

Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

***RESEARCH AND DEVELOPMENT
DEPARTMENT***

REPORT NO. 03-16

REPORT ON O'HARE CUP RESERVOIR FILL EVENT EXPERIMENT

CONDUCTED FROM MAY 1, 2003 THROUGH MAY 21, 2003

September 2003

Metropolitan Water Reclamation District of Greater Chicago

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DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

INTRODUCTION

A full-scale experiment was conducted from May 1, 2003 to May 21, 2003 at O'Hare CUP Reservoir to study the potential for odor formation during storage of combined sewer overflows (CSOs) without mechanical aeration. This was a follow-up experiment to the two similar full-scale experiments that were conducted from May 12, June 12, and August 13, to September 3 in 2002. As in the two experiments conducted in 2002 the objective of this experiment was also to collect information and data for use in the evaluation and design of aeration systems of the future McCook and Thornton Reservoirs.

The experimental plan dated April 19, 2002 for the O'Hare CUP Reservoir (Appendix AI) was followed in this experiment. The experimental plan calls for two scenarios, one a Manmade Fill Event, and the other a Natural Fill Event. The fill event covered in this report was a Natural Fill Event.

The O'Hare CUP Reservoir experimental plan was put into effect following the Natural Fill Event that occurred on May 1, 2003. The O'Hare CUP Reservoir began filling with CSO at 0505 hours (military time) May 1, 2003 and became static at 0100 hours (military time) on May 2, 2003. A total of 72 million gallons of CSO was captured in the reservoir.

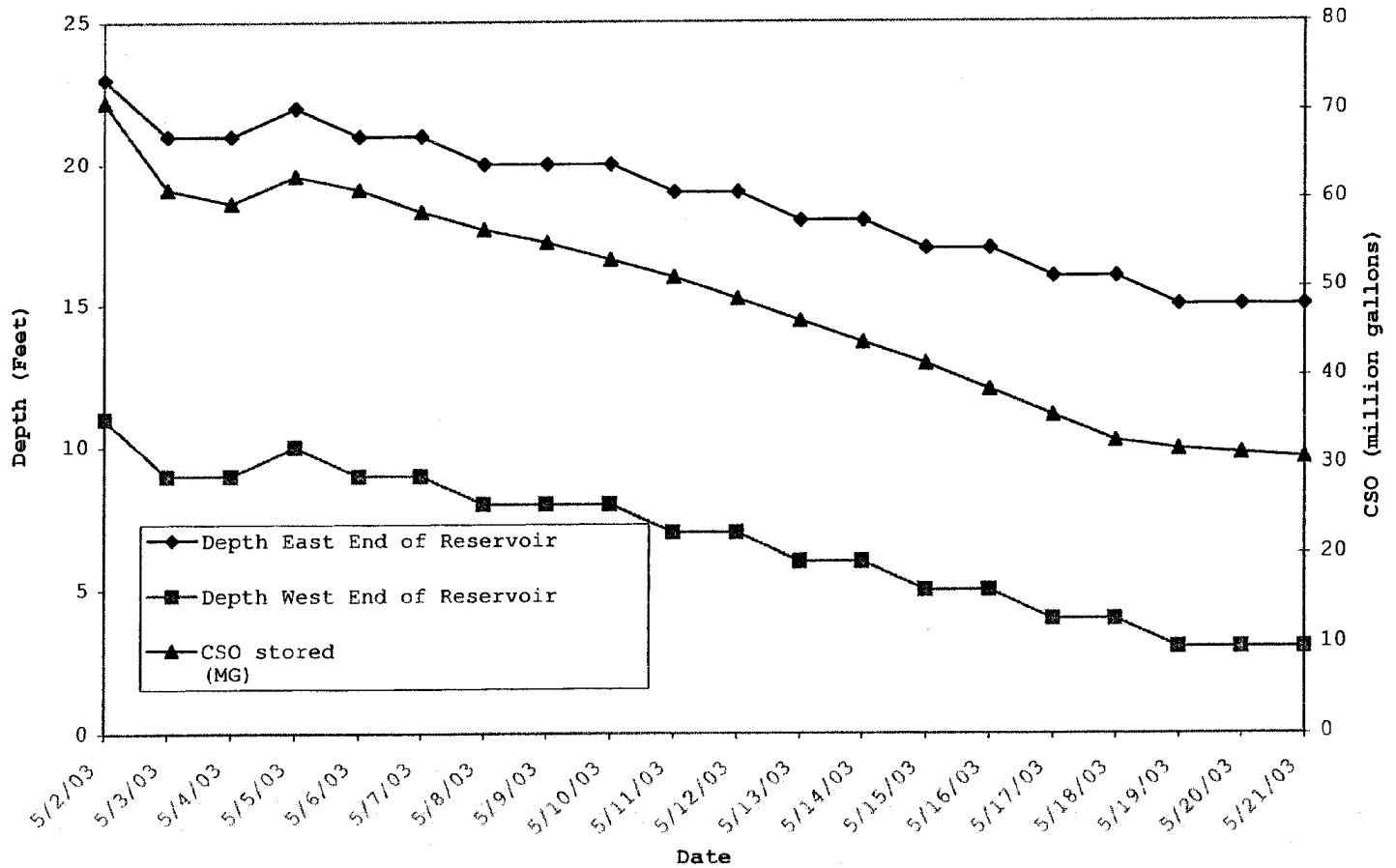
Approximately 1.39 inches of rain was recorded on May 1 for this storm event. On May 4 the reservoir was drained to 60 million gallons in anticipation of additional rainfall. On May 5, 2003 the reservoir began filling again at 1030 hours (military time) adding a little over one million gallons of CSO to the 60 million gallons of CSO that was already in the reservoir. Approximately 1.10 inches of rain fell on May 4 and 0.25 inches of rain fell on May 5. Reservoir influent sampling and in-situ sampling for dissolved oxygen (DO), BOD₅, total suspended solids (TSS), volatile suspended solids (VSS), and ammonia-nitrogen (NH₄-N) were performed for both the fill events according to the test protocol given in Appendix AI.

From May 6 to May 21 a gradual decline in liquid volume was observed. On May 21 the volume of CSO in the reservoir was only 31 million gallons. This loss in CSO was attributed to leaks in the gates separating the reservoir from the tunnel system, resulting in some of the stored CSO draining back to the James C. Kirie WRP. This decrease in liquid volume and corresponding depths of water in the reservoir during May 6 through May 21 can be seen in Figure 1. The difference in water depths between east and west ends of the reservoir is due to the fact that the bottom of the reservoir is sloped, and unrelated to the leakage problem. During this period water

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FIGURE 1

RESERVOIR DEPTH AND CSO VOLUME FOR THE O'HARE CUP RESERVOIR DURING
THE MAY 1 THROUGH MAY 21, 2003 FILL EVENT



elevation varied from 23 feet to 15 feet in the east side of the reservoir and from 11 feet to 3 feet on the west side of the reservoir.

Due to the decreasing volume of CSO in the reservoir, bottom solids at the western end of the reservoir were exposed to air increasing the odor potential of the reservoir. Because of this condition a decision was made on May 20 to terminate the experiment and drain the reservoir. Draining of the reservoir was initiated on May 21. The aerators were not turned on for this experiment.

RESULTS

Liquid sampling for various chemical parameters, DO readings, sediment sampling, and odor monitoring was conducted during this experiment as described below.

Reservoir Influent Sampling

Hourly liquid samples were collected of the CSO inflows to the reservoir during the two fill events. The samples were analyzed for BOD₅, TSS, NH₄-N, nitrite (NO₂-N), and nitrate (NO₃-N). The results of the analyses are given in Tables AII-1 and AII-2 and plotted in Figures AII-1 and AII-2 in Appendix AII.

