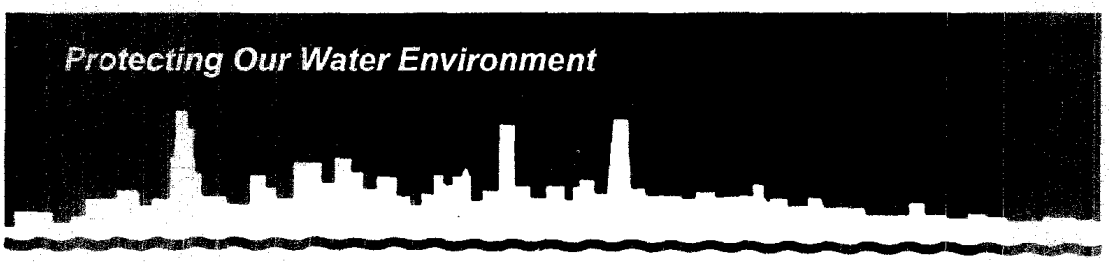


Metropolitan Water Reclamation District of Greater Chicago

# RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 04-16

REPORT ON O'HARE CUP RESERVOIR FILL EVENT EXPERIMENT

CONDUCTED FROM MAY 30, 2004 THROUGH JUNE 30, 2004

September 2004

*Metropolitan Water Reclamation District of Greater Chicago*
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# REPORT ON O'HARE CUP RESERVOIR FILL EVENT EXPERIMENT CONDUCTED FROM MAY 30, 2004 THROUGH JUNE 30, 2004

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**September 2004**

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## ACKNOWLEDGEMENTS

The assistance provided by the Maintenance and Operations Department Staff at the James C. Kirie WRP in successfully completing this experiment is greatly appreciated. Special thanks to Messrs. Mohamedusman Baki, AETPO III, and Joseph Wadz, AETPO I at the James C. Kirie WRP, who were very cooperative during the conduct of this report.

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Particular thanks are due to Ms. Laura Franklin, Principal Office Support Specialist, for her diligence in typing 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

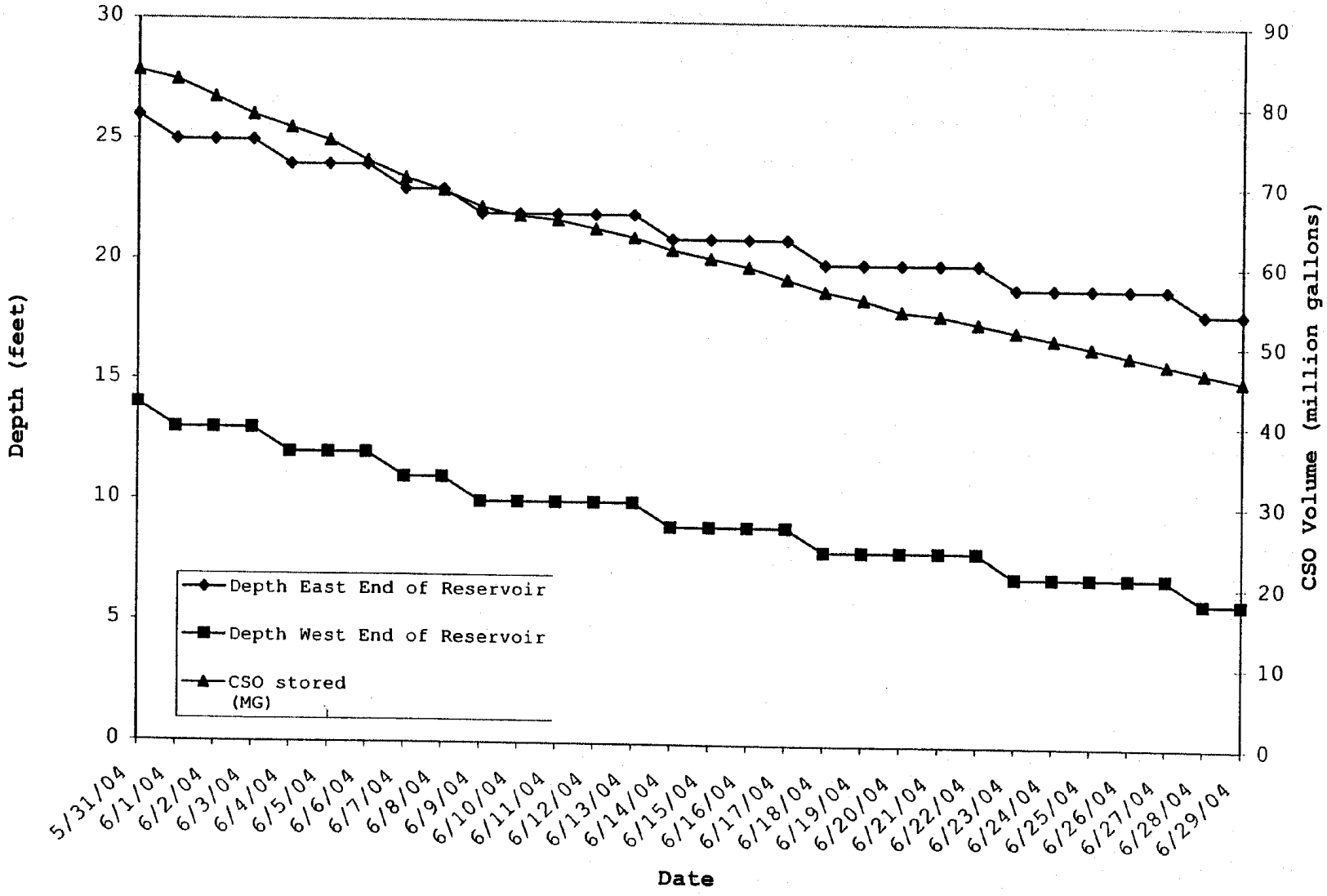
A full-scale experiment was conducted from May 30, 2004, through June 30, 2004, to study the potential for odor formation during the storage of combined sewer overflow (CSO) without mechanical aeration. This was a follow-up experiment to the previous full-scale experiments that were conducted in 2002 and 2003. As in the previous experiments conducted in 2002 and 2003, 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 experiment 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 30, 2004. The O'Hare CUP Reservoir began filling with CSO at 1925 hours (military time) May 30, 2004, and became static at 1830 hours on May 31, 2004. A total of 83 million gallons of CSO was captured in the reservoir.

From June 1 to June 30 a gradual decline in liquid volume was observed. On June 30 the volume in the reservoir was only 46 million gallons. This loss in CSO volume was attributed to leaks in the gates separating the reservoir from the tunnel. This decrease in liquid volume and corresponding depths of water from June 1, 2004, through June 30, 2004, can be seen in Figure 1. The difference in water depths between the east and west ends of the reservoir is unrelated to the leakage problem, but is due to the fact that the reservoir bottom is sloped. During this period water depth varied from 26 to 18 feet in the east end of the reservoir and from 14 to 6 feet in the west end of the reservoir.

