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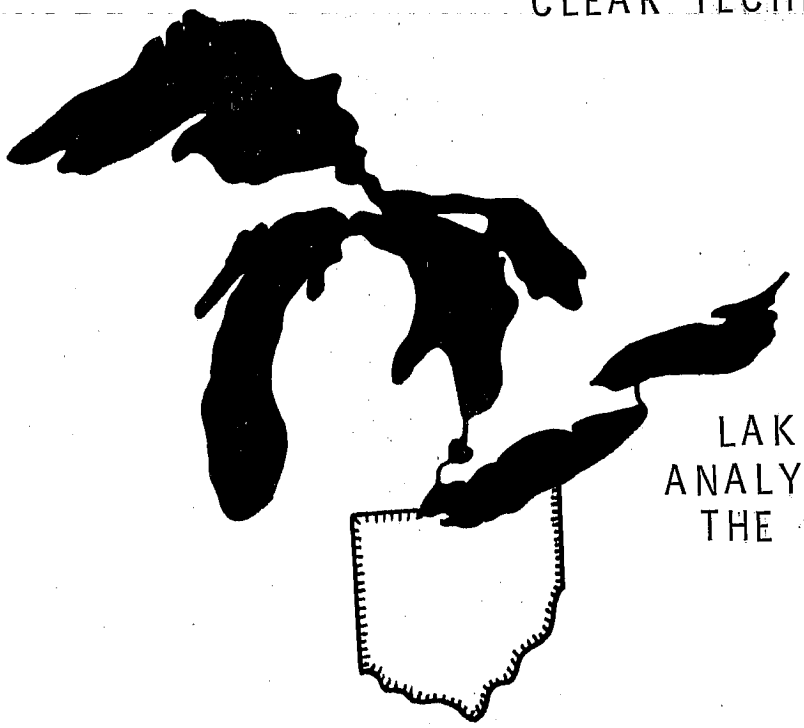

LAKE ERIE WATER QUALITY ANALYSES IN THE VICINITY OF THE HURON DIKED DISPOSAL FACILITY, OHIO

by
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Introduction

Construction of the Huron Diked Disposal Facility, Huron Harbor, Ohio, was completed by the U.S. Army Corps of Engineers in 1975. This structure was built to contain polluted sediments resulting from harbor maintenance dredging operations as required by Public Law 91-611. The semicircular structure is located on the western side of the west breakwater at Huron, Ohio (Figure 1). It has an approximate radius of 1,100 feet and occupies about 63 acres of lake surface. When filled to a depth of 7 feet above datum (LWD), it will have a capacity of 2,150,000 cubic yards. The landward arc (Section 1), as well as the outer western breakwall arm (Section 3) of the dike, are constructed of graded rock rubble. Water within the dike must pass through a stone filter before entering Lake Erie. The top part of these two sections also contain a rubber pond liner with a woven wire backing which concentrates filtration through the lower part of the dike. The inner breakwall arm of the dike (Section 4) consists of an exterior of sheet metal pile capped with concrete to minimize water passage through this section. The remaining lakeward arc (Section 2) of the dike is constructed of sheet metal pile cells filled with stone which are also impermeable to water flow. An effluent overflow weir is provided between two of these cells near junction of the lakeward arc and the rubblemound breakwater (Figure 1).

In 1976 the U.S. Environmental Protection Agency (Gedeon, 1977) conducted a monitoring study of the Huron Diked Disposal Facility in order to determine the effects on the quality of Lake Erie water surrounding the dike disposal area as a result of the deposition of dredged material within the dike. During the study period (April-November 1976), the deposition of dredged material within the dike "did not produce any significantly measurable decrease in water quality near the dike area". The present study was undertaken to continue this monitoring effort and to assess the efficiency of the dike filtration system after three years of operation.