The concentration ranges of these parameters for the May 1 Fill Event are as follows: BOD₅ 15 to 38 mg/L, with a mean value of 22 mg/L, TSS 28 to 188 mg/L, with a mean value of 57 mg/L, NO₂-N 0.05 to 0.11 mg/L, with a mean value of 0.08 mg/L, NO₃-N 0.92 to 3.34 mg/L, with a mean value of 2.68 mg/L, NH₄-N 1.50 to 7.38 mg/L with a mean value of 3.81 mg/L. Based on the mean concentrations of BOD₅ and TSS it can be said that the CSO captured during this fill event was on the low end of the current McCook Reservoir design assumption of BOD₅ 30 to 80 mg/L and TSS 100-200 mg/L.

Additional samples of CSO inflow were collected at 0605 hours on May 1 and analyzed for fecal coliform and dissolved oxygen. The results of these analyses are 7.9 mg/L of dissolved oxygen and 220,000 CTS/100 mL fecal coliforms as given in Table AII-1.

The concentration ranges of these parameters for the May 5 Fill Event CSO inflows are: BOD₅ 8 to 23 mg/L, with a mean value of 15 mg/L. TSS 4 to 36 mg/L with a mean value of 26 mg/L, NO₂-N 0.21 to 0.82 mg/L with a mean value of 0.50 mg/L, NO₃-N 0.04 to 0.80 mg/L with a mean value of 0.35 mg/L, NH₄-N 3.28 to 3.56 mg/L with a mean value of 3.41 mg/L. Again, based on the mean concentrations of BOD₅ and TSS it can be said that the CSO captured was on the low end of the current McCook Reservoir design assumption of BOD₅, 30 to 80 mg/L and TSS, 100-200 m/L.

Because of the short duration of the May 5 Fill Event there was no analysis of the influent during the May 5 Fill Event for DO and fecal coliform bacteria. The results of the analysis for the second fill event on May 5 are given in Table AII-2 and plotted in Figure AII-2 in Appendix AII.

Stored Liquid Sampling

Liquid grab samples were collected in the reservoir using a small remote controlled boat (RCB) at three locations along the south wall of the reservoir namely East South (ES), Middle South (MS), and West South (WS) at various depths as shown in Figure AII-3. These were analyzed for BOD₅, TSS, VSS, and NH₄-N, and sulfide. The concentration ranges for these parameters are as follows: BOD₅ 5 to 17 mg/L, TSS 4 to 32 mg/L, VSS 2 to 26 mg/L, NH₄-N 2.4 to 7.1 mg/L and sulfide 0.00 to 2.20 mg/L as can be seen in Table AII-3. Sulfide samples were only collected from East 15, Center 10, and West 5 sampling sites. The sulfide samples were collected from May 2 through May 21. Three sets of samples were collected from the reservoir for the analysis of chlorophyll a during the period of May 6 through May 21. The chlorophyll concentrations range from 0.0 µg/L to 394.7 µg/L as can be seen in Table AII-4. The chlorophyll samples were collected from the same locations as that of the DO and liquid grab samples at a depth of 5 feet.

Stored Liquid Measurements of Dissolved Oxygen and Temperature

Dissolved oxygen and temperature readings in the reservoir were taken with a probe mounted on the RCB at three locations East South (ES), Middle South (MS), and West South (WS)

at various depths on the south shore of the reservoir. Sampling locations are seen in Figure AII-3. As can be seen from Table AII-5 the DO concentrations varied from 0.00 to 21.1 mg/L and temperature varied from 12.1°C to 19.6°C. The DO results are plotted in Figure AII-4.

Air Emission Monitoring

Daily odor and H₂S monitoring at five locations around the reservoir was done as per the experimental plan. The odor monitoring locations are shown in Figure AII-5. The results shown in Table AII-6 show the concentrations of H₂S, in parts per billion (ppb), in the ambient air at five locations around the reservoir. The concentrations of H₂S in the ambient air varied from 2 to 14 ppb indicating practically no H₂S-related odors as a result of storage in the reservoir. Table AII-7 contains qualitative odor evaluations of the same five locations as perceived by persons conducting the odor surveys.

Odors were detected in 16 out of 105 observations. A breakdown of the odors is as follows: Very Faint 9, Faint 6, and Easily Noticeable 1. No odor was detected 89 times out of the total 105 observations, and very strong odor was never detected during the entire period of this experiment.

Sediment Measurements

Bottom sediments were collected on May 21, 2003 from four different locations after the reservoir was drained and the depths of the sediments were measured. The locations of the of the depth measurements of sediment deposits are shown in Figure AIII-1. The data on sediment deposit depths are shown in Table AIII-1. The data on sediment deposit depths along with total solids (TS) and total volatile solids (TVS) concentrations are given in Table AIII-1.

The depth of sediments varied from 0.06 inch to 0.94 inch with a mean value of 0.45 inch. The mean TS concentration of the sediment was 6.27 percent and 43.64 percent volatile solids. The mean sediment depth for this fill event was on the low end of projected estimates for a comparable size fill event (0.6 to 3.6 inches projected). Because of the small amount of sediment on the bottom of the reservoir, only four sampling sites were used. At the other areas of the reservoir there was insufficient amount of bottom sediments for collection of samples.

Another set of sediment depth measurements was collected from six pans specially installed for this experiment at the bottom of this reservoir. The locations of the pans are shown in Figure AIII-1 and the results of depth measurements are

shown in Table AIII-2. The depths of the sediments in the pans varied from 0.03 inch to 0.06 inch with a mean value of 0.04 inch. The purpose of the sediment pans was to compare the results of sediment deposits in stationary containers such as the pans (13 1/2" L x 10" W x 10" D) with that of freely moving sediments in the rest of the reservoir.

The mean depth of sediment deposits in pans is significantly lower (0.04 inch) compared to the mean deposit of 0.47 inch in the reservoir. This difference cannot be explained.

DISCUSSION OF RESULTS

Odor Production

The objective of this experiment was the same as for the experiments conducted in 2002, i.e., to determine the odor potential from the CSO stored in the O'Hare CUP Reservoir without aeration and to use the information in the evaluation of aeration systems of the future McCook and Thornton Reservoirs. As can be seen from Table AII-6, the maximum H₂S measured in the ambient air during the 21-day CSO storage at any of the five locations around the reservoir was 14 ppb. The threshold odor concentration for H₂S (given by the USEPA) is 25 ppb. Similarly, qualitative odor perception by the individuals conducting the odor survey given in Table AII-7 indicates very little or no odor problem experienced during the experiment. Qualitative odor survey results indicate that no odor was perceived at all for 89 out of a total of 105 observations, and strong or very strong odor was never perceived during the entire period of this experiment.

Dissolved Oxygen in the Stored Liquid

As can be seen from Table AII-5 and Figure AII-4 DO concentrations in the reservoir varied widely. However, once the reservoir was filled the DO began a steady rise.

DO concentrations showed a similar pattern to those of the previous fill events. Similar patterns included a general rise in DO after several days storage of the CSO in the reservoir.

Comparison of Influent and Stored Liquid Quality

The BOD₅ values of the CSO stored in the reservoir ranged from 6 to 17 mg/L and the TSS values ranged from 4 to 32 mg/L during the 19-day holding period. In comparison to these BOD₅ and TSS values, BOD₅ in the influent to the reservoir during the May 1-2 fill event varied from 15 to 38 mg/L and TSS varied from 28 mg/L to 188 mg/L as shown in Table AII-1.