FIGURE 1: DEPTH AND CSO VOLUME FOR THE RESERVOIR O'HARE CUP RESERVOIR
MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT



## RESULTS

Liquid sampling for various chemical parameters, dissolved oxygen (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 into the reservoir during the fill event. The samples were analyzed for $BOD_5$, TSS, $NH_4$-N, nitrite ($NO_2$-N) and nitrate ($NO_3$-N). The results are given in Table AII-1 and plotted in Figures AII-1 in Appendix AII.

The concentration ranges of these parameters for the May 30, 2004, Fill Event are as follows: $BOD_5$ 14 to 110 mg/L, with a mean value of 31 mg/L, TSS 20 to 516 mg/L, with a mean value of 94 mg/L, $NO_2$-N 0.075 to 0.160 mg/L with a mean value of 0.106 mg/L, $NO_3$-N 1.065 mg/L to 2.119 mg/L with a mean value of 1.671 mg/L, $NH_4$-N 2.04 to 9.08 mg/L with a mean value of 3.48 mg/L.

Additional samples of CSO inflow were collected at 2325 hours on May 30 and analyzed for fecal coliform and dissolved oxygen. The results of these analyses are 5.5 mg/L of dissolved oxygen and 1,000,000 CTS/100 mL fecal coliforms as given in Table AII-1.

### 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-2. These were analyzed for $BOD_5$, TSS, VSS, $NH_4$-N, sulfide, and chlorophyll. The results are given in Tables AII-2 and AII-3. The concentration ranges of these parameters are as follows $BOD_5$ 3 to 142 mg/L, TSS 4 to 184 mg/L, VSS 2 to 60 mg/L, $NH_4$-N 0.06 to 13.44 mg/L, and sulfide 0.00 mg/L to 4.68 mg/L. Sulfide samples were only collected from the bottom depths from East, Middle and West sampling areas. The sulfide samples were collected from June 4, 2004, through June 24, 2004. The chlorophyll concentrations ranged from 5.9 µg/L to 356.7 µg/L. 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 and readings were also taken at the ramp. The DO values taken from the ramp were collected from the liquid surface. Sampling locations are shown in Figure AII-2. As can be seen from Table AII-4 the DO concentrations varied from 0.0 m/L to 27.1 mg/L and temperature varied from 16.5°C to 26.5°C.

### Odor Monitoring

Daily odor and $H_2S$ measurements at five locations around the reservoir was done as per the experimental plan. The odor locations are shown in Figure AII-3. The results shown in Table AII-5 show the concentrations 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 varied from 0 to 14 ppb indicating practically no $H_2S$-

related odor as a result of storage in the reservoir.

Table AII-6 contains qualitative odor evaluations of the same five locations as perceived by persons conducting the odor survey. Odors were perceived 29 times out of a total of 140 observations. The breakdown of the number of times odor was perceived is as follows: Very Faint 10, Faint 8, and Easily noticeable 11. No odor was detected 111 times out of the total 140 observations and strong and very strong odors were never detected during the entire period of this experiment.

Table AII-7 contains the concentrations of $H_2S$ in the ambient air at the five locations around the reservoir taken on June 29, 2004, one hour prior to turning the aerators on and during the four hour period after turning the aerators on, as described in the Experimental Plan. The concentrations of $H_2S$ in the ambient air before the aerators were turned on ranged from 5 to 7 ppb. During the four hours the aerators were turned on, the $H_2S$ values ranged from 5 to 10 ppb.

Table AII-8 contains the qualitative odor evaluations from the same five locations during the period one hour prior to turning the aerators on and for the four hours after turning the aerators on. During the hour prior to turning the aerators on, no odors were detected at any of the five locations. After the aerators were turned on, odors were detected at locations 3, 4, and 5, but none of the odors was perceived as being strong.

Table AII-9 contains $H_2S$ concentrations taken at the same five locations after the reservoir was drained on June 30, 2004, but before the sediment was removed. The range of $H_2S$ values in the ambient air ranged from 4 to 8 ppb.

Table AII-10 contains qualitative odor evaluations from the same five sites after the reservoir was drained on June 30, 2004. Qualitative odor evaluations were conducted two times, once at 6:55 AM and the other at 9:20 AM, similar to quantitative monitoring results shown in Table AII-9. As can be seen in Table AII-10, no odors were detected at any of the five locations surrounding the reservoir.

**Sediment Measurements**

Bottom sediments were collected from the floor of the reservoir on June 30, 2004, from 11 different locations after the reservoir was drained and the depths of the sediment measured. The locations of the depth measurements of sediment deposits are shown in Figure 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 0.031 inch to 2.125 inches with a mean value of 0.599 inch. The TS concentration of the sediments varied from 6.03 to 8.23 percent with a mean concentration of 7.30 percent. The TVS concentration varied from 29.75 to 39.92 percent with a mean concentration of 34.79 percent. Most of the sediments were concentrated on the southeast end of the reservoir from where six of the total 11 samples were collected, as can be seen in Figure AIII-1.

## DISCUSSION OF RESULTS

### Odor Production

The objective of this experiment was the same as for the experiments conducted in 2002 and 2003, 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-5, the maximum $H_2S$ measured in the ambient air during the 30 day CSO storage at any of the five locations was 14 ppb. The threshold odor concentration for $H_2S$ is 25 ppb. Similarly, qualitative odor perception by the individuals conducting the odor survey given in Table AII-6 indicates very little or no odor problem experienced during the experiment. Qualitative odor survey results indicate that odors were perceived only 29 times out of 140 total observations, and no odors were perceived 111 times out of the 140 total observations. Strong or very strong odors were never perceived during the entire period of this experiment.

Turning on the aerators made no appreciable difference in the concentration of $H_2S$ in the ambient air at the five odor sampling locations as shown in Table AII-7. However, turning on the aerators did increase the intensity slightly of perceived odors as shown in Table AII-8, mostly at Location 4. Location 3 and 5 also had one instance of odor perception, which happened just after the aerators were turned on. The odor locations can be seen on Figure AII-3.

Even after the reservoir was drained, the exposed sediments were not a significant source of $H_2S$ or odors as can be seen in Tables AII-9 and AII-10.

### Dissolved Oxygen in the Stored Liquid

As can be seen from Table AII-4 DO concentrations varied widely. However, once the reservoir was filled the DO remained high, particularly at shallow depths.

DO concentrations showed a similar pattern to those of previous fill events. Previous fill events also showed a general rise in DO after several days of storage in the reservoir.

### Comparison of Influent and Stored Liquid Quality

The $BOD_5$ values of the CSO stored in the reservoir ranged from 3 to 142 mg/L and the TSS values ranged from 4 to 184 mg/L during the 30-day holding period (see Table AII-2). In comparison to these $BOD_5$ and TSS values, $BOD_5$ in the influent during the May 30-31, 2004, fill event varied from 14 to 110 mg/L and TSS varied from 20 to 516 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 30, 2004, to June 30, 2004, 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 CSO. This finding is consistent with the conclusions drawn from the previous experiments conducted on May 12 to June 12, 2002, August 13 to September 3, 2002, and May 1 to May 21, 2003.