Objectives of Study

Water quality at three stations within the Huron Diked Disposal Facility and at three stations immediately outside the facility in Lake Erie was monitored during the period August to November 1979. Water quality at a seventh station in the vicinity of the City of Huron water intake was also analyzed. The objective of the study was to determine the impact of the diked facility on Lake Erie water quality by measuring differences between stations inside the dike and those outside of the facility.

Methods of Investigation

Water quality sampling was conducted at six stations in and around the Huron Diked Disposal Facility (Figure 1). Stations H-01, H-02, and H-03 were positioned inside the facility and stations H-04, H-05, and H-06 were located outside the dike. Stations H-01 and H-04 were positioned along the rubblemound position of the dike near the southern end of the structure, stations H-03 and H-05 were established near the junction of the rubblemound and cellular dike sections, and stations H-02 and H-06 were set along the cellular dike near the overflow weir. An additional station (0-43), which was part of a U.S. Environmental Protection Agency, National Great Lakes Program nearshore monitoring program, was also sampled. This station was located approximately 0.5 miles west of the diked structure at water intake for the City of Huron water treatment plant (Figure 2).

Water samples were taken four times at approximately one month intervals during the period August to November 1979:

Sampling Period	Diked Facility Sampling Date (Julian)	Huron Water Intake Sampling Date (Julian)
1	15 August (227)	5 August (217)
2	10 September (253)	10 September (253)
3	21 October (294)	21 October (294)
4	27 November (331)	Not scheduled

Two sets of samples were collected at each station, one set was collected approximately 0.5 meter below the water surface and one set collected approximately 0.5 meter above the lake bottom. At stations where the water depth was less than 1.0 meter only one sample was normally taken. Samples were analyzed for the following parameters using analytical methods and quality control procedures approved by USEPA for the Lake Erie nearshore water quality surveillance program (Herdendorf, 1979):

Water Quality Parameters

1. Turbidity
2. Suspended Solids
3. Soluble Reactive Phosphorus
4. Total Phosphorus
5. Nitrate & Nitrite Nitrogen
6. Ammonia Nitrogen
7. Total Kjeldahl Nitrogen
8. Chemical Oxygen Demand
9. Total Iron
10. Total Manganese
11. Total Arsenic

At the time of preparing this report the analyses of samples from USEPA Station O-43 (Huron water intake) are incomplete. These analyses are scheduled for completion by July 1980 and will be available from the Center for Lake Erie Area Research at that time.

Results

The results of the chemical analyses for the four sampling periods at the seven stations are presented in Table 1. Table 2 presents a comparison of mean water quality values for stations inside the dike, stations outside the dike and the station at the Huron water intake. These data are given for each parameter for each sampling period. The right-hand column lists mean values for the entire study period which provide for a rapid assessment of the dike's containment effectiveness and the relationship of the water quality in the vicinity of the dike to the water quality at the Huron water intake.

The following discussion contains a summary of the study results for each of the eleven test parameters.

Turbidity. The highest average turbidity values were observed within the dike in October (53.8 ntu). In November the average turbidity outside the dike was 52.5 ntu (68% greater than inside the dike), reflecting the general turbid nature of the lake at that time of the year. The turbidity at the Huron water intake was only about 25% of the average values measured in the vicinity of the dike. Surface and bottom values showed only small variations except at station H-02 (inside dike) in October where the bottom turbidity was near 15 times higher than the surface value. This major difference at station H-02 was also noted for several other parameters including suspended solids, soluble and total phosphorus, chemical oxygen demand, total iron, total manganese and total arsenic.

Suspended Solids. The mean concentration of suspended solids inside the dike during the study period was 39.1 mg/l as compared to 32.2 mg/l outside the dike and only 12.8 mg/l at the Huron water intake. Gedeon (1977) reported mean dike values of 29 mg/l and 23 mg/l outside of the dike for 1976. The highest 1979 values were measured in November and can be attributed to rough lake conditions.

