# REVISION AND UPDATE OF NPDES MIXING ZONE DEMONSTRATION (VOLUME IIR)

# NPDES PERMIT NO. IN 0000108

Prepared for:

## BP PRODUCTS NORTH AMERICA, INC.
## WHITING REFINERY
## Whiting, Indiana

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# EXPLANATION OF
# REVISION AND UPDATE OF NPDES MIXING ZONE DEMONSTRATION
# (VOLUME IIR)

As part of the update of the BP Products North America Inc., Whiting Refinery NPDES Permit Renewal Application, this explanation addresses revisions to the Mixing Zone Demonstration documented in Volume II (submitted August 1994) and Volume IIR (submitted March 1998). Since March of 1998, the following four areas have changed to the degree that necessitates additional information to be submitted to IDEM. Specifically, these areas are:

1. Update of the Outfall 001 effluent flowrate to reflect recent conditions (November 1, 1999 to October 31, 2001). The original effluent flow used in the March 1998 Volume IIR covered a period from 1991 to 1994.
2. Revision of the multiport diffuser design to account for the changed effluent flowrate.
3. Use of the current USEPA supported version of the CORMIX dispersion model.
4. Extension of the Lake Michigan Biomonitoring Program to include recent surveys (Oct 1997, Aug 1998, Aug 1999, and Aug 2000) – Attachment 6.

These changes augment the overriding conclusion of the Volume IIR Mixing Zone Demonstration that implementation of an alternate mixing zone for BP is appropriate and valid. The hydrodynamic studies and biological assessments (including updates/revisions included herein) demonstrate that the proposed BP mixing zone meets the requirements of Indiana regulation and is protective of human health, aquatic life, and wildlife.

## Effluent Flow

As more recent Outfall 001 data is available, the long-term average effluent flow has been updated from an original database of 1991 to 1994 to a current database of Nov 1, 1999 to Oct 31, 2001. The March 1998 Volume IIR presented an average Outfall 001 effluent flow of 13 mgd. The updated average effluent flow is now 17.6 mgd as presented in the revised Volume I Form 2C permit application. This flow serves as the basis for the multiport diffuser design as the 1991 USEPA Technical Support Document

for Water Quality-based Toxics Control (TSD) recommends a port exit velocity of 10 ft/sec at average effluent flow.

Multiport Diffuser Design

Given the increase in average effluent flow from 13 mgd to 17.6 mgd, a design change to the multiport diffuser was necessary to facilitate the maintenance of a 10 ft/sec port exit velocity. Table 2-1 of Volume IIR was revised to incorporate the new effluent flow. As shown in Revised Table 2-1, the selected design kept the original port diameter of 6 in, but increased the number of ports from 10 to 14 to accommodate the increased flow. Further the total diffuser length was kept constant at 90 ft, so the increased number of ports reduced the port spacing from 10 ft to 6.9 ft. The 6.9 ft spacing is greater than the minimum recommended port spacing given in Revised Table 2-1 (5 ft).

CORMIX Dispersion Modeling

In order to evaluate the dispersion and size of a mixing zone from a multiport diffuser, the USEPA-endorsed computer model CORMIX, developed by Dr. Gerhard Jirka at Cornell University, was used for analysis in the 1994 Volume II and the 1998 Volume IIR. For Volume IIR, CORMIX v2.1 was the most recent version available at that time. Since 1998 the model has undergone subsequent revisions and support sponsor changes. For this 2002 permit application update, CORMIX v4.1 (ref: CORMIX-GI Version 4.1GT, June 2000, Oregon Graduate Institute) was used for analysis. As done previously, the CORMIX expert system was utilized to determine achievable dispersion at the edge of the Jet Entrainment Zone, the Near-Field Zone, and the Far-Field Zone.

In regards to model inputs for this analysis, a 90-ft diffuser (approximate length) with fourteen 6-in diameter ports spaced 6.9 ft apart was chosen as an appropriate design for the BP discharge. As mentioned previously, in the 1998 Volume IIR analysis, a 90-ft diffuser with ten 6-in diameter ports spaced 10 ft apart was chosen as an appropriate design. The updated diffuser design remains unidirectional with all 14 ports pointing toward the center of the lake (due north, away from shore). The 6-in diameter ports and 6.9-ft port spacing provide standard dimensions for ease of installation and still maintain the recommended 10 ft/sec exit velocity. Other configurations could be used for final

design; however, port diameters should not be too small where clogging from debris might occur and spacing should be large enough where immediate entrainment of adjacent ports is avoided.

Revised Table 2-2 presents a comparison of the original Volume IIR model inputs with the current revised inputs. The only inputs requiring a change were average effluent flow, number of ports, and port spacing. All other CORMIX input parameters remained consistent with original values (reference for these inputs can be found in Volume IIR).

For the revised input parameters described above, model runs were conducted for dispersion estimation as a function of distance from the diffuser at Site S3500. The CORMIX v4.1 model output is given in Revised Attachment 4 and graphically presented in Revised Figure 2-2. Identical to results from 1998 at S3500, the plume is projected to be fully vertically mixed in the jet entrainment zone (per CORMIX classification) and extends to a distance of one-half of the diffuser length (45 to 50 ft). In essence, the plume classifications and mathematical equations used in 1998 (v2.1) are very similar to those used for this analysis (v4.1). However, due to the increased effluent flow, the dispersion projected at this distance decreased from 54:1 in March 1998 to 42:1.

After the jet entrainment zone, the CORMIX v4.1 model projects a transition zone that is "insignificant in spatial extent and will be bypassed" (same as CORMIX v2.1). Therefore, there is no additional dispersion gained in the transition zone and the extent of the Near-Field Zone is equal to the extent of the Discharged Induced Mixing Zone (DIMZ). At the DIMZ, the extent of discharge-induced mixing is equal to 45 to 50 ft from the diffuser where a dispersion of 42:1 is achieved. Since Indiana law limits the mixing zone to the DIMZ for a Lake Michigan discharger, BP proposes a mixing zone of 50 feet around the diffuser structure, the same size as proposed in 1998.

Past the Near-Field Zone, physical mixing continues, and CORMIX v4.1 dispersion projects into the Far-Field Zone up to a user-specified distance of 3,300 ft. The actual extent of the Far-Field Zone, used for regulatory application is determined from regulatory definitions, not from hydrodynamic principles since the plume will continue to disperse at the molecular level over great distances. The 1991 TSD suggests that the DIMZ occupy 10 percent of the far-field zone, therefore, an appropriate far-field distance of 500 ft can be

established for the BP diffuser. At this distance, CORMIX v4.1 projects an effluent dispersion of 60:1 for the far-field zone, compared to 77:1 predicted in March 1998. A total mixing zone of 500 feet radius around the diffuser structure is consistent with USEPA approaches to protecting the environment and is the same size proposed in 1998.

As with the previous analysis, the proposed multiport discharge configuration adds a margin of safety to protect the quality of the receiving waters as compared to the existing Outfall 001 structure. A graphical depiction of the BP mixing zone delineation (42:1 dispersion at 50 ft from the diffuser) is given in Revised Figure 3-1.

Lake Michigan Biomonitoring Program

To incorporate recent biomonitoring program data from 1997, 1998, 1999, and 2000, Attachment 6 from Volume IIR has been updated and is enclosed herein. Again, the biological data reflect patterns reported in March 1998 and have not changed the fundamental conclusions presented in Volume IIR. The revised Attachment 6 gives the biomonitoring program database in its entirety and further establishes pre-diffuser baseline conditions towards the demonstration of protection to human health, aquatic life, and wildlife.

**REVISED TABLE 2-1. PORT SIZES AND SPACING FOR A MULTIPORT DIFFUSER**
**BP WHITING**

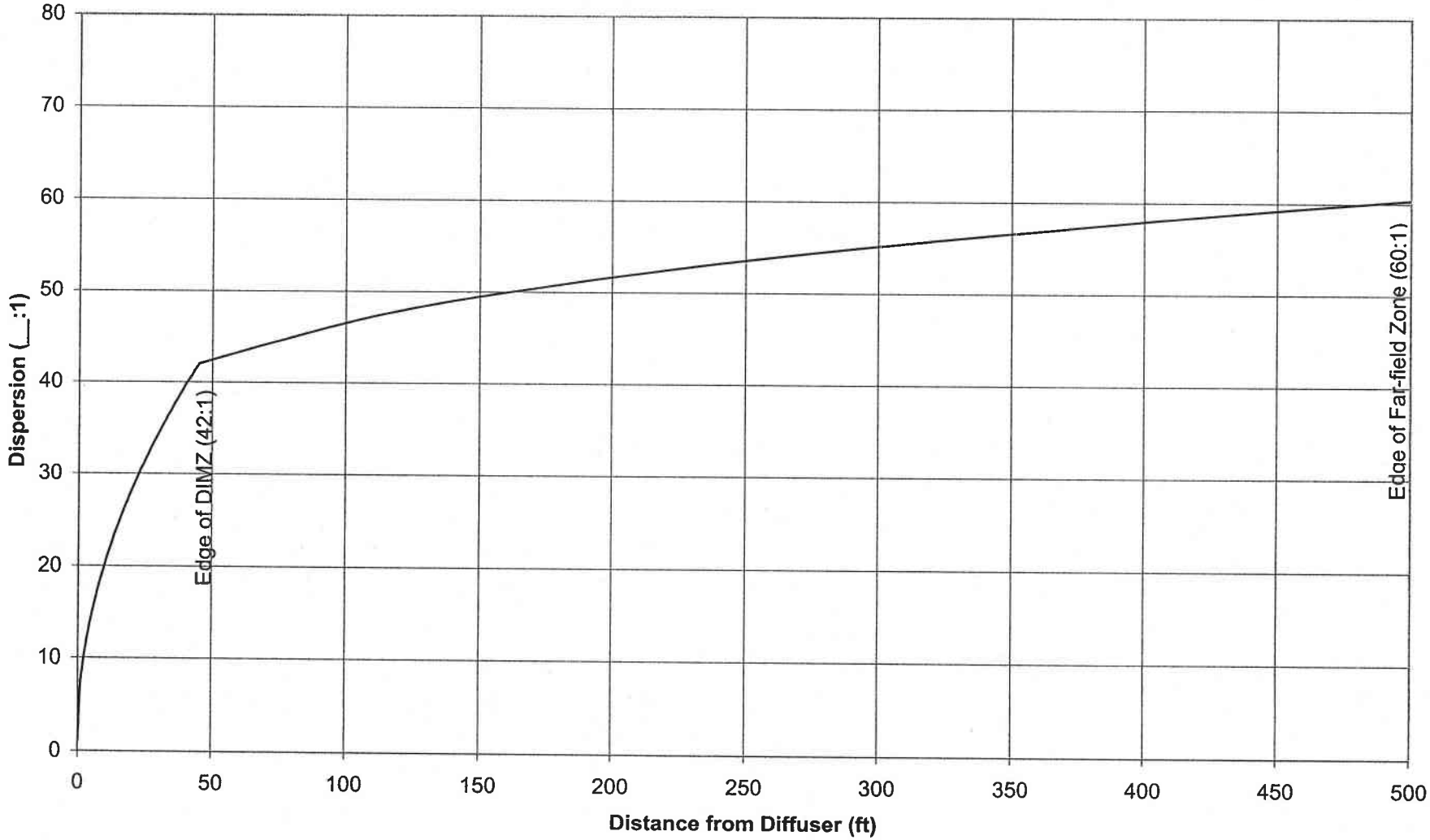
| NUMBER OF PORTS | AVERAGE EFFLUENT FLOW (mgd) | EFFLUENT FLOW (cfs) | EXIT VELOCITY (ft/sec) | PORT AREA (sq ft) | PORT DIAMETER (in) | MIN PORT SPACING (ft) | DIFFUSER LENGTH (ft) |
|---|---|---|---|---|---|---|---|
| 1 | 17.61 | 27.24 | 10 | 2.72 | 22.3 | | |
| 2 | 17.61 | 27.24 | 10 | 1.36 | 15.8 | 13.2 | 13.2 |
| 3 | 17.61 | 27.24 | 10 | 0.91 | 12.9 | 10.8 | 21.5 |
| 4 | 17.61 | 27.24 | 10 | 0.68 | 11.2 | 9.3 | 27.9 |
| 5 | 17.61 | 27.24 | 10 | 0.54 | 10.0 | 8.3 | 33.3 |
| 6 | 17.61 | 27.24 | 10 | 0.45 | 9.1 | 7.6 | 38.0 |
| 7 | 17.61 | 27.24 | 10 | 0.39 | 8.4 | 7.0 | 42.2 |
| 8 | 17.61 | 27.24 | 10 | 0.34 | 7.9 | 6.6 | 46.1 |
| 9 | 17.61 | 27.24 | 10 | 0.30 | 7.4 | 6.2 | 49.7 |
| 10 | 17.61 | 27.24 | 10 | 0.27 | 7.1 | 5.9 | 53.0 |
| 11 | 17.61 | 27.24 | 10 | 0.25 | 6.7 | 5.6 | 56.2 |
| 12 | 17.61 | 27.24 | 10 | 0.23 | 6.5 | 5.4 | 59.1 |
| 13 | 17.61 | 27.24 | 10 | 0.21 | 6.2 | 5.2 | 62.0 |
| **14** | **17.61** | **27.24** | **10** | **0.19** | **6.0** | **5.0** | **64.7** |
| 15 | 17.61 | 27.24 | 10 | 0.18 | 5.8 | 4.8 | 67.3 |

Note: In the March 1998 Permit Renewal Application (Volume IIR), the average effluent flowrate was 13 mgd, resulting in a selected design of ten 6-in ports to maintain an exit velocity of 10 ft/sec