2. During the 30-day holding period of CSO, no significant odors emanated from the reservoir even though dissolved oxygen concentrations at the beginning of the fill event were very low.

3. The depths of the sediment deposits at the bottom of the reservoir found during this experiment were higher than the May 2003 experiment but, still lower than the projected estimates of sediment deposits for a comparable size fill event at the McCook and Thornton Reservoirs.

4. Turning on the aerators made no appreciable difference in the concentrations of $H_2S$ in the ambient air at the five odor sampling stations. Turning on the aerators did increase the intensity of perceived odors slightly at certain locations around the reservoir. However, none of the odors were perceived as strong.

5. Draining the reservoir made no appreciable difference in the concentrations of $H_2S$ in the ambient air nor did it result in an increase of perceived odors.

# 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, IN-SITU RESERVOIR, AND AIR SAMPLES DURING O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

TABLE AII-1: RESULTS OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR MAY 30-31, 2004, 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 |
|---|---|---|---|---|---|---|
| 5/30/04 | 1925 | 110 | 400 | 0.155 | 1.065 | 9.02 |
| 5/30/04 | 2025 | 94 | 368 | 0.159 | 1.097 | 9.08 |
| 5/30/04 | 2125 | 100 | 516 | 0.160 | 1.429 | 4.82 |
| 5/30/04 | 2225 | 35 | 110 | 0.128 | 2.018 | 2.21 |
| 5/30/04 | 2325 | 28 | 56 | 0.119 | 1.964 | 2.56 |
| 5/31/04 | 0025 | 19 | 46 | 0.100 | 1.406 | 2.58 |
| 5/31/04 | 0125 | 19 | 48 | 0.085 | 1.193 | 2.19 |
| 5/31/04 | 0225 | 17 | 28 | 0.075 | 1.435 | 2.04 |
| 5/31/04 | 0325 | 22 | 26 | 0.082 | 1.591 | 2.90 |
| 5/31/04 | 0425 | 18 | 28 | 0.085 | 1.633 | 2.30 |
| 5/31/04 | 0525 | 17 | 22 | 0.080 | 1.703 | 2.26 |
| 5/31/04 | 0625 | 15 | 34 | 0.089 | 1.743 | 2.48 |
| 5/31/04 | 0725 | 15 | 30 | 0.091 | 1.721 | 2.92 |
| 5/31/04 | 0825 | 15 | 22 | 0.103 | 1.611 | 3.87 |
| 5/31/04 | 0925 | 15 | 30 | 0.106 | 1.630 | 3.70 |
| 5/31/04 | 1430 | 15 | 20 | 0.098 | 1.880 | 2.99 |
| 5/31/04 | 1530 | 14 | 20 | 0.096 | 2.037 | 2.69 |
| 5/31/04 | 1630 | 14 | 22 | 0.101 | 2.119 | 2.82 |
| 5/31/04 | 1730 | 14 | 26 | 0.111 | 2.118 | 3.25 |
| 5/31/04 | 1830 | 14 | 28 | 0.105 | 2.022 | 2.95 |
| Minimum | | 14 | 20 | 0.075 | 1.065 | 2.04 |
| Mean | | 31 | 94 | 0.106 | 1.671 | 3.48 |
| Maximum | | 110 | 516 | 0.160 | 2.119 | 9.08 |

Note: DO and fecal coliform bacteria in the sample collected at 2325 hours on 5/30/04 were 5.5 mg/L and 1,000,000 CTS/100 mL, respectively.

FIGURE AII-1: CONCENTRATIONS OF $BOD_5$, TSS AND $NH_4$-N IN HOURLY GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR MAY 30-31, 2004, FILL EVENT EXPERIMENT