Soluble Reactive Phosphorus (SRP). The mean concentrations of SRP inside and outside the dike were 8.9 and 11.5 µg/l respectively. The 1979 concentrations were approximately half of the values reported by Gedeon (1977). Again, weather conditions in November resulted in high concentrations. Mean concentration at the Huron water intake for the first half of the study period was only 2.0 µg/l.

Total Phosphorus (TP). Average TP concentrations for water inside the dike, outside the dike, and at the Huron water intake were 91.7, 93.8 and 41.6 µg/l respectively. In 1976, Gedeon (1977) found mean TP

concentrations of 58-65 µg/l which exceeded Ohio EPA standards on almost all occasions. However, Ohio EPA standards were relaxed to 1.0 mg/l from 0.025 mg/l in 1978. Therefore, although the 1979 concentrations were about 30% higher than those in 1976, they did not exceed Ohio EPA standards.

Nitrate & Nitrite. Mean concentrations of nitrate plus nitrite for water inside the dike, outside the dike and at the Huron water intake were 0.56, 0.58 and 0.21 mg/l respectively. Gedeon (1977) reported a mean dike value of 0.54 mg/l and 0.38 mg/l for outside the dike for 1976.

Ammonia. An exceptionally high ammonia concentration was observed in the water within the dike in August (1370 µg/l at station H-03 and mean of 1301 µg/l for all three dike stations). For the rest of the study period concentration rarely exceeded 10% of these values. The mean concentrations of ammonia inside the dike, outside the dike and at the Huron water intake were 388.0, 23.4 and 11.8 µg/l respectively. The mean value compares favorably with those obtained by Gedeon (1977).

Total Kjeldahl Nitrogen (TKN). Gedeon (1977) showed a range of 0.34 to 2.78 mg/l for TKN inside the dike in 1976. In 1979 inside dike concentrations were similar, ranging from 0.57 to 2.42 mg/l TKN. The mean concentrations inside and outside the dike were 1.28 and 0.78 mg/l respectively.

Chemical Oxygen Demand (COD). COD was relatively stable throughout the study period, averaging 16.1 mg/l inside the dike and 13.7 mg/l outside the dike. The values compare favorably with those obtained in 1976 by Gedeon (1977).

Total Iron. The Ohio EPA water quality standard for total iron is 1000 µg/l. This concentration was exceeded in August, September and November inside the dike and in August, October and November outside the dike. The mean concentrations inside and outside the dike were 1381 and 1129 µg/l respectively. Gedeon (1977) found somewhat lower concentrations in 1976, but the majority of dike samples exceed the present Ohio standards.

Total Manganese. The Ohio EPA water quality standard for manganese is 50 µg/l. Both inside and outside dike samples exceeded this value in November, but the mean values for the other three months were below this concentration. The mean concentrations inside and outside the dike for the entire study period were 64.2 and 39.1 µg/l respectively. Gedeon (1977) found similar concentrations in 1976.

Total Arsenic. The Ohio EPA water quality standard for arsenic is also 50 µg/l. Only two samples inside the dike and no samples from outside the dike exceeded this concentration. The mean concentrations inside and outside the dike during the entire study period were 26.0 and 18.5 µg/l. Although almost all samples were below the Ohio standard, the mean values were 3 to 5 times higher than those reported by Gedeon (1977) for 1976.

Conclusions

The Huron Diked Disposal Facility appears to be reasonably effective in containing pollutants within the structure. Of the eleven water quality parameters tested, eight were significantly lower outside the dike and the other three (soluble and total phosphorus and nitrate & nitrite) were nearly equal or slightly higher outside. Water quality at the Huron water intake was significantly better than the water quality in the vicinity of the dike. Measurements reported from the water intake, however, do not include all parameters or do not extend as late into the year. If these data were available for the intake station, the differences between the stations outside the dike and the intake station would likely be much smaller. Most samples taken outside the dike were within Ohio EPA water quality standards.

References

Gedeon, A. S. 1977. 1976. Huron Harbor, Ohio dike study. U.S. Environmental Protection Agency, Region V, Michigan-Ohio District Office. 126 p.

