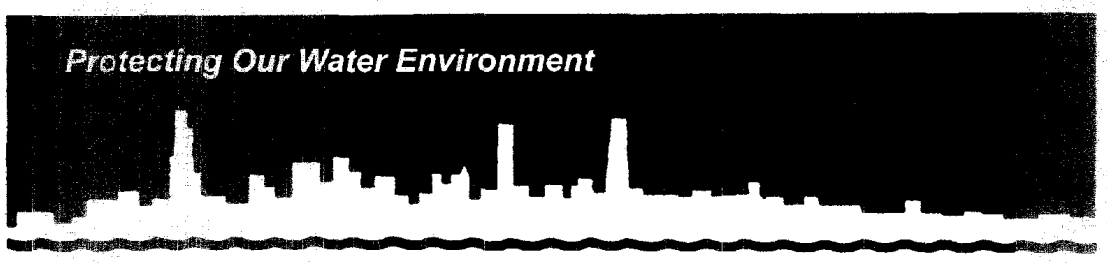


Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 02-13

REPORT ON O'HARE CUP RESERVOIR FILL EVENT

EXPERIMENT CONDUCTED FROM

MAY 12, 2002 THROUGH JUNE 12, 2002

December 2002

Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street Chicago, IL 60611-2803 (312) 751-5600

REPORT ON O'HARE CUP RESERVOIR FILL EVENT EXPERIMENT CONDUCTED FROM MAY 12, 2002 THROUGH JUNE 12, 2002

By

Jain S. Jain
Research Scientist III

Dale MacDonald
Research Scientist I

Bernard Sawyer
Assistant Director of Research and Development
Environmental Monitoring and Research Division

Research and Development Department
Richard Lanyon, Director

December 2002

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF TABLES (Continued)

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of Messrs. Dustin Gallagher, Laboratory Technician I, Marc Byrnes, Laboratory Technician I, Shafiq Rahman, Laboratory Technician I, Rodney Pierson, Laboratory Technician I, and Ms. Tiffiany Tate, Laboratory Technician II, all from the Environmental Monitoring and Research Division of the Research and Development Department, for conducting odor runs and gathering sediments data. Special thanks to Ms. Mary Pat Buckley, Pollution Control Officer III of the Industrial Waste Division, and her staff in gathering dissolved oxygen data and for collecting water samples for general chemistry during the two fill events. Very special thanks to Ms. Janet Kolar, Engineering Draftsman II of the Engineering Department, for providing AutoCAD maps of the O'Hare CUP reservoir.

Last but not least, the authors wish to acknowledge the assistance of Ms. Laura Franklin, Principal Office Support Specialist, for her diligence and patience in typing and proofreading the manuscript of this report.

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 12, 2002 through June 12, 2002 at the O'Hare CUP Reservoir to study the potential for odor formation during storage of combined sewer overflows (CSOs) without mechanical aeration. The objective of the experiment was to use the information collected in this full-scale experiment in the evaluation of aeration systems of the future McCook and Thornton Reservoirs.

The experimental plan dated April 19, 2002 for the O'Hare CUP Reservoir experiment is given in Appendix AI. The experimental protocol 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 which occurred on May 12, 2002. The O'Hare CUP Reservoir began filling with CSO at approximately 0030 hrs (military time) on May 12, 2002 and reached a static level (representing approximately 75 MG CSO in the reservoir) at 1645 hrs on May 12, 2002. Approximately 1.95 and 0.25 inches of rainfall was recorded on May 11 and May 12, respectively, for this storm event.

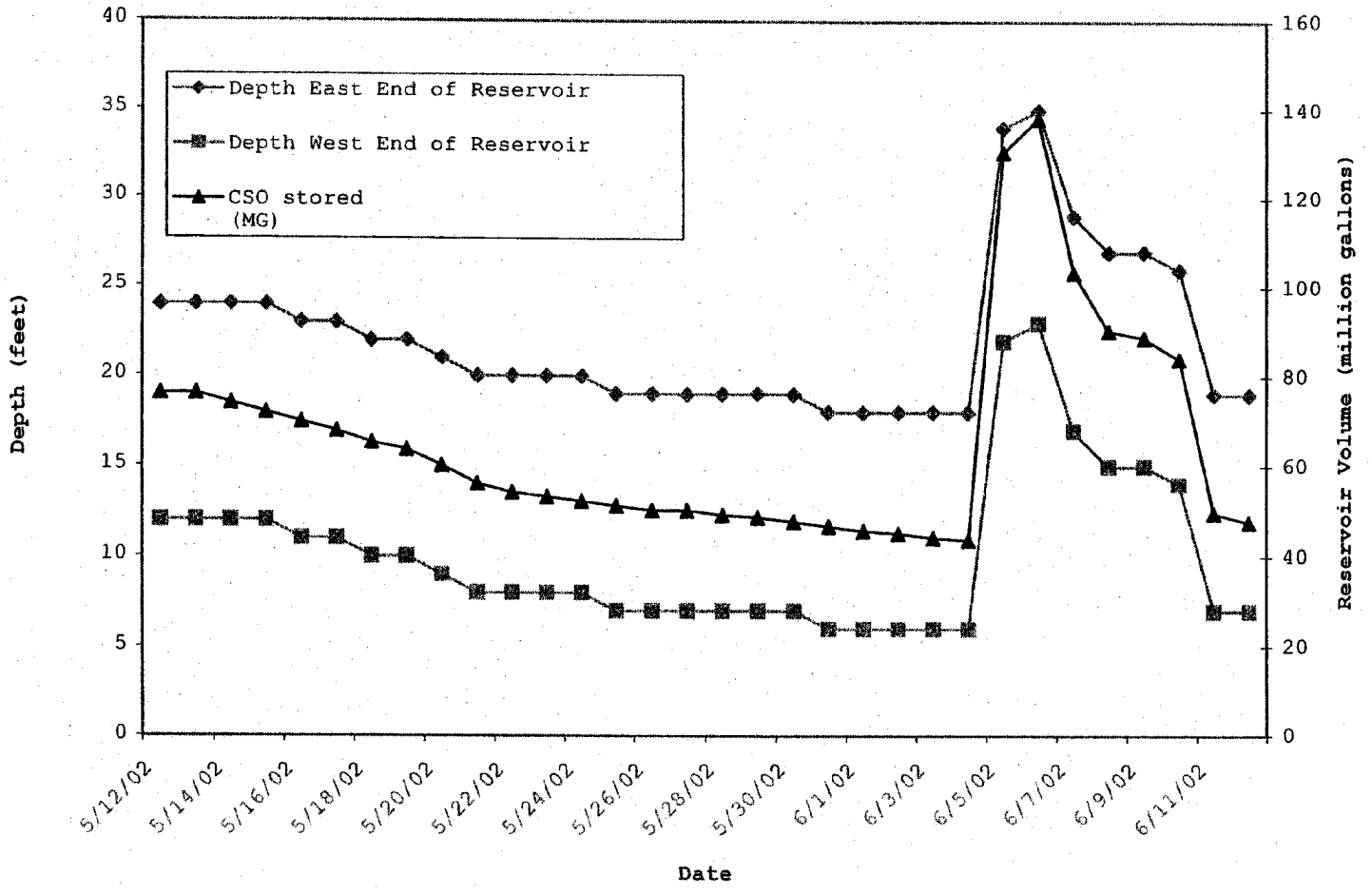
From May 12 to June 4, 2002, a gradual decline in liquid volume was observed in the reservoir. This was attributed to leaks in the gates separating the reservoir from the tunnel system, resulting in some of the stored CSO draining back to the James C. Kirie WRP. This decrease in liquid volume and related depth of water in the reservoir can be seen in Figure 1. The difference in water depth between the east and west ends of the reservoir is due to the fact that the bottom of the reservoir is sloped, and is unrelated to the leakage problem. During this period, water elevation in the reservoir varied from 24 feet to 18 feet on the east side of the reservoir and from 12 feet to 6 feet on the west side of the reservoir, corresponding to a decrease in CSO volume stored in the reservoir from approximately 75 MG on May 12 to 45 MG before another fill event was experienced on June 4.