CONCLUSIONS

The main conclusions of this report are:

1. Based on the results of the full-scale experiment conducted at the O'Hare CUP Reservoir from May 1, 2003 to May 21, 2003, it can be concluded that the future McCook and Thornton Reservoirs may not require maintenance of 2.0 mg/L DO throughout the reservoir as provided in the proposed design in order to ensure a reasonably odor free environment in the vicinity of these two reservoirs during the storage of CSOs. This finding is consistent with the conclusions drawn from the previous experiments conducted at the O'Hare CUP Reservoir on May 12, June 12 and August 13 to September 3 in 2002.
2. During the 19-day holding period of CSOs, without any aeration, no significant odors emanated from the reservoir even though dissolved oxygen concentrations at the beginning of the fill event were very low.
3. The depth of the sediment deposits at the bottom of the reservoir found during this experiment

were lower than sediment depths measured in the 2002 fill events. This finding again confirms the conclusions drawn in the previous reports that the actual sediment deposits for a comparable size fill event in the McCook and Thornton Reservoirs would be lower than the projected estimates of the sediment deposits for these two reservoirs.

APPENDIX AI

EXPERIMENTAL PLAN FOR O'HARE CUP RESERVOIR
(REVISED 4-19-02)

EXPERIMENTAL PLAN FOR O'HARE CUP RESERVOIR
(Revised 4-19-02)

Objective

To study the potential for odor formation during storage of CSOs without mechanical aeration. To study the potential for release of odors from anaerobic sediments. To use the information gained to aid in the design of the future McCook and Thornton Reservoirs.

Experimental Protocol (based upon perceived concerns of the Corps of Engineers)

I. Man-made Fill Event

Experiment 1

During a rain event, M&O will operate the Kirie WRP such that approximately 60 million gallons of combined sewage (approximately 21 feet of liquid depth at the deep end) will enter the O'Hare CUP Reservoir. Based upon an analysis of historical data, M&O will attempt to obtain a rain/sewage mix that will result in a BOD₅ of from 80 to 100 mg/l. As the reservoir fills, collect liquid samples of the influent flow to the reservoir for chemical analysis as is currently done using the automatic sampling system currently in place.

Do not turn on the surface aerators.

When the reservoir has reached a static condition with no further inflow (approximately 21-foot depth at deep end), conduct daily measurements of dissolved oxygen concentrations at six locations equally spaced around the perimeter of the reservoir at depths of 5, 10, and 20 feet at each location [a 20-foot depth may not be possible at the shallow (west) end, so take the measurement at the lowest depth]. Also collect six, one-gallon water samples (5-foot depth and 20-foot depth at the east, center, and west ends of the reservoir) for chemical analysis. At locations where there is less than 20 feet of depth, collect liquid samples at the lowest depth. Water samples will be analyzed for BOD₅, NH₄-N, TSS, and VSS. Water samples will only be collected on weekdays.

In addition, conduct daily odor monitoring surveys along the entire upper perimeter of the reservoir using subjective odor assessments by two trained individuals, and measure H₂S using a meter. The odor monitoring will be conducted in the early afternoon by R&D staff. M&O staff at Kirie will be notified each day as to the presence of R&D staff at the reservoir.

Continue this monitoring for seven days unless a strong odor is detected emanating from the reservoir. If a strong odor is detected, inform M&O and R&D supervisory staff immediately. M&O Dept. staff will then make an assessment of the severity of the odor, and if deemed necessary by M&O, the experiment will be terminated, and M&O will begin draining the reservoir immediately.

During draining, do not turn the aerators on, as this may worsen the spread of the odors.

If no strong odors are detected, begin draining the reservoir after seven days to an elevation of approximately 18 feet of water depth at the deep end of the reservoir. At this depth, the seven most easterly surface aerators can be activated. The remaining two surface aerators will be off. Turn on the seven aerators in order to resuspend some of the settled solids and begin monitoring for odors (it is understood that the surface aerators will not have enough input energy to thoroughly mix the sediment layer). Continue odor monitoring every hour for 4 hours. Then **turn off the aerators** and completely drain the reservoir.

After the reservoir is empty, measure the depth of the settled solids at six evenly spaced locations on the reservoir floor, and collect samples of the sediments for total solids and total volatile solids analysis. Also determine the wet density of the settled solids by weighing a measured volume of collected sediment at each of the six locations. This may be done using the small plastic pans which M&O has agreed to install on the bottom of the reservoir.

Then have the private contractor clean the bottom of the reservoir. For experiments that end early (before seven days of storage) due to odors, also collect sediment samples after the reservoir has been completely drained. However, for a case where the reservoir is being drained due to odors, do not conduct the resuspension part of the experiment. Just drain the reservoir as fast as possible.

Experiment 2

Repeat the above Experiment 1, except for this test fill the reservoir with 90 million gallons of combined sewage (approximately 27 feet of liquid depth at the deep end).

Since 90 million gallons is a significant liquid volume, it is understood that M&O will have the authority to terminate this experiment and begin draining the reservoir in the middle of the test, in the event that a rainstorm is forecast. M&O will notify R&D if the decision is made to drain the reservoir in the middle of a test. It is estimated by M&O that it would take approximately 24 to 36 hours to empty the reservoir and be ready for a predicted significant rain event.

If no significant odors are detected at the end of seven days, an attempt will be made to measure the sediment oxygen demand (SOD) of the settled solids before the reservoir is completely drained. This will require draining the reservoir to a liquid depth of approximately 16 feet at the deep end, and launching a small R&D boat over the water surface. It will take approximately six hours to conduct the SOD measurements. At the end of the SOD measurements, the reservoir would be completely drained, sampled, and cleaned as described for Experiment 1.

Due to logistical considerations, only one set of SOD measurements will be attempted during this entire study. M&O and R&D will work together to coordinate this extra SOD determination and address any safety issues. It is understood that SOD measurements will not be made until all safety issues have been resolved.

It should also be noted that SOD measurements cannot be made when initial dissolved oxygen levels near the sediment/water interface are less than 2 mg/l.

Experiment 3

Repeat the above Experiment 1, except for this test wait 30 days before beginning to empty the reservoir. After the first 7 days, reduce dissolved oxygen monitoring to once per week, but continue daily odor monitoring by R&D staff in the early afternoon, except for weekends. M&O staff will check the reservoir for odors on weekends and holidays.

It is noted that the private contractor cleaning the reservoir may incur larger than normal costs when required to clean the reservoir bottom after this long storage time, as the settled solids may have objectionable characteristics.

Experiment 4

Repeat the above Experiment 2, except for this test wait 30 days before beginning to empty the reservoir. Use the same monitoring schedule as for the above Experiment 3.

Further Man-made Experiments

Review the results of the above four experiments, and then design additional modifications of the experimental plan as appropriate.

II. Natural Fill Event

When the reservoir fills due to a natural storm event, institute the same experimental protocol as described for Experiment 3 above, i.e., a 30-day holding period with no aeration, if possible.

Evaluate all data at the end of 2002, and decide if experiments should continue in 2003.

If any experiment is in progress, and a significant rainfall is predicted in the near future, M&O will have the discretion to drain the reservoir early to prepare for the anticipated large storm event.

It is understood that the O'Hare CUP Reservoir is an operational component of the District's collection system, and the proposed experiments should not interfere with M&O operational needs.

Groundwater Monitoring Program

During all of the above experiments, follow the existing groundwater monitoring protocol as described in the memorandum, dated February 28, 2000, from Buckley to Kukielka, with the following exception. For the first experiment with a 7-day holding time and the first experiment with a 30-day holding time, sample the four groundwater monitoring wells on the perimeter of the reservoir daily instead of weekly, and analyze for ammonia and fecal coliform. After evaluating the results, a decision will be made as to whether daily groundwater sampling is needed for all experiments.

Interagency Cooperation

The Army Corps of Engineers has reviewed the experimental plan, and is in agreement with the proposed experiment. The Illinois Environmental Protection Agency will be informed of our plan to conduct this experiment.