Herdendorf, C. E., L. A. Fay, D. D. Larson and Lester J. Walters. 1979. 1978 Nearshore surveillance program for western Lake Erie. Ohio State University, CLEAR Tech. Report No. 109. 36 p.

TABLES

TABLE 1. WATER QUALITY ANALYSES FOR THE HURON DIKED DISPOSAL FACILITY, AUGUST TO NOVEMBER 1979

Station	Sampling Depth	Turbidity (ntu) Aug. 15	Sept. 10	Oct. 21	Nov. 27	Suspended Solids (ppm) Aug. 15	Sept. 10	Oct. 21	Nov. 27
*H-01 S	0.5m	34	16	14	27	60.43	15.52	16.18	31.00
B	0.7m	--	15	--	--	--	20.16	--	NA
H-02 S	0.5m	20	12	14	31	29.61	15.12	18.52	28.60
B	3.0m	21	17	200	74	34.73	23.91	158.54	125.96
H-03 S	0.5m	21	17	19	22	34.02	31.16	22.00	21.52
B	3.5m	24	18	22	25	35.62	28.17	28.29	25.04
H-04 S	0.5m	33	11	8	37	55.83	15.53	8.70	36.52
B	2.6m	35	10	17	43	60.00	15.62	11.14	53.52
H-05 S	0.5m	19	10	10	60	30.42	17.05	9.14	75.32
B	5.0m	25	11	11	57	38.29	17.25	8.22	93.88
H-06 S	0.5m	12	10	9	53	17.04	15.99	6.84	49.60
B	6.1m	20	12	13	65	33.00	36.00	14.98	53.68
**O-43 S		3	11	7	--	--	13.64	9.82	--
B		2	12	6	--	--	17.82	--	--

Station	Sampling Depth	Ammonia (ppm) Aug. 15	Sept. 10	Oct. 21	Nov. 27	Soluble Reactive Phosphorus (ppb) Aug. 15	Sept. 10	Oct. 21	Nov. 27
*H-01 S	0.5m	1222.0	127.7	41.0	51.1	4.0	5.4	1.5	37.4
B	0.7m	--	124.5	--	--	--	7.4	--	--
H-02 S	0.5m	1280.0	94.1	31.8	72.5	2.7	13.5	1.6	41.0
B	3.0m	1275.0	133.7	52.2	77.4	3.2	7.2	4.2	14.3
H-03 S	0.5m	1360.0	134.2	41.2	92.6	7.4	1.0T	1.2	17.1
B	3.5m	1370.0	156.4	43.2	108.8	8.6	1.0T	2.7	10.4
H-04 S	0.5m	8.0	18.1	4.0	81.0	23.9	2.1	7.9	33.8
B	2.6m	7.9	10.0	14.0	60.3	2.0	2.1	10.6	35.0
H-05 S	0.5m	4.5	8.0	5.4	73.5	6.0	1.1	9.0	30.1
B	5.5m	9.5	28.0	4.1	71.1	1.0	4.0	10.1	26.8
H-06 S	0.5m	1.0T	11.8	1.5	53.1	4.5	2.0	6.2	17.0
B	6.1m	1.0	23.5	3.3	57.3	4.7	4.2	8.2	20.4
**O-43 S		2.0	8.9	1.0	--	0.5	3.3	--	--
B		8.0	28.1	2.6	--	0.5	3.6	--	--