On June 4, 2002, while CSO from the first event was still in the reservoir, another Natural Fill Event occurred which added approximately an additional 95 MG of CSO to the reservoir bringing the CSO volume to approximately 140 MG. Approximately 3.14 (0.65 inches on June 3 + 2.49 inches on June 4) inches of rainfall was recorded for this storm event. The reservoir was partially dewatered on June 6, 2002 and June 7, 2002 to a final volume of approximately 90.9 MG. The

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 1

VARIATION IN WATER DEPTH AND COMBINED SEWER OVERFLOW VOLUME STORED DURING O'HARE CUP RESERVOIR FILL EVENTS OF MAY 12, 2002 AND JUNE 4, 2002



reservoir was further dewatered from June 9 to June 10, 2002 to a volume of approximately 48.7 MG to prepare for the mixing test described in the Experimental Plan.

On June 11, 2002, seven surface aerators (aerator No. 3 through aerator No. 9) were turned on in the reservoir. They ran for four hours as part of the odor testing. The final draining of the reservoir began on June 16 at 1815 hrs and was completed on June 17 at 0605 hrs.

RESULTS

Liquid sampling, dissolved oxygen (DO) readings, 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. These samples were analyzed for BOD_5, TSS, NO_2-N, NO_3-N, and NH_4-N. The results of the analyses are given in Table AII-1 and Table AII-2 and Figures AII-1 and AII-2 in Appendix AII.

The concentration ranges of these parameters for the May 12 fill event are: BOD_5 20 to 126 mg/L with a mean of 39 mg/L, TSS 32 to 282 mg/L with a mean of 86 mg/L, NH_4-N 1.54 to 5.50 mg/L with a mean of 2.59 mg/L, NO_2-N 0.00 to 0.153 mg/L with a mean of 0.073 mg/L, and NO_3-N 0.018 to 1.488 mg/L with a mean of 1.158 mg/L. Based on the mean concentrations of BOD_5 and TSS, it can be said that the CSO captured in the reservoir during the fill event of May 12 was on the low end of the current McCook CUP Reservoir design assumptions of BOD_5 30 to 80 mg/L, and SS 100-200 mg/L.

An additional sample of CSO inflow was collected at 0601 hrs on May 12 for fecal coliform and DO determination. The

results of these analyses are 6.8 mg/L DO and 270,000 CTS/100 mL fecal coliform as given in Table AII-1.

The results of analyses for the second fill event of June 4 are given in Table AII-2. The concentration ranges of these parameters are: BOD_5 16 to 68 mg/L with a mean of 27 mg/L, TSS 22 to 186 mg/L with a mean of 60 mg/L, NH_4-N 1.97 to 5.23 mg/L with a mean of 2.61 mg/L, NO_2-N 0.052 to 0.102 mg/L with a mean of 0.067 mg/L, NO_3-N 1.182 to 1.570 mg/L with a mean of 1.417 mg/L. Based on the mean concentrations of BOD_5 and TSS, it can be said that the CSO captured in the reservoir during the fill event of June 4 was weaker in strength than the initial fill event and also on the low end of the current McCook CUP Reservoir design assumptions.

One more grab sample of CSO inflow was taken during the fill event of June 4 at 1210 hrs for DO determination. Its value is 5.9 mg/L as given in Table AII-2.

Stored Liquid Sampling

Liquid grab samples were collected in the reservoir using a small remotely controlled boat (RCB) at three locations, namely, East South (ES), Middle South (MS), and West South (WS) at various depths along the south side of the reservoir as shown in Figure AII-3 in Appendix AII. These samples were

seven analyzed for BOD_5, NH_4-N, TSS, and VSS. The concentration range for these parameters are: BOD_5 4 to 24 mg/L, TSS 1 to 33 mg/L, VSS 0 to 25 mg/L, and NH_4-N 1.85 to 9.23 mg/L as can be seen in Table AII-3. In addition, one set of samples was collected on June 10, 2002 which was analyzed for chlorophyll *a*. The concentration of chlorophyll *a* varied from 57.3 to 177.5 µg/L indicating algal growth in the reservoir during the period of this experiment. The results of these analyses are shown in Table AII-4.

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 six locations, namely, East South (ES), Middle South (MS), West South (WS), East North (EN), Middle North (MN), and West North (WN), at various depths around the reservoir as shown in Figure AII-3. The results of these are given in Table AII-5 and plots of DO versus time are shown in Figures AII-4 and AII-5. Figure AII-4 contains DO results for the three (ES, MS, and WS) south side locations and Figure AII-5 contains DO results for the three (EN, MN, and WN) north side locations. As can be seen from Table AII-5, the DO concentrations varied from 0.00 to 16.3 mg/L and the temperatures varied from 12.1 to 21.2 °C.

It was planned to take DO measurements at three depths, namely, 5-ft, 10-ft, and 15-ft from the surface of the water, at all locations. However, it was not possible to take DO readings at all three depths because of water depth constraints at four locations, namely, Middle South, Middle North, West South, and West North.

Air Emission Monitoring

Daily odor and H_2S monitoring at five locations around the reservoir was done as per the experimental plan. The odor monitoring locations are shown in Figure AII-6. The results in Table AII-6 show the concentration of H_2S, in parts per billion (ppb), in the ambient air at five locations around the reservoir. The concentrations of H_2S in the ambient air around the reservoir varied from 0 to 14 ppb indicating practically no H_2S-related odors produced as a result of storage of CSO in the reservoir. Table AII-7 contains qualitative evaluations of odors at the same five locations as perceived by the persons conducting the odor surveys.

No strong odors were observed as a result of odor monitoring. Only for 45 of the total 185 observations, were very faint to easily noticeable odors perceived, and no odors were perceived at all for 140 out of a total of 185 observations.

Again, odor intensity perceived was infrequent and very low in intensity, indicating no significant impact as a result of the storage of CSOs. One odor complaint from a private citizen was received on June 17, 2002 during cleanup of the sediment on the reservoir bottom after the reservoir had been drained.

Sediment Measurements

Bottom sediments were collected from 18 locations after the reservoir was drained and the depth of sediment deposits were measured in the reservoir. The locations of depth measurements of sediment deposits are shown in Figure AIII-1 in Appendix AIII. The data on sediment deposit depths, along with TS and TVS concentrations are given in Table AIII-1 in Appendix AIII.

The depth of sediments varied from 0.06 to 2.9 inches with a mean of 0.6 inches. The mean TS concentration of the sediments was 6.9 percent with 43 percent volatile solids. The mean sediment depth was slightly lower than observed for previous fill events at the O'Hare CUP Reservoir, when mechanical aeration had been used. The mean sediment depth was also on the low end of projected estimates for a comparable size fill event at the McCook and Thornton Reservoirs (0.6 - 3.6 inches projected).

Another set of sediment depth measurements was collected from six pans specially installed for this experiment at the bottom of the reservoir. The locations of these pans are shown in Figure AIII-1 and results of depth measurements are given in Table AIII-2. The depths of sediment in the pans varied from 1.5 to 2.0 inches with a mean of 1.73 inches. The purpose of sediment depth measurement in the 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 rest of the reservoir.

Due to the fact that a second, unanticipated, fill event occurred during the middle of the study, it was impossible to determine if disproportional amounts of previously settled sediments might have been pushed into the pans from the water velocity generated during the second fill event. Therefore, it was not possible to make any conclusions regarding why the sediment depth in the pans was somewhat higher on average, and also more uniform, than the sediment depth on the main reservoir bottom.

DISCUSSION

Odor Production

The main objective of this full-scale experiment was to evaluate 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 Tables AII-6 and AII-7 in Appendix AII, the maximum H_2S concentration measured in the ambient air during the 30 days of storage of CSO at any of the five locations around the reservoir was 14 ppb (Table AII-6). The threshold odor concentration for H_2S (given by the USEPA) is 25 ppb. Similarly, qualitative odor perception by the individuals conducting the odor survey given in Table AII-7 indicate very little or no odor problem experienced during the experiment. Qualitative odor survey results shown in Table AII-7 indicates that no odor was perceived at all during 140 times out of a total of 185 observations, and strong or very strong odor was never perceived during the entire period of this experiment.