APPENDIX AII

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW, IN-SITU
RESERVOIR, AND AIR SAMPLES DURING O'HARE CUP RESERVOIR MAY 1,
2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-1

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING
THE O'HARE CUP RESERVOIR MAY 1-2, 2003 FILL EVENT

Date	Time Collected (military time)	BOD ₅ mg/L	TSS mg/L	NO ₂ -N mg/L	NO ₃ -N mg/L	NH ₄ -N mg/L
5/1/03	0505	38	188	0.052	0.924	1.50
5/1/03	0605	27	72	0.055	1.514	4.80
5/1/03	0705	20	68	0.060	1.804	4.12
5/1/03	0805	34	72	0.063	2.506	7.38
5/1/03	0905	21	56	0.067	2.534	3.84
5/1/03	1005	19	28	0.066	2.536	3.52
5/1/03	1105	20	44	0.067	2.661	3.89
5/1/03	1205	17	40	0.072	2.584	3.63
5/1/03	1305	15	40	0.070	2.689	3.47
5/1/03	1405	15	36	0.076	2.893	4.18
5/1/03	1505	20	36	0.082	3.213	4.04
5/1/03	1605	23	76	0.079	3.044	4.16
5/1/03	1705	23	72	0.095	3.274	4.68
5/1/03	1805	21	48	0.096	3.335	4.38
5/1/03	1905	21	44	0.101	3.210	4.15
5/1/03	2005	29	64	0.106	3.113	3.74
5/1/03	2105	21	48	0.094	2.922	2.87
5/1/03	2205	16	40	0.087	2.904	2.76

AII-1

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-1 (Continued)

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING
THE O'HARE CUP RESERVOIR MAY 1-2, 2003 FILL EVENT

Date	Time Collected (military time)	BOD ₅ mg/L	TSS mg/L	NO ₂ -N mg/L	NO ₃ -N mg/L	NH ₄ -N mg/L
5/1/03	2305	18	28	0.089	2.760	3.06
5/2/03	0005	23	48	0.089	2.757	3.25
5/2/03	0105	26	56	0.090	2.789	3.23
5/2/03	0205	18	52	0.096	2.979	3.15
Min.		15	28	0.052	0.924	1.50
Mean		22	57	0.080	2.679	3.81
Max.		38	188	0.106	3.335	7.38

Note: DO and fecal coliform bacteria in the sample were collected at 0605 hours on 5/1/03 were 7.9 m/L and 220,000 CTS/100 mL, respectively.

AII-2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-2

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR MAY 5, 2003 FILL EVENT

Date	Time Collected (military time)	BOD ₅ mg/L	SS mg/L	NO ₂ -N mg/L	NO ₃ -N mg/L	NH ₄ -N mg/L
5/5/03	1100	23	28	0.461	0.804	3.31
5/5/03	1200	18	36	0.520	0.417	3.28
5/5/03	1300	8	36	0.821	0.142	3.56
5/5/03	1400	10	4	0.208	0.039	3.47
Min.		8	4	0.208	0.039	3.28
Mean		15	26	0.503	0.351	3.41
Max.		23	36	0.821	0.804	3.56

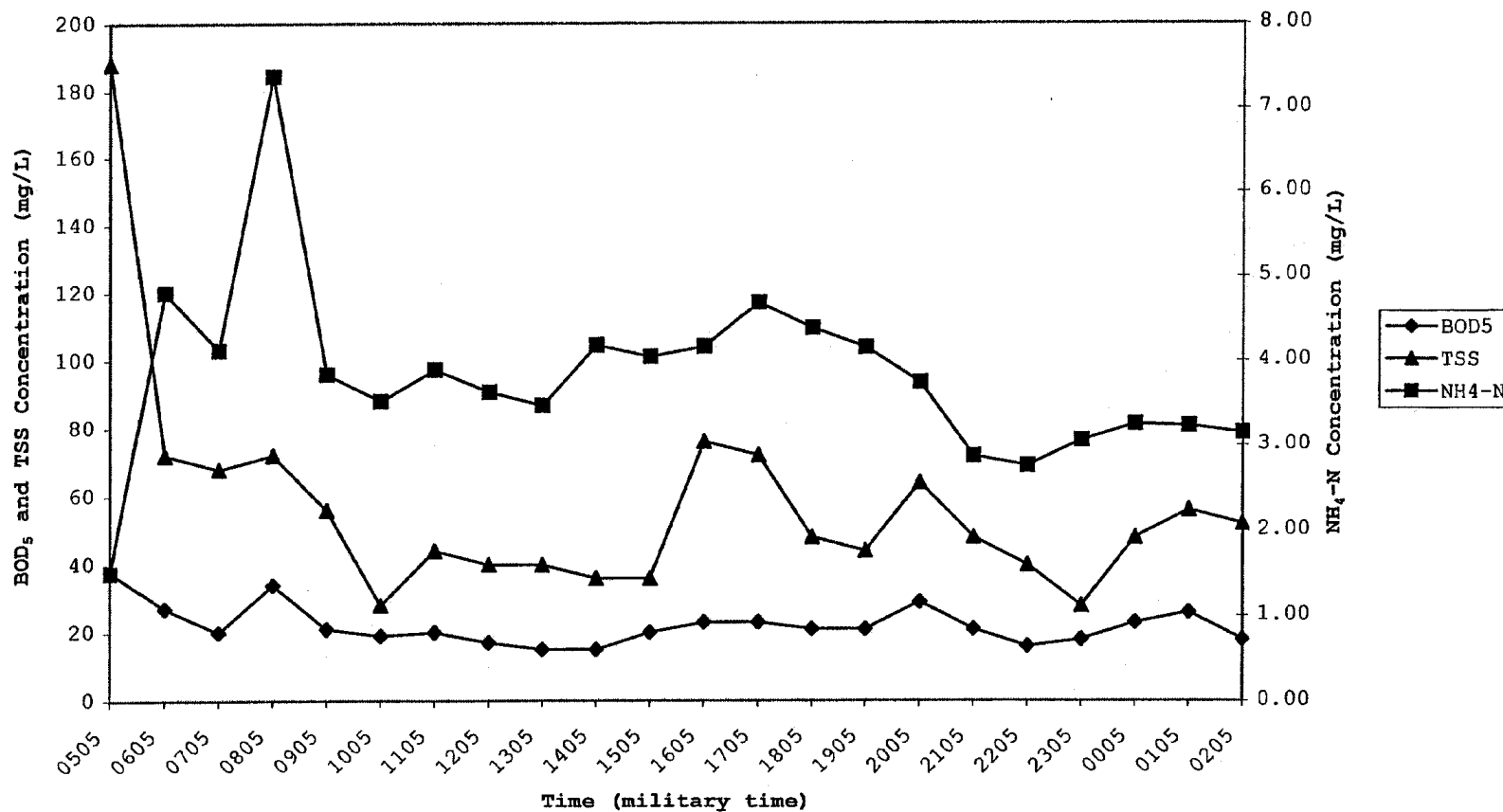
Note: Dissolved oxygen and fecal coliform samples were not collected.

AII-3

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-1

CONCENTRATION OF BOD₅, TSS AND NH₄-N IN HOURLY GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR MAY 1 AND 2, 2003 FILL EVENT