**REVISED TABLE 2-2. CORMIX v4.1 MODEL INPUTS**
**BP WHITING**

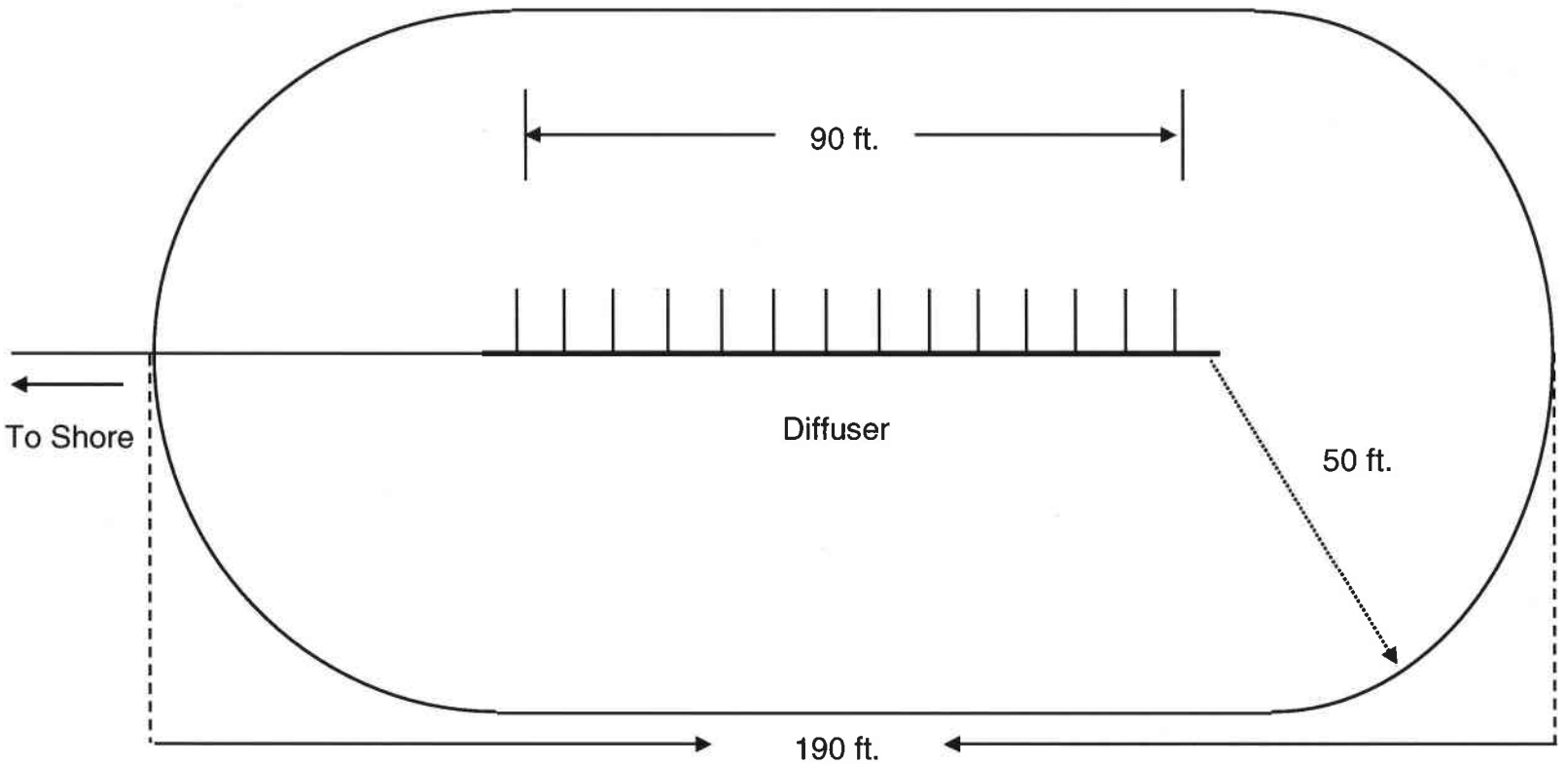
| PARAMETER | UNITS | MARCH 1998 VOLUME IIR VALUE | APRIL 2002 REVISED VALUE | REASON FOR CHANGE |
|---|---|---|---|---|
| Average Effluent Flow | mgd | 13 | 17.61 | Update from 1991-1994 DMR to 1999-2001 DMR |
| Diffuser Length | feet | 90 | 90 | Same |
| Number of Ports | # | 10 | 14 | Increased effluent flow |
| Port Diameter | inches | 6 | 6 | Same |
| Port Exit Velocity | ft/sec | 10 | 10 | Same |
| Port Angle | degrees | 0 | 0 | Same |
| Port Spacing | feet | 10 | 6.9 | Increased number of ports |
| Diffuser height off bottom | feet | 1.6 | 1.6 | Same |
| Distance from Shore to 1st Port | feet | 3,500 | 3,500 | Same |
| Distance from Shore to Last Port | feet | 3,590 | 3,590 | Same |
| Effluent Temperature | degrees C | 30 | 30 | Same |
| Lake Temperature | degrees C | 10 | 10 | Same |
| Temperature Difference | degrees C | 20 | 20 | Same |
| Lake Depth | feet | 28.5 | 28.5 | Same |
| Lake Velocity | ft/sec | 0.33 | 0.33 | Same |

## REVISED FIGURE 2-2. CORMIX v4.1 RESULTS FOR A MULTIPORT DIFFUSER
## BP WHITING OUTFALL 001




ADVENT No. 01534/Fig2-2.xls

3-Apr-2002




Dispersion at edge of discharge-induced mixing zone = 42:1
Total surface area of discharge-induced mixing zone = 0.39 acre

Prepared For
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**REVISED FIGURE 3-1. ALTERNATE MIXING ZONE DELINEATION**

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# 4

# ATTACHMENT 4

CORMIX v4.1 MODEL OUTPUT

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ATTACHMENT 4 - CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222
                        CORNELL MIXING ZONE EXPERT SYSTEM
          Subsystem CORMIX2:  Submerged Multiport Diffuser Discharges
 CORMIX-GI Version 4.1GT
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:    S3500
 Design case:        Base Case
 FILE NAME:          \\Dean\c\Program Files\CORMIX-GI\My Files\bpamoco.prd
 Time stamp:         Wed Dec  5 10:33:48 2001

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =      8.69  HD     =      8.69
 UA     =      0.100 F      =      0.047 USTAR =0.7647E-02
 UW     =      2.000 UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=  U          RHOAM =  999.7019

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:      DITYPE= unidirectional_perpendicular
 BANK   =  LEFT      DISTB =   1080.52  YB1    =   1066.80  YB2    =   1094.23
 LD     =     27.43  NOPEN =   14       SPAC   =      2.11
 D0     =      0.152 A0     =      0.018 H0     =      0.50
 Nozzle/port arrangement:   unidirectional_without_fanning
 GAMMA =      90.00  THETA =      0.00  SIGMA =      0.00  BETA   =     90.00
 U0     =      3.021 Q0     =      0.772        =0.7715E+00
 RHO0   =  995.6470  DRHO0 =0.4055E+01  GP0    =0.3978E-01
 C0     = 0.1000E+03 CUNITS=  PERCENT
 IPOLL =  1          KS     =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0     =0.2813E-01  m0     =0.8497E-01  j0     =0.1119E-02  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B   =      0.009 lM     =      7.87  lm     =      8.50
 lmp    =  99999.00  lbp    =  99999.00  la     =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0     =0.7715E+00  M0     =0.2331E+01  J0     =0.3069E-01
 Associated 3-d length scales (meters)
 LQ     =      0.51  LM     =     10.77  Lm     =     15.27  Lb     =     30.69
                                         Lmp    =  99999.00  Lbp    =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =    157.00  FRD0   =     38.80  R      =     30.21
 (slot)              (port/nozzle)

FLOW CLASSIFICATION
 2222222222222222222222222222222222222222
 2  Flow class (CORMIX2)       =    MU2    2
 2  Applicable layer depth HS =     8.69  2
 2222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     = 0.1000E+03 CUNITS=  PERCENT
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 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
      1080.52 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 50 display intervals per module
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-------------------------------------------------------------------------------
BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
      0.00     0.00     0.50     1.0 0.100E+03    0.01    13.72

END OF MOD201: DIFFUSER DISCHARGE MODULE
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

 In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY
  MIXED over the entire layer depth (HS =    8.69m).
   Full mixing is achieved after a plume distance of about five
   layer depths from the diffuser.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
      0.00     0.00     0.50     1.0 0.100E+03    0.01    13.72
      0.27     0.00     0.58     6.8 0.147E+02    0.17    13.55
      0.55     0.00     0.65     9.2 0.109E+02    0.35    13.39
      0.82     0.00     0.73    11.0 0.906E+01    0.52    13.24
      1.10     0.00     0.81    12.6 0.794E+01    0.69    13.10
      1.37     0.00     0.88    14.0 0.716E+01    0.87    12.97
      1.65     0.00     0.96    15.2 0.658E+01    1.04    12.85
      1.92     0.00     1.04    16.3 0.612E+01    1.22    12.73
      2.19     0.00     1.11    17.4 0.575E+01    1.39    12.62
      2.47     0.00     1.19    18.4 0.544E+01    1.56    12.51
      2.74     0.00     1.27    19.3 0.517E+01    1.74    12.41
      3.02     0.00     1.35    20.2 0.494E+01    1.91    12.32
      3.29     0.00     1.42    21.1 0.474E+01    2.08    12.23
      3.57     0.00     1.50    21.9 0.457E+01    2.26    12.14
      3.84     0.00     1.58    22.7 0.441E+01    2.43    12.06
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.11 | 0.00 | 1.65 | 23.5 | 0.426E+01 | 2.61 | 11.99 |
| 4.39 | 0.00 | 1.73 | 24.2 | 0.413E+01 | 2.78 | 11.91 |
| 4.66 | 0.00 | 1.81 | 24.9 | 0.402E+01 | 2.95 | 11.84 |
| 4.94 | 0.00 | 1.88 | 25.6 | 0.391E+01 | 3.13 | 11.77 |
| 5.21 | 0.00 | 1.96 | 26.3 | 0.381E+01 | 3.30 | 11.71 |
| 5.49 | 0.00 | 2.04 | 26.9 | 0.371E+01 | 3.47 | 11.65 |
| 5.76 | 0.00 | 2.11 | 27.6 | 0.363E+01 | 3.65 | 11.59 |
| 6.04 | 0.00 | 2.19 | 28.2 | 0.355E+01 | 3.82 | 11.53 |
| 6.31 | 0.00 | 2.27 | 28.8 | 0.347E+01 | 4.00 | 11.48 |
| 6.58 | 0.00 | 2.34 | 29.4 | 0.340E+01 | 4.17 | 11.43 |
| 6.86 | 0.00 | 2.42 | 30.0 | 0.333E+01 | 4.34 | 11.38 |
| 7.13 | 0.00 | 2.50 | 30.6 | 0.327E+01 | 4.52 | 11.33 |
| 7.41 | 0.00 | 2.58 | 31.1 | 0.321E+01 | 4.69 | 11.29 |
| 7.68 | 0.00 | 2.65 | 31.7 | 0.316E+01 | 4.86 | 11.24 |
| 7.96 | 0.00 | 2.73 | 32.2 | 0.310E+01 | 5.04 | 11.21 |
| 8.23 | 0.00 | 2.81 | 32.8 | 0.305E+01 | 5.21 | 11.17 |
| 8.50 | 0.00 | 2.88 | 33.3 | 0.300E+01 | 5.39 | 11.13 |
| 8.78 | 0.00 | 2.96 | 33.8 | 0.296E+01 | 5.56 | 11.10 |
| 9.05 | 0.00 | 3.04 | 34.3 | 0.292E+01 | 5.73 | 11.07 |
| 9.33 | 0.00 | 3.11 | 34.8 | 0.287E+01 | 5.91 | 11.04 |
| 9.60 | 0.00 | 3.19 | 35.3 | 0.283E+01 | 6.08 | 11.02 |
| 9.88 | 0.00 | 3.27 | 35.8 | 0.279E+01 | 6.25 | 10.99 |
| 10.15 | 0.00 | 3.34 | 36.3 | 0.276E+01 | 6.43 | 10.97 |
| 10.42 | 0.00 | 3.42 | 36.7 | 0.272E+01 | 6.60 | 10.95 |
| 10.70 | 0.00 | 3.50 | 37.2 | 0.269E+01 | 6.78 | 10.94 |
| 10.97 | 0.00 | 3.57 | 37.7 | 0.265E+01 | 6.95 | 10.92 |
| 11.25 | 0.00 | 3.65 | 38.1 | 0.262E+01 | 7.12 | 10.91 |
| 11.52 | 0.00 | 3.73 | 38.6 | 0.259E+01 | 7.30 | 10.90 |
| 11.80 | 0.00 | 3.81 | 39.0 | 0.256E+01 | 7.47 | 10.89 |
| 12.07 | 0.00 | 3.88 | 39.5 | 0.253E+01 | 7.64 | 10.88 |
| 12.34 | 0.00 | 3.96 | 39.9 | 0.251E+01 | 7.82 | 10.87 |
| 12.62 | 0.00 | 4.04 | 40.3 | 0.248E+01 | 7.99 | 10.87 |
| 12.89 | 0.00 | 4.11 | 40.7 | 0.245E+01 | 8.17 | 10.86 |
| 13.17 | 0.00 | 4.19 | 41.2 | 0.243E+01 | 8.34 | 10.86 |
| 13.44 | 0.00 | 4.27 | 41.6 | 0.240E+01 | 8.51 | 10.86 |
| 13.72 | 0.00 | 4.34 | 42.0 | 0.238E+01 | 8.69 | 10.85 |

Cumulative travel time = 80. sec

Plume centerline may exhibit slight discontinuities in transition to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

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BEGIN MOD251: DIFFUSER PLUME IN CO-FLOW

Phase 1: Vertically mixed, Phase 2: Re-stratified

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Phase 2: The flow has RESTRATIFIED at the beginning of this zone.

This flow region is INSIGNIFICANT in spatial extent and will be by-passed.

END OF MOD251: DIFFUSER PLUME IN CO-FLOW

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** End of NEAR-FIELD REGION (NFR) **

The initial plume WIDTH values in the next far-field module will be

CORRECTED by a factor 1.72 to conserve the mass flux in the far-field!
The correction factor is quite large because of the small ambient velocity relative to the strong mixing characteristics of the discharge!
This indicates localized RECIRCULATION REGIONS and internal hydraulic JUMPS.

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BEGIN MOD241: BUOYANT AMBIENT SPREADING

Profile definitions:
- BV = top-hat thickness, measured vertically
- BH = top-hat half-width, measured horizontally in y-direction
- ZU = upper plume boundary (Z-coordinate)
- ZL = lower plume boundary (Z-coordinate)
- S = hydrodynamic average (bulk) dilution
- C = average (bulk) concentration (includes reaction effects, if any)

Plume Stage 1 (not bank attached):