In fact even after draining the reservoir to a volume of approximately 48.7 MG on June 11, 2002 and turning the seven aerators on, practically no odors were generated as can be

seen from the H_2S monitoring results of June 11, 2002 given in Table AII-6 in Appendix AII. The highest measured H_2S concentration on June 11 was 10 ppb.

Dissolved Oxygen in the Stored Liquid

As can be seen from Table AII-5 and Figures AII-4 and AII-5 in Appendix AII, DO levels in reservoir varied widely. However, the pattern of DO profiles at the south side of the reservoir (Figure AII-4) and at the north side of the reservoir (Figure AII-5) remained similar, except for May 16 when a small rain event occurred. A comparison of Figures AII-4 and AII-5 indicates that the May 16 rain event increased the DO level on the north side sampling locations, but had little effect on the DO levels on the south side locations of the reservoir. The reason for the difference is not known.

In general, for the first ten days after the fill event, DO concentrations in the reservoir were less than 1.0 mg/L, right from the beginning, and often were 0.1-0.2 mg/L. Dissolved oxygen concentrations increased significantly in the May 30 samples, possibly due to photosynthetic activity. After the second fill event on June 4, DO concentrations dropped again to near zero in many of the samples collected on June 7. Dissolved oxygen concentrations then increased ranging 0.0 to

14.1 mg/L in the final set of samples which were collected on June 10.

Potential Effect of Photosynthetic Activity

During the later part of the study, the CSO stored in the reservoir developed a green hue indicating the presence of chlorophyll containing algae. Therefore, on June 10, one liquid sample was collected for chlorophyll *a* analysis, the results of which are given in Table AII-4. It shows a significant concentration of chlorophyll *a* in the reservoir.

Also, DO measurements were conducted twice on June 10, once at dawn and the second time in the afternoon to see diurnal change in DO levels because of the presence of primary producers, including algae. Examination of Table AII-5 shows that the DO levels at all locations on the north side of the reservoir increased in the afternoon. However, DO levels at the south side locations did not show such an increase.

Comparison of Influent and Stored Liquid Quality

The BOD_5 values of the CSO stored in the reservoir ranged from 4 to 24 mg/L and the total suspended solids concentrations ranged from 1 to 33 mg/L during the 30-day holding period as shown in Table AII-3 in Appendix AII. In comparison to these BOD_5 and SS values, BOD_5 in the influent to the

reservoir during the May 12 fill event varied from 20 to 126 mg/L and SS varied from 32 to 282 mg/L, and BOD_5 in the influent during June 4 fill event varied from 16 to 68 mg/L and SS varied from 22 to 186 mg/L. The lower BOD_5 and SS values in the bulk liquid during storage are probably due to a combination of gravity settling and biological degradation.

CONCLUSIONS

The main conclusions of the report are:

1. Based on the results of the full-scale experiment conducted at the O'Hare CUP Reservoir from May 12, 2002 through June 12, 2002, it can be concluded that the future McCook and Thornton Reservoirs may not require maintenance of 2 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.
2. During a 30-day holding period of CSOs, without any aeration, no significant odors emanated from the reservoir even though dissolved oxygen concentrations in the stored CSOs dropped to near zero for a number of days.
3. Agitation of the accumulated sediments at the bottom of the reservoir during the draining process did not result in any odor problem.
4. One odor complaint from a private citizen was received on June 17, 2002 after the reservoir had been drained, but before cleanup of the

sediment on the reservoir bottom had begun. Thus, effective sediment management is important.

5. The depth of the sediment deposits at the bottom of the reservoir found during this experiment was on the low end of projected estimates for a comparable size fill event at the McCook and Thornton 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 BOD_5 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 BOD_5, NH_4-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 H_2S 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 SAMPLES DURING O'HARE CUP RESERVOIR MAY 12, 2002 AND JUNE 4, 2002 FILL EVENTS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-1

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW GRAB SAMPLES COLLECTED ON MAY 12, 2002
DURING THE O'HARE CUP RESERVOIR MAY 12, 2002 FILL EVENT

Sample 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
5/12/02	0101	124	282	0.000	0.025	5.50
5/12/02	0201	126	244	0.000	0.018	4.74
5/12/02	0301	60	200	0.067	1.257	4.00
5/12/02	0401	25	130	0.057	1.095	1.54
5/12/02	0501	23	88	0.053	1.488	1.70
5/12/02	0601	37	66	0.119	1.325	1.79
5/12/02	0701	30	56	0.095	1.428	2.15
5/12/02	0801	21	40	0.069	1.360	2.65
5/12/02	0901	29	38	0.071	1.466	2.36
5/12/02	1001	22	44	0.066	1.190	2.57
5/12/02	1101	20	32	0.063	1.445	1.98
5/12/02	1201	20	40	0.068	1.485	2.12
5/12/02	1301	23	46	0.068	1.363	2.11
5/12/02	1401	27	50	0.083	1.240	2.13
5/12/02	1501	22	34	0.120	1.244	2.10
5/12/02	1601	28	36	0.153	1.132	2.20
5/12/02	1701	22	38	0.096	1.122	2.46
Min.		20	32	0.000	0.018	1.54
Mean		39	86	0.073	1.158	2.59
Max.		126	282	0.153	1.488	5.50

Note: DO and fecal coliforms in the sample collected at 0601 hrs on 5/12/02 were 6.8 mg/L and 270,000 CTS/100 mL, respectively.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-2

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW GRAB SAMPLES COLLECTED ON JUNE 4, 2002
DURING THE O'HARE CUP RESERVOIR JUNE 4, 2002 FILL EVENT