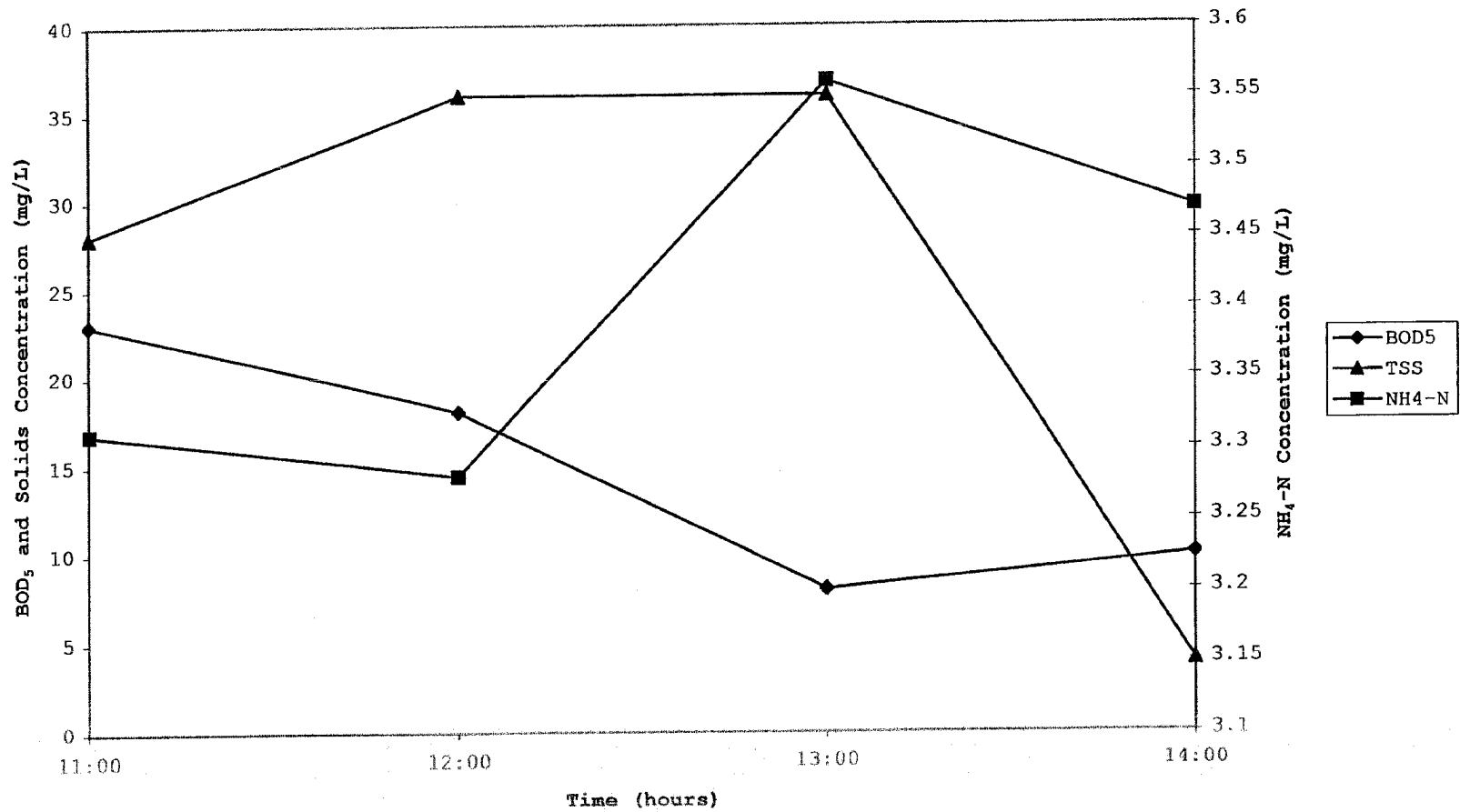
AII-4

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-2

CONCENTRATION OF BOD₅, TSS AND NH₄-N IN HOURLY GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR MAY 5, 2003 FILL EVENT

AII-5



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	East 5* ¹	East 15* ¹	East 20* ¹	Middle 5* ¹	Middle 10* ¹	Middle 15* ¹	West 5* ¹	West 10* ¹
-----BOD ₅ (mg/L)-----								
5/2/03	15	17	NS ²	14	16	NS	14	NS
5/6/03	**	9	NS	**	8	NS	5	NS
5/7/03	**	11	NS	**	7	NS	**	NS
5/8/03	6	9	NS	**	7	NS	10	NS
5/9/03	8	10	NS	**	9	NS	**	NS
5/12/03	9	9	NS	8	9	NS	7	NS
5/15/03	12	***	NS	11	8	NS	14	NS
5/21/03	17	***	NS	13	***	NS	***	NS
Minimum	6	9		8	7		5	
Mean	11	11		12	9		10	
Maximum	17	17		14	16		14	

AII-6

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	East 5* ¹	East 15* ¹	East 20* ¹	Middle 5* ¹	Middle 10* ¹	Middle 15* ¹	West 5* ¹	West 10* ¹
-----NH ₄ -N (mg/L)-----								
5/2/03	3.30	3.37	NS	3.27	3.36	NS	3.37	NS
5/6/03	3.77	3.54	NS	4.12	3.64	NS	3.94	NS
5/7/03	3.80	3.68	NS	3.75	3.75	NS	3.84	NS
5/8/03	3.53	3.53	NS	3.55	3.41	NS	7.09	NS
5/9/03	3.68	3.85	NS	3.64	3.71	NS	3.74	NS
5/12/03	3.23	3.35	NS	3.38	3.33	NS	3.42	NS
5/15/03	2.54	***	NS	2.88	3.18	NS	2.69	NS
5/21/03	3.37	***	NS	2.44	***	NS	***	NS
Minimum	2.5	3.4		2.4	3.2		2.7	
Mean	3.4	3.6		3.4	3.5		4.0	
Maximum	3.8	3.9		4.1	3.8		7.1	

AII-7

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	East 5* ¹	East 15* ¹	East 20* ¹	Middle 5* ¹	Middle 10* ¹	Middle 15* ¹	West 5* ¹	West 10* ¹
-----TSS (mg/L)-----								
5/2/03	12	28	NS	24	16	NS	20	NS
5/6/03	8	8	NS	9	8	NS	12	NS
5/7/03	10	12	NS	16	8	NS	4	NS
5/8/03	10	16	NS	20	14	NS	4	NS
5/9/03	8	20	NS	14	14	NS	13	NS
5/12/03	16	16	NS	32	20	NS	16	NS
5/15/03	4	***	NS	14	8	NS	20	NS
5/21/03	22	***	NS	14	***	NS	***	NS
Minimum	4	8		9	8		4	
Mean	11	17		18	13		13	
Maximum	22	28		32	20		20	

AII-8

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	East 5* ¹	East 15* ¹	East 20* ¹	Middle 5* ¹	Middle 10* ¹	Middle 15* ¹	West 5* ¹	West 10* ¹
-----VSS (mg/L)-----								
5/2/03	8	24	NS	16	12	NS	20	NS
5/6/03	4	4	NS	4	4	NS	12	NS
5/7/03	6	10	NS	12	2	NS	2	NS
5/8/03	8	14	NS	14	10	NS	2	NS
5/9/03	4	18	NS	12	12	NS	11	NS
5/12/03	14	10	NS	26	16	NS	8	NS
5/15/03	2	***	NS	10	6	NS	10	NS
5/21/03	18	***	NS	12	***	NS	***	NS
Minimum	2	4		4	2		2	
Mean	8	13		13	9		9	
Maximum	18	24		26	16		20	

AII-9

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	East 5* ¹	East 15* ¹	East 20* ¹	Middle 5* ¹	Middle 10* ¹	Middle 15* ¹	West 5* ¹	West 10* ¹
-----Sulfide (mg/L)-----								
5/2/03	NS	0.00	NS	NS	0.00	NS	0.00	NS
5/6/03	NS	0.00	NS	NS	0.00	NS	0.00	NS
5/15/03	NS	0.00	NS	NS	0.69	NS	0.00	NS
5/21/03	NS	0.18	NS	NS	2.20	NS	0.11	NS
Minimum		0.00			0.00		0.00	
Mean		0.05			0.72		0.03	
Maximum		0.18			2.20		0.11	

*Number represents depth in feet.

**Analysis not completed due to incorrect dilutions used.

***Sample was bottom sediments instead of water.

¹See Figure AII-3.

²NS = No sample.

