U.S. Coast Guard submitted five more samples. Four of these were materials collected on the property of the Youngstown Steel Company. One of these samples had the physical appearance and odor of black asphaltic deposits collected on the beaches. The second sample was a sample from a pipe-line and resembled No. 6 fuel oil. The third sample was a large piece of plastic which had been embedded in the soil along the canal and was covered with black asphalt-like material. The fourth sample was a water sample from an overflow pipe at Youngstown Steel. The last sample was a sample of water from an overflow pipe at Inland Steel Plant #1.

Daily water sampling was initiated for the purpose of determining the type of oil in the waters located at the two monitors in Indiana Harbor and Dickey Road.

Sampling locations are shown in Figure 1.

Analyses Performed

The oil and asphalt-like substances were analyzed by the organic chemistry laboratory to obtain infrared spectra, gas chromatography flame ionization profiles and refractive indexes on selected samples. The bottom sediment and water samples were analyzed for the customary domestic and industrial pollutants as shown in Tables 2 and 3. In addition, two samples of the black asphaltic-like materials from the beaches were analyzed for selected parameters as shown in Table 2.

Laboratory Findings

The laboratory findings available to date are shown in Tables 2, 3, 4, and 5.

All of the infrared spectra and flame ionization profiles obtained from the beach samples and floating oil collected on the surface of Lake Michigan were very similar, indicating that all samples were the same type of material.

Infrared spectra were obtained on known reference samples of asphalt and No. 6 fuel oil. These two substances give very similar infrared spectra. The infrared spectra from the beach and floating oil samples also gave similar spectra, suggesting that the materials tested were either asphalt or No. 6 fuel oil, or a mixture of both, as is indicated in Table 4.

The samples were next characterized by flame ionization. With this latter test the reference samples of asphalt and No. 6 fuel oil provided clearly distinct profiles. The flame ionization profiles of the beach samples and floating oil samples from Lake Michigan gave flame ionization profiles more closely resembling, but not identical to, No. 6 oil.

The refractive indices obtained from the black asphaltic-like material from the beaches and the floating oil from Lake Michigan ranged all the way from 1.3302 to 1.6581. However, the majority was in the range 1.6495 to 1.6528, which is essentially the same range of indices obtained from various mixtures of asphalt and No. 6 fuel oil (see Table 5 for indices of selected mixtures of asphalt and No. 6 fuel oil).

The refractive index of three of the Lake samples therefore had a greater value than the index obtained from the asphalt reference sample. Two of the Lake samples had a refractive index characteristic of light oil.

Revised 10/5/67

TABLE 2
Bottom Sediment Analyses of Dredgings
Indiana Harbor Canal at 138th Street
Results Expressed in mg/kg

September 22, 1967

Parameter	Barge A		Barge B		79th St. Beach		Ardmore St. Beach 5800 N	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
NH_3-N	578	1,480	410	1,080	N.T.	N.T.	N.T.	N.T.
NO_3-N	3.4	8.7	1.8	4.7	N.T.	N.T.	N.T.	N.T.
Org-N	1,422	3,650	1,170	3,080	N.T.	N.T.	N.T.	N.T.
T. Kj-N	2,000	5,130	1,580	4,160	1,400	1,730	2,570	3,840
T.Sol.P. as P.	8.2	21	3.3	8.7	N.T.	N.T.	N.T.	N.T.
Total P. as P.	2,350	6,030	1,810	4,770	N.T.	N.T.	N.T.	N.T.
% T. Solids	39		38		81		67	
% V. Solids		19		18		64		80
COD	19,420	49,900	6,850	18,010	N.T.	N.T.	N.T.	N.T.
Phenols	4800×10^{-3}	12300×10^{-3}	4074×10^{3}	10720×10^{-3}	N.T.	N.T.	N.T.	N.T.
Oil & Grease	33,780	86,500	22,680	59,800	181,730	224,000	461,230	690,000
Sulfide	738	1,890	417	1,100	N.T.	N.T.	N.T.	N.T.
Cyanide	6.7*	17	6.5*	17	N.T.	N.T.	N.T.	N.T.
Total Fe					N.T.	N.T.	N.T.	N.T.
Copper					N.T.	N.T.	N.T.	N.T.
Cadmium					N.T.	N.T.	N.T.	N.T.
Nickel					N.T.	N.T.	N.T.	N.T.
Zinc					N.T.	N.T.	N.T.	N.T.
Chromium					N.T.	N.T.	N.T.	N.T.
Lead					N.T.	N.T.	N.T.	N.T.
D. O.					N.T.	N.T.	N.T.	N.T.