Station	Sampling Depth	Total Phosphorus (ppb) Aug. 15	Sept. 10	Oct. 21	Nov. 27	Total Kjeldahl Nitrogen (ppm) Aug. 15	Sept. 10	Oct. 21	Nov. 27
*H-01 S	0.5m	131.5	60.5	63.6	101.7	2.42	1.14	0.83	0.59
B	0.7m	--	67.1	--	--	--	0.99	--	--
H-02 S	0.5m	109.4	69.9	54.0	95.9	1.98	0.78	0.70	0.76
B	3.0m	95.2	68.1	108.2	93.0	2.00	1.26	0.69	2.31
H-03 S	0.5m	102.2	74.7	68.9	92.8	2.27	0.96	0.68	0.95
B	3.5m	11.3	142.1	99.4	104.3	2.30	1.47	0.87	0.81
H-04 S	0.5m	157.0	58.1	77.7	126.3	1.03	0.82	0.51	0.77
B	2.6m	147.2	58.9	64.0	149.9	1.00	0.65	0.58	0.94
H-05 S	0.5m	128.1	61.2	75.0	128.8	0.88	0.65	0.50	1.08
B	5.5m	77.1	61.9	46.0	117.9	0.79	0.99	0.54	1.14
H-06 S	0.5m	56.4	57.4	103.2	176.7	0.65	0.74	0.51	0.95
B	6.1m	80.0	63.0	58.5	120.1	0.74	0.60	0.52	1.12
**O-43 S		18.5	58.3	39.2	--	--	--	--	--
B		28.3	65.6	39.8	--	--	--	--	--

TABLE 1. (Cont'd) WATER QUALITY ANALYSES FOR THE HURON DIKED DISPOSAL FACILITY, AUGUST TO NOVEMBER 1979

Station		Sampling Depth	Nitrate & Nitrite (ppm) Aug. 15	Sept. 10	Oct. 21	Nov. 27	Chemical Oxygen Demand (ppm) Aug. 15	Sept. 10	Oct. 21	Nov. 27
*H-01	S	0.5m	0.606	0.336	0.300	1.410	20	9.4	9.8	16
	B	0.7m	--	0.361	--	--	--	14.0	--	--
H-02	S	0.5m	0.557	0.320	0.305	1.020	18	9.2	11	11
	B	3.0m	0.557	0.369	0.286	1.014	22	20.0	11	50
H-03	S	0.5m	0.595	0.368	0.292	0.747	23	12	10	12
	B	3.5m	0.588	0.384	0.292	0.743	20	13	11	12
H-04	S	0.5m	0.195	0.071	0.184	1.590	26	12.0	6.5	14
	B	2.6m	0.192	0.049	0.206	1.585	23	9.6	7.7	18
H-05	S	0.5m	0.260	0.056	0.156	2.460	15	11	5.4	20
	B	5.0m	0.245	0.095	0.134	2.335	25	11	5.8	22
H-06	S	0.5m	0.275	0.056	0.127	1.470	12	12	8.1	14
	B	6.1m	0.264	0.057	0.125	1.800	17	11	5.6	16
**O-43	S		0.325	0.093	.131	--	--	--	--	--
	B		0.335	0.102	.124	--	--	--	--	--

Station		Sampling Depth	Total Manganese (ppb) Aug. 15	Sept. 10	Oct. 21	Nov. 27	Total Arsenic (ppb) Aug. 15	Sept. 10	Oct. 21	Nov. 27
*H-01	S	0.5m	67	28	40	37	31	33	9.4	17
	B	0.7m	--	34	--	--	--	42	--	--
H-02	S	0.5m	42	23	36	38	28	35	11	15
	B	3.0m	43	32	40	520	27	68	12	90
H-03	S	0.5m	44	38	24	38	29	24	10	13
	B	3.5m	44	41	33	75	28	5	12	14
H-04	S	0.5m	57	25	24	38	16	22	11.0	17
	B	2.6m	57	28	32	66	19	25	9.8	17
H-05	S	0.5m	33	36	18	68	21	34	7.7	20
	B	5.5m	44	17	22	63	20	20	10.0	14
H-06	S	0.5m	25	27	15	66	17	23	9.0	12
	B	6.1m	35	28	14	53	14	25	8.3	17
**O-43	S		--	--	--	--	--	--	--	--
	B		--	--	--	--	--	--	--	--