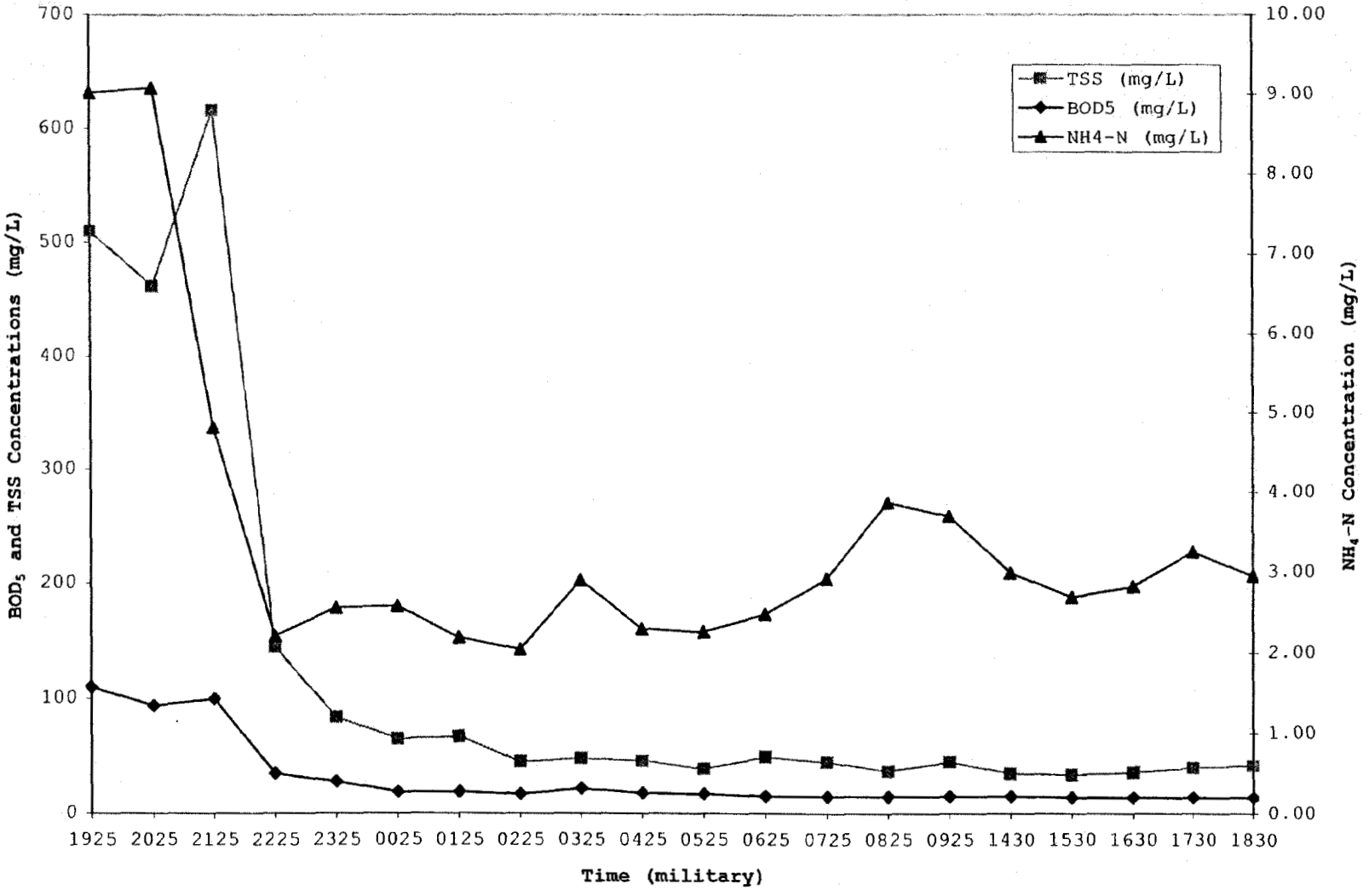
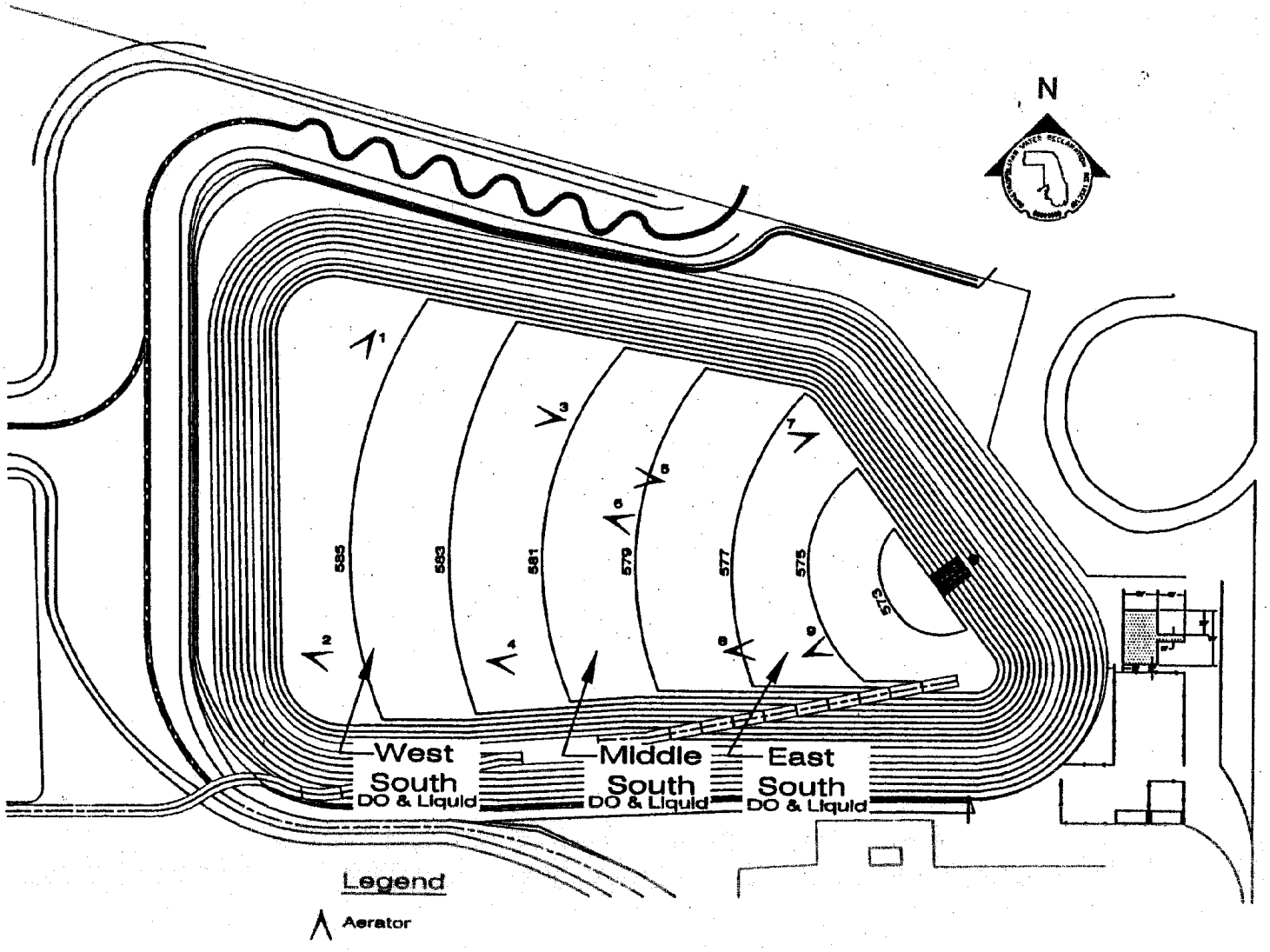


FIGURE AII-2: LOCATIONS OF LIQUID SAMPLING AND DISSOLVED OXYGEN MEASUREMENTS
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT




H:\DMAC\OHARECUPDISOXYGENSouth.dwg, 12/11/02 at 16.19

TABLE AII-2: RESULTS OF IN-SITU SAMPLE ANALYSES FOR $BOD_5$, $NH_4$-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Date | ES 5*[1] | ES 15*[1] | ES 20*[1] | MS 5*[1] | MS 10*[1] | MS 15*[1] | WS 5*[1] |
|---|---|---|---|---|---|---|---|
| | | | | $BOD_5$ (mg/L) | | | |
| 6/1/04 | 12 | NS | 13 | 11 | 12 | NS | 12 |
| 6/2/04 | 9 | NS | 14 | 8 | NS | 11 | 10 |
| 6/3/04 | 7 | NS | 8 | 7 | NS | 10 | 8 |
| 6/4/04 | 8 | NS | 15 | 7 | NS | 18 | 8 |
| 6/5/04 | 6 | NS | 16 | 7 | NS | 13 | 7 |
| 6/6/04 | 7 | NS | 30 | 5 | NS | 14 | 6 |
| 6/7/04 | 11 | NS | 19 | 4 | NS | 13 | 5 |
| 6/10/04 | 7 | 17 | 142 | 5 | 8 | NS | 6 |
| 6/17/04 | 4 | 24 | NS | 3 | 13 | NS | 7 |
| 6/24/04 | 9 | 39 | NS | 9 | 15 | NS | 8 |
| Minimum | 4 | 17 | 8 | 3 | 8 | 10 | 5 |
| Mean | 8 | 27 | 32 | 7 | 12 | 13 | 8 |
| Maximum | 12 | 39 | 142 | 11 | 15 | 18 | 12 |