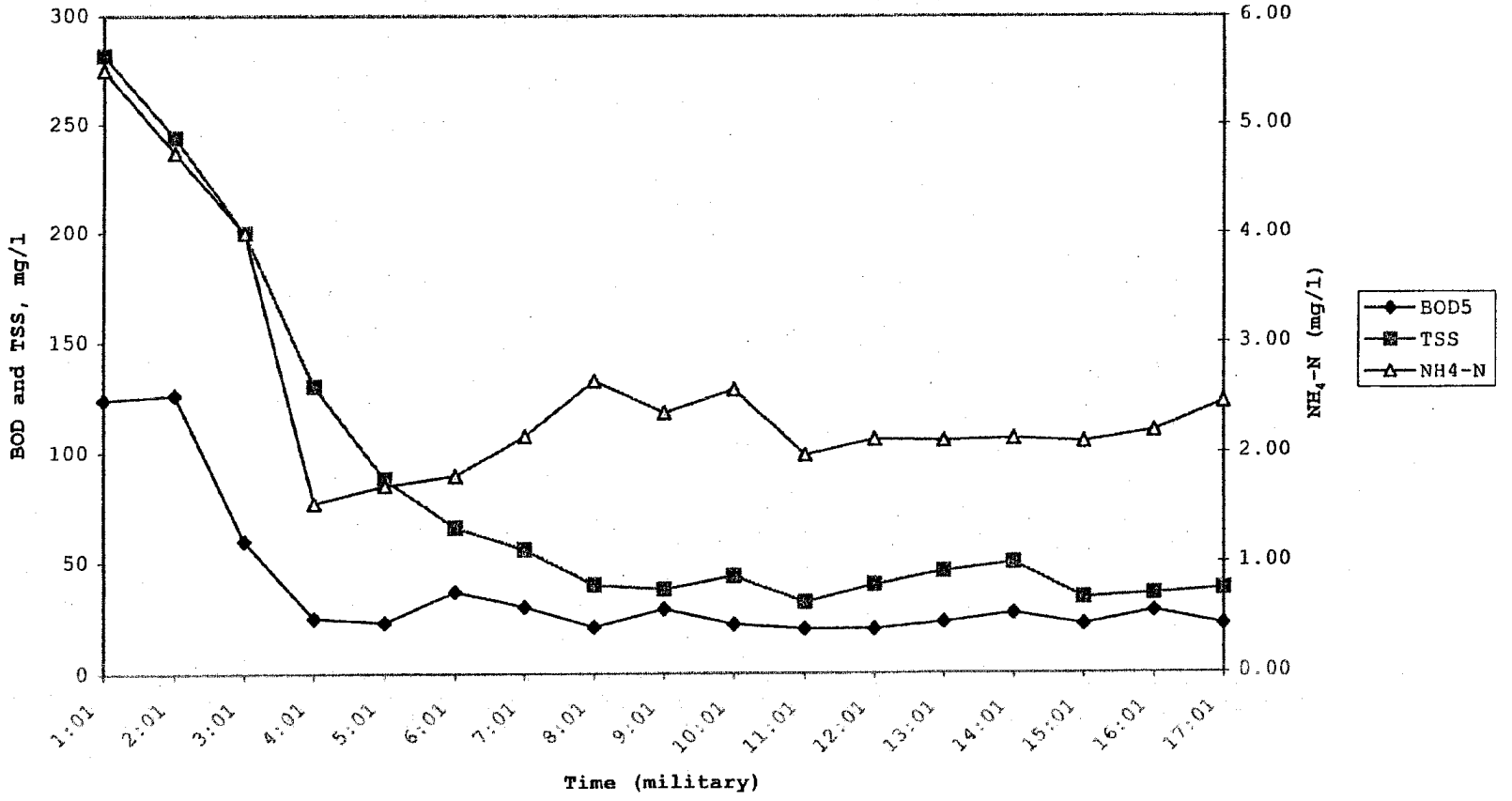
Sample Date	Time Collected (military time)	BOD_5 mg/L	TSS mg/L	NO_2-N mg/L	NO_3-N mg/L	NH_4-N mg/L
6/4/02	1210	27	56	0.053	1.182	3.80
6/4/02	1310	68	136	0.065	1.225	4.53
6/4/02	1410	54	186	0.102	1.570	5.23
6/4/02	1510	45	136	0.077	1.434	3.11
6/4/02	1610	30	86	0.065	1.533	2.63
6/4/02	1710	33	88	0.056	1.411	2.06
6/4/02	1810	21	46	0.052	1.343	2.04
6/4/02	1910	20	26	0.058	1.391	2.22
6/4/02	2010	20	34	0.058	1.367	2.40
6/4/02	2110	21	36	0.057	1.447	2.36
6/4/02	2210	20	28	0.059	1.438	2.31
6/4/02	2310	20	26	0.060	1.432	2.08
6/5/02	0010	18	28	0.059	1.321	2.09
6/5/02	0110	17	22	0.060	1.408	2.02
6/5/02	0210	16	22	0.065	1.484	1.97
6/5/02	0310	17	28	0.075	1.530	2.03
6/5/02	0410	16	36	0.082	1.521	2.02
6/5/02	0510	19	54	0.094	1.469	1.99
Min.		16	22	0.052	1.182	1.97
Mean		27	60	0.067	1.417	2.61
Max.		68	186	0.102	1.570	5.23

Note: DO in the sample collected at 1210 hrs on 6/4/02 was 5.9 mg/L.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-1

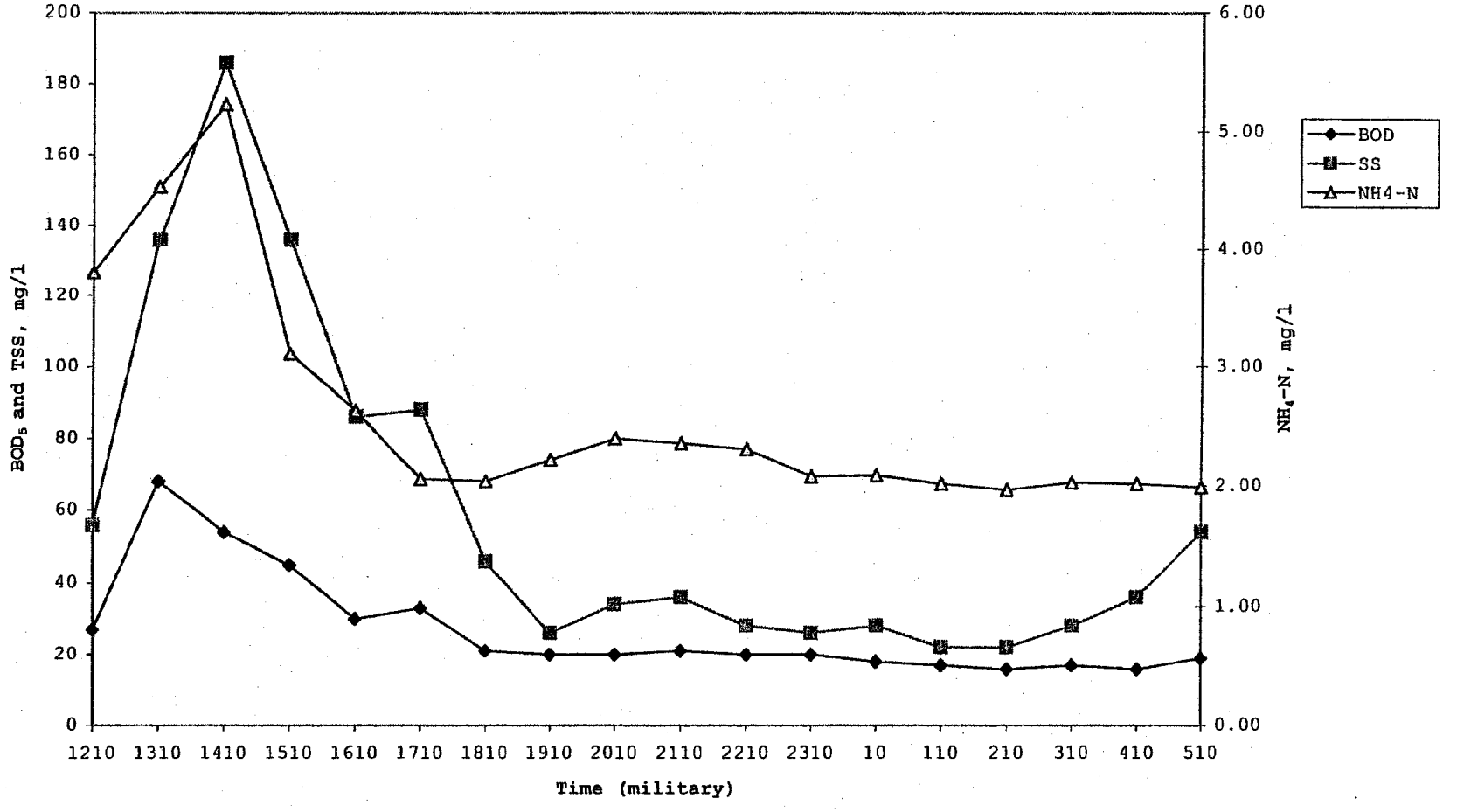
BOD_5, TSS, AND NH_4-N IN HOURLY GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR MAY 12, 2002 FILL EVENT O'HARE CUP RESERVOIR EXPERIMENT