Station		Sampling Depth	Total Iron (ppb) Aug. 15	Sept. 10	Oct. 21	Nov. 27
*H-01	S	0.5m	2000	450	640	1700
	B	0.7m	--	740	--	--
H-02	S	0.5m	940	430	660	1800
	B	3.0m	930	6800	820	2500
H-03	S	0.5m	1000	760	680	1300
	B	3.5m	1100	800	740	2500
H-04	S	0.5m	1600	370	230	1800
	B	2.6m	1700	770	1200	3200
H-05	S	0.5m	840	450	400	3400
	B	5.0m	1200	350	840	1100
H-06	S	0.5m	410	400	410	1900
	B	6.1m	890	460	480	2700
**O-43	S		--	--	--	--
	B		--	--	--	--

*Water depth at Station H-01 too shallow to warrant both surface and bottom samples in August, October and November

**Water analyses for USEPA Station O-43 scheduled for completion by July 1980

TABLE 2

COMPARISON OF WATER QUALITY INSIDE AND

OUTSIDE OF HURON DIKED DISPOSAL FACILITY

Parameter	Aug.	Sept.	Oct.	Nov.	Mean
Turbidity (ntu)					
Inside dike	24.0	15.8	53.8	35.8	32.4
Outside dike	24.0	10.7	11.3	52.5	24.6
Huron intake	2.5	11.5	6.5	--	6.8
Suspended Solids (mg/l)					
Inside dike	38.9	22.3	48.8	46.4	39.1
Outside dike	39.1	19.6	9.8	60.4	32.2
Huron intake	--	15.7	9.8	--	12.8
Sol. React. Phosphorus (µg/l)					
Inside dike	3.5	5.9	2.2	24.0	8.9
Outside dike	7.0	2.6	9.0	27.2	11.5
Huron intake	0.5	3.5	--	--	2.0
Total Phosphorus (µg/l)					
Inside dike	109.9	80.4	78.8	97.5	91.7
Outside dike	107.6	60.1	70.7	136.6	93.8
Huron intake	23.4	62.0	39.5	--	41.6
Nitrate & Nitrite (mg/l)					
Inside dike	0.58	0.36	0.30	0.99	0.56
Outside dike	0.24	0.06	0.16	1.87	0.58
Huron intake	0.33	0.10	--	--	0.21
Ammonia Nitrogen (µg/l)					
Inside dike	1301.4	128.4	41.9	80.5	388.0
Outside dike	5.3	16.6	5.4	66.1	23.4
Huron intake	5.0	18.5	--	--	11.8
Kjeldahl Nitrogen (mg/l)					
Inside dike	2.19	1.10	0.75	1.08	1.28
Outside dike	0.85	0.74	0.53	1.00	0.78
Huron intake	--	--	--	--	--
Chemical Oxygen Demand (mg/l)					
Inside dike	20.6	12.9	10.6	20.2	16.1
Outside dike	19.7	11.1	6.5	17.3	13.7
Huron intake	--	--	--	--	--

TABLE 2 (Cont'd)

COMPARISON OF WATER QUALITY INSIDE AND

OUTSIDE OF HURON DIKED DISPOSAL FACILITY

Parameter	Aug.	Sept.	Oct.	Nov.	Mean
Total Iron (µg/l)					
Inside dike	1194	1663	708	1960	1381
Outside dike	1107	467	593	2350	1129
Huron intake	--	--	--	--	--
Total Manganese (µg/l)					
Inside dike	48.0	32.7	34.6	141.6	64.2
Outside dike	49.8	26.8	20.8	59.0	39.1
Huron intake	--	--	--	--	--
Total Arsenic (µg/l)					
Inside dike	28.6	34.5	10.9	29.8	26.0
Outside dike	17.8	30.6	9.3	16.2	18.5
Huron intake	--	--	--	--	--