TABLE AII-2 (Continued): RESULTS OF IN-SITU SAMPLE ANALYSES FOR $BOD_5$, $NH_4$-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Date | ES 5*[1] | ES 15*[1] | ES 20*[1] | MS 5*[1] | MS 10*[1] | MS 15*[1] | WS 5*[1] |
|---|---|---|---|---|---|---|---|
| | | | | $NH_4$-N (mg/L) | | | |
| 6/1/04 | 3.98 | NS | 3.67 | 3.98 | 3.95 | NS | 3.91 |
| 6/2/04 | 4.05 | NS | 3.63 | 4.07 | NS | 3.79 | 4.04 |
| 6/3/04 | 4.13 | NS | 3.75 | 3.99 | NS | 3.80 | 4.09 |
| 6/4/04 | 4.16 | NS | 4.06 | 4.27 | NS | 4.55 | 3.99 |
| 6/5/04 | 4.04 | NS | 3.62 | 4.10 | NS | 4.05 | 3.92 |
| 6/6/04 | 4.09 | NS | 4.29 | 4.21 | NS | 4.04 | 3.99 |
| 6/7/04 | 2.23 | NS | 4.78 | 4.24 | NS | 4.62 | 4.33 |
| 6/10/04 | 4.45 | 5.10 | 13.44 | 4.29 | 4.39 | NS | 4.26 |
| 6/17/04 | 4.25 | 6.28 | NS | 4.14 | 5.58 | NS | 2.59 |
| 6/24/04 | 0.06 | 7.28 | NS | 0.06 | 6.48 | NS | 0.25 |
| Minimum | 0.06 | 5.10 | 3.62 | 0.06 | 3.95 | 3.79 | 0.25 |
| Mean | 3.54 | 6.22 | 5.16 | 3.74 | 5.10 | 4.14 | 3.54 |
| Maximum | 4.45 | 7.28 | 13.44 | 4.29 | 6.48 | 4.62 | 4.33 |

TABLE AII-2 (Continued): RESULTS OF IN-SITU SAMPLE ANALYSES FOR $BOD_5$, $NH_4$-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Date | ES 5*[1] | ES 15*[1] | ES 20*[1] | MS 5*[1] | MS 10*[1] | MS 15*[1] | WS 5*[1] |
|---|---|---|---|---|---|---|---|
| | | | | TSS (mg/L) | | | |
| 6/1/04 | 18 | NS | 24 | 6 | 8 | NS | 20 |
| 6/2/04 | 4 | NS | 16 | 18 | NS | 6 | 20 |
| 6/3/04 | 22 | NS | 14 | 4 | NS | 18 | 10 |
| 6/4/04 | 8 | NS | 20 | 10 | NS | 10 | 12 |
| 6/5/04 | 14 | NS | 8 | 12 | NS | 16 | 12 |
| 6/6/04 | 12 | NS | 20 | 10 | NS | 10 | 12 |
| 6/7/04 | 14 | NS | 10 | 10 | NS | 10 | 12 |
| 6/10/04 | 10 | 12 | 22 | 6 | 10 | NS | 6 |
| 6/17/04 | 9 | 14 | NS | 4 | 7 | NS | 12 |
| 6/24/04 | 23 | 184 | NS | 34 | 12 | NS | 23 |
| Minimum | 4 | 12 | 8 | 4 | 7 | 6 | 6 |
| Mean | 13 | 70 | 17 | 11 | 9 | 12 | 14 |
| Maximum | 23 | 184 | 24 | 34 | 12 | 18 | 23 |

TABLE AII-2 (Continued): RESULTS OF IN-SITU SAMPLE ANALYSES FOR $BOD_5$, $NH_4$-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Date | ES 5*[1] | ES 15*[1] | ES 20*[1] | MS 5*[1] | MS 10*[1] | MS 15*[1] | WS 5*[1] |
|---|---|---|---|---|---|---|---|
| | | | | VSS (mg/L) | | | |
| 6/1/04 | 10 | NS | 10 | 4 | 6 | NS | 16 |
| 6/2/04 | 2 | NS | 6 | 10 | NS | 4 | 10 |
| 6/3/04 | 14 | NS | 10 | 2 | NS | 14 | 6 |
| 6/4/04 | 6 | NS | 18 | 6 | NS | 8 | 10 |
| 6/5/04 | 10 | NS | 6 | 8 | NS | 12 | 8 |
| 6/6/04 | 8 | NS | 10 | 2 | NS | 6 | 8 |
| 6/7/04 | 8 | NS | 8 | 4 | NS | 8 | 4 |
| 6/10/04 | 8 | 10 | 12 | 4 | 2 | NS | 2 |
| 6/17/04 | 8 | 5 | NS | 1 | 6 | NS | 8 |
| 6/24/04 | 20 | 60 | NS | 31 | 6 | NS | 17 |
| Minimum | 2 | 5 | 6 | 1 | 2 | 4 | 2 |
| Mean | 9 | 25 | 10 | 7 | 5 | 9 | 9 |
| Maximum | 20 | 60 | 18 | 31 | 6 | 14 | 17 |

TABLE AII-2 (Continued): RESULTS OF IN-SITU SAMPLE ANALYSES FOR $BOD_5$, $NH_4$-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Date | ES**[1] | MS**[1] | WS**[1] |
|---|---|---|---|
| | Sulfide (mg/L) | | |
| 6/4/04 | 2.26 | 0.14 | 0.37 |
| 6/10/04 | 0.89 | 0.46 | 0.00 |
| 6/17/04 | 2.10 | 1.07 | 0.00 |
| 6/24/04 | 4.68 | 3.32 | 0.00 |
| Minimum | 0.89 | 0.14 | 0.00 |
| Mean | 2.48 | 1.25 | 0.09 |
| Maximum | 4.68 | 3.32 | 0.37 |

NS = Sample not collected.
*Number refers to depth of water sample in feet.
**Sample collected near bottom of the reservoir.
[1]See Figure AII-2 for locations.

TABLE AII-3: RESULTS OF CHLOROPHYLL *a* IN µg/L FROM SAMPLES COLLECTED AT A DEPTH OF 5 FEET IN THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Date | ES[1] | MS[1] | WS[1] |
|---|---|---|---|
| 6/4/04 | 5.9 | 7.2 | 5.9 |
| 6/17/04 | 56.7 | 52.1 | 89.6 |
| 6/24/04 | 293.7 | 356.7 | 293.7 |

[1]See Figure AII-2 for locations.