| X | Y | Z | S | C | BV | BH | ZU | ZL |
|---|---|---|---|---|---|---|---|---|
| 13.72 | 0.00 | 8.69 | 42.0 | 0.238E+01 | 8.69 | 18.65 | 8.69 | 0.00 |
| 33.44 | 0.00 | 8.69 | 47.2 | 0.212E+01 | 6.12 | 29.77 | 8.69 | 2.57 |
| 53.17 | 0.00 | 8.69 | 50.6 | 0.198E+01 | 5.00 | 39.07 | 8.69 | 3.69 |
| 72.89 | 0.00 | 8.69 | 53.2 | 0.188E+01 | 4.33 | 47.36 | 8.69 | 4.36 |
| 92.62 | 0.00 | 8.69 | 55.3 | 0.181E+01 | 3.88 | 54.97 | 8.69 | 4.81 |
| 112.34 | 0.00 | 8.69 | 57.1 | 0.175E+01 | 3.55 | 62.07 | 8.69 | 5.14 |
| 132.07 | 0.00 | 8.69 | 58.8 | 0.170E+01 | 3.30 | 68.78 | 8.69 | 5.39 |
| 151.80 | 0.00 | 8.69 | 60.3 | 0.166E+01 | 3.09 | 75.18 | 8.69 | 5.59 |
| 171.52 | 0.00 | 8.69 | 61.7 | 0.162E+01 | 2.93 | 81.30 | 8.69 | 5.76 |
| 191.25 | 0.00 | 8.69 | 63.0 | 0.159E+01 | 2.79 | 87.20 | 8.69 | 5.90 |
| 210.97 | 0.00 | 8.69 | 64.3 | 0.155E+01 | 2.67 | 92.89 | 8.69 | 6.01 |
| 230.70 | 0.00 | 8.69 | 65.6 | 0.152E+01 | 2.57 | 98.41 | 8.69 | 6.11 |
| 250.42 | 0.00 | 8.69 | 66.9 | 0.150E+01 | 2.49 | 103.78 | 8.69 | 6.20 |
| 270.15 | 0.00 | 8.69 | 68.1 | 0.147E+01 | 2.41 | 109.00 | 8.69 | 6.28 |
| 289.88 | 0.00 | 8.69 | 69.3 | 0.144E+01 | 2.34 | 114.09 | 8.69 | 6.34 |
| 309.60 | 0.00 | 8.69 | 70.6 | 0.142E+01 | 2.29 | 119.07 | 8.69 | 6.40 |
| 329.33 | 0.00 | 8.69 | 71.8 | 0.139E+01 | 2.23 | 123.94 | 8.69 | 6.45 |
| 349.05 | 0.00 | 8.69 | 73.1 | 0.137E+01 | 2.19 | 128.71 | 8.69 | 6.50 |
| 368.78 | 0.00 | 8.69 | 74.3 | 0.135E+01 | 2.15 | 133.39 | 8.69 | 6.54 |
| 388.50 | 0.00 | 8.69 | 75.6 | 0.132E+01 | 2.11 | 137.99 | 8.69 | 6.57 |
| 408.23 | 0.00 | 8.69 | 76.9 | 0.130E+01 | 2.08 | 142.50 | 8.69 | 6.60 |
| 427.96 | 0.00 | 8.69 | 78.3 | 0.128E+01 | 2.05 | 146.94 | 8.69 | 6.63 |
| 447.68 | 0.00 | 8.69 | 79.6 | 0.126E+01 | 2.03 | 151.31 | 8.69 | 6.66 |
| 467.41 | 0.00 | 8.69 | 81.0 | 0.123E+01 | 2.01 | 155.61 | 8.69 | 6.68 |
| 487.13 | 0.00 | 8.69 | 82.5 | 0.121E+01 | 1.99 | 159.85 | 8.69 | 6.70 |
| 506.86 | 0.00 | 8.69 | 83.9 | 0.119E+01 | 1.97 | 164.03 | 8.69 | 6.71 |
| 526.58 | 0.00 | 8.69 | 85.4 | 0.117E+01 | 1.96 | 168.16 | 8.69 | 6.73 |
| 546.31 | 0.00 | 8.69 | 87.0 | 0.115E+01 | 1.95 | 172.23 | 8.69 | 6.74 |
| 566.04 | 0.00 | 8.69 | 88.6 | 0.113E+01 | 1.94 | 176.25 | 8.69 | 6.75 |
| 585.76 | 0.00 | 8.69 | 90.2 | 0.111E+01 | 1.93 | 180.22 | 8.69 | 6.76 |
| 605.49 | 0.00 | 8.69 | 91.9 | 0.109E+01 | 1.92 | 184.15 | 8.69 | 6.76 |
| 625.21 | 0.00 | 8.69 | 93.6 | 0.107E+01 | 1.92 | 188.03 | 8.69 | 6.77 |
| 644.94 | 0.00 | 8.69 | 95.3 | 0.105E+01 | 1.92 | 191.87 | 8.69 | 6.77 |
| 664.66 | 0.00 | 8.69 | 97.1 | 0.103E+01 | 1.91 | 195.67 | 8.69 | 6.77 |
| 684.39 | 0.00 | 8.69 | 99.0 | 0.101E+01 | 1.91 | 199.43 | 8.69 | 6.77 |
| 704.11 | 0.00 | 8.69 | 100.9 | 0.991E+00 | 1.92 | 203.15 | 8.69 | 6.77 |
| 723.84 | 0.00 | 8.69 | 102.8 | 0.973E+00 | 1.92 | 206.84 | 8.69 | 6.77 |
| 743.57 | 0.00 | 8.69 | 104.8 | 0.954E+00 | 1.92 | 210.49 | 8.69 | 6.77 |
| 763.29 | 0.00 | 8.69 | 106.9 | 0.936E+00 | 1.93 | 214.11 | 8.69 | 6.76 |
| 783.02 | 0.00 | 8.69 | 109.0 | 0.918E+00 | 1.93 | 217.70 | 8.69 | 6.76 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 802.74 | 0.00 | 8.69 | 111.1 | 0.900E+00 | 1.94 | 221.25 | 8.69 | 6.75 |
| 822.47 | 0.00 | 8.69 | 113.3 | 0.883E+00 | 1.94 | 224.78 | 8.69 | 6.74 |
| 842.19 | 0.00 | 8.69 | 115.6 | 0.865E+00 | 1.95 | 228.28 | 8.69 | 6.73 |
| 861.92 | 0.00 | 8.69 | 117.9 | 0.848E+00 | 1.96 | 231.75 | 8.69 | 6.72 |
| 881.65 | 0.00 | 8.69 | 120.2 | 0.832E+00 | 1.97 | 235.19 | 8.69 | 6.71 |
| 901.37 | 0.00 | 8.69 | 122.7 | 0.815E+00 | 1.98 | 238.61 | 8.69 | 6.70 |
| 921.10 | 0.00 | 8.69 | 125.1 | 0.799E+00 | 1.99 | 242.00 | 8.69 | 6.69 |
| 940.82 | 0.00 | 8.69 | 127.7 | 0.783E+00 | 2.01 | 245.36 | 8.69 | 6.68 |
| 960.55 | 0.00 | 8.69 | 130.3 | 0.768E+00 | 2.02 | 248.70 | 8.69 | 6.67 |
| 980.27 | 0.00 | 8.69 | 132.9 | 0.752E+00 | 2.03 | 252.02 | 8.69 | 6.65 |
| 1000.00 | 0.00 | 8.69 | 135.6 | 0.737E+00 | 2.05 | 255.32 | 8.69 | 6.64 |

Cumulative travel time = 9943. sec

Simulation limit based on maximum specified distance = 1000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD241: BUOYANT AMBIENT SPREADING

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CORMIX2: Submerged Multiport Diffuser Discharges End of Prediction File

2222222222222222222222222222222222222222222222222222222222222222222222222222222

# 6

# ATTACHMENT 6

## LAKE MICHIGAN BIOMONITORING PROGRAM DATABASE AND SUMMARY REPORT

# LAKE MICHIGAN BIOMONITORING PROGRAM DATABASE AND SUMMARY REPORT

## Attachment 6 Volume II (Revised)

Prepared for:

**BP**

**Whiting Refinery, Whiting, Indiana**

Prepared by:


The **ADVENT** Group, Inc.

201 Summit View Drive, 3rd Floor

Brentwood, TN 37027


**April 3, 2002**

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## EXECUTIVE SUMMARY

A long-term biomonitoring and baseline data documentation program for Lake Michigan was initiated in 1994 by BP (formerly Amoco Oil Company) in support of the National Pollution Discharge Elimination System (NPDES) Permit Renewal Application process (ADVENT 1994, ADVENT 1998). This document reports results for samples collected from May 1995 to August 2000, which comprise the long-term biomonitoring and baseline database.

Samples were obtained from two study sites in Lake Michigan, representing (1) the location for a proposed multi-port treated water discharge (S3500) and (2) a regional Lake Michigan control site (C3501). Background biomonitoring data have been documented from physical, chemical, and biological samples collected during ice-free periods at site S3500 since May 1995. Site C3501 was established during October 1996. Sites S3500 and C3501 provide spatial and temporal reference data for southern Lake Michigan at the proposed diffuser location.

Phytoplankton, zooplankton, chlorophyll *a*, sediment, and benthos samples were collected from each site concurrent with measured water quality parameters and collection of composite water-column samples for water chemistry analyses. The two study sites, S3500 and C3501, are situated approximately 3500 feet northeast of Outfall 001 for the BP refinery in southern Lake Michigan near Whiting, IN.

Key findings from the bioassessment collections include the following:

1. **Sediment Composition**

    - The top 10 cm of sediment material at both C3501 and S3500 is 80% sand and 17% silt. Sand-sized particles dominated at all sites and was relatively homogenous (variations were about 4-5% within and between study sites).

2. **Benthic Macroinvertebrates**

    - Chironomids, Oligochaetes, snails, and clams were the only organisms collected at both sites. Aquatic worms (Oligochaeta) and Gastropods (snails; the genus *Valvata* in particular) were the most dominant organisms throughout the biomonitoring program. Early benthos collections were dominated by aquatic worms, however, from April 1997 to August 2000 this dominance shifted as snail abundance increased dramatically, and aquatic worm abundance decreased concurrently. Richness and density values indicate a patchy spatial distribution of few organisms. The benthos assemblages were relatively unchanged from year to year with the above exception noted.

3. **Phytoplankton**

    - The phytoplankton was moderately diverse exhibiting cell density values typical of oligotrophic to mildly mesotrophic lake conditions. Diatoms were the most common group, accounting for a mean of 60% of total cell abundance. With the exception of August 2000, mean total phytoplankton density was consistent with expected lake patterns. August 2000 densities were significantly higher at both sites than the database mean density and can be attributed to a large increase in diatom abundance. Taxonomic

composition, richness, and diversity values were consistent between yearly collections. Euplanktonic algae (free-floating attached diatom forms) were present in the collections, showing the importance of turbulence in re-suspending benthic algae.

4. **Zooplankton**

- The zooplankton assemblage consisted of 22 different taxa, including rotifers (Rotifera) and cladocerans and copepods (Crustacea). Zooplankton richness and density values were consistent with oligotrophic to mildly mesotrophic lake conditions. Total density values for August 2000 showed significantly higher mean densities than any previous year. Rotifers were typically the most abundant and accounted for nearly half of the total zooplankton collected.

5. **Chlorophyll *a*, Water Quality and Chemistry**

- Mean chlorophyll *a* concentration of approximately 1.27 $mg/M^3$ at each site indicated low nutrient availability at both sites. This result is consistent with the values for an oligotrophic to mild mesotrophic lake. Water quality values and water chemistry results were seasonally appropriate, reflect oligotrophic to mild mesotrophic lake conditions, and do not indicate any degradation or change in water quality since biomonitoring began. Depth profile measurements showed no stratification and indicated a complete mixing of the water column at both C3501 and S3500.

## 1.0 INTRODUCTION

BP (formerly Amoco Oil Company) completed an initial Mixing Zone Demonstration study in 1994 as a component of a National Pollutant Discharge Elimination System (NPDES) Permit Renewal Application. The Permit Renewal Application (Permit Number IN0000108) was submitted in August of 1994 to the Indiana Department of Environmental Management (IDEM) for the Whiting Refinery facility. This application included a request for a multi-port high-rate diffuser that is designed to maximize dispersion and mixing, and assure minimal exposure of discharge waters to Lake Michigan biota (ADVENT 1994). An important component of the Mixing Zone Demonstration included results of a short-term (summer 1994) biomonitoring and assessment study that indicated the BP treated effluent had no detrimental ecological effects to the biota of southern Lake Michigan.

BP initiated a long-term biomonitoring program following submittal of the NPDES Permit Renewal Application to verify the findings of the short-term study and build a baseline limnological database for the proposed multi-port diffuser site. A revised Mixing Zone Demonstration document, incorporating results of the baseline limnological database from May 1995 through September 1997, was submitted to IDEM (March 1998) to further support and update the NPDES Permit Renewal Application. This document is a second update of the 1994 Mixing Zone Demonstration document that includes the entire biomonitoring database from 1995 to 2000.

The monitoring program includes the following objectives:

- To support and augment the findings presented in the Volume II (1994 and 1998) NPDES Permit Renewal Application Mixing Zone Demonstrations.
- To document the variability of baseline ecological conditions in southern Lake Michigan and further expand the ecological database for the location of the proposed multi-port diffuser.

## 2.0 STUDY SITES

Two study sites, S3500 and C3501, were chosen to represent Lake Michigan in the region of the proposed diffuser. The study site locations were selected following a study of the area, including (1) an intensive sonar survey to record bottom topography, (2) a diver-assisted visual survey to evaluate substrate homogeneity, and (3) evaluation of diver-collected sediment samples for visual inspection for homogeneity. A general description for each study site is given below, and study site locations are shown in Figure 2-1.

In addition to sites S3500 and C3501, a third area identified as Dunes was monitored in June 1996. The Dunes study area was used to compare S3500 and C3501 to an undisturbed, pristine Lake Michigan site. See Appendix D for Dunes site sample locations, site description, sampling methods and results.

### 2.1 S3500

Site S3500 was chosen to represent Lake Michigan at the proposed diffuser location. This site was included in the Attachment 5 Bioassessment Data Summary of Volume II (ADVENT 1994), the attachment 6 Bioassessment Data Summary of Volume II (ADVENT 1998), and was

retained as a monitoring study site for the 1997-2000 collections. S3500 is located approximately 3,500 feet from BP Outfall 001 along a magnetically corrected compass heading of approximately 39° at latitude 41° 40.976' and longitude 87° 28.093' (Stoller 1995*a*). The S3500 site area is shown on Sheet 29 of National Oceanic and Atmospheric Administration (NOAA) Recreational Chart 14926 (January 20, 1990). Geographical Positioning System (GPS) coordinates show the distance to be 0.27 nautical miles (1,640 feet) from the BP intake buoy.

## 2.2 C3501

Site C3501 was established in 1996 to augment the S3500 samples and investigate the spatial variation in physical, chemical, and biological characteristics for the southern region of Lake Michigan proposed as the diffuser location. This site is located approximately 3,500 feet from BP Outfall 001 along a magnetically corrected compass bearing of approximately 18° at latitude 41° 41.149' and longitude 87° 28.349' (Stoller 1995*a*). Site C3501 is separated from S3500 by a distance of approximately 1,500 feet along a bearing of 311.5° from magnetic North. The site C3501 area is shown on Sheet 29 of NOAA Recreational Map 14926 (January 20, 1990).

## 2.3 Physical Description of General Study Area

Physical characteristics of the study area can be influenced by lake-wide patterns and shoreline-related effects. Lake-wide currents, seasonal wind patterns, thermal convection, and Coriolis forces that influence the deeper open waters of southern Lake Michigan contribute to the physical conditions at C3501 and S3500. However, in the near shore zone (up to one mile from shore) the influence from localized storms in combination with shallow waters more often affect physical conditions in the study area because of the relative close proximity to the shoreline. For example, localized storms and wind currents may induce highly variable currents and turbulence in the shallow near shore waters, but have a negligible effect on deeper lake-wide currents or stratification, which are influenced more by seasonal wind and storm patterns. Shoreline currents mainly follow the direction of the wind and in the case of localized wind blowing towards the shore will deflect to follow the shore in 28-30 feet of water. This region is in close proximity to the shoreline and reflects at best a flooded beach. Winds and shoreline currents are likely more pronounced at the study site than for the outer near shore zone of southern Lake Michigan.

Wind and current at the study area typically result in wave turbulence to the lake bottom and promote complete mixing throughout the water column at sites C3501 and S3500. The study site bottom is flat, with sediment dominated by small-grain sand and some silt that is easily disturbed and re-suspended into the water column. Sediment material suspended in the water column has resulted in underwater visibility problems and low Secchi disk depths during and immediately following periods of moderate to strong local winds. Stratification of the water column or formation of a thermocline is short lived, if present. Measurements at the study sites, even during calm periods, have shown uniform temperature, conductivity, and dissolved oxygen profiles indicating complete mixing of the water column.

The trophic status of southern Lake Michigan has been classified as mesotrophic (Great Lakes Water Quality Board, 1977). This trophic status is intermediate between an oligotrophic (clear water, low nutrient concentration, and low biological productivity) and eutrophic (nutrient rich and highly productive) designation. Measured densities and community composition for phytoplankton and zooplankton; chlorophyll *a* concentration; and water quality and chemistry parameters from the water column at the study sites coincide with the mesotrophic designation.

## 3.0 METHODS

As part of the long-term Lake Michigan biomonitoring program, the following collections were made at both C3501 and S3500:

- Sediment;
- Benthic macroinvertebrates;
- Phytoplankton;
- Zooplankton;
- Chlorophyll *a*;
- Water quality; and,
- Water chemistry.

### 3.1 Sediment

Sediment was collected at C3501 and S3500 with the aid of SCUBA using a hand-held coring device constructed of 2 inch diameter by 8 inch long polyvinyl chloride (PVC) pipe with removable caps. Open core tubes were pushed into the sediment to a depth of 4 inches (marked on the core tube), and the exposed end of the tube was capped. The tube containing sediment was slowly removed and immediately capped on the bottom before sediment material was lost. Two sediment cores were taken from established grid positions and maintained as individual replicates.