FIGURES

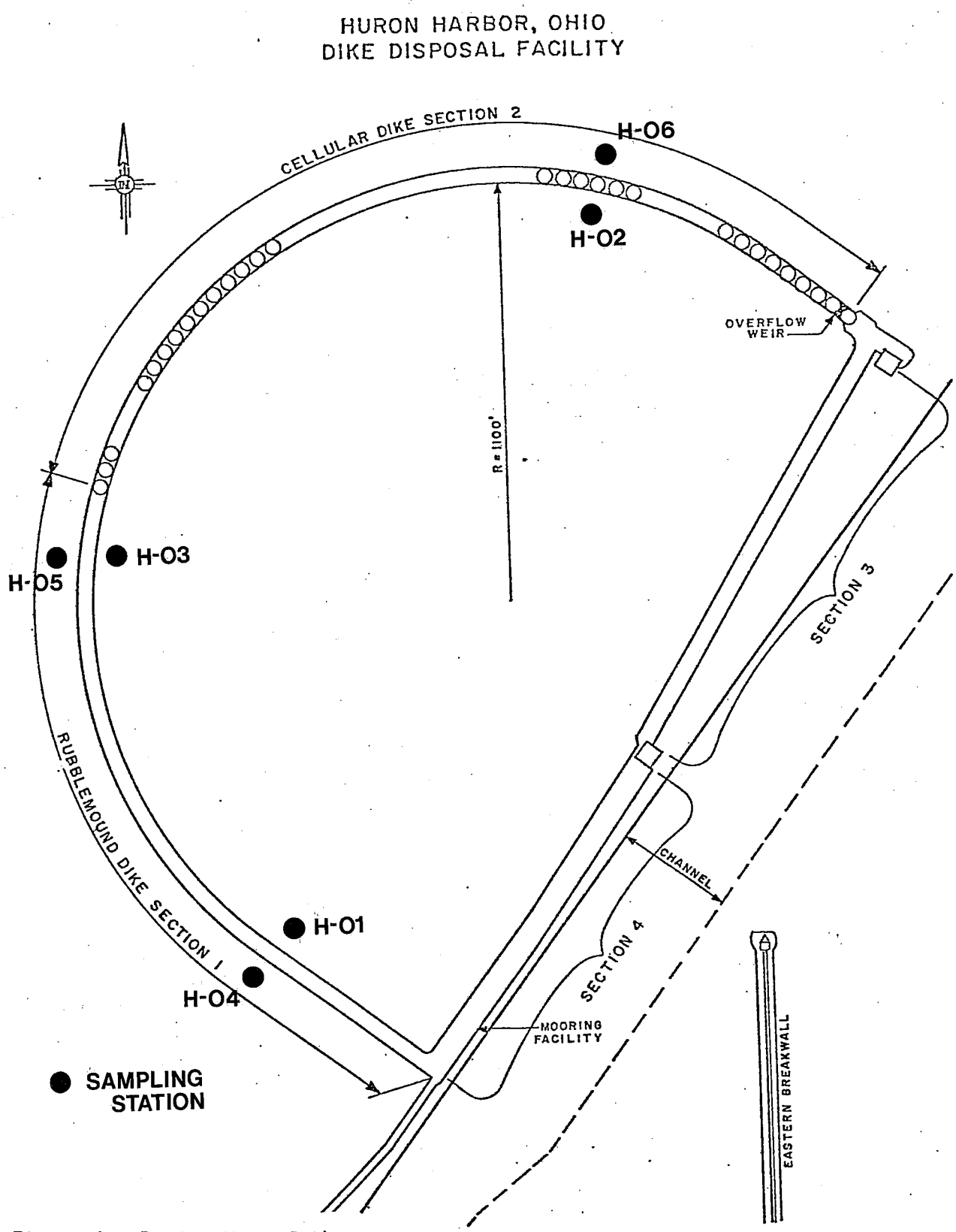

Figure 1. Design Map of the Huron Diked Disposal Facility Showing Sampling Stations