TABLE AII-4: DISSOLVED OXYGEN AND TEMPERATURE READINGS AT SEVERAL LOCATIONS AND VARIOUS DEPTHS IN THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| | Ramp | | ES 5 | | ES 10 | | ES 15 | | ES 20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 6/1/04 | 0.2 | 20.2 | 0.1 | 17.7 | 0.1 | 16.5 | 0.0 | 17.0 | 0.0 | 16.6 |
| 6/2/04 | 2.1 | 19.8 | 0.7 | 18.8 | 0.7 | 17.0 | 1.1 | 17.1 | 0.8 | 17.9 |
| 6/3/04 | 1.5 | 23.3 | 0.2 | 18.3 | 0.3 | 17.1 | 0.2 | 16.9 | 0.1 | 17.7 |
| 6/4/04 | 1.3 | 21.7 | 0.2 | 18.8 | 0.1 | 17.0 | 0.1 | 17.2 | 0.1 | 18.3 |
| 6/5/04 | 6.0 | 16.9 | 0.4 | 19.7 | 0.2 | 16.9 | 0.2 | 17.3 | 0.2 | 18.8 |
| 6/6/04 | 19.0 | 22.3 | 20.3 | 19.8 | 0.6 | 17.0 | 0.6 | 16.9 | 0.9 | 17.4 |
| 6/7/04 | 22.6 | 26.2 | 15.6 | 21.9 | 0.1 | 17.1 | 0.1 | 17.7 | 0.7 | 19.9 |
| 6/10/04 | 6.2 | 19.2 | 3.6 | 23.8 | 9.0 | 21.6 | 0.1 | 19.4 | 0.1 | 20.9 |
| 6/17/04* | 11.6 | 25.7 | 11.8 | 23.7 | 9.1 | 18.0 | 0.4 | 22.3 | NS | NS |
| 6/17/04 | 27.1 | 26.3 | 14.1 | 24.0 | 1.5 | 18.3 | 0.9 | 19.7 | NS | NS |
| 6/24/04* | 13.3 | 21.2 | 6.4 | 22.3 | 16.2 | 20.6 | 1.5 | 18.8 | NS | NS |
| 6/24/04 | 11.2 | 22.1 | 8.3 | 22.1 | 19.4 | 19.8 | 0.0 | 17.3 | NS | NS |
| Min. | 0.2 | 16.9 | 0.1 | 17.7 | 0.1 | 16.5 | 0.0 | 16.9 | 0.0 | 16.6 |
| Mean | 10.2 | 22.1 | 6.8 | 20.9 | 4.8 | 18.1 | 0.4 | 18.1 | 0.4 | 18.4 |
| Max. | 27.1 | 26.3 | 20.3 | 24.0 | 19.4 | 21.6 | 1.5 | 22.3 | 0.9 | 20.9 |

TABLE AII-4 (Continued): DISSOLVED OXYGEN AND TEMPERATURE READINGS AT SEVERAL LOCATIONS AND VARIOUS DEPTHS IN THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| | MS 5 | | MS 10 | | MS 15 | | WS 5 | | WS 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 6/1/04 | 0.5 | 18.2 | 0.0 | 17.0 | NS | NS | 0.5 | 18.1 | 0.1 | 17.6 |
| 6/2/04 | 1.0 | 18.9 | 0.4 | 17.8 | 0.6 | 18.6 | 0.2 | 19.1 | 0.3 | 19.4 |
| 6/3/04 | 0.1 | 17.9 | 0.1 | 17.3 | 0.1 | 17.2 | 0.1 | 18.5 | 0.1 | 18.3 |
| 6/4/04 | 0.3 | 19.0 | 0.0 | 17.4 | 0.0 | 18.1 | 0.2 | 19.6 | 0.1 | 18.5 |
| 6/5/04 | 1.0 | 19.8 | 0.4 | 17.2 | 0.5 | 17.9 | 0.3 | 19.4 | 1.8 | 18.5 |
| 6/6/04 | 22.0 | 20.8 | 1.0 | 17.4 | 0.6 | 18.9 | 21.4 | 20.2 | 6.4 | 20.1 |
| 6/7/04 | 23.0 | 22.8 | 0.2 | 19.4 | 3.7 | 19.0 | 16.5 | 25.3 | 3.0 | 20.2 |
| 6/10/04 | 3.2 | 23.8 | 0.2 | 18.5 | NS | NS | 6.8 | 24.6 | NS | NS |
| 6/17/04* | 19.3 | 26.5 | 0.3 | 21.9 | NS | NS | 10.1 | 25.8 | NS | NS |
| 6/17/04 | 16.3 | 26.2 | 2.0 | 21.7 | NS | NS | 15.4 | 26.1 | NS | NS |
| 6/24/04* | 9.6 | 22.5 | 19.2 | 20.9 | NS | NS | 8.8 | 22.6 | NS | NS |
| 6/24/04 | 8.2 | 22.2 | 14.9 | 20.6 | NS | NS | 11.8 | 22.0 | NS | NS |
| Min. | 0.1 | 17.9 | 0.0 | 17.0 | 0.0 | 17.2 | 0.1 | 18.1 | 0.1 | 17.6 |
| Mean | 8.7 | 21.6 | 3.2 | 18.9 | 0.9 | 18.3 | 7.7 | 21.8 | 1.7 | 18.9 |
| Max. | 23.0 | 26.5 | 19.2 | 21.9 | 3.7 | 19.0 | 21.4 | 26.1 | 6.4 | 20.2 |

NS = Reading not taken.
*Reading taken at 8 am in the morning. The other readings were taken in the early afternoon.