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-2

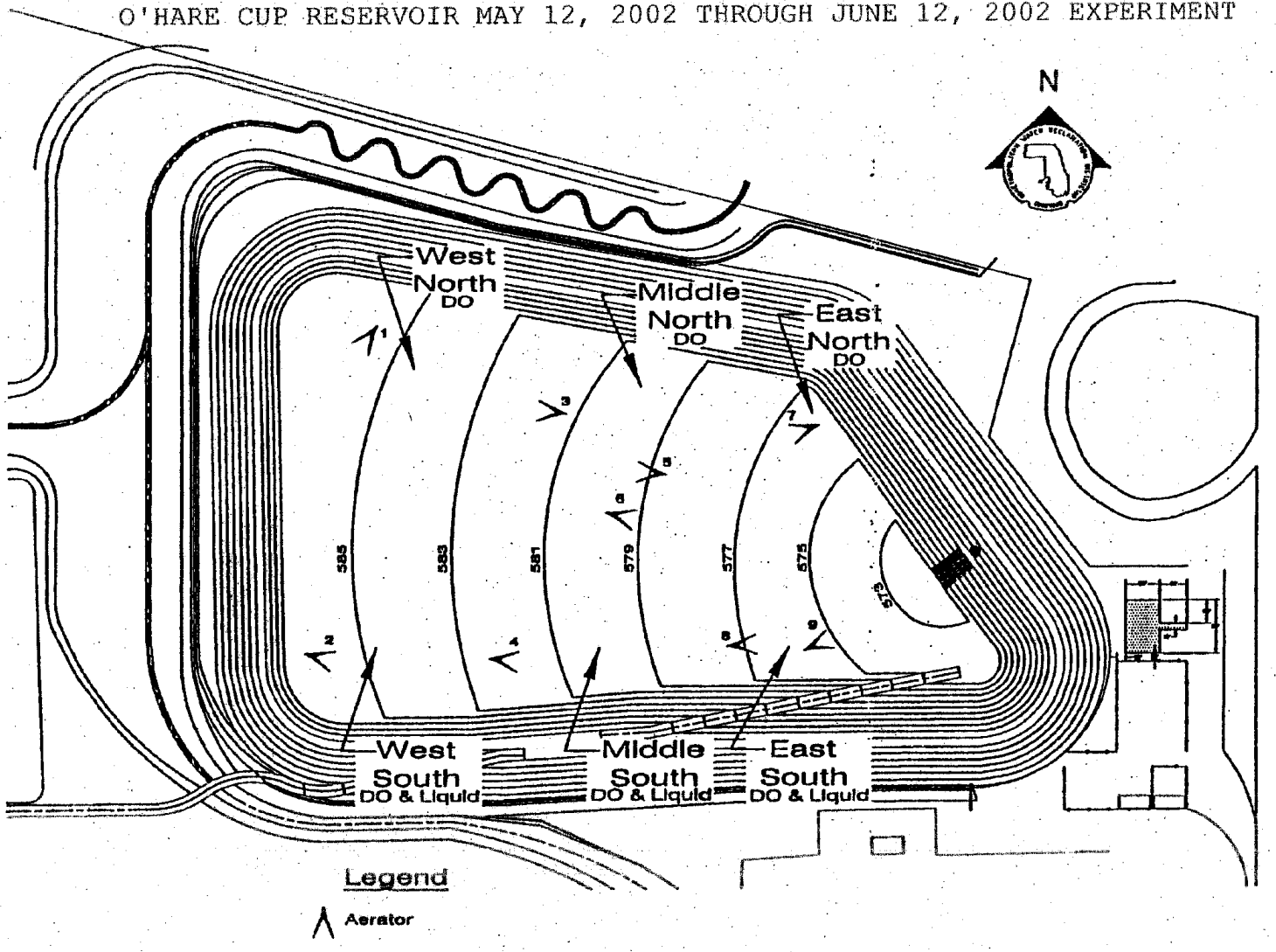
BOD5, TSS, AND AMMONIA IN HOURLY COMPOSITE SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR JUNE 4, 2002 FILL EVENT



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-3

LOCATIONS OF LIQUID SAMPLING AND DISSOLVED OXYGEN MEASUREMENTS
O'HARE CUP RESERVOIR MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3

RESULTS OF ANALYSES FOR BOD_5 AND NH_4-N AT VARIOUS DEPTHS IN THE O'HARE CUP RESERVOIR
MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT

	BOD_5, mg/L					NH_4-N, mg/L				
	East South		Middle South		West South	East South		Middle South		West South
Date	5-Foot	15-Foot	5-Foot	10-Foot	5-Foot	5-Foot	15-Foot	5-Foot	10-Foot	5-Foot
5/13/02	16	18	17	16	18	2.56	2.47	2.63	2.75	2.85
5/14/02	15	16	15	15	13	2.90	2.88	3.00	2.77	2.98
5/15/02	15	14	17	15	23	3.00	3.12	3.11	3.10	3.09
5/16/02	16	14	12	16	14	2.97	3.09	2.99	3.03	3.08
5/17/02	11	12	12	13	12	3.34	2.88	2.99	2.92	2.69
5/23/02	9	11	9	24	10	3.16	3.02	2.84	3.22	3.23
5/30/02	19	23	4	9	9	1.85	4.47	2.85	3.70	2.14
6/7/02	10	11	11	10	11	2.81	2.98	2.82	2.92	2.69
6/10/02	12	12	15	15	14	2.98	4.83	2.37	3.01	9.23
Min.	9	11	4	9	9	1.85	2.47	2.37	2.75	2.14
Mean	14	15	12	15	14	2.84	3.30	2.84	3.05	3.55
Max.	19	23	17	24	23	3.34	4.83	3.11	3.70	9.23

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3 (Continued)

RESULTS OF ANALYSES FOR TSS AND VSS AT VARIOUS DEPTHS IN THE O'HARE CUP RESERVOIR
MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT

	Total Suspended Solids (TSS), mg/L					Volatile Suspended Solids (VSS), mg/L				
	East South		Middle South		West South	East South		Middle South		West South
Date	5-Foot	15-Foot	5-Foot	10-Foot	5-Foot	5-Foot	15-Foot	5-Foot	10-Foot	5-Foot
5/13/02	16	16	26	16	20	2	4	14	8	2
5/14/02	24	12	20	22	24	18	10	8	12	18
5/15/02	12	20	14	12	20	2	4	10	4	12
5/16/02	20	14	18	20	26	12	8	6	14	10
5/17/02	20	12	18	18	4	4	6	10	14	0
5/23/02	9	12	10	11	11	0	4	7	3	4
5/30/02	23	6	1	4	8	16	1	1	0	8
6/7/02	21	18	21	18	18	8	10	13	9	11
6/10/02	20	22	33	23	24	11	17	25	14	15
Min.	9	6	1	4	4	0	1	1	0	0
Mean	18	15	18	16	17	8	7	10	9	9
Max.	24	22	33	23	26	18	17	25	14	18

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-4

RESULTS OF CHLOROPHYLL CONCENTRATION ANALYSIS FROM SAMPLES COLLECTED AT VARIOUS DEPTHS IN THE O'HARE CUP RESERVOIR ON JUNE 10, 2002

Location	Chlorophyll *a* (µg/L)
East South - 5-Foot Depth	133.7
East South - 15-Foot Depth	57.3
Middle South - 5-Foot Depth	145.0
Middle South - 10-Foot Depth	82.6
West South - 5-Foot Depth	177.5

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-5

DISSOLVED OXYGEN AND TEMPERATURE READINGS AT VARIOUS DEPTHS IN THE O'HARE CUP RESERVOIR
MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT

	East South						Middle South				West South	
	5-Foot		10 Feet		15-Foot		5-Foot		10-Foot		5-Foot	
Date	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
5/13/02	0.5	12.2	0.5	12.1	0.5	12.1	0.5	12.5	0.5	12.4	0.5	12.5
5/14/02	0.1	12.2	0.1	12.3	0.1	12.8	0.2	12.4	0.1	12.5	0.0	12.3
5/15/02	0.2	12.3	0.1	12.2	0.1	12.3	0.1	12.5	0.0	12.3	0.0	12.6
5/16/02	0.1	12.4	0.1	13.5	0.1	14.9	0.0	12.4	0.1	13.5	0.2	15.3
5/17/02	0.1	13.7	0.0	12.6	0.0	13.0	0.1	13.6	0.0	13.7	0.0	13.9
5/18/02	0.2	14.2	0.2	13.4	0.4	13.0	0.1	13.5	0.1	13.9	0.7	14.9
5/19/02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/21/02	0.0	13.4	0.0	13.0	0.0	13.4	0.0	13.3	0.0	13.3	0.0	13.5
5/23/02	1.7	15.6	0.0	13.3	0.1	14.2	1.8	15.3	0.1	15.4	0.4	15.2
5/30/02	6.8	13.6	7.0	13.9	8.7	13.5	7.9	14.3	9.4	14.4	8.9	19.1
6/7/02	6.4	16.4	2.1	16.7	0.1	17.6	0.4	16.4	0.0	16.3	8.9	18.7
6/10/02 (am)	9.0	16.2	1.0	16.2	1.2	16.9	8.7	17.5	8.0	17.0	8.1	16.4
6/10/02 (pm)	0.1	16.1	0.1	16.2	0.3	16.3	4.3	16.3	0.4	16.5	14.1	21.2
Minimum	0.0	12.2	0.0	12.1	0.0	12.1	0.0	12.4	0.0	12.3	0.0	12.3
Mean	2.1	14.2	0.9	13.8	1.0	14.2	2.0	14.2	1.6	14.3	3.5	15.5
Maximum	9.0	16.4	7.0	16.7	8.7	17.6	8.7	17.5	9.4	17.0	14.1	21.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-5 (Continued)