* =Sulfide interference present

N.T. = No Test

Revised 10/5/67

TABLE 3
Bottom Sediment Analyses of Dredgings
Indiana Harbor Canal at 138th Street
Results Expressed in mg/kg

September 23, 1967

Parameter	Barge Wet	Barge Dry	Bucket Wet	Bucket Dry	Water mg/l
NH_3-N	456	1,200	872		3.60
NO_3-N	1.2	3.2	1.2	2.7	0.18
Org-N	1,180	3,110	1,260	2,870	0.49
T.Kj-N	1,636	4,310	2,132	4,850	4.09
T.Sol. P. as P.	3.1	8.2	14	32	0.12
Total P. as P.	2,150	5,660	2,460	5,600	0.88
T. Solids	(38%)		(44%)		232 (mg/l)
V. Solids		(16%)		(20%)	234 (mg/l)
COD	6,500	17,100	18,050	41,000	16
Phenols	3400×10^{-3}	8950×10^{3}	1850×10^{3}	4210×10^{3}	17×10^{-3}
Oil and Grease	33,840	89,200	53,830	122,200	9.7
Sulfide	575	15,110	720	1,640	-
Cyanide	6.6*	17	6.4*	15	0.35
Total Fe					
Copper					
Cadmium					
Nickel					
Zinc					
Chromium					
Lead					
D.O.	N.T.	N.T.	N.T.	N.T	1.80

* = Sulfide interference present

N.T. = No Test

TABLE 4 a

Infrared, Gas Chromatography Flame Ionization and Refractive Index Analyses of Oil in Water, Floating Oil, Asphaltic-Like Material from Beaches and Oil in Bottom Sediments

Sampled by	CPO Sample No.	Date	Location	Type Sample	Physical Appearance	I.R. Spectra	G.C.Flame Ionization	Refractive Index
CPO	738	9/23/67	Sinclair Refinery	Reference	Asphalt			1.6524
"	740	"	"	"	#6 Fuel Oil			1.6490
"	691	9/19/67	Indiana Harbor	Water	Black-Oily	A or 6	-	1.3312
"	692	"	Indiana Harbor Canal	"	" "	"	-	1.3311
USCG	(L)*693	9/11/67	Lake 42°52'30" - 87°25'24"	Floating Oil	" "	"	6	1.6545
"	(B)*694	9/18/67	North end of 55th St. Beach	" "	" "	"	6	1.6581
"	(A)*695	"	South end of 55th St. Beach	" "	" "	"	6	1.3302
"	(J)*696	"	Jackson Park Entrance	" "	" "	"	6	1.6540
"	(C)*697	"	Jackson Park Harbor	" "	" "	"	6	1.6507
"	(I)*698	"	Jackson Park Harbor	" "	" "	Ins.	Ins.	Ins.
"	(P)*699	9/19/67	Calumet Harbor Beach	" "	" "	A or 6	6	1.6513
"	(K)*700	"	Mouth of Indiana Harbor	" "	" "	"	6	1.6519
"	(G)*701	"	Front of Ind.Harbor Light Stn.	" "	" "	"	6	1.6528
"	(H)*702	"	One mile off Ind. Harbor Canal	" "	" "	"	6	1.4882
"	(E)*703	"	1/4 Mile off Whiting Beach	" "	" "	Ins.	Ins.	Ins.
"	(D)*704	"	1/4 Mile off Whiting Boat Club	" "	" "	Ins.	Ins.	Ins.
CPO	720	9/22/67	Outfall #43 Lake George Shell Oil Co.	Water	" "			
"	721	"	50' upstream from dredging operation IHC at 138th St.	Floating Oil	" "			1.6496
"	722	"	Dredgings from Barge IHC at 138th St.	Bottom Sediment	Bright, clear yellow-EX			1.4986 EX
"	723	"	" "	"	" "			1.4960 EX

TABLE 4b

Infrared, Gas Chromatography Flame Ionization and Refractive Index Analyses of Oil in Water, Floating Oil, Asphaltic-Like Material from Beaches and Oil in Bottom Sediments

Sampled by	CPO Sample No.	Date	Location	Type Sample	Physical Appearance	I.R. Spectra	G.C.Flame Ionization	Refractive Index
CPO	724	9/22/67	Hammond Beach	Soft Asphaltic	Black	A or 6	6	
"	725	"	Whiting Beach	"	"	"	6	
"	726	"	Calumet Park Inner 100th St. Beach	"	"	"	6	
"	727	"	79th St. Boat Launching Site	"	"	"	6	1.6497 1.6506
"	728	"	75th St. Beach	"	"	"	6	
"	729	"	57th St. Beach	"	"	"	6	
"	730	"	Ardmore St. Beach 5800N	"	"	"	6	1.6495
"	731	"	Albion St. Beach 6600N	"	"	"	6	
"	732	"	Juneway Terrace Beach 7800N	"	"	"	6	
"	733	"	Evanston Beach - Dempster St.	"	"	"	6	
"	734	"	Wilmette Beach - Lake Ave.	"	"	"	6	
"	735	9/23/67	Dredging operations - IHC 138th St.	Water	Bright,clear yellow-EX			
"	736	"	Dredgings from bucket	Bottom Sediment	" "			1.4928 EX
"	737	"	Dredgings from barge	"	Bright,clear yellow			1.4960
USCG	1*741	9/21/67	100 yards off Standard Oil	Floating Oil	Black	A or 6	6	1.6494
"	2*742	"	Inside Youngstown Steel east breakwater	" "	"	"	6	1.6496