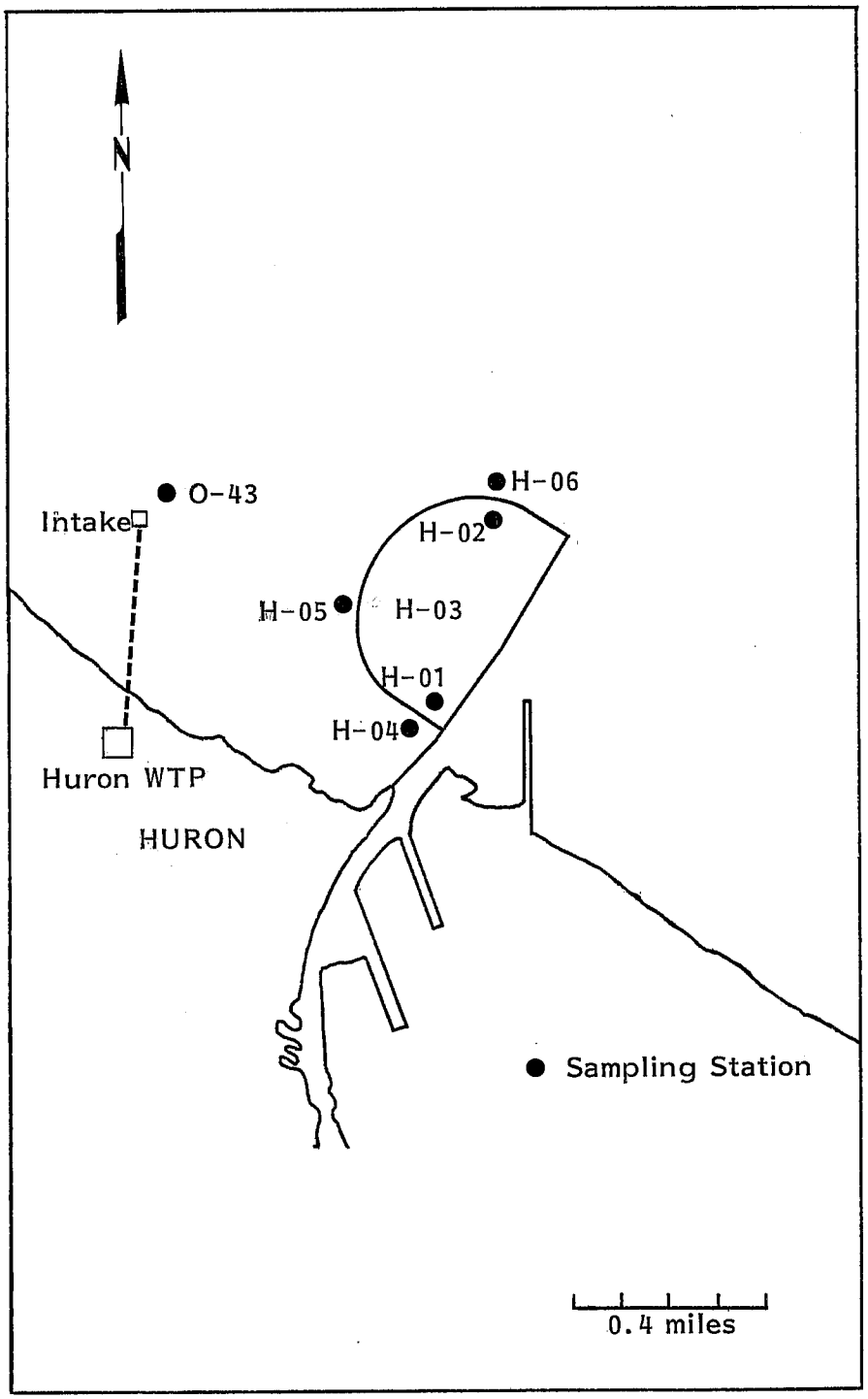

Figure 2. Location Map of Sampling Stations in the Vicinity of the Huron Diked Disposal Facility