AII-10

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-4

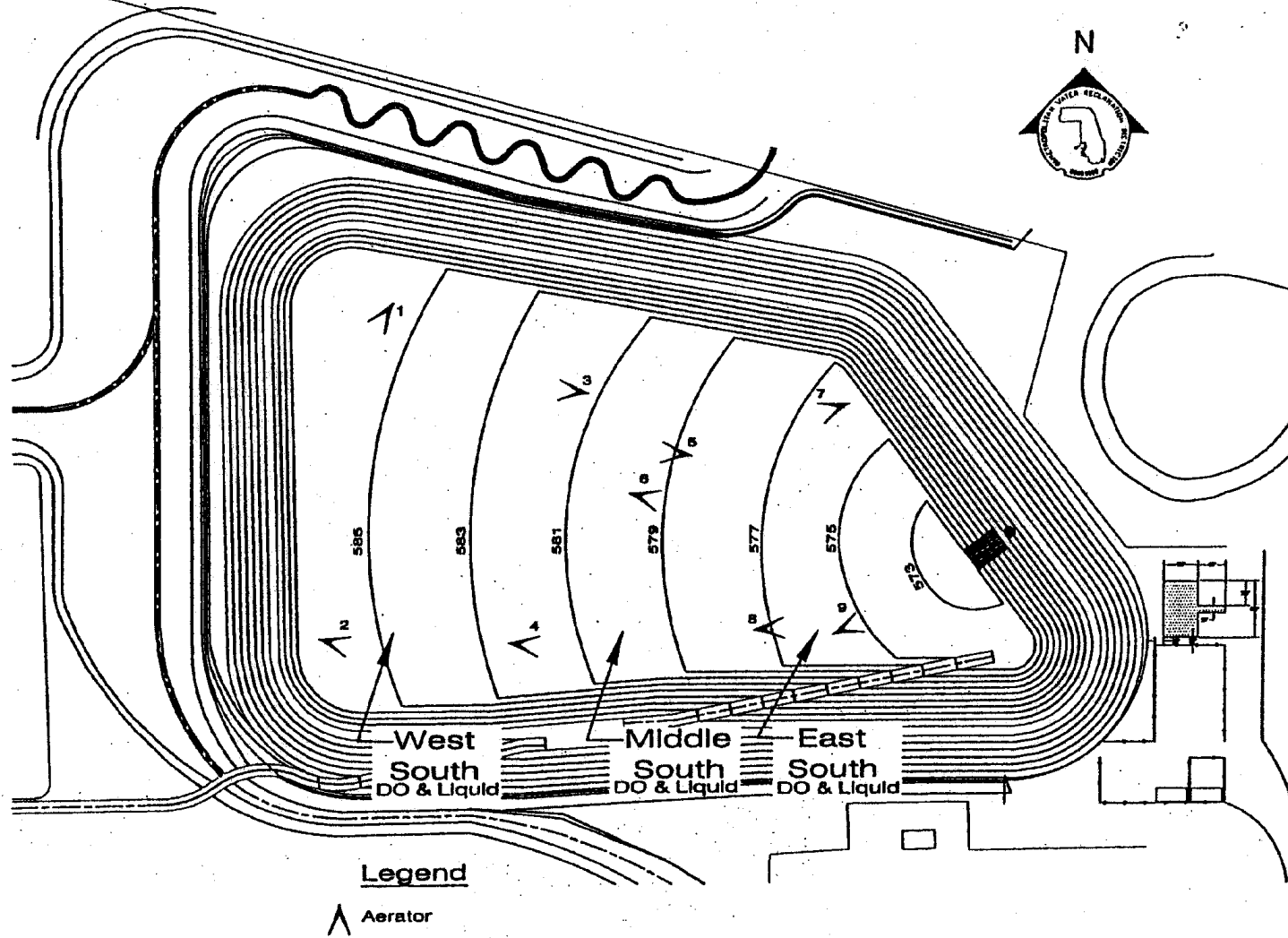
RESULTS OF CHLOROPHYLL *a* IN $\mu\text{G/L}$ FROM SAMPLES COLLECTED AT A DEPTH OF 5 FEET IN THE O'HARE CUP RESERVOIR DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	East	Center	West
5/6/03	0.690	0.000	3.276
5/15/03	167.182	161.680	225.256
5/21/03	84.628	98.316	394.652

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-3

LOCATIONS OF LIQUID SAMPLING AND DISSOLVED OXYGEN MEASUREMENTS
O'HARE CUP RESERVOIR MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT



AII-12

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-5

DISSOLVED OXYGEN AND TEMPERATURE READINGS AT SEVERAL LOCATIONS AND VARIOUS DEPTHS DURING THE O'HARE CUP RESERVOIR MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	ES1/5 ¹		ES1/10 ¹		ES1/15 ¹		MS2/5 ¹		MS2/10 ¹		WS3/5 ¹	
	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C
5/2/03	1.10	12.2	0.40	12.3	0.60	12.6	0.60	12.6	3.90	12.1	1.00	13.1
5/3/03	*	*	*	*	*	*	*	*	*	*	*	*
5/4/03	*	*	*	*	*	*	*	*	*	*	*	*
5/5/03	**	**	**	**	**	**	**	**	**	**	**	**
5/6/03	0.10	14.4	0.10	14.8	0.10	14.9	21.10	17.7	11.90	15.9	3.90	16.3
5/7/03	9.70	15.8	0.20	13.2	0.00	13.9	0.10	15.6	10.10	14.2	0.20	16.0
5/8/03	1.90	15.7	0.00	13.1	0.10	13.4	3.70	15.6	2.50	15.0	7.60	15.8
5/9/03	9.70	15.5	0.00	13.6	0.00	14.2	4.10	15.6	4.90	14.6	4.20	15.7
5/10/03	2.40	15.0	0.00	13.5	0.20	14.1	2.50	15.4	0.10	15.0	2.70	17.5
5/11/03	7.40	17.1	5.10	16.7	0.30	14.1	4.10	16.1	2.90	15.3	1.60	15.1
5/12/03	9.80	22.5	7.50	14.6	7.20	14.5	11.80	15.5	10.10	15.5	10.00	15.5
5/13/03	10.20	15.4	9.10	15.2	8.30	15.3	10.40	15.3	8.70	15.2	11.00	15.4
5/14/03	8.30	15.5	7.30	15.1	6.20	15.5	11.40	15.7	17.80	16.1	17.70	16.2
5/15/03	10.70	15.1	6.10	14.9	5.7	14.9	20.30	15.1	12.10	15.0	17.20	15.1
5/16/03	9.80	15.1	6.90	15.1	7.40	15.0	8.70	15.0	7.30	14.9	12.7	16.0
5/19/03	7.10	15.6	8.70	14.9	1.40	15.8	8.60	16.8	8.40	16.4	10.30	18.4
5/20/03	16.90	19.5	6.50	15.5	1.60	15.9	12.0	19.6	8.60	16.7	13.30	19.0
5/21/03	12.00	18.5	2.90	15.6	1.80	17.4	16.30	18.6	4.70	18.1	18.80	18.2
Min.	0.10	12.20	0.00	12.30	0.00	12.60	0.10	12.60	0.10	12.10	0.20	13.10
Mean	7.81	15.74	4.05	14.54	2.51	14.77	8.84	16.01	7.60	15.33	8.54	16.22
Max.	16.90	19.50	9.10	16.70	8.30	17.40	21.10	19.60	17.80	18.10	18.80	19.00

*Data not recorded due to faulty probe.

**Reservoir began filling again, no readings were taken that day.

¹See Figure AII-3 for locations.