TABLE 4c

Infrared, Gas Chromatography Flame Ionization and Refractive Index Analyses of Oil in Water, Floating Oil, Asphaltic-Like Material from Beaches and Oil in Bottom Sediments

Sampled by	CPO Sample No.	Date	Location	Type Sample	Physical Appearance	I.R. Spectra	G.C.Flame Ionization	Refractive Index
USCG	3*743	9/21/67	In front of Sinclair Lake George	Floating oil	Black	A or 6	6	1.6499
"	744	"	No identification	" "	"	"	6	1.6512
CPO	745	9/25/67	Directly behind barge in Wake	Water	Clear			
"	746	"	Behind barge after dumping at dumping site	"	Muddy-black			
"	747	"	500' from dumping site	"	Turbid			
"	748	"	1,000' from dumping site	"	Clear			
"	749	"	Down wind of dumping site	"	"			
"	750	"	"	"	"			
USCG	1*759	9/27/67	Next to Youngstown Steel oil docks	Soft Asphaltic	Black	A or 6	6	1.6524
"	2*760	"	Fuel oil pipeline at Youngstown Steel	Oil	Black	"	6	1.6520
"	3*761	"	Ball of plastic buried in sand at Youngstown Steel oil dock	Soft Asphaltic	Black	"	6	1.6506
"	4*762	"	Overflow next to new fill area at Youngstown Steel	Floating oil	Black	Ins.	Ins.	1.6520
"	5*763	"	Overflow pipe at Inland Steel Plant #1	Water	Brownish Black	"	"	1.6511

* = Coast Guard Identification

A = Most resembles asphalt

6 = Most resembles #6 Fuel Oil

EX = Soxhlet Extraction

Ins. = Insufficient Sample

TABLE 5

Refractive Index Values of Mixtures of Asphalt and #6 Fuel Oil

CPO Sample No.	% Asphalt by wt.	% #6 Fuel Oil by wt.	Refractive Index
739	100 *	0	1.6506
	75	25	1.6530
	50	50	1.6525
	25	75	1.6505
	0	100**	1.6509
740	0	100	1.6490

* Heated 6 hrs. at 100° C.

** Heated 8 hrs. at 100° C and stood on bench top over weekend, exposed to the atmosphere.

The above findings indicate that major portion of the large oil slick which occurred on Lake Michigan the week of September 17 was comprised of No. 6 fuel oil and contained some asphaltic products. However, some areas of both heavier and lighter oils were found.

Analysis of three of the four samples that were collected by the U. S. Coast Guard at Youngstown Steel Company on September 27 indicated a mixture of No. 6 fuel oil and asphalt. The oily content of the other two samples of that group was not great enough to provide reliable results from infrared and flame ionization.

The results of the samples of September 27 may be compared to the values shown in Table 5 which shows the refractive index of mixtures of the reference samples of #6 oil and asphalt. By this comparison, it would appear that the area next to Youngstown Steel oil docks was contaminated with approximately 50% asphalt in #6 fuel oil. It was noted that the refractive index of the sample of asphalt used for this comparison (Sample No. 739.) was lower than the refractive index of the reference sample of asphalt used previously (Sample No. 738). Similarly, the fuel oil pipeline and the overflow next to a new fill area also appeared to have mixtures of about 50% asphalt in fuel oil. Also a piece of plastic material dug up in the sandy area was apparently coated with about 25% of asphalt in #6 fuel oil.

Samples collected in the Indiana Harbor Canal and in the Indiana Harbor on September 19 had refractive indexes similar to the index of the sample collected by the Coast Guard at the south end of 55th Street Beach on September 18 but differed from the other beach samples. These samples were characteristic of light oils.

The water samples and bottom sediment samples collected at the dredge site on September 22 were extracted for oil content and characterization. Ardmore Beach and 79th Street samples were run with and without extraction. The extracts from the bottom sediment samples and the water were a bright yellow color, while the extracts from the beach samples were jet black. All other samples were run without extracting samples.

A sample of floating oil collected 50 feet upstream from the dredging operation at 138th Street on September 22, 1967 had the same refractive index as samples collected on the same date at the 79th Street boat launching site and Ardmore Street beach (5800 N). The refraction index of this sample was not identical but was very close to the value obtained for the No. 6 fuel oil.

The results from the inorganic analysis of bottom sediments are shown in Tables2 and 3. These findings indicate large amounts of industrial and domestic pollutants were present in the bottom sediments as reflected in the high concentrations of ammonia nitrogen, phosphorus,

phenols, sulfides, and oil and grease. The results of metals analysis on the dredging samples are still pending and will be provided in the near future. The two samples of solidified materials taken from the 79th Street Beach and Ardmore Beach showed extremely high volatile solids. Oil and grease were very high as would be expected.

The sample taken from the bucket of the dredge on September 23 gave much higher results for most parameters than did those taken from the barge. The barge results from September 22 show that there was a considerable difference in the values from samples taken from one end of the barge to the other, indicating that the dredgings at the site were very heterogeneous.