DISSOLVED OXYGEN AND TEMPERATURE READINGS AT VARIOUS DEPTHS IN THE O'HARE CUP RESERVOIR
MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT

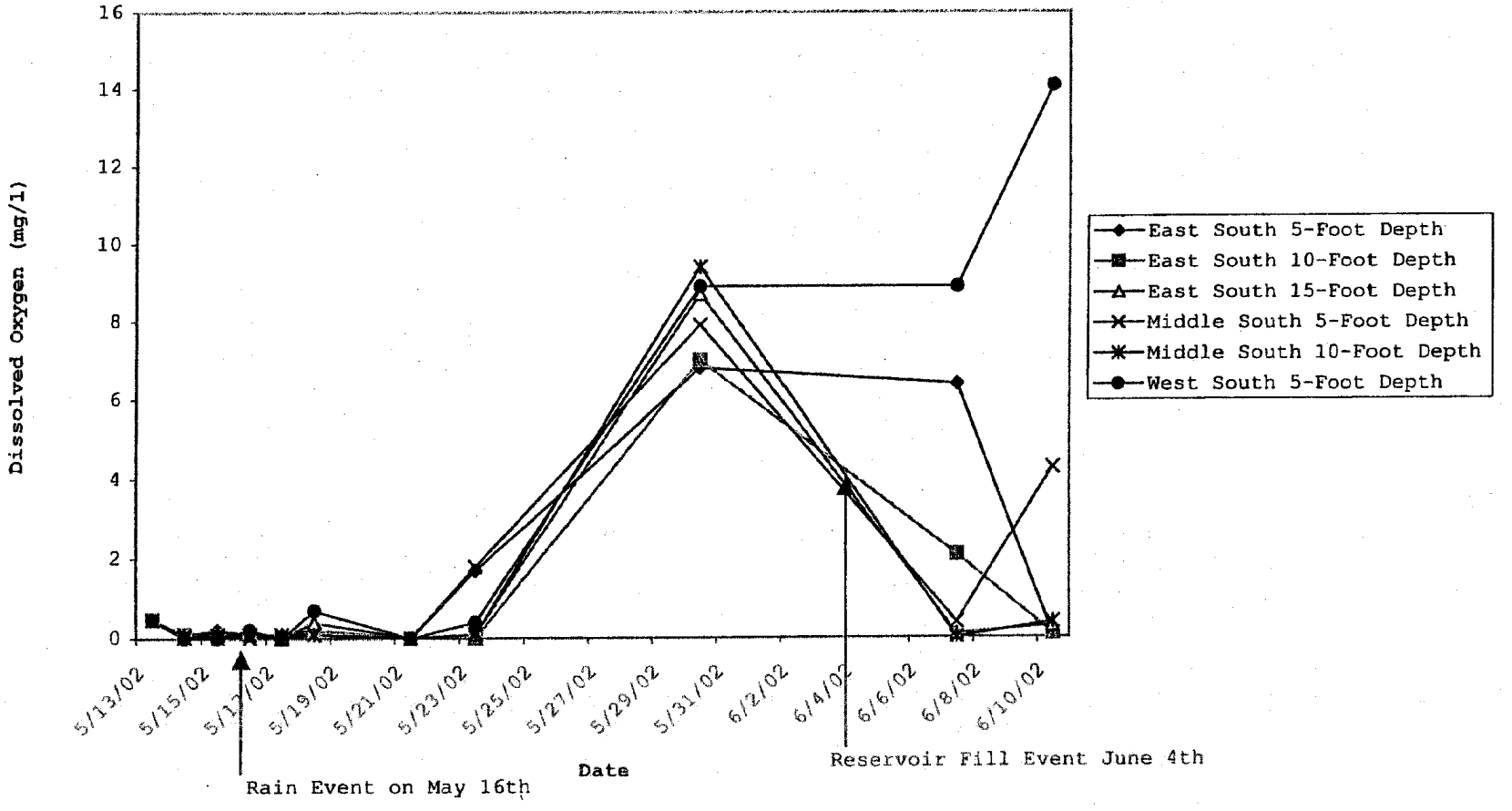
	East North						Middle North				West North	
	5-Foot		10 Feet		15-Foot		5-Foot		10-Foot		5-Foot	
Date	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C	DO mg/L	Temp. °C
5/13/02	0.5	12.4	0.5	12.1	0.5	12.1	0.4	12.4	0.5	12.1	0.4	12.5
5/14/02	0.1	12.3	0.0	12.2	0.0	12.1	0.0	12.1	0.0	12.2	0.0	12.6
5/15/02	0.0	12.4	0.0	12.3	0.0	12.2	0.0	12.2	0.0	12.1	0.0	12.1
5/16/02	1.6	12.7	2.2	13.4	3.2	13.3	1.0	15.2	4.1	12.5	5.3	15.2
5/17/02	0.0	15.3	0.0	13.4	0.0	16.6	0.0	17.3	0.0	17.3	0.0	17.5
5/18/02	0.3	16.4	0.2	16.5	0.1	14.2	*	14.4	0.1	14.1	0.1	13.8
5/19/02	0.2	12.6	0.0	13.8	0.0	13.7	*	*	*	*	*	*
5/21/02	0.1	14.6	0.0	13.4	0.0	13.0	0.0	13.4	0.0	13.3	0.1	13.8
5/23/02	1.6	15.5	1.5	15.6	0.1	15.5	1.0	15.4	0.1	15.4	0.4	15.2
5/30/02	11.4	15.3	13.4	13.6	16.3	13.4	11.5	16.5	13.0	17.2	11.5	16.5
6/7/02	0.2	16.5	0.2	16.4	0.1	16.3	0.2	16.5	0.4	17.4	2.5	18.3
6/10/02 (am)	0.0	16.2	0.1	16.2	0.0	16.2	0.1	16.3	0.1	16.5	0.1	16.4
6/10/02 (pm)	2.6	17.7	1.9	16.1	0.1	16.0	1.9	16.8	1.4	16.2	5.7	16.8
Minimum	0.0	12.3	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1
Mean	1.4	14.6	1.5	14.3	1.6	14.2	1.5	14.9	1.6	14.7	2.2	15.1
Maximum	11.4	17.7	13.4	16.5	16.3	16.6	11.5	17.3	13.0	17.4	11.5	18.3

*Dissolved oxygen value not recorded due to meter malfunction.
5/16/02 Readings taken during heavy rain.
5/23/02 Readings taken during a rain event.
A second Fill Event occurred on June 4, 2002.
The first reading for 6/10/02 was taken at dawn and the second reading was taken in the afternoon during periods of light rain and slightly heavier rain.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-4