FIGURE AII-3: ODOR AND $H_2S$ MONITORING LOCATIONS
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

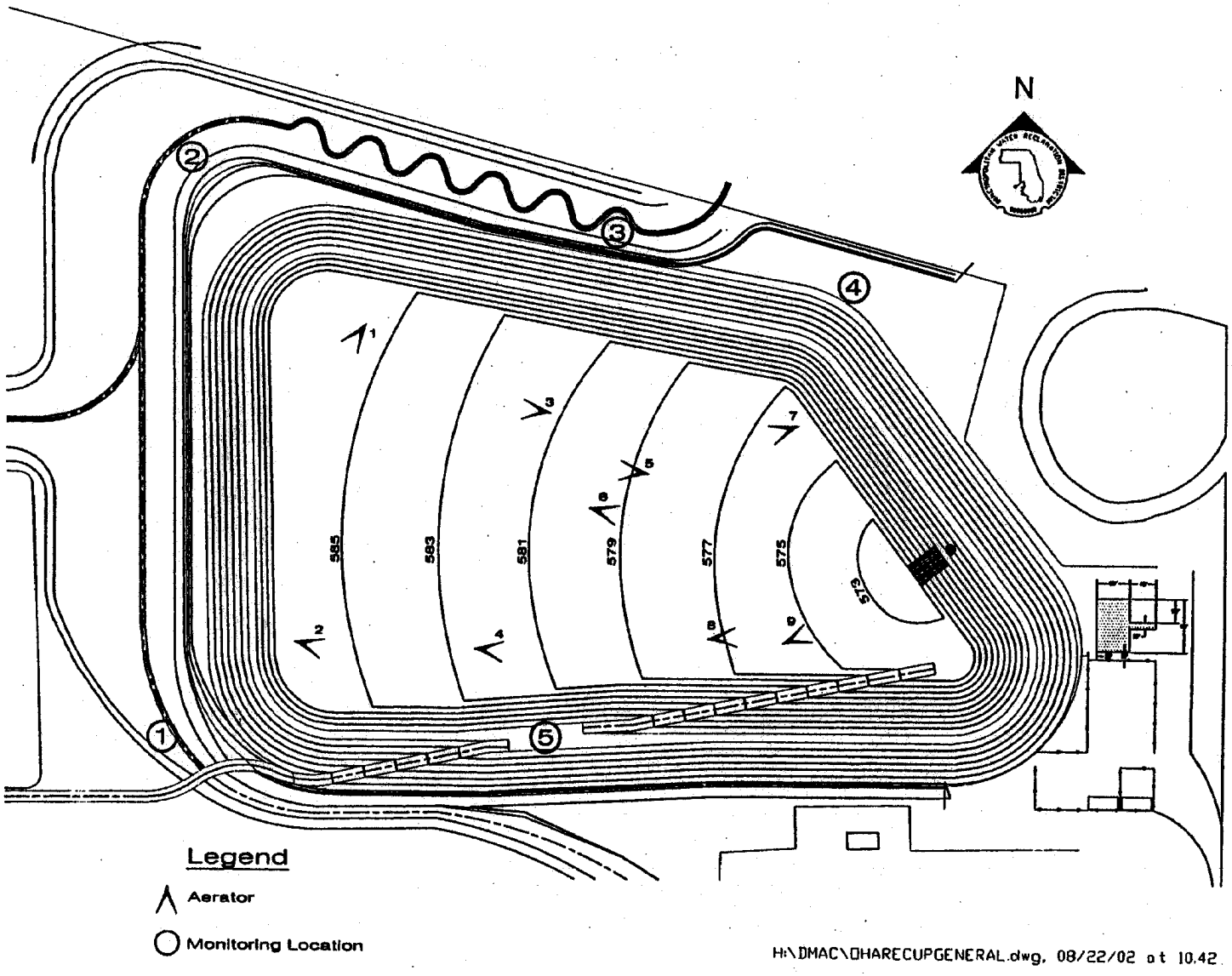


TABLE AII-5: HYDROGEN SULFIDE MONITORING DATA IN PARTS PER BILLION (ppb) AROUND THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Date | Location[1] | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 6/1/04 | 4 | 4 | 4 | 4 | 4 |
| 6/2/04 | 5 | 5 | 6 | 6 | 6 |
| 6/3/04 | 2 | 8 | 10 | 3 | 0 |
| 6/4/04 | 7 | 13 | 11 | 13 | 14 |
| 6/5/04 | 11 | 10 | 10 | 3 | 10 |
| 6/6/04 | 7 | 8 | 8 | 10 | 9 |
| 6/7/04 | 6 | 9 | 4 | 3 | 9 |
| 6/8/04 | 6 | 9 | 9 | 9 | 10 |
| 6/9/04 | 6 | 5 | 5 | 4 | 6 |
| 6/10/04 | 0 | 0 | 0 | 0 | 0 |
| 6/11/04 | 0 | 2 | 1 | 2 | 2 |
| 6/12/04 | 7 | 5 | 2 | 5 | 7 |
| 6/13/04 | 3 | 7 | 6 | 6 | 7 |
| 6/14/04 | 9 | 10 | 9 | 9 | 10 |
| 6/15/04 | 6 | 6 | 5 | 7 | 9 |
| 6/16/04 | 4 | 5 | 6 | 9 | 7 |
| 6/17/04 | 0 | 0 | 3 | 3 | 3 |
| 6/18/04 | 6 | 7 | 6 | 6 | 8 |
| 6/19/04 | 5 | 8 | 7 | 7 | 9 |
| 6/20/04 | 10 | 11 | 11 | 7 | 9 |
| 6/21/04 | NA | NA | NA | NA | NA |
| 6/22/04 | 7 | 4 | 7 | 7 | 8 |
| 6/23/04 | 6 | 8 | 7 | 8 | 9 |
| 6/24/04 | 8 | 7 | 8 | 8 | 4 |
| 6/25/04 | 10 | 7 | 11 | 11 | 8 |
| 6/26/04 | 7 | 5 | 8 | 6 | 9 |
| 6/27/04 | 7 | 8 | 8 | 6 | 8 |
| 6/28/04 | 10 | 11 | 8 | 9 | 11 |
| Min. | 0 | 0 | 0 | 0 | 0 |
| Mean | 6 | 7 | 7 | 6 | 7 |
| Max. | 11 | 13 | 11 | 13 | 14 |

NA = Readings not taken due to meter malfunction.
[1]See Figure AII-3.

TABLE AII-6: QUALITATIVE ODOR INTENSITY MONITORING AROUND RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Site No. | Site Name | No Odor | Very Faint | Faint | Easily Noticeable | Strong | Very Strong | Total Number of Readings During Experiment |
|---|---|---|---|---|---|---|---|---|
| 1 | Southwest Corner Monitoring Well | 18 | 4 | 5 | 1 | 0 | 0 | |
| 2 | Northwest Corner Monitoring Well | 21 | 2 | 0 | 5 | 0 | 0 | |
| 3 | Middle of North Side | 23 | 2 | 1 | 2 | 0 | 0 | |
| 4 | Northeast Corner Monitoring Well | 24 | 2 | 0 | 2 | 0 | 0 | |
| 5 | South Landing | 25 | 0 | 2 | 1 | 0 | 0 | |
| | Total Number of Readings | 111 | 10 | 8 | 11 | 0 | 0 | 140 |

TABLE AII-7: HYDROGEN SULFIDE IN PARTS PER BILLION (ppb) AROUND THE RESERVOIR BEFORE AND AFTER TURNING ON THE AERATORS ON JUNE 29, 2004, PRIOR TO THE RESERVOIR DRAWDOWN
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Time[1] | Location[2] | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 9:00 AM | 7 | 6 | 5 | 5 | 6 |
| 10:00 AM | 5 | 6 | 6 | 8 | 5 |
| 11:00 AM | 6 | 6 | 5 | 10 | 7 |
| 12:00 PM | 9 | 6 | 7 | 6 | 6 |
| 1:00 PM | 6 | 8 | 8 | 8 | 9 |
| 2:00 PM | 7 | 7 | 5 | 6 | 8 |

[1]Aerators were turned on at 10:00 AM on June 29, 2004. The 9:00 AM results were taken before the aerators were turned on.
[2]See Figure AII-3.

TABLE AII-8: QUALITATIVE ODOR INTENSITY[1] MONITORING AROUND THE O'HARE CUP RESERVOIR BEFORE AND DURING THE PERIOD WHEN THE AERATORS WERE IN OPERATION PRIOR TO THE RESERVOIR DRAWDOWN O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Time | Location[2] | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 9:00 AM | 0 | 0 | 0 | 0 | 0 |
| 10:00 AM[3] | 0 | 0 | 3 | 1 | 1 |
| 11:00 AM | 0 | 0 | 0 | 2 | 0 |
| 12:00 PM | 0 | 0 | 0 | 3 | 0 |
| 1:00 PM | 0 | 0 | 0 | 2 | 0 |
| 2:00 PM | 0 | 0 | 0 | 1 | 0 |

[1]0 - No odor, 1 - Very faint, 2 - Faint, 3 - Easily detectable.