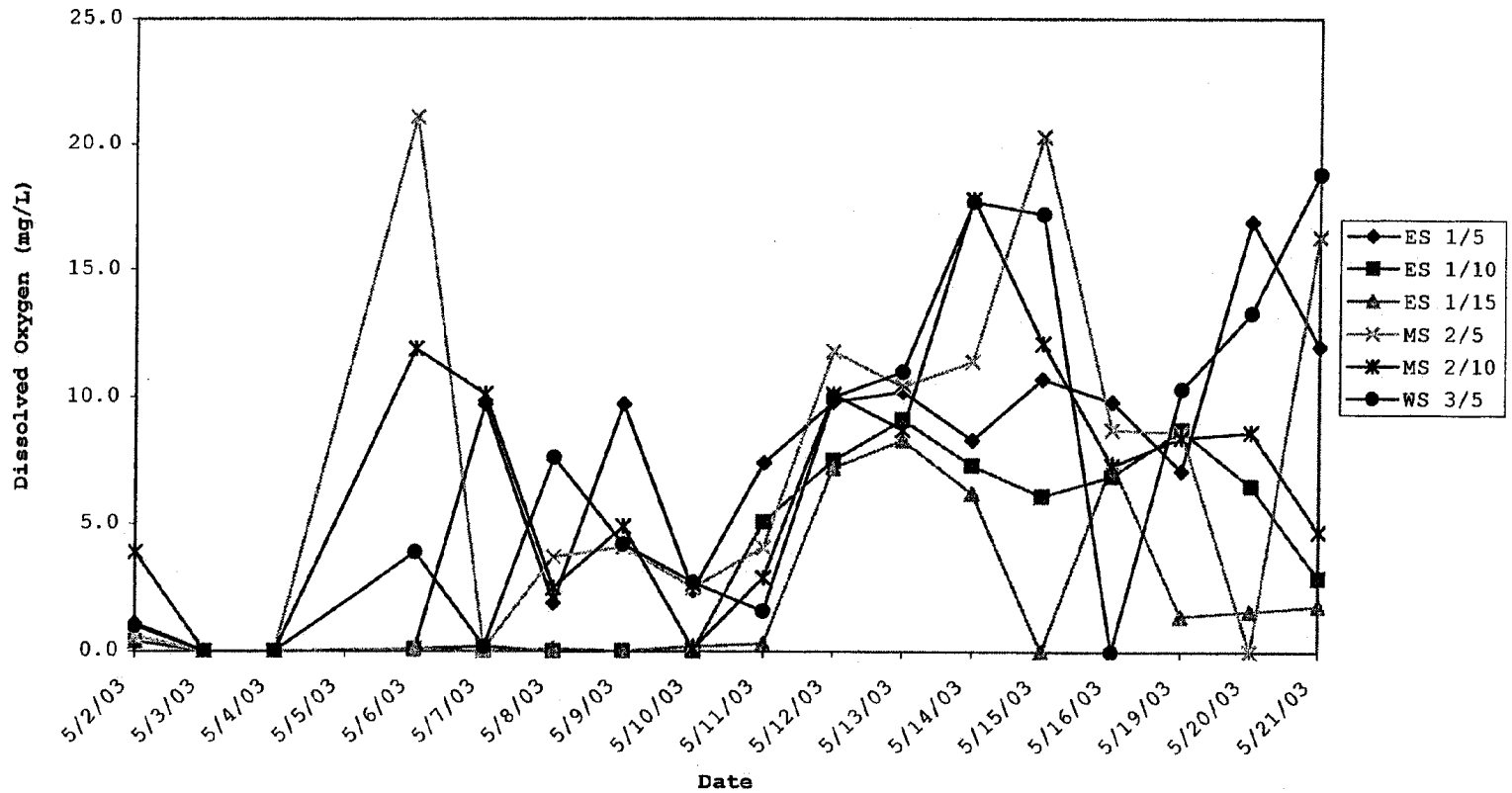
AII-13

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-4

DISSOLVED OXYGEN CONCENTRATIONS IN THE O'HARE CUP RESERVOIR ALONG THE SOUTH SIDE OF THE RESERVOIR AT DIFFERENT LOCATIONS AND DIFFERENT DEPTHS MAY 1, 2003 THROUGH MAY 21, 2003

AII-14

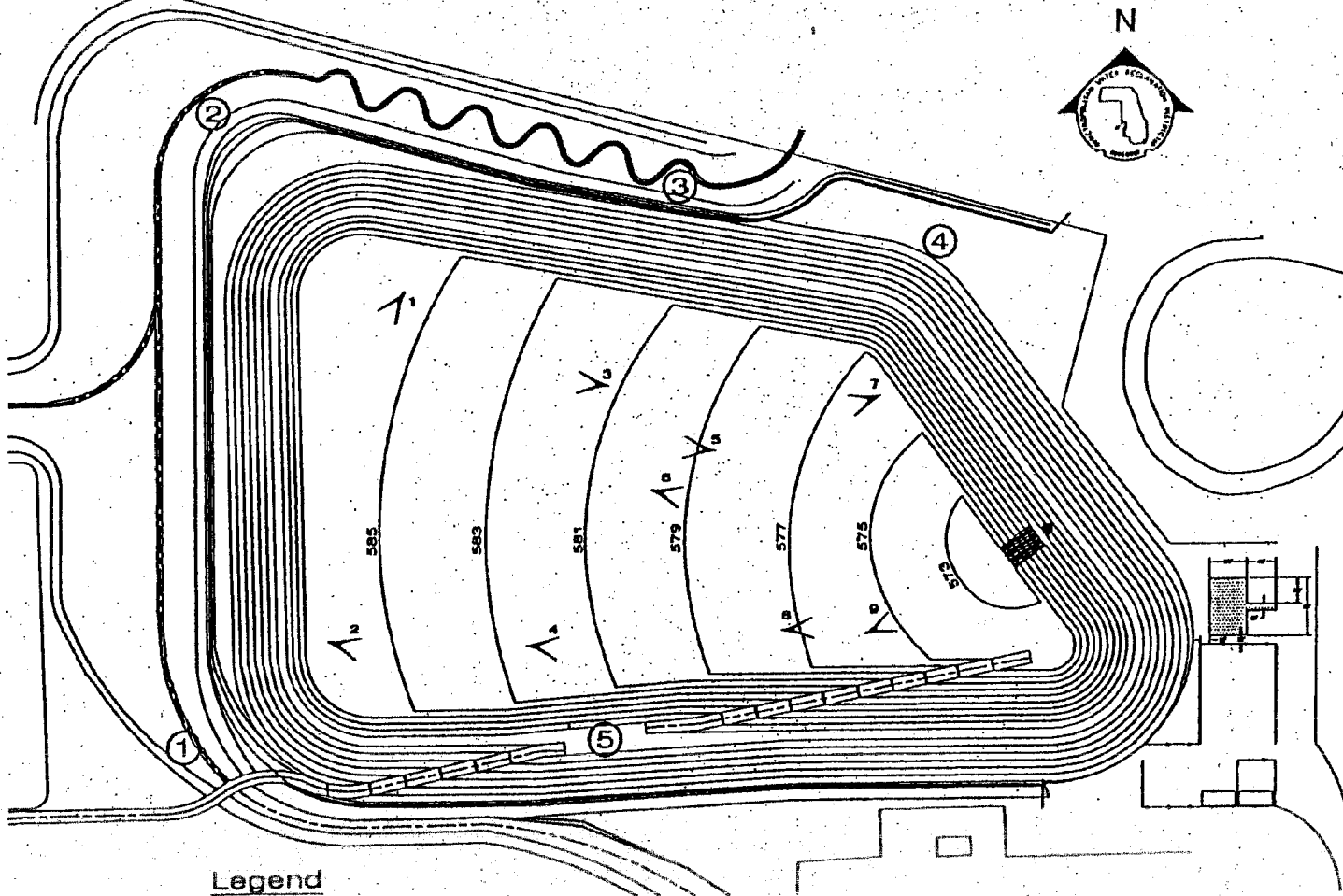


METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO



FIGURE AII-5

ODOR AND H₂S MONITORING LOCATIONS
O'HARE CUP RESERVOIR MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

AII-15



Legend

-  Aerator
-  Monitoring Location

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-6

HYDROGEN SULFIDE MONITORING DATA IN PARTS PER BILLION (ppb) AROUND THE O'HARE CUP RESERVOIR
DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Date	Location 1 ¹	Location 2 ¹	Location 3 ¹	Location 4 ¹	Location 5 ¹
5/2/03	7	7	7	9	7
5/3/03	14	13	12	11	10
5/4/03	10	8	8	11	9
5/5/03	2	2	1	1	2
5/6/03	9	8	9	10	9
5/7/03	7	7	4	8	7
5/8/03	8	8	10	9	8
5/9/03	7	9	11	10	11
5/10/03	6	7	8	9	9
5/11/03	NA	NA	NA	NA	NA
5/12/03	11	10	10	10	8
5/13/03	9	12	11	12	13
5/14/03	12	14	10	10	12
5/15/03	12	10	9	10	10
5/16/03	10	10	10	9	11
5/17/03	12	9	12	12	14
5/18/03	7	7	9	10	11
5/19/03	4	4	4	5	5
5/20/03	10	12	10	11	13
5/21/03*	5	6	5	4	5
5/21/03**	3	5	3	2	5
Min	2	2	1	1	2
Mean	8	8	8	9	9
Max	14	14	12	12	14

NA = Readings not taken due to meter malfunction.