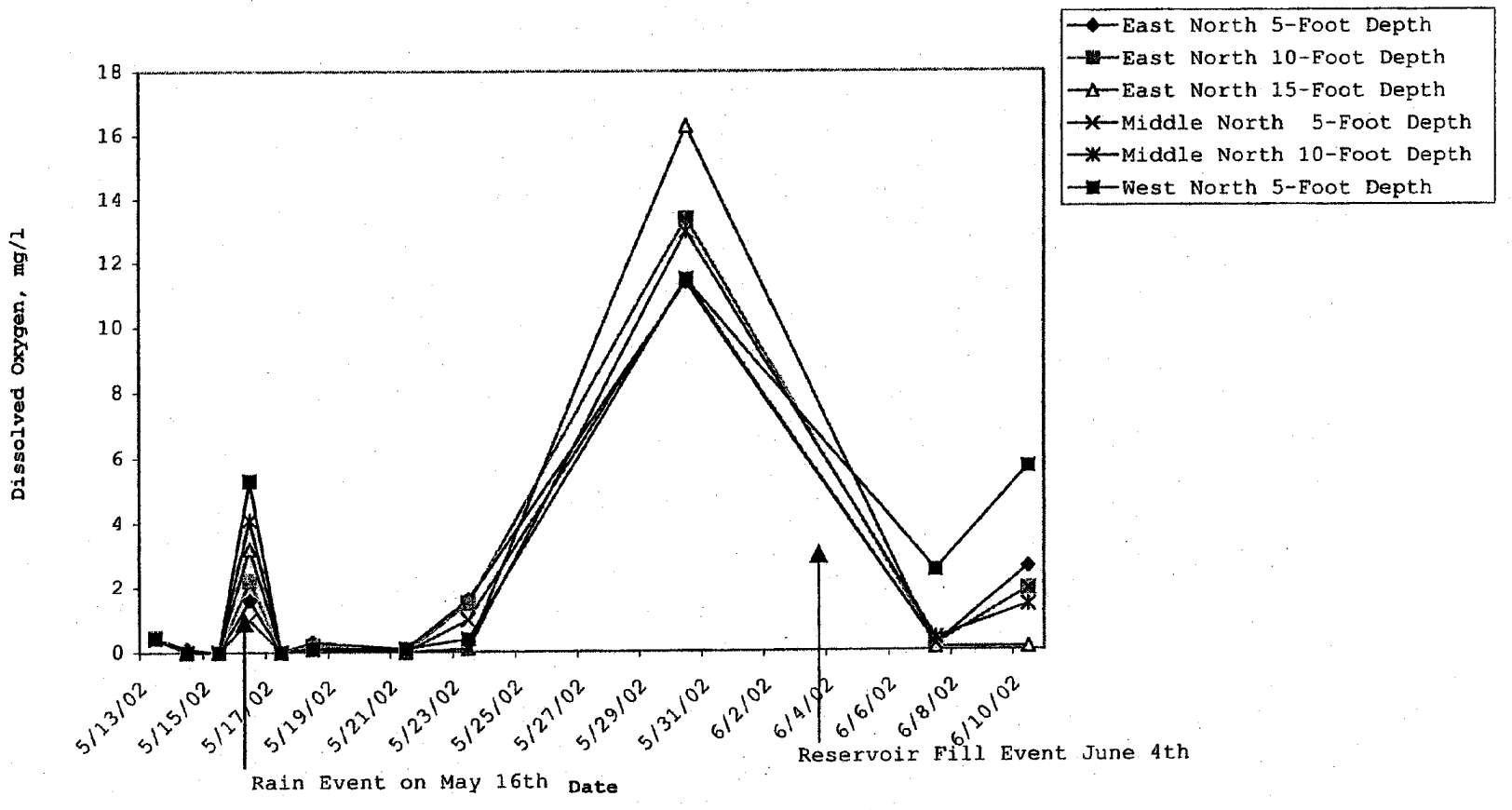
DISSOLVED OXYGEN IN THE O'HARE CUP RESERVOIR ALONG THE SOUTH SIDE OF THE RESERVOIR AT DIFFERENT LOCATIONS AND AT VARIOUS DEPTHS MAY 12, 2002 THROUGH JUNE 12, 2002, EXPERIMENT



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-5

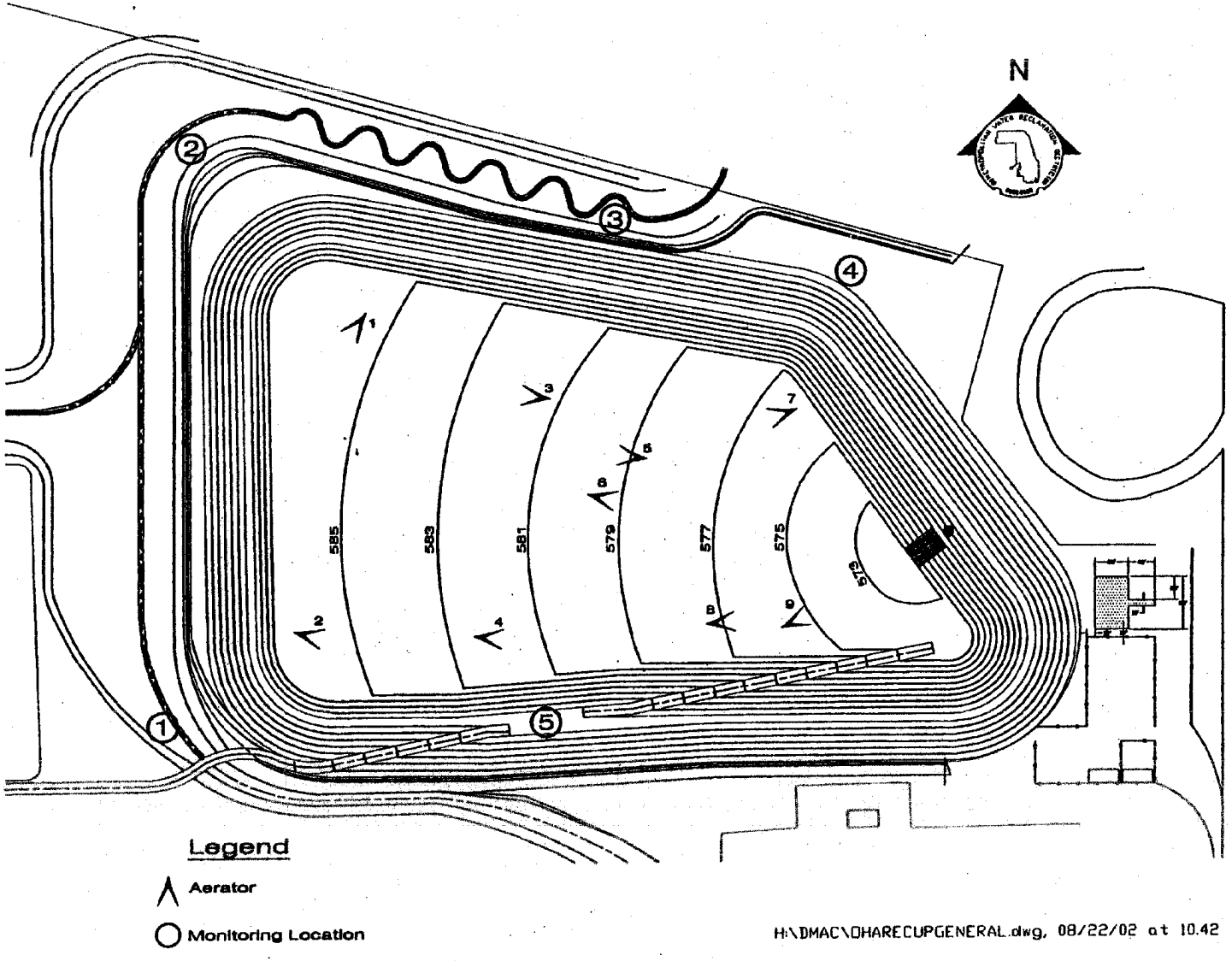
DISSOLVED OXYGEN IN THE O'HARE CUP RESERVOIR ALONG THE NORTH SIDE OF THE RESERVOIR AT DIFFERENT LOCATIONS AND VARIOUS DEPTHS MAY 12, 2002 THROUGH JUNE 12, 2002, EXPERIMENT



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-6

ODOR AND H_2S MONITORING LOCATIONS
O'HARE CUP RESERVOIR MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-6

HYDROGEN SULFIDE MONITORING DATA IN PARTS PER BILLION AROUND O'HARE CUP RESERVOIR
MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT

Date	Location 1*	Location 2*	Location 3*	Location 4*	Location 5*
5/13/02	5	7	7	6	5
5/14/02	0	7	7	9	10
5/15/02	9	10	3	10	12
5/15/02	7	9	10	9	10
5/17/02	4	5	4	5	5
5/18/02	5	4	6	6	6
5/19/02	6	7	6	6	6
5/20/02	6	8	9	5	8
5/21/02	7	6	8	7	7
5/22/02	5	6	6	7	8
5/23/02	0	2	4	5	5
5/24/02	7	6	6	7	8
5/25/02	0	1	0	0	1
5/26/02	5	6	6	2	9
5/27/02	1	6	7	0	7
5/28/02	5	9	7	6	10
5/29/02	14	6	6	6	9
5/30/02	7	5	6	7	7
5/31/02	7	9	9	10	13
6/1/02	10	7	11	10	12
6/2/02	5	6	7	5	11
6/5/02	11	0	0	0	3
6/6/02	2	0	4	5	5
6/7/02	6	8	8	0	9
6/8/02	7	0	7	7	8
6/9/02	5	4	6	0	5
6/10/02	4	5	5	NA	NA