[2]See Figure AII-3.

[3]Aerators were turned on at 10:00 AM on June 29, 2004. The 9:00 AM results were taken before the aerators were turned on.

TABLE AII-9: HYDROGEN SULFIDE IN PARTS PER BILLION (ppb) AROUND THE RESERVOIR AFTER THE RESERVOIR WAS DRAINED ON JUNE 30, 2004 O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Time | Location[1] | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 6:55 AM | 4 | 6 | 4 | 4 | 5 |
| 9:20 AM | 7 | 7 | 8 | 7 | 6 |

[1]See Figure AII-3.

TABLE AII-10: QUALITATIVE ODOR INTENSITY[1] MONITORING AROUND THE RESERVOIR AFTER THE RESERVOIR WAS DRAINED ON JUNE 30, 2004
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

| Time | Location[2] | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 6:55 AM | 0 | 0 | 0 | 0 | 0 |
| 9:20 AM | 0 | 0 | 0 | 0 | 0 |

[1]0 - No odor.
[2]See Figure AII-3.

# APPENDIX AIII

## LOCATIONS OF SAMPLING SITES AND RESULTS OF BOTTOM SEDIMENT MEASUREMENTS DURING O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT

FIGURE AIII-1: LOCATIONS OF SEDIMENT DEPTH MEASUREMENTS AT THE BOTTOM OF THE RESERVOIR
SAMPLES COLLECTED ON JUNE 30, 2004

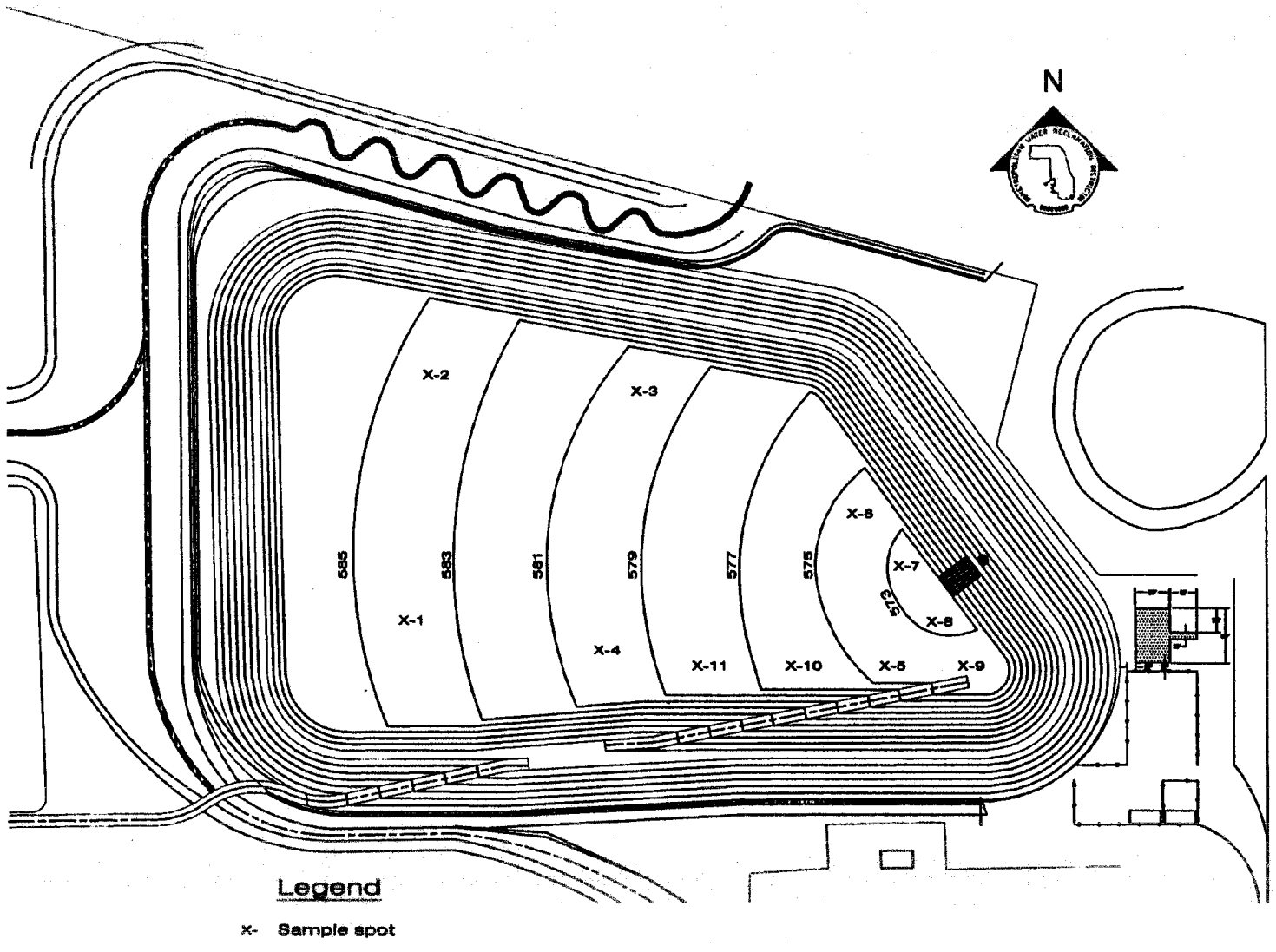


TABLE AIII-1: DEPTH AND PERCENT SOLIDS RESULTS IN THE BOTTOM SEDIMENTS AFTER DRAINING THE RESERVOIR
O'HARE CUP RESERVOIR MAY 30, 2004, THROUGH JUNE 30, 2004, FILL EVENT EXPERIMENT
RESULTS FROM SAMPLES COLLECTED ON JUNE 30, 2004

| Site | Depth Inches | Total Solids (TS) Percent | Total Volatile Solids (TVS) Percent |
|---|---|---|---|
| 1 | 0.031 | 6.03 | 31.99 |
| 2 | 0.063 | 6.86 | 30.73 |
| 3 | 0.125 | 8.23 | 29.75 |
| 4 | 1.000 | 8.06 | 36.27 |
| 5 | 1.000 | 7.52 | 39.37 |
| 6 | 0.250 | 7.85 | 30.68 |
| 7 | 0.250 | 6.71 | 31.31 |
| 8 | 0.875 | 6.85 | 39.92 |
| 9 | 2.125 | 7.14 | 39.88 |
| 10 | 0.750 | 7.79 | 33.06 |
| 11 | 0.125 | 7.24 | 39.70 |
| Min. | 0.031 | 6.03 | 29.75 |
| Mean | 0.599 | 7.30 | 34.79 |
| Max. | 2.125 | 8.23 | 39.92 |