* Readings taken before reservoir was drained.

** Readings taken after reservoir was drained.

¹See Figure AII-5.

AII-16

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-7

QUALITATIVE ODOR INTENSITY MONITORING AROUND THE O'HARE CUP RESERVOIR
DURING THE MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT

Location No.**	Total Number of Observations	Number of Times Odor Perceived with Varying Intensity*					
		No Odor	Very Faint	Faint	Noticeable	Strong	Very Strong
1	21	15	3	2	1	0	0
2	21	19	0	2	0	0	0
3	21	19	2	0	0	0	0
4	21	19	1	1	0	0	0
5	21	17	3	1	0	0	0
Total Number of Readings	105	89	9	6	1	0	0

*A subjective odor intensity as interpreted by the person doing the monitoring.

**See Figure AII-5.

AII-17

APPENDIX AIII

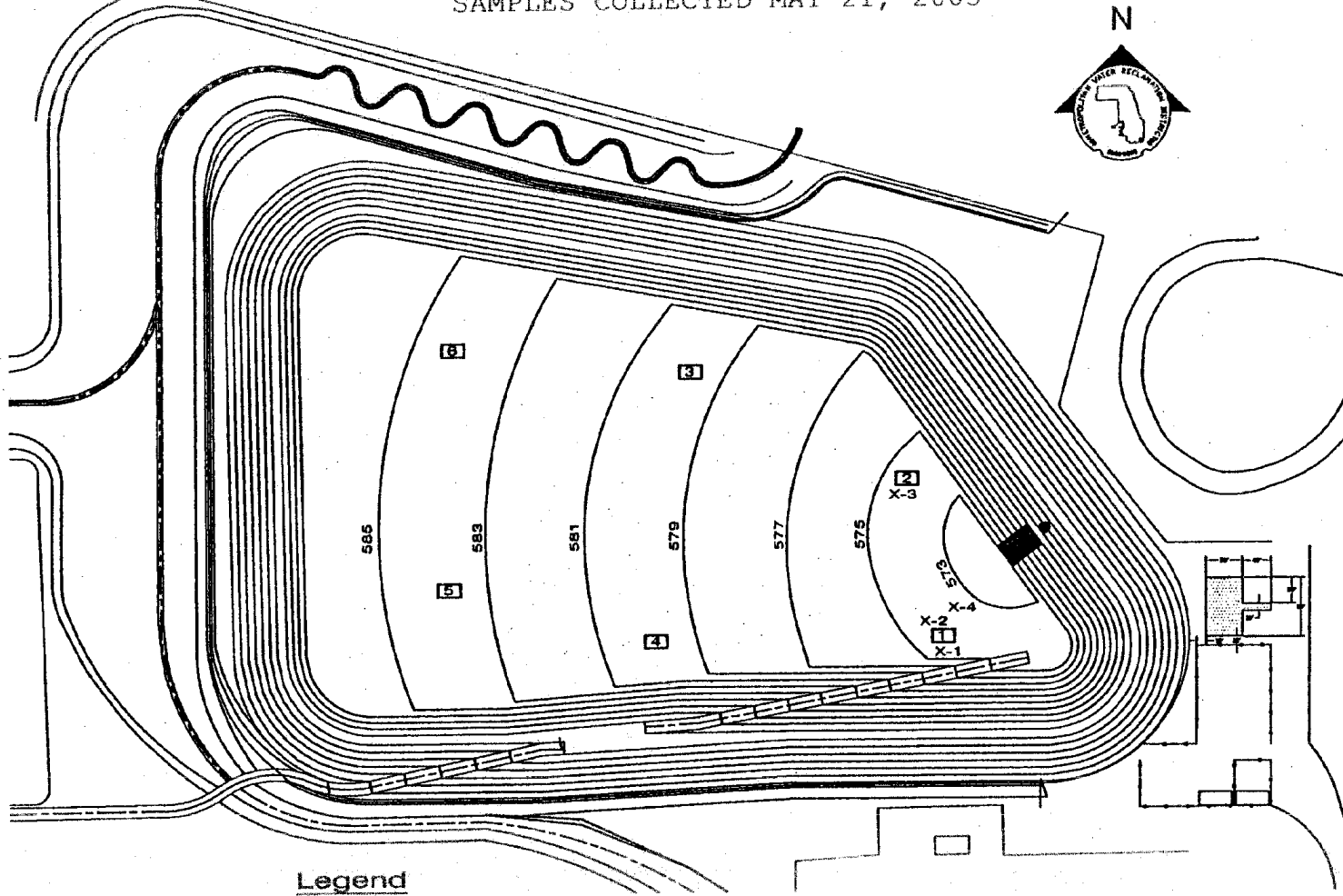
LOCATIONS OF SAMPLING SITES AND RESULTS OF BOTTOM SEDIMENTS
MEASUREMENTS DURING O'HARE CUP RESERVOIR MAY 1, 2003 THROUGH
MAY 21, 2003 FILL EVENT EXPERIMENT

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AIII-1

LOCATIONS OF SEDIMENT DEPTH MEASUREMENTS AT THE BOTTOM OF THE RESERVOIR
AND THE SIX PANS INSTALLED FOR THE EXPERIMENT
SAMPLES COLLECTED MAY 21, 2003

AIII-1



Legend

- x- Sample spot
- Sediment pans

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-1

SEDIMENT DEPTH AND SOLIDS RESULTS FROM THE BOTTOM AFTER
 DRAINING THE RESERVOIR DURING THE O'HARE CUP RESERVOIR
 MAY 1, 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT
 RESULTS FROM MAY 21, 2003 MEASUREMENTS

Site ¹	Depth Inches	Total Solids (TS) Percent	Total Volatile Solids (TVS) Percent
1	0.19	8.27	39.39
2	0.06	7.62	39.35
3	0.63	1.63	39.51
4	0.94	7.54	56.31
Min.	0.06	1.63	39.35
Mean	0.45	6.27	43.64
Max.	0.94	8.27	56.31

Note: Dry Density of combined sediments is 1.28 g/mL.

¹See Figure AIII-1.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-2

SEDIMENT DEPTH AND SOLIDS RESULTS FROM THE
 SEDIMENT PANS INSTALLED AT THE BOTTOM OF THE
 RESERVOIR DURING THE O'HARE CUP RESERVOIR MAY 1,
 2003 THROUGH MAY 21, 2003 FILL EVENT EXPERIMENT
 RESULTS FROM MAY 21, 2003 MEASUREMENTS

Site ¹	Depth Inches	Total Solids (TS) Percent	Total Volatile Solids (TVS) Percent
1	0.06	4.46	40.29
2	0.06	3.77	41.64
3	0.03	2.48	40.23
4	0.03	1.87	41.23
5	0.03	6.63	43.51
6	0.03	3.60	41.22
Min.	0.03	1.87	40.23
Mean	0.04	3.80	41.35
Max.	0.06	6.63	43.51

¹See Figure AIII-1.