Grid positions were configured using depth contours and specifications for the proposed multi-port diffuser mixing zone. The grid approach optimized sample collection for a maximum spatial area. The grid configuration used a benchmark point "B-0" that represented the longitudinal center of the 90-foot-long diffuser. Two 750-foot-long transects (B+ and B-) were established at right angles to the longitudinal axis of the diffuser, and a third (D+) as an extension of the diffuser axis (Figure 3-1). Sediment sample points were selected at 0, 75, 125, 250, 500, and 750 feet from the center point of the diffuser (zero position being common to all three transects). Four additional 75-foot-long transects (A+, A-, C+, and C-) were established from each end of the proposed diffuser location and perpendicular to the diffuser axis. Sediment sample points were selected at 0, 25, and 75 feet from the diffuser along these four transects (site D+25 being common to zero position of the A+ and A- transects). A total of 28 sample positions were configured. Figure 3-1 shows, as an inset, the general location of S3500, the overall configuration of the sampling position matrix, and detailed sampling positions surrounding the proposed diffuser location.

A sediment characterization study was conducted at S3500 during November 1995 when all 28 sample positions were used for sediment collection and analyses. A total of 72 sediment samples were collected at S3500 to evaluate sediment composition variation on three spatial scales: 0-6 inches apart, 3-6 feet apart and 25 feet apart, or greater. Sediment samples collected to evaluate variation at a 2 inch distance (5 cm) consisted of three replicate cores taken adjacent (i.e., PVC pipe touching) to each other. These adjacent cores were identified as

replicates A, B, and C. Samples collected to evaluate variation on a scale of 3-6 feet apart (1.8 meters) consisted of three replicate cores (separated by approximately 3 feet each) taken at arm-length distance in random directions from the adjacent samples. These samples were identified as replicates D, E, and F. Four of 28 sample positions were selected for collecting replicates A through F. Two replicate sediment samples collected approximately 1 meter apart were obtained at all 24 remaining sample positions shown in Figure 3-1. These samples were used to evaluate composition variability at 25 feet or greater distance, and to maximize spatial sampling for sediment composition analyses.

Statistical tests were used to independently determine significance for differences among the four intensively sampled sites based on replicates A, B, and C (adjacent samples) and based on replicates D, E, and F (3-6 foot samples). Results of *t*-tests for statistical differences in mean percent composition of sand, silt, clay, and gravel between the 0-2 inch samples and the 3-6 feet samples showed the following:

1. No statistical differences were found among the four sampling positions (A-25, B0, C+25 and B+750) for mean percent composition of sand, silt, clay, and gravel based on sediment samples representing 6 square inches (98 $cm^2$) from each sample location.

2. No statistical differences were found among the four sampling positions for mean percent composition of sand, silt, clay, and gravel based on sediment samples representing approximately 6 square feet (0.55 $m^2$) from each sample location.

3. No statistical differences were observed in mean percent composition of sand, silt, clay, and gravel between samples representing 6 square inches (replicates A, B, and C) and samples representing 6 square feet (replicates D, E, and F) from the four identical sample locations.

4. Sample data for replicates A through F collected from sites a-25, B0, C+25, and B+750 may be combined to represent an area of approximately $7.5 \times 10^4$ square feet to further refine the particle size composition characteristics for the sample site.

5. Statistical test results showed no significant differences in mean percent composition for each of the particle size categories between the area represented by the $7.5 \times 10^4$ square foot area (24 sediment samples) and the remaining sample positions at S3500 (48 sediment samples).

Based on the above findings, a description for the sediment composition was generated using the entire suite of sediment samples collected 3-6 feet apart from sites A-25, B0, C+25, and B+750, and all samples from the B- and B+ transect (34 sediment samples). Sediment samples collected from the D+ transect were not analyzed, and thus, not used to characterize the sediment composition at S3500.

The sediment survey indicated the number of sediment samples could be reduced without loss of information due to the relative homogeneity of the sediment. However, a large spatial area was needed to adequately characterize the benthos community assemblage. During June 1996, sediment was collected from S3500 at 75, 125, 250, 500 and 750 feet along the B+, B-, and D transects and sites A0, B0, and C0 for a total of 18 sample positions. This configuration of sites resulted in a sampling area of approximately 12.9 acres (5.2 ha) spanning a distance of 1500 feet. This same sampling scheme of 18 sample positions was repeated at C3501 and

S3500 during October 1996, April 1997, October 1997, and August 1998. In August 1999, samples were taken at ten locations at 75, 125, and 250 feet along the B+, B-, and D transects and at site B0. Only three locations at 25 feet along the B+, B-, and D transects were used to collect samples in August 2000.

The ADVENT Group, Inc. (Brentwood, TN) analyzed sediment material for particle size distribution following benthic organism analyses and receipt of sediment material from Commonwealth Biomonitoring. Sediment material from each sample position was completely mixed then analyzed using ASTM Method D421 (sieve method) for particles 75 microns (µm) and larger, and ASTM Method D422-63 (hydrometer) for silts and clays. Size determinations were based on the Wentworth-Krumbein-Udden size classification for sediment grains.

Descriptive statistics, including the arithmetic mean and standard deviation were derived for gravel, sand, silt, and clay fractions determined from the sediment analyses. Site-specific sediment data were compared to the minimum, mean, and maximum values between sites and the database (Stoller 1995b, Stoller 1996a, Schafer 1997, Schafer 1998a).

### 3.2 Benthos

Benthic macroinvertebrate collection methods were the same as for sediment described above. Additional core samples were collected for benthos analysis only from S3500 during November 1995 at positions B+75, B-75, B+250, B-250, B+750, D+75 and D+500 in order to adequately represent the sampling area spatially. The November 1995 sampling scheme was altered to include 18 sediment sample positions (Figure 3-1) in subsequent sampling periods to verify the 1995 results that indicated a highly variable and patchy distribution for the benthos. Benthic macroinvertebrate core samples were obtained from all 18 sampling positions during June 1996, which further expanded the spatial range of the benthos samples. Some June 1996 benthos samples contained one or zero organisms, and extrapolation of low density to commonly used units, such as number of organisms per meter, would be inappropriate and inaccurate. To better account for the variation in patchiness for the benthos, two sediment core samples were collected approximately 1 meter apart from each of the 18 sample positions and used for benthos evaluation during October 1996, April 1997, October 1997, and August 1998. Benthos sampling locations conformed to that of the sediment in both August 1999 and 2000. This sampling scheme of 36 benthos samples was conducted at both sites. Two samples were retained from each grid position to increase the sampled volume to approximately 410 $cm^3$, reducing the number of cores with zero organisms and maximizing sampling efficiency. Sediment material from each core tube was transferred to a 750 mL plastic storage container upon return to the research vessel. A 3 mL aliquot of 3% formalin solution was added to all sediment samples to preserve benthos organisms prior to shipment to Commonwealth Biomonitoring, Inc. (Indianapolis, IN) for organism identification and enumeration.

Descriptive community structure parameters related to taxonomic richness, organism density, and diversity were determined for the benthic macroinvertebrate data. Density values are expressed as the number of organisms per square meter (organisms/$m^2$) which best conforms to convention. However, density values should be cautiously interpreted due to the small sample size and the extremely patchy and variable nature of benthic macroinvertebrate distribution in Lake Michigan. Summary statistics were used to show differences in composition of the major taxonomic groups, and statistical tests were used to determine the level of significance for richness and density between sites S3500 and C3501. In addition, sample means were compared to the overall benthic macroinvertebrate database.

### 3.3 Phytoplankton

A depth-integrated composite of the water column collected at position "B0" was used to obtain grab samples for phytoplankton analyses. The composite water sample was retained in a large bucket into which water was pumped from a submersible pump attached to a hose that was slowly lowered and raised from the water surface to 0.5 m above the bottom. The compositing bucket contained sufficient volume for grab samples consisting of (a) a single 1.0 liter (L) plastic bottle for phytoplankton, (b) two 1.0 L amber plastic bottles for chlorophyll *a* analyses, (c) two 1.0 L plastic amber bottles for phytoplankton biomass determination (1998 and 1999), and (d) a full set of water chemistry sample bottles. The water column was again composited for each replicate sample. Three replicate samples were collected at both S3500 and C3501 for the years 1995 through 1999.

In contrast to the above methodology, August 2000 phytoplankton samples were collected by grab samples from mid-depth of the water column. Long-term biomonitoring studies at the S3500 and C3501 study sites have consistently shown complete mixing of the water column. Wind conditions at the time of sampling promoted mixing, and *in situ* water quality measurements indicated that mid-depth samples likely represent the entire water column. Mid-depth level was determined by depth gauge and samples were obtained by SCUBA diver. Plastic 1.0 L sample bottles were carried to the mid-depth level (12 feet) prior to removing the sample bottle top. Three replicate 1.0 L phytoplankton samples were collected at both S3500 and C3501 for phytoplankton biovolume determination.

Phytoplankton identification samples were preserved with approximately 1.0 mL Lugol's preservative and stored on ice until transport to ADVENT for analyses. Phytoplankton samples were concentrated to a measured volume (near 10 mL) by removing excess water following a 24 hour minimum settling period. Identification and enumeration of non-diatom algal forms were then conducted with the aid of a Palmer-Maloney counting chamber (volume 0.1 mL) using a Wild compound microscope at 400X and 500X total magnification.

Phytoplankton biomass samples were immediately stored on ice without preservation following collection and shipped overnight to Chadwick & Associates, Inc. (Littleton, CO.). Phytoplankton biomass (milligrams per cubic meter [$mg/M^3$]) was determined by weight of the sample residue following filtration through a pre-weighed 0.45 µm membrane filter. In August 2000, however, phytoplankton biovolume was measured. Phytoplankton biovolume (cubic micrometers per milliliter [$\mu m^3/mL$]) measurements are convenient in that they can be converted to either an estimate of wet weight biomass (g/mL) by a factor of 1.03 (based on the specific gravity of algae), or to an estimate of organic carbon (in gm/mL) by a factor of 0.06. Biovolume measurements also account for weight added by preservation in Lugol's solution.

Diatom cells were cleaned by organic digestion with hydrogen peroxide catalyzed by potassium dichromate crystals followed by a complete removal of chemical residue by replacement with de-ionized water. A suspension of cleaned diatoms in de-ionized water was allowed to air dry on a microscope cover slip prior to permanent mounting on a microscope slide using high refractive index mounting media. Diatom frustule identification and enumeration was conducted at 1000X to 1200X total magnification using oil immersion sub-stage condenser and objectives. Three permanent diatom slides were prepared from each replicate phytoplankton sample. A minimum of 600 diatom frustules were identified and counted per replicate. Diatoms were enumerated as a group during the non-diatom analyses to estimate diatom density.

Phytoplankton descriptive statistics, representing total cell density, diatom cell density, algae group relative percent abundance, diatom assemblage diversity, and diatom richness were determined for each replicate and used to compare S3500 and C3501. Biomass estimates of the phytoplankton collections were determined for samples collected in late summer 1998 and 1999. Biovolume estimates were determined for phytoplankton samples collected in 2000. A baseline biomonitoring database reflecting the near shore area of southern Lake Michigan selected for the diffuser site consists of the S3500 and C3501 sample results from May 1995 to August 2000.

### 3.4 Zooplankton

Zooplankton samples were collected from the "B0" position of the sampling grid by a vertical net tow. The cylindrical plankton net of 80 µm mesh with a 0.5 m diameter opening, and a length to opening ratio of 5.1 to 1, was equipped with a removable 80 µm mesh plankton bucket that concentrated collected organisms and allowed for easy transfer to sample containers. Vertical tows were made by lowering the net to approximately 0.5 m above the lake bottom followed by slow retrieval to the water surface. The contents of the plankton net were washed into the plankton bucket and transferred to a 250 mL plastic storage bottle. A total of three replicate samples consisting of a single vertical tow of 20 feet per replicate were collected at S3500 and C3501. Zooplankton samples were narcotized with club soda for no less than 5 minutes prior to preservation with 3% formalin. Samples were stored on ice and shipped to Chadwick & Associates (Littleton, CO) for analyses. Zooplankton samples were sub-sampled for organism identification and enumeration purposes, and the entire sample filtered through an 80 µm mesh pre-weighed screen to determine biomass. Enumeration data was used to determine zooplankton density expressed as number of organisms per cubic meter (No./$M^3$). Zooplankton biomass (mg/$M^3$) was determined by weight of the zooplankton residue following a 24 hour minimum drying period at 105 °C for each of three consecutive identical weights. Biomass was reported in 1998, 1999, and 2000. Additionally, zooplankton biovolume (µ$m^3$/mL) was measured in 1998, 1999, and 2000.

Zooplankton species group composition and community descriptive statistics were determined for the zooplankton assemblage and used to compare sites S3500 and C3501. Sample means were compared to the database for samples collected from May 1995 to August 2000.

### 3.5 Chlorophyll *a*

Chlorophyll *a* samples were obtained from a composite of the water column at position "B0" as described for phytoplankton in Section 3.3 above. A total of 2 liters per replicate chlorophyll *a* sample were retained to ensure sufficient residue was available for analysis because of the oligotrophic to mesotrophic nature of Lake Michigan. Five replicate grab samples for chlorophyll *a* were retained for analyses during May 1995 for both sites. Six replicate samples were collected from S3500 during June 1996. Three replicate chlorophyll *a* samples were collected from C3501 and S3500 between October 1996 and August 2000. Chlorophyll *a* samples were immediately fixed with a suspension of magnesium carbonate and stored on ice after collection. Chlorophyll *a* samples were packed with ice and shipped for overnight delivery to Chadwick & Associates, Inc. (Littleton, CO) for analyses.

Chlorophyll *a* concentrations were determined using spectrophotometric methods following filtration and 24 hour acetone extraction (method 10200[H], APHA). Optical density readings of

750 nanometers (nm) were used for background turbidity correction and 663 nm was used for calculation of chlorophyll *a* in milligrams per cubic meter (mg/M$^3$).

### 3.6 *In situ* Water Quality

A Series III multi-parameter probe and transmitter (Hydrolab, Inc.) was used to determine depth profiles for pH (s.u.), conductivity (μmhos/cm), water temperature (°C), and dissolved oxygen (mg/L). Determinations were made at each site from sample point B0 at 3 foot (1.1 meter) intervals from the lake bottom to the surface.

### 3.7 Water Chemistry

Water chemistry samples were obtained from a composite of the water column at position B0 as described for phytoplankton in Section 3.3. One composite water column sample was analyzed for water chemistry parameters at both C3501 and S3500 during May 1995. Two replicate samples were retained for water chemistry analyses at S3500 during June 1996. Two replicate water chemistry samples were collected and averaged from C3501, and one water chemistry sample was retained for analysis from S3500 during October 1996. One water chemistry sample was collected for analysis at each of C3501 and S3500 during April 1997, September and October 1997, August 1998, and August 1999. One mid-depth grab sample was taken in August 2000. All water chemistry sample containers were stored in the dark on ice and shipped for overnight delivery to ACZ Laboratories (Steamboat Springs, CO).

### 3.8 Data Analyses

Mean values, standard deviation (s.d.), or 25$^{th}$ and 75$^{th}$ percentile limits were determined for sediment composition categories and selected numerical and community structure descriptive statistics. All results were also compared to the existing database compiled for the study area that includes information from previous sediment characterization studies (Stoller 1995a) and biomonitoring studies (Stoller 1995b, 1996a, Schafer 1997). Comparisons of mean density, species richness, and community composition descriptive parameters for phytoplankton, zooplankton, and benthos samples collected were also compared to the existing database complied for the study area. Box plots indicate the median value as well as the 25$^{th}$ and 75$^{th}$ percentiles of the data. Statistical significance for differences between mean density or richness values was determined by using the appropriate form of the *t*-test. Statistical tests were not used when graphical representation of the data clearly showed no difference in results for the study sites and the range for the existing database.

## 4.0 RESULTS

### 4.1 Sediment Composition

Sediments from the sample sites can be described as fine-grained sand with silts that exhibit an even spatial distribution. Analyses indicated that sand-sized particles (4.74 millimeters [mm] to 0.75 mm diameter) were the dominant component of the lake bottom material. Sand particles accounted for a mean composition of 80% with an observed range from 49% to 94%. Silt particles (0.074 mm to 0.005 mm diameter) were the next most common particle size and accounted for 17% of the sediment composition, ranging from 3% to 50%. Clay particles (less than 0.005 mm diameter) were a minor component of the sediment, consisting of 2% of the sediment, and ranged from 0% to 19%. Gravel-sized particles occurred intermittently and were observed in 112 of 228 sediment samples. Gravel exhibited a mean composition of less than

1% and a maximum of 11.4%. Figures 4-1a through 4-1d show the sediment composition data, including the database mean percent abundance value and the database minimum and maximum for each particle size category. The percent composition data for each sediment sample is presented in Appendix A.

Table 4-1 shows the mean, minimum, and maximum percent abundance of each particle size category for each site as well as the database mean.

## 4.2 Benthos

Benthic macroinvertebrate analyses consistently indicated an assemblage of low richness, density, and diversity with an overall patchy spatial distribution. A total of 323 benthos core samples were analyzed from May 1995 to August 2000. The most abundant organisms collected were Oligochaetes (aquatic worms) and Gastropods (snails). These two classes accounted for 62% of total organisms sampled. Benthos community composition descriptive parameters are shown in Table 4-2.

Aquatic worms as a group accounted for 37.5% of the organisms at S3500 and 42.4% of the organisms at C3501 (39.8% overall). Snail abundance averaged 34.6% of the total organisms collected at both sites, as compared to both Pelycepoda (clams and mussels; 9.9%) and Chironomids (aquatic flies; 14.5%). Figure 4-2 shows the site-specific benthos group relative composition for the database from 1995 to 2000. Additionally, Figures 4-3a and b graphically indicate the spring and late summer variation among the groups identified.

Sample richness values ranged from 0 to 12 taxa with mean richness values of 4 taxa at both S3500 and C3501. Figure 4-4 shows the site-specific minimum, mean, and maximum richness values in comparison to the database mean, minimum, and maximum richness for samples collected from 1995-2000. Richness values within this range have consistently been observed in samples from S3500 and C3501 (Figure 4-4).

Total density values for the samples ranged from 0 to 3440 organisms per square meter (orgs/m$^2$) with a mean of 544 orgs/m$^2$ at S3500 and 413 orgs/m$^2$ at C3501 (Table 4-2). The wide range in organism density and variability of the per-sample assemblage indicates a patchy distribution of the benthos at S3500 and C3501. Minimum benthos density was zero. Figure 4-5 graphically presents the benthos data for both S3500 and C3501, allowing for inter-site comparison and comparison to the benthos database.

Benthos community diversity values measured by the Shannon-Wiener Diversity Index and Simpson's Diversity Index indicated low community diversity. Diversity values ranged from 0.0 to 2.2 (Shannon-Wiener Index) and 0.0 to 1.0 (Simpson's Index) (Table 4-2). It is important to note, however, that the Shannon-Wiener Diversity Index is not accurate when richness values are below 10. Mean diversity values for the database are shown in Table 4-2. Figure 4-6 shows the minimum, maximum, and mean Simpson's Diversity Index values for S3500 and C3501.

Appendix B lists the organisms found at each sample site during the 1995-2000 biomonitoring program.

## 4.3 Phytoplankton

The phytoplankton was moderately diverse and exhibited cell density values typical for oligotrophic to mildly mesotrophic lake conditions. Seven major groups of algae were

represented and include the diatoms (Bacillariophyta), green algae (Chlorophyta), blue-green algae (Cyanophyta), yellow-green algae (Chrysophyta), euglenoids (Euglenophyta), dinoflagellates (Pyrrhophyta), and cryptomonads (Cryptophyta). Diatoms were the most common group, which accounted for a mean of 58.4% and a range of 27.9% to 92.1% of total cell abundance. Among the soft algae groups (non-diatom taxa), green algae were the next most abundant with a mean cell abundance of 15.7% followed by the yellow-green algae (13.0%), dinoflagellates (3.2%), and the blue-green algae (3.9%). Table 4-3 shows the phytoplankton community characteristics for Lake Michigan from 1995 through 2000. In addition, Figure 4-7 provides the site-specific percent abundance for each major phytoplankton group. A taxonomic listing for the soft algae and diatoms is presented in Appendix B.

Richness for the soft algae ranged from 6 to 21 taxa with a mean of 13 taxa from a total of 77 taxa identified (Table 4-3). The yellow-green algae *Dinobryon sociale* variety *americum*, the green algae complex *Chlorella/Chlorococcum humicola* and *Chlamydomonas* sp., and the dinoflagellate *Chroomonas nordstedtii*, were the most abundant soft algae forms and demonstrated seasonal succession in the lake. *Dinobryon* and *Chlorella/Chlorococcum* were more abundant during the spring and *Chlamydomonas* and *Chroomonas* tended to be more abundant during the fall sampling periods.

Diatom richness ranged from 17 to 55 taxa with a mean of 37 taxa from a total of 168 taxa identified (Table 4-3). Figure 4-8 shows the site-specific diatom richness values compared to the overall database mean, minimum, and maximum. Diatom taxa commonly encountered include *Asterionella formosa*, *Diatoma tenuis* and the variety *elongatum*, several varieties of *Fragilaria capucina* and *Fragilaria construens*, and species of the genera *Nitzschia*, *Stephanodiscus*, and *Cyclotella*.

Total phytoplankton density ranged from 244 to 7,432 cells per milliliter (cells/mL) with a mean of 1,294 cells/mL. Figure 4-9 shows the site-specific total phytoplankton density values for Lake Michigan from 1995-2000. Total phytoplankton density, or standing crop, was relatively consistent with the expected lake patterns throughout the biomonitoring program with the exception of 1997. The 1997 standing crop was abnormally low and did not exhibit the expected peak during spring for algal standing crop. Figure 4-10 shows the 1997 phytoplankton data as compared to a typical lake phytoplankton standing crop pattern represented by the 1998 sample year.

Phytoplankton biomass results ranged from 150 to 6,725 mg/M$^3$, with a mean of 2,930 mg/M$^3$. Although mean phytoplankton biomass was higher at C3501 (3,013 mg/M$^3$) than at S3500 (2,848 mg/M$^3$), site-specific biomass values fell within the same range in both 1998 and 1999. Additionally, phytoplankton biovolume averaged 1,970,889 µm$^3$/mL in August 2000, ranging from 1,092,885 to 2,446,341 µm$^3$/mL. This level of variability is not uncommon when measuring phytoplankton biovolume. Site-specific phytoplankton biomass and biovolume values are shown as compared to the database values in Table 4-3. Appendix B provides a list of all measured biomass and biovolume values.

Soft algae samples were never as diverse as the diatom assemblage in contrast to what the soft algae species list in Appendix B may suggest. However, it is more common to focus on the diatom assemblage diversity since diatoms represent the major component of the phytoplankton. The diversity of the diatom assemblage was always greater than that of the soft algae. The diatom assemblage mean value for Simpson's Diversity was 0.11 with a range of 0.25 depicting the lowest diversity to 0.04 for the highest diversity. Shannon-Wiener Diversity values for the diatom assemblage ranged from 1.76 to 3.40 with a mean value of 2.71. The

diatom assemblage diversity values are representative of moderate to high diversity for the number of taxa observed. Figure 4-11 depicts the site-specific Shannon-Wiener Diversity Index data and the mean value for the entire diatom assemblage.

The temporal distribution of mean phytoplankton abundance for the major algae groups by sampling period is shown in Figure 4-12a and 4-12b.

## 4.4 Zooplankton

The zooplankton assemblage consisted of 22 different taxa, which included rotifers (Rotifera) and cladocerans and copepods that represented the Crustacea. Zooplankton richness, diversity, and total density values, with the exception of the August 2000 samples, were consistent with oligotrophic to mildly mesotrophic lake conditions. Rotifers were typically most abundant and accounted for a mean of 46.3% and range of 0% to 100% of total zooplankton abundance. Copepods accounted for a mean of 39.7% of total abundance and cladocerans for 14.2%. Table 4-4 shows the Lake Michigan zooplankton community characteristics from 1995-2000. Mean richness was 5 taxa with a range of 1 to 10 taxa. Actual zooplankton richness may be slightly higher because the determination of richness values included immature specimens that could not be classified. However, based on the mature specimens in the samples at the time of collection, any increase in taxa from among the immature life stages would be minimal. Figure 4-13 depicts the site-specific zooplankton richness values. Appendix B lists the zooplankton taxa and abundance data for all the collections.

Zooplankton density ranged from a low of 2 organisms to a high of 131,785 organisms per cubic meter (No./$M^3$) with a mean density of 11,463 No./$M^3$. The assemblage was highly variable with respect to abundance within each group between sample replicates. Total density values among replicates were usually similar although typically were higher during late summer and fall. Early summer and spring samples contained the highest number of copepod nauplii and copepodids that could not be identified to genus. Figure 4-14a and b show the site-specific zooplankton mean density values for 1995-1999 and 1995-2000 respectively.

A review of Figure 4-14b indicates that the composition of the August 2000 zooplankton assemblage includes nearly a 30-fold increase in zooplankton mean density as compared to the 1995-1999 sampling period. The significantly higher zooplankton density levels can be attributed to a greater density of rotifers, and to a lesser degree cladoceran organisms, while the density of copepods was similar to the database. The high density of zooplankton for the year 2000 coincided with a 30-year low-lake level.

Zooplankton biomass values ranged from 0.01 to 155.17 mg/$M^3$ with a mean of 19.13 mg/$M^3$ from June 1998 to August 2000 (Table 4-4). Zooplankton exhibited the highest biomass values at both sites during August 1999, although the greatest zooplankton densities were found in August 2000. Site-specific zooplankton mean densities were not statistically different.

Zooplankton biovolume averaged 307.44 $\mu m^3$/mL from June 1998 to August 2000 and ranged from 0.36 to 2,949.43 $\mu m^3$/mL. Mean zooplankton biovolume was higher at C3501 than at S3500 (Table 4-3). Site-specific biovolumes are shown in Appendix B.

Zooplankton diversity values were determined with the inclusion of immature specimens that could not be classified because it was believed the immature specimens likely represented a pulse bloom of a single taxon within the organism group. Simpson's Diversity Index values ranged from 0.19 to 1.00 on a scale of 1.00 for no diversity to 0.00 for maximum diversity. The

mean Simpson's Diversity Index value for the zooplankton was 0.58. Shannon-Wiener Diversity Index values ranged from 0.00, depicting an assemblage with no diversity, to a value of 1.73 depicting moderate diversity for the number of taxa typically represented by the zooplankton. Again, it is important to note that the Shannon-Wiener Diversity Index is not accurate when richness values are below 10. Abundance values of nauplii copepods for all samples collected during April 1997 were well in excess of abundance values for other organisms and abundance values of nauplii observed in previous samples from the study sites. As a result, Simpson's Diversity and Shannon-Wiener Diversity values for the April 1997 zooplankton samples reflected the lowest diversity measures.

## 4.5 Chlorophyll *a*

Chlorophyll *a* concentrations ranged from 0.11 to 4.27 mg/M$^3$ with a mean value of 1.27 mg/M$^3$ (Figure 4-15). The mean concentration is consistent with oligotrophic to mildly mesotrophic lake conditions and the phytoplankton and zooplankton samples collected from the study sites. It is important to note that the chlorophyll *a* concentrations from the study sites are expressed by convention as mg/M$^3$, and two liters of sample water per replicate were necessary to achieve a reliable analytical result. These two factors provide further evidence of the oligotrophic nature of the study sites. Appendix C lists the chlorophyll *a* concentration data for each study site and sampling period.

## 4.6 *In situ* Water Quality

Field determined water quality parameters indicate that complete mixing of the water column occurs at C3501 and S3500. Determinations of dissolved oxygen show a profile of saturation or near saturation from the surface to the bottom. Differences in conductivity determinations from the surface to the bottom were absent or negligible. Temperature differences between the surface water and water at the lake sediment surface were typically less than two degrees (°C) and attributable to warming effects of ambient air near the top of the water column. *In situ* water quality measurements are presented in Appendix C. Table 4-5 is a summary of the field-determined water quality and shows the mean, minimum, and maximum values by depth for each of the parameters measured.

## 4.7 Water Chemistry

Water chemistry values determined by laboratory analyses for samples collected from the study sites are within values expected for southern Lake Michigan. Nitrogen and phosphorus related analytes exhibited some variability at concentrations near or below analytical detection limits and are consistent with oligotrophic to mild mesotrophic nutrient conditions. Concentrations for the major nitrogen and phosphorus related nutrients were generally less than 0.5 mg/L. Additionally, concentrations of major ions and dissolved constituents are consistent with oligotrophic to mild mesotrophic lake conditions. A summary table of mean, minimum, and maximum values for the water chemistry analytes and chlorophyll *a* concentrations is presented in Table 4-6. Water chemistry results from water samples collected from a composite of the water column at each sample site are presented in Appendix C.

## 5.0 CONCLUSIONS

### 5.1 Sediment Composition

The composition of the top 10 cm of sediment material at C3501 and S3500 consists of approximately 80% sand and 17% silt coupled with minor contributions of gravel and clay (Table 4-1). Particle size distribution shows a 4-5% variation among same-site samples and between study locations which indicates a patchy distribution with respect to the presence of gravel and clay. Temporal changes in overall sediment composition among all sampling periods were not observed for either S3500 or C3501. The sediment information supports a characterization of the study area as a large flat zone of unconsolidated sand and silt conducive to disturbed surface materials and rippled surface topography with little to no slope in 28-30 feet of water.

### 5.2 Benthos

The benthic macroinvertebrate community (organisms living on and in the sediments) at C3501 and S3500 is highly variable and patchy with respect to spatial and temporal measures. The uniform, sandy bottom composition and constant disturbance at the sediment surface from currents and wave action create an unstable and harsh habitat. Therefore, the benthic organisms are subjected to continuous habitat disruption and abrasion from the bottom material. Benthos sampling has found midge larvae (Chironomidae), aquatic worms (Oligochaeta), snails (Gastropoda), and small clams (Pelycepoda), but little else. The exotic Zebra mussel (*Dreissena polymorpha*) has been infrequently collected, and when found, the sample typically included an attachment site such as gravel or buried wood debris.

Two notable changes in benthos community composition have taken place over the 6 year study. First, snail density was substantially increased during the April 1997 sampling period, and their densities have continued to rise. In both August 1999 and 2000, snails (best represented by the genus *Valvata*) accounted for roughly 80% of the benthic organisms at both sites, as compared to comprising approximately 43% of the organisms in 1998 and less than 15% before April 1997. In contrast, aquatic worms have continually decreased in abundance since 1995, in which they constituted approximately 61% of the benthos community. In August 2000, aquatic worms accounted for only 16% of the organisms at S3500 and 7% at C3501. With the above exceptions noted, taxonomic composition and low richness and density values were consistent among all collections.

Lastly, it is important to note that the genera *Harnischia*, *Tanytarsus*, and *Procladius* of aquatic fly (Chironomidae), typically found in clean water and unpolluted sediment habitats, were observed in core benthos samples collected during late summer 1998 (Schafer 1999). At that time, these genera were proposed as possible site-specific indicator taxa, but they have not been observed in any subsequent collections. However, a shift away from these proposed indicator taxa and towards a dominance of snails does not necessarily indicate a recent degradation of the sediments. Sampling variability in a highly patchy distribution of organisms, combined with the turbulence-disturbed sediment surface and a sediment composition dominated by sand, can account for an absence of soft-bodied Chironomidae in the samples.

### 5.3 Phytoplankton

Diatoms dominated the phytoplankton assemblage. Taxonomic composition, richness, and measures of diversity for non-diatom and diatom components were consistent for all phytoplankton collections. However, mean phytoplankton total density values at C3501 and

S3500 for August 2000 were statistically greater than the database mean phytoplankton density. A greater abundance of the diatom component accounted for this overall increase in total phytoplankton density. The diatom assemblage exhibit higher diversity values than either benthos or zooplankton because of their greater richness values and the large number of taxa with similar abundance.

Planktonic algae dominated the phytoplankton assemblage. Common planktonic algae included centric diatom genera (*Cyclotella* and *Stephanodiscus*) and select species of chain-forming and colonial diatoms (*Asterionella, Fragilaria* and *Synedra*). These taxa were common in previous collections from the study sites and their dominance patterns correspond with typical Lake Michigan seasonal succession (Barbiero and Tuchman 2000). The presence of euplanktonic taxa in the assemblage provides evidence that turbulence in the water column is the likely mechanism for re-suspension of benthic algae into the plankton. However, in the near-shore region of the study sites it is possible that inflow from local streams and runoff can also introduce euplanktonic taxa.

Spring and fall phytoplankton abundance and species composition for the S3500 and C3501 samples generally correspond to expected seasonal patterns in the near shore and more akin to deeper waters. A general successional pattern for stratified lakes shows phytoplankton numbers to increase in spring due to nutrient replenishment from spring overturn, warmer temperatures, and longer daylight hours. Diatoms tend to dominate the spring assemblage. The total phytoplankton standing crop decreases during summer, but can show a relative increase due to blue-green algae in late summer until fall overturn. The fall period is characterized by a second pulse in diatom biomass before a general decrease in total phytoplankton standing crop during the winter ice season. During winter, dominant forms generally include cryptomonads, mobile chrysophytes, and diatoms.

### 5.4 Zooplankton

Zooplankton samples were dominated by rotifers, but also included species of copepods and cladocerans. All organisms identified were commonly observed throughout the biomonitoring program. Zooplankton community structure data is highly variable with respect to composition and abundance because of the patchy distribution of the communities and relatively immediate response to changes in environmental triggers such as algae blooms, temperature, light, and/or chemical variations. Samples that contain obvious effects of short-term reproductive events are typical and may account for the significant increase in rotifer organisms in many samples. For example, in September/October 1997 the number of copepodids and crustacea nauplii accounted for a mean of approximately 56% of the zooplankton organisms at both sites (Stoller 1997), while rotifers dominated the assemblages in October 1996, August 1998, August 1999, and August 2000 (Schafer 1998a, Schafer 1999a, Shepherd Miller 2000).

Variability in zooplankton richness and density was expected because of the many factors (currents, temperature, light, food availability, and predation) that influence zooplankton distribution and periods of reproduction as mentioned. Because of the highly variable nature of zooplankton communities, especially in a physically turbulent habitat such as present at the sampling locations, the collection methods and analyses used here focus on the overall zooplankton assemblage. This approach maximizes the ability to detect composition differences at two locations at any one time.

### 5.5 Chlorophyll *a*, *in situ* Water Quality, and Water Chemistry

The chlorophyll *a* data are consistent with the water chemistry results and indicate low nutrient availability and oligotrophic lake conditions. Field-determined water quality parameters indicate that complete mixing of the water column occurs at C3501 and S3500. Determinations of dissolved oxygen show profile of saturation or near saturation from the surface to the bottom. Differences in conductivity determinations from the surface to the bottom were absent or negligible. Temperature differences between the surface water and water at the lake sediment surface were typically less than two degrees (°C) and attributable to warming effects of ambient air near the top of the water column.

Water chemistry values determined by laboratory analyses for samples collected from the study sites are within values expected for southern Lake Michigan. Nitrogen and phosphorus related analytes exhibited some variability at concentrations near or below analytical detection limits indicating oligotrophic to mild mesotrophic nutrient conditions. Laboratory results agree with the field-measured water quality data and indicate clear, slightly alkaline waters with low to moderate hardness and low nutrient availability.

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# Tables

## TABLE 4-1. LAKE MICHIGAN SEDIMENT SUMMARY

| Substrate | Units | C3501 Min. | C3501 Max. | C3501 Mean | S3500 Min. | S3500 Max. | S3500 Mean | Database Mean [1] |
|---|---|---|---|---|---|---|---|---|
| Clay | Percent | 0.0 | 18.7 | 2.3 | 0.4 | 7.9 | 2.6 | 2.5 |
| Gravel | Percent | 0.0 | 6.8 | 0.6 | 0.0 | 11.4 | 0.3 | 0.4 |
| Sand | Percent | 49.1 | 94.3 | 79.7 | 67.2 | 93.5 | 80.2 | 80.0 |
| Silt | Percent | 2.9 | 50.3 | 17.7 | 3.4 | 30.8 | 16.8 | 17.2 |

1 Database mean values encompass data collected at C3501 and S3500 from November 1995 to August 2000.

**TABLE 4-2. LAKE MICHIGAN BENTHOS SUMMARY**

| Parameter | Units | C3501 Min. | C3501 Max. | C3501 Mean | S3500 Min. | S3500 Max. | S3500 Mean | Database Mean [1] |
|---|---|---|---|---|---|---|---|---|
| Total Density | No./$m^2$ | 0 | 2,800 | 413 | 0 | 3,440 | 544 | 483 |
| Richness | Number | 0 | 12 | 4 | 0 | 10 | 4 | 4 |
| Simpson's Diversity | Value | 0.00 | 1.00 | 0.41 | 0.00 | 1.00 | 0.39 | 0.40 |
| Shannon-Wiener Diversity | Value | 0.00 | 2.20 | 1.03 | 0.00 | 2.04 | 1.10 | 1.07 |
| Percent Oligochaetes | Percent | 0.0 | 100 | 42.4 | 0.0 | 100 | 37.5 | 39.8 |
| Percent Snails | Percent | 0.0 | 100 | 32.0 | 0.0 | 100 | 36.8 | 34.6 |
| Percent Clams and Mussels | Percent | 0.0 | 100 | 8.6 | 0.0 | 80.8 | 11.0 | 9.9 |
| Percent Chironomids | Percent | 0.0 | 71.4 | 15.0 | 0.0 | 100 | 14.0 | 14.5 |

1 Database mean values encompass data collected at C3501 and S3500 from November 1995 to August 2000.

**TABLE 4-3. LAKE MICHIGAN PHYTOPLANKTON SUMMARY**

| Parameter | Units | C3501 Min. | C3501 Max. | C3501 Mean | S3500 Min. | S3500 Max. | S3500 Mean | Database Mean [1] |
|---|---|---|---|---|---|---|---|---|
| Total Density | No./mL | 244 | 5,783 | 1,307 | 283 | 7,432 | 1,281 | 1,294 |
| Total Biomass [2] | $mg/M^3$ | 200 | 6,725 | 3,013 | 150 | 6,400 | 2,848 | 2,930 |
| Total Biovolume [3] | $\mu m^3/mL$ | 1,092,885 | 2,401,141 | 1,923,298 | 1,276,277 | 2,446,341 | 2,018,481 | 1,970,889 |
| Soft Algae [4] | | | | | | | | |
| Richness | Number | 6 | 24 | 13 | 6 | 24 | 13 | 13 |
| Density | No./mL | 111 | 1,683 | 448 | 86 | 1,157 | 423 | 435 |
| Percent Green Algae | Percent | 2.2 | 33.1 | 15.7 | 2.5 | 33.5 | 15.7 | 15.7 |
| Percent Yellow-Green Algae | Percent | 0.0 | 53.4 | 12.8 | 0.7 | 48.1 | 13.3 | 13.0 |
| Percent Dinoflagellates | Percent | 0.0 | 23.9 | 3.5 | 0.0 | 23.9 | 3.0 | 3.2 |
| Percent Blue-Green Algae | Percent | 0.0 | 14.6 | 3.9 | 0.0 | 13.3 | 4.0 | 3.9 |
| Diatoms | | | | | | | | |
| Richness | Number | 25 | 53 | 38 | 17 | 55 | 37 | 37 |
| Density | No./mL | 103 | 5,235 | 858 | 86 | 6,698 | 858 | 858 |
| Percent of Total Density | Percent | 27.9 | 92.1 | 58.2 | 29.1 | 90.5 | 58.6 | 58.4 |
| Simpson's Diversity Index | Value | 0.04 | 0.21 | 0.11 | 0.04 | 0.25 | 0.12 | 0.11 |
| Shannon-Wiener Diversity Index | Value | 2.11 | 3.40 | 2.76 | 1.76 | 3.30 | 2.67 | 2.71 |

1 Database mean values encompass data collected at C3501 and S3500 from November 1995 to August 2000.
2 Total biomass estimates calculated in 1998 and 1999.
3 Total biovolume estimates calculated in 2000.
4 Soft algae percentage groups based on total phytoplankton density.

## TABLE 4-4. LAKE MICHIGAN ZOOPLANKTON SUMMARY

| Parameter | Units | C3501 Min. | C3501 Max. | C3501 Mean | S3500 Min. | S3500 Max. | S3500 Mean | Database Mean [1] |
|---|---|---|---|---|---|---|---|---|
| Total Density | No./$M^3$ | 2 | 131,785 | 11,192 | 7 | 124,848 | 11,733 | 11,476 |
| Total Biomass [2] | mg/$M^3$ | 0.21 | 155.17 | 23.55 | 0.01 | 80.00 | 14.90 | 19.13 |
| Total Biovolume [3] | $\mu m^3$/mL | 0.36 | 2,760.69 | 338.52 | 0.80 | 2,949.43 | 277.84 | 307.44 |
| Richness | Number | 1 | 9 | 5 | 1 | 10 | 5 | 5 |
| Simpson's Diversity Index | Value | 0.19 | 1.00 | 0.61 | 0.29 | 1.00 | 0.55 | 0.58 |
| Shannon-Wiener Diversity Index | Value | 0.00 | 1.53 | 0.76 | 0.00 | 1.73 | 0.86 | 0.81 |
| Percent Rotifers | Percent | 2.6 | 100.0 | 49.1 | 0.0 | 100.0 | 43.7 | 46.3 |
| Percent Cladocera | Percent | 0.0 | 76.8 | 13.6 | 0.0 | 100.0 | 14.6 | 14.2 |
| Percent Copepoda | Percent | 0.0 | 96.7 | 37.4 | 0.0 | 97.1 | 41.8 | 39.7 |

1 Database mean values encompass data collected at C3501 and S3500 from November 1995 to August 2000.
2 Total biomass measurements were calculated in 1998, 1999, and 2000.
3 Total biovolume measurements were calculated in 1998, 1999, and 2000.

TABLE 4-5. *IN SITU* WATER QUALITY SUMMARY OF SITES C3501 AND S3500

| Depth (ft) | Dissolved Oxygen (mg/L) | | | | Temperature (°C) | | | | Conductivity (µmhos/cm) | | | | pH (s.u.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Mean | n [1] | Min. | Max. | Mean | n [1] | Min. | Max. | Mean | n [1] | Min. | Max. | Mean | n [1] |
| surface | 7.6 | 12.7 | 9.8 | 50 | 8.5 | 25.6 | 18.6 | 50 | 272 | 540 | 314 | 50 | 7.3 | 8.4 | 8.0 | 45 |
| 1 to 3 | 7.6 | 12.7 | 9.7 | 48 | 8.5 | 25.4 | 18.5 | 48 | 275 | 450 | 306 | 48 | 7.4 | 8.4 | 8.0 | 44 |
| 5 to 6 | 7.4 | 12.6 | 9.7 | 50 | 8.5 | 25.6 | 18.3 | 50 | 275 | 374 | 302 | 50 | 7.3 | 8.4 | 8.1 | 46 |
| 8 to 9 | 7.2 | 12.6 | 9.6 | 46 | 8.4 | 26.0 | 18.6 | 46 | 273 | 330 | 299 | 46 | 7.3 | 8.4 | 8.0 | 42 |
| 10 to 12 | 7.1 | 13.3 | 9.7 | 50 | 8.2 | 25.4 | 18.0 | 50 | 100 | 330 | 295 | 50 | 7.2 | 8.4 | 8.0 | 46 |
| 14 to 15 | 7.1 | 95.0 | 11.3 | 51 | 8.0 | 25.4 | 17.9 | 51 | 271 | 372 | 301 | 51 | 7.1 | 8.4 | 8.0 | 47 |
| 17 to 18 | 7.2 | 12.8 | 9.6 | 46 | 7.9 | 25.4 | 18.4 | 46 | 270 | 380 | 300 | 46 | 7.0 | 8.4 | 8.0 | 42 |
| 20 to 21 | 7.2 | 12.8 | 9.7 | 51 | 7.9 | 24.8 | 17.8 | 51 | 33 | 441 | 297 | 51 | 6.9 | 8.4 | 8.0 | 47 |
| 24 to 25 | 7.2 | 12.8 | 9.6 | 54 | 7.8 | 24.8 | 18.0 | 54 | 267 | 370 | 297 | 54 | 6.8 | 8.4 | 8.0 | 50 |
| 27 to 28 | 7.9 | 12.7 | 10.1 | 37 | 7.8 | 24.6 | 16.6 | 37 | 286 | 360 | 306 | 36 | 6.7 | 8.3 | 7.9 | 32 |
| 29+ | 10.5 | 10.6 | 10.5 | 2 | 12.5 | 13.3 | 12.9 | 2 | 297 | 310 | 304 | 2 | 8.2 | 8.3 | 8.2 | 2 |

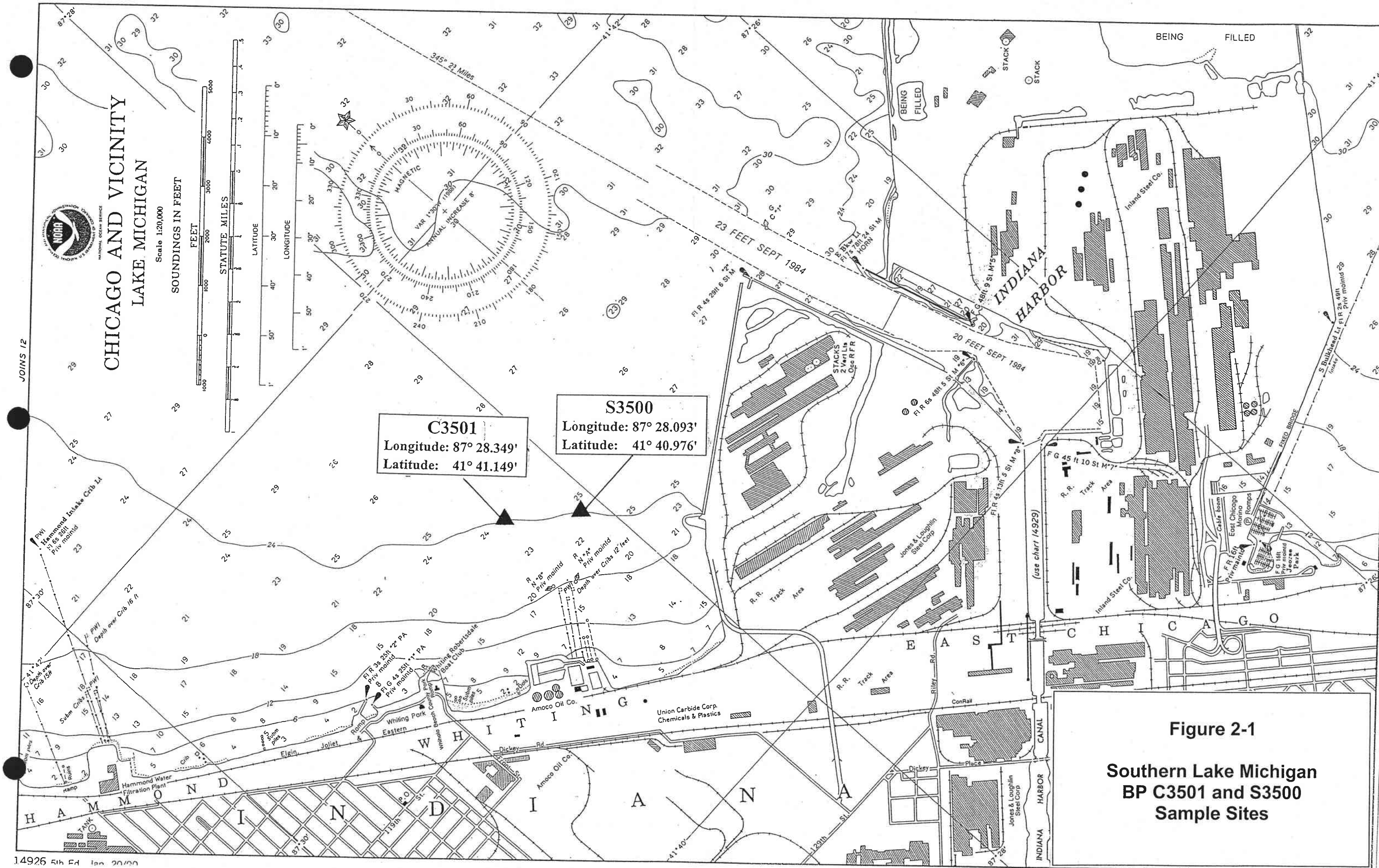
1 Number of observations

## TABLE 4-6. LAKE MICHIGAN WATER CHEMISTRY CONSTITUENTS

| Parameter | Units | Method | MDL [1] | PQL [2] | Min. | Max. | Mean | n [3] |
|---|---|---|---|---|---|---|---|---|
| pH | s.u. | 9040A | 0.1 | 0.1 | 6.90 | 8.70 | 8.07 | 14 |
| Total Suspended Solids (TSS) | mg/L | EPA160.2 | 5 | 20 | <5.00 | 7.00 | <5.00 | 16 |
| Total Dissolved Solids (TDS) | mg/L | EPA 160.1 | 10 | 20 | 140.00 | 198.00 | 168.81 | 16 |
| Alkalinity as $CaCO_3$ | mg/L | EPA310.2 | 10 | | 110.00 | 110.00 | 110.00 | 2 |
| Chloride | mg/L | 2951 | 1 | 5 | 12.00 | 17.00 | 13.34 | 16 |
| Total Organic Carbon (TOC) | mg/L | EPA415.1 | 1 | 5 | 2.00 | 20.00 | 4.59 | 16 |
| Hardness as $CaCO_3$ | mg/L | EPA130.2 | 1 | 7 | 133.00 | 160.00 | 145.81 | 16 |
| Total Kjeldahl Nitrogen (TKN) | mg/L | EPA351.1 | 0.1 | 0.5 | 0.13 | 1.90 | 0.67 | 14 |
| Nitrate/Nitrite | mg/L | 9200 | 0.02 | 0.1 | 0.10 | 1.50 | 0.38 | 16 |
| Total Nitrogen | mg/L | Calc. | 0.04 | | 1.56 | 1.74 | 1.65 | 2 |
| Total Phosphorus | mg/L | EPA365.4 | 0.01 | 0.05 | 0.01 | 0.12 | 0.03 | 16 |
| Ortho-Phosphorus | mg/L | EPA365.2 | 0.005 | 0.03 | <0.005 | 0.05 | 0.02 | 16 |
| Silica | mg/L | 6010 | 0.2 | 0.5 | <0.50 | 0.80 | 0.50 | 16 |
| Sulfate | mg/L | EPA375.4 | 2 | | 25.00 | 26.00 | 25.50 | 2 |
| Total Calcium | mg/L | EPA215.1 | 0.01 | | 54.00 | 85.00 | 69.50 | 2 |
| Calcium, Dissolved | mg/L | M200.7 ICP | 0.2 | 1 | 36.00 | 37.90 | 36.88 | 4 |
| Total Magnesium | mg/L | EPA242.1 | 0.001 | | 12.00 | 12.00 | 12.00 | 2 |
| Magnesium, Dissolved | mg/L | M200.7 ICP | 0.2 | 1 | 11.60 | 11.80 | 11.70 | 4 |
| Total Sodium | mg/L | EPA273.1 | 0.002 | | 7.00 | 7.70 | 7.35 | 2 |
| Total Potassium | mg/L | EPA258.1 | 0.1 | | 0.30 | 3.30 | 1.80 | 2 |
| Chlorophyll *a* | $mg/M^3$ | 10200 H | 0.01 | 0.05 | 0.11 | 4.27 | 1.27 | 116 |

1 Method Detection Limit
2 Practical Detection Limit
3 Number of samples

# Figures




**C3501**
Longitude: 87° 28.349'
Latitude: 41° 41.149'

**S3500**
Longitude: 87° 28.093'
Latitude: 41° 40.976'

**Figure 2-1**

**Southern Lake Michigan BP C3501 and S3500 Sample Sites**

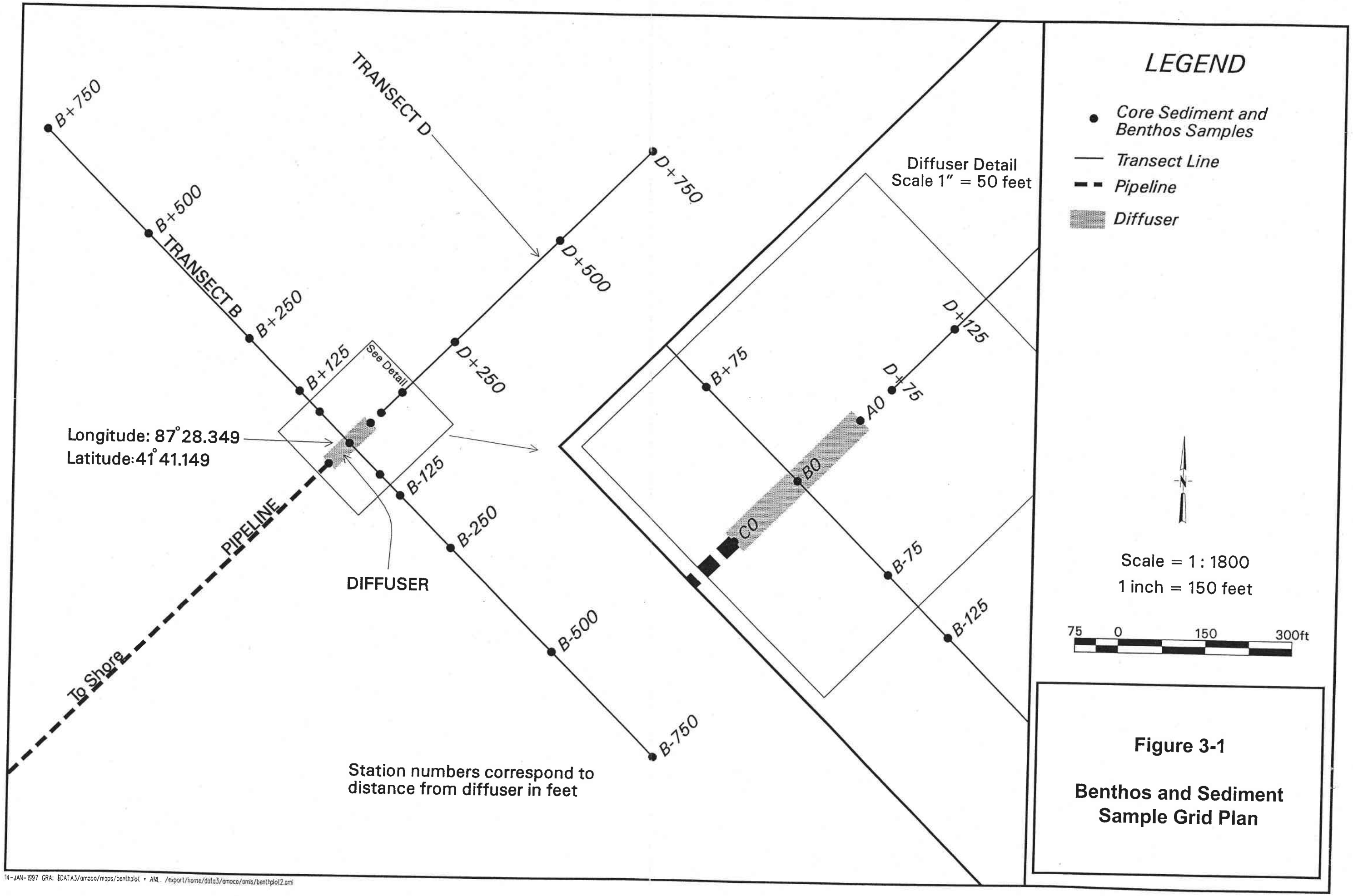



**Figure 3-1**

**Benthos and Sediment Sample Grid Plan**

14-JAN-1997 GRA: $DATA3/amoco/mcas/benthplot + AML: /export/home/data3/amoco/amis/benthplot2.aml

FIGURE 4-1a. PERCENT SAND IN SEDIMENT LAKE MICHIGAN 1995-2000

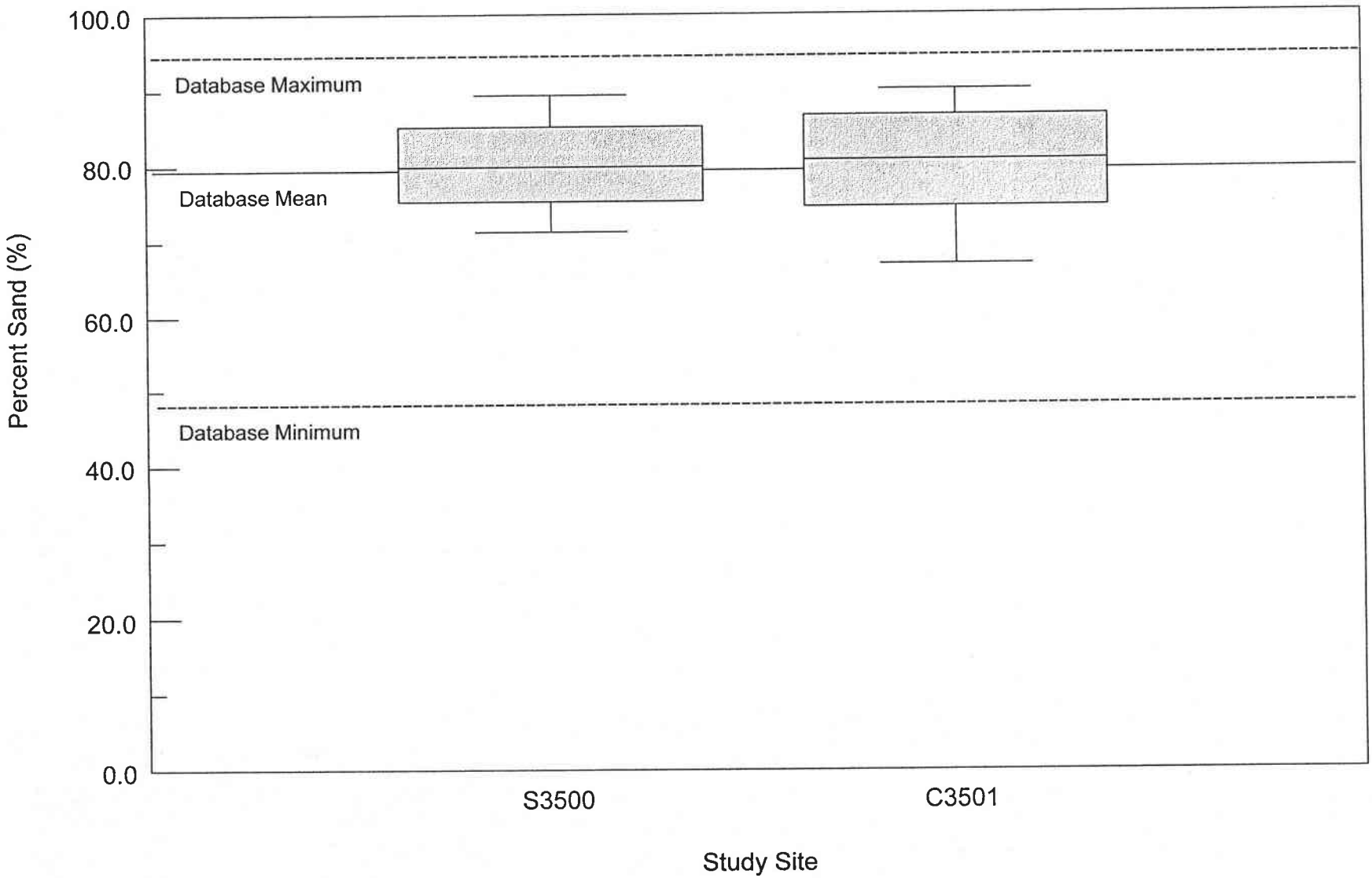


**FIGURE 4-1b. PERCENT SILT IN SEDIMENT LAKE MICHIGAN 1995-2000**

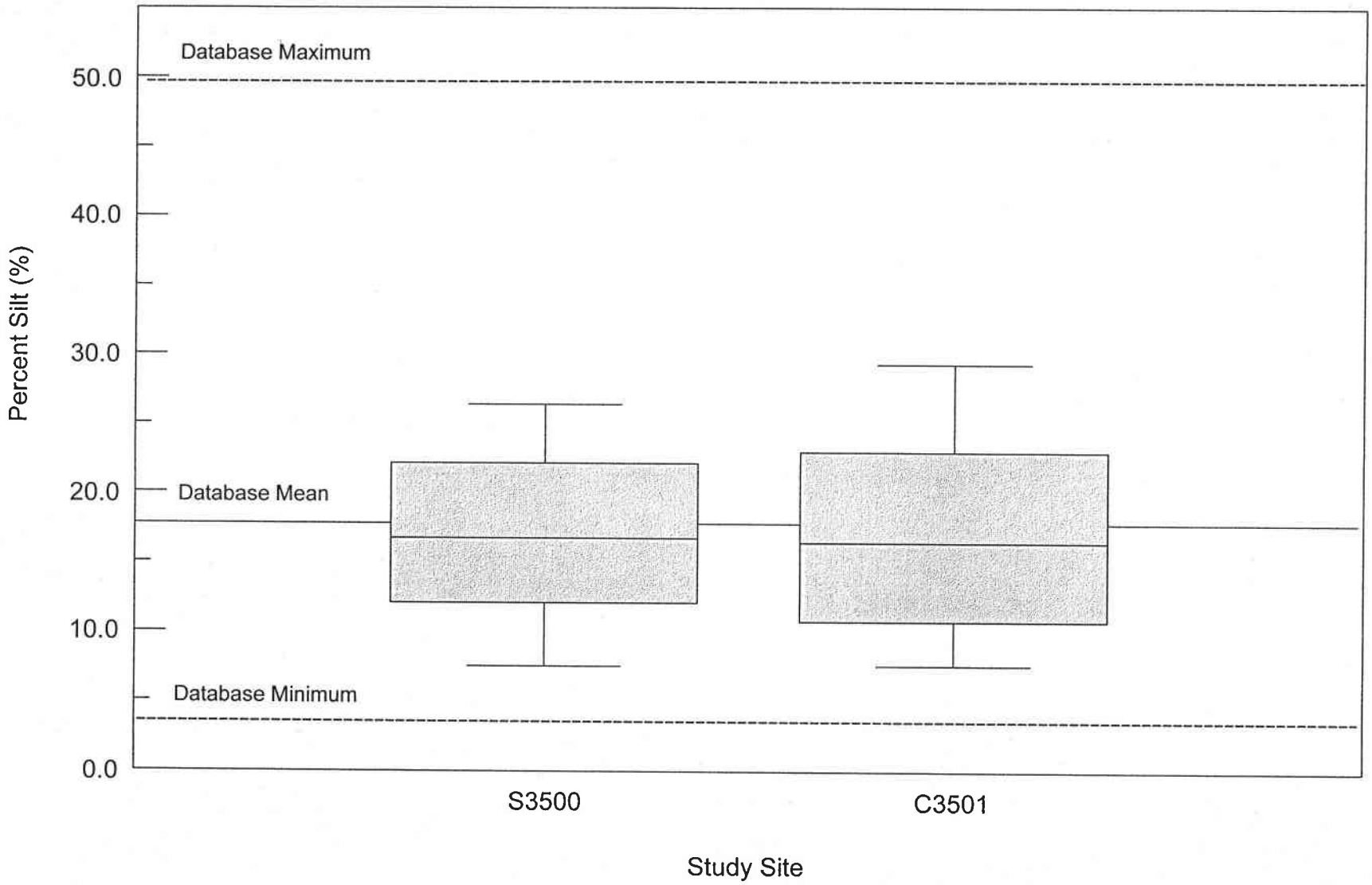


FIGURE 4-1c. PERCENT CLAY IN SEDIMENT LAKE MICHIGAN 1995-2000

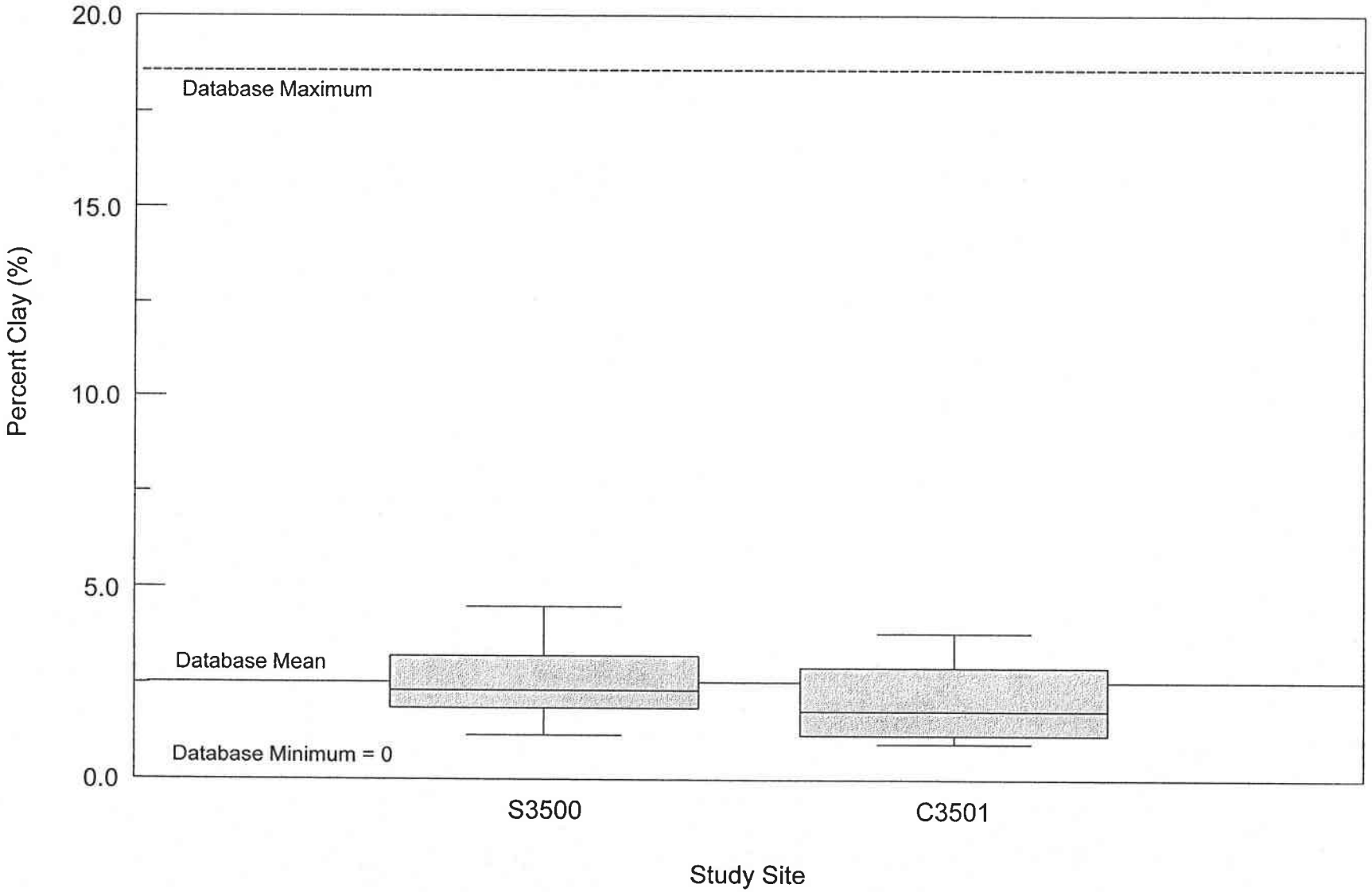
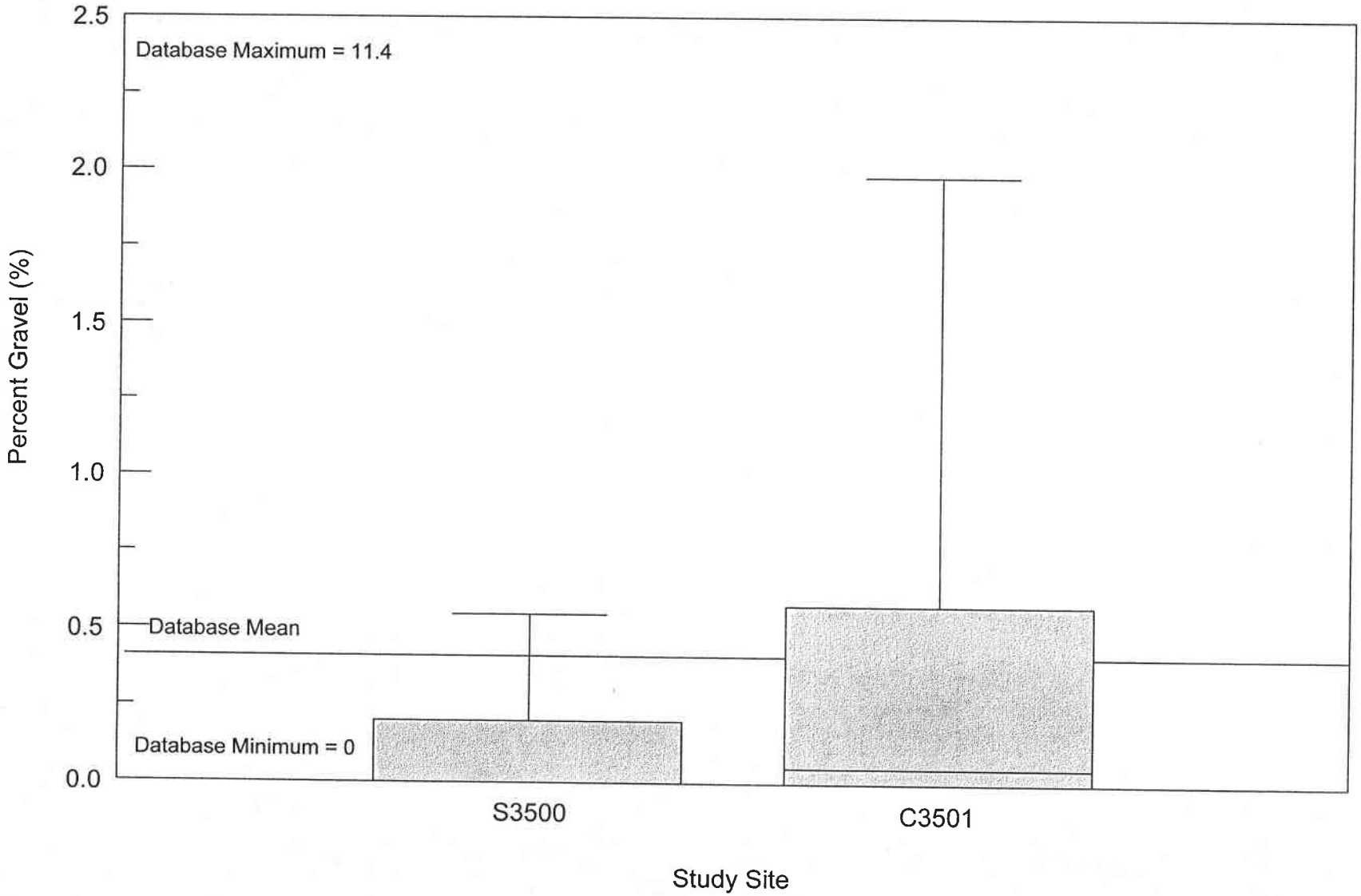
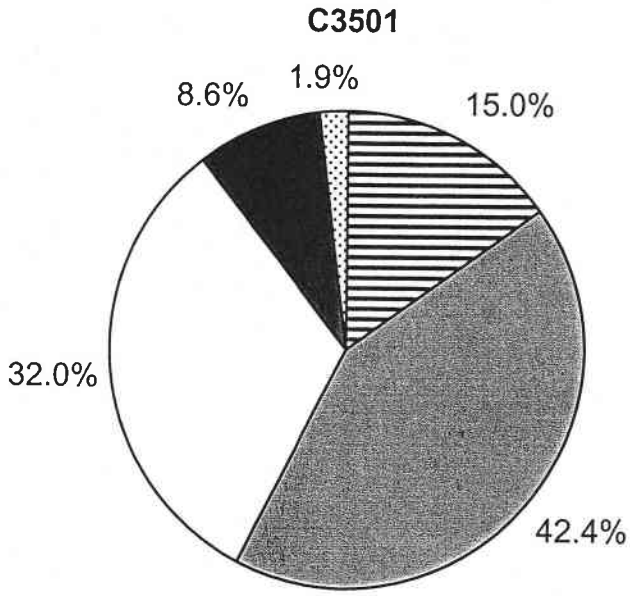
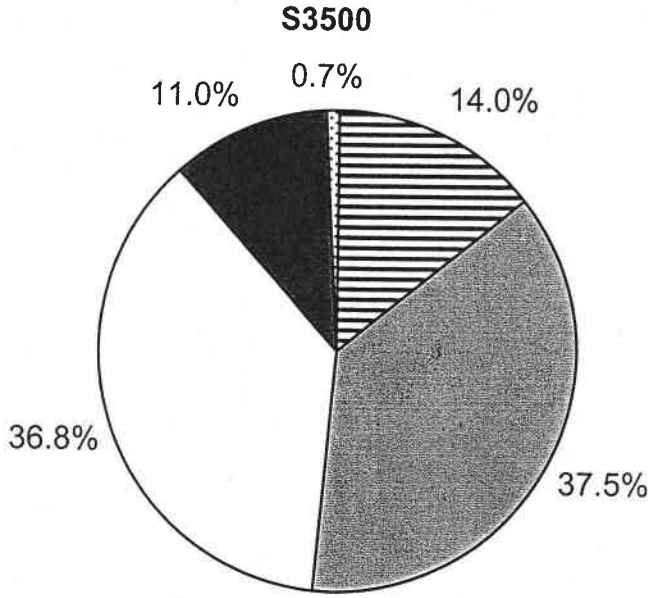


**FIGURE 4-1d. PERCENT GRAVEL IN SEDIMENT LAKE MICHIGAN 1995-2000**



## FIGURE 4-2. LAKE MICHIGAN BENTHOS RELATIVE MEAN ABUNDANCE BY GROUP 1995-2000




Chironomidae Oligochaeta Gastropoda Pelycepoda Other

**FIGURE 4-3a. BENTHOS MEAN SPRING/FALL RELATIVE ABUNDANCE**
**LAKE MICHIGAN SITE S3500**

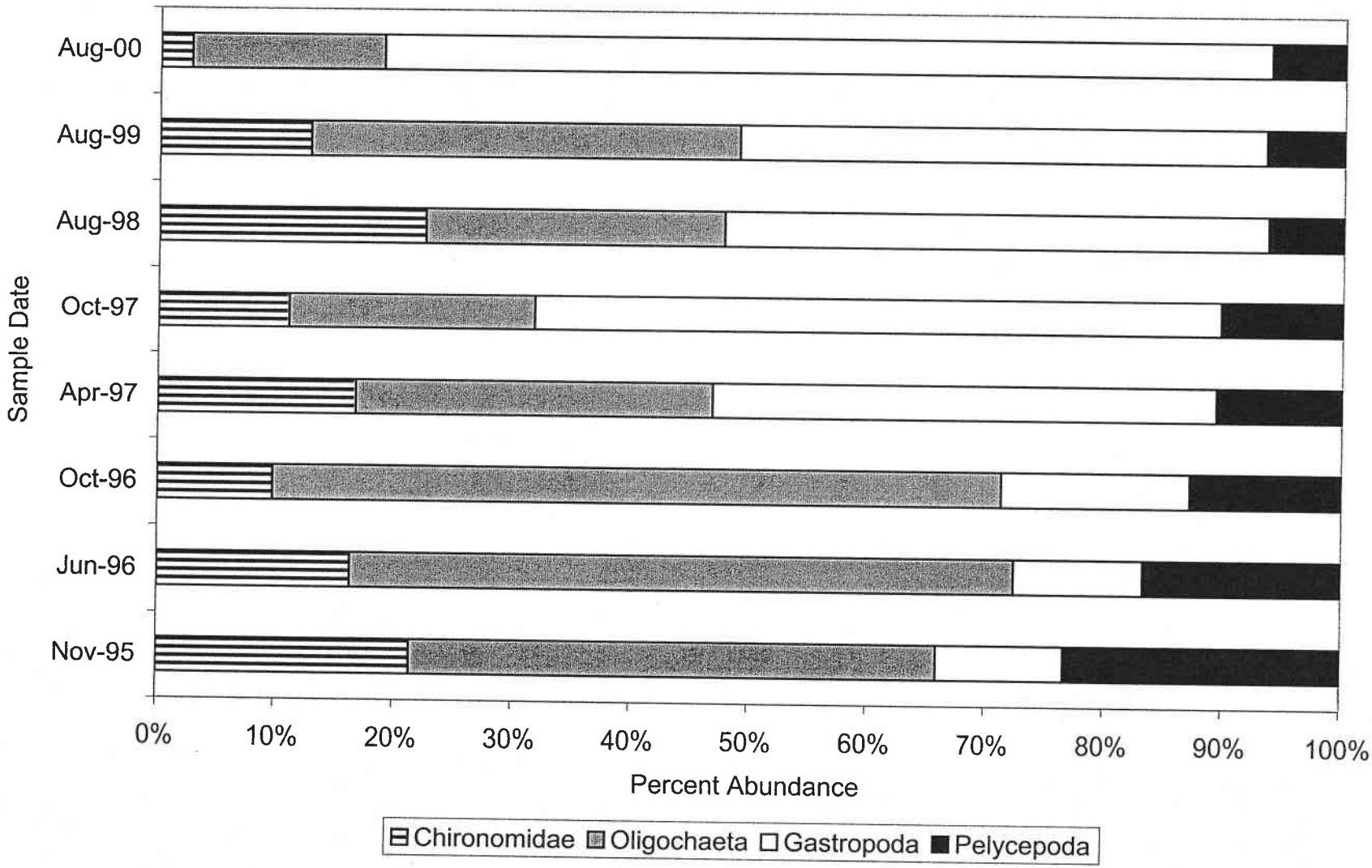