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-6 (Continued)

HYDROGEN SULFIDE MONITORING DATA IN PARTS PER BILLION AROUND O'HARE CUP RESERVOIR
MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT

Date	Location 1*	Location 2*	Location 3*	Location 4*	Location 5*
6/11/02	NA	2	2	1	2
6/11/02	2	3	4	3	2
6/11/02	4	2	3	10	6
6/11/02	3	3	2	3	3
6/11/02	4	4	5	5	6
6/12/02	5	2	2	3	2
Mean	5.25	5.00	5.55	5.16	6.88
Minimum	0.00	0.00	0.00	0.00	1.00
Maximum	14.00	10.00	11.00	10.00	13.00

*See Figure AII-6.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-7

QUALITATIVE ODOR INTENSITY MONITORING AROUND O'HARE CUP RESERVOIR
MAY 12, 2002 THROUGH JUNE 12, 2002 EXPERIMENT

Location No.**	Total Number of Observations	Number of Times Odor Perceived with Varying Intensity*					
		No Odor	Very Faint	Faint	Easily Noticeable	Strong	Very Strong
1	37	29	4	1	3	0	0
2	37	32	3	1	1	0	0
3	37	32	4	1	0	0	0
4	37	24	6	6	1	0	0
5	37	23	8	4	2	0	0
Total Number of Intensity Readings	185	140	25	13	7	0	0

*A subjective odor intensity as interpreted by the person conducting the monitoring.
**See Figure AII-6.

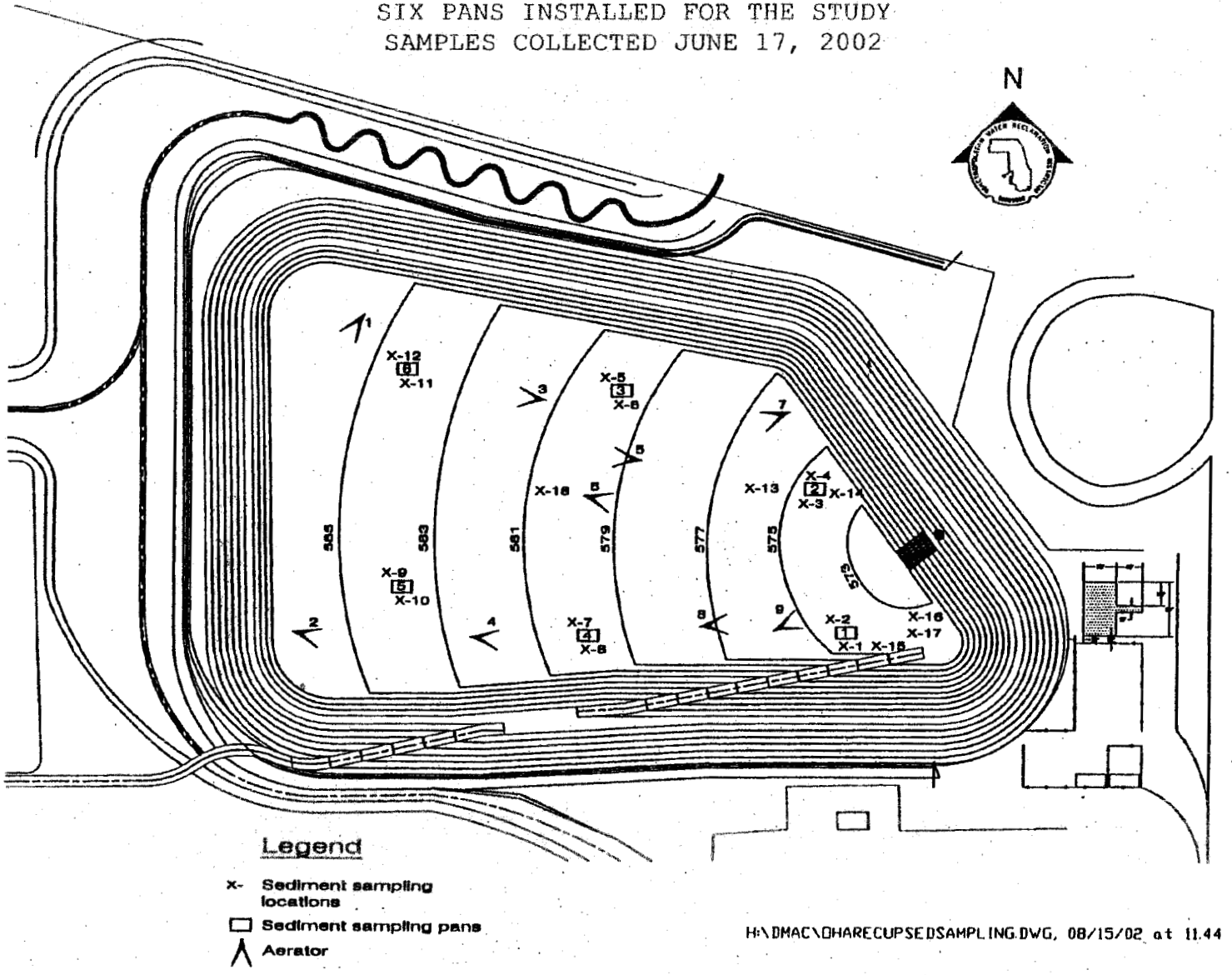
APPENDIX AIII

LOCATIONS OF SAMPLING AND RESULTS OF BOTTOM SEDIMENTS MEASUREMENTS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AIII-1

LOCATIONS OF SEDIMENT DEPTH MEASUREMENTS AT THE BOTTOM OF THE RESERVOIR AND IN THE SIX PANS INSTALLED FOR THE STUDY
SAMPLES COLLECTED JUNE 17, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-1

MEASUREMENTS OF SEDIMENT DEPOSITS ON JUNE 17, 2002 AFTER DRAINING THE O'HARE CUP RESERVOIR

Site*	Depth Inches	Total Solids (TS) Percent	Total Volatile Solids (TVS) Percent of TS
1	1.2500	7.83	44.84
2	1.2500	7.24	44.63
3	0.1250	4.43	44.52
4	0.1250	4.95	44.54
5	0.1250	6.63	40.97
6	0.0625	6.91	42.36
7	0.8750	7.24	41.33
8	1.0625	7.17	44.57
9	0.2500	6.77	43.13
10	0.0625	6.79	41.71
11	0.0625	6.83	41.62
12	0.0625	6.42	40.51
13	1.2500	7.80	45.71
14	0.1250	6.07	39.41
15	0.5000	7.57	45.93
16	0.2500	9.67	37.01
17	2.9375	7.11	47.16
18	0.6250	7.43	42.74
Minimum	0.0625	4.4300	37.0100
Mean	0.6111	6.9367	42.9272
Maximum	2.9375	9.6700	47.1600

*See Figure AIII-1.
Total volume of CSO captured in both events (May 12 fill event 75 MG and June 4 fill event 96 MG) = 171 MG
Estimated volume of sediment = 29,000 ft^3
Estimated dry solids = 65 tons

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-2

MEASUREMENT OF SEDIMENT DEPOSITS IN THE SIX PANS ON JUNE 17, 2002 AFTER DRAINING THE O'HARE CUP RESERVOIR

Site*	Depth Inches	Total Solids (TS) Percent	Total Volatile Solids (TVS) Percent of TS
1	1.63	6.10	41.15
2	2.00	0.63	57.08
3	1.75	0.92	48.23
4	1.75	4.41	42.75
5	1.50	1.76	43.58
6	1.75	0.62	44.48
Min.	1.50	0.62	41.15
Mean	1.73	2.41	46.21
Max.	2.00	6.10	57.08

*See Figure AIII-1.
Average wet density 1.01 g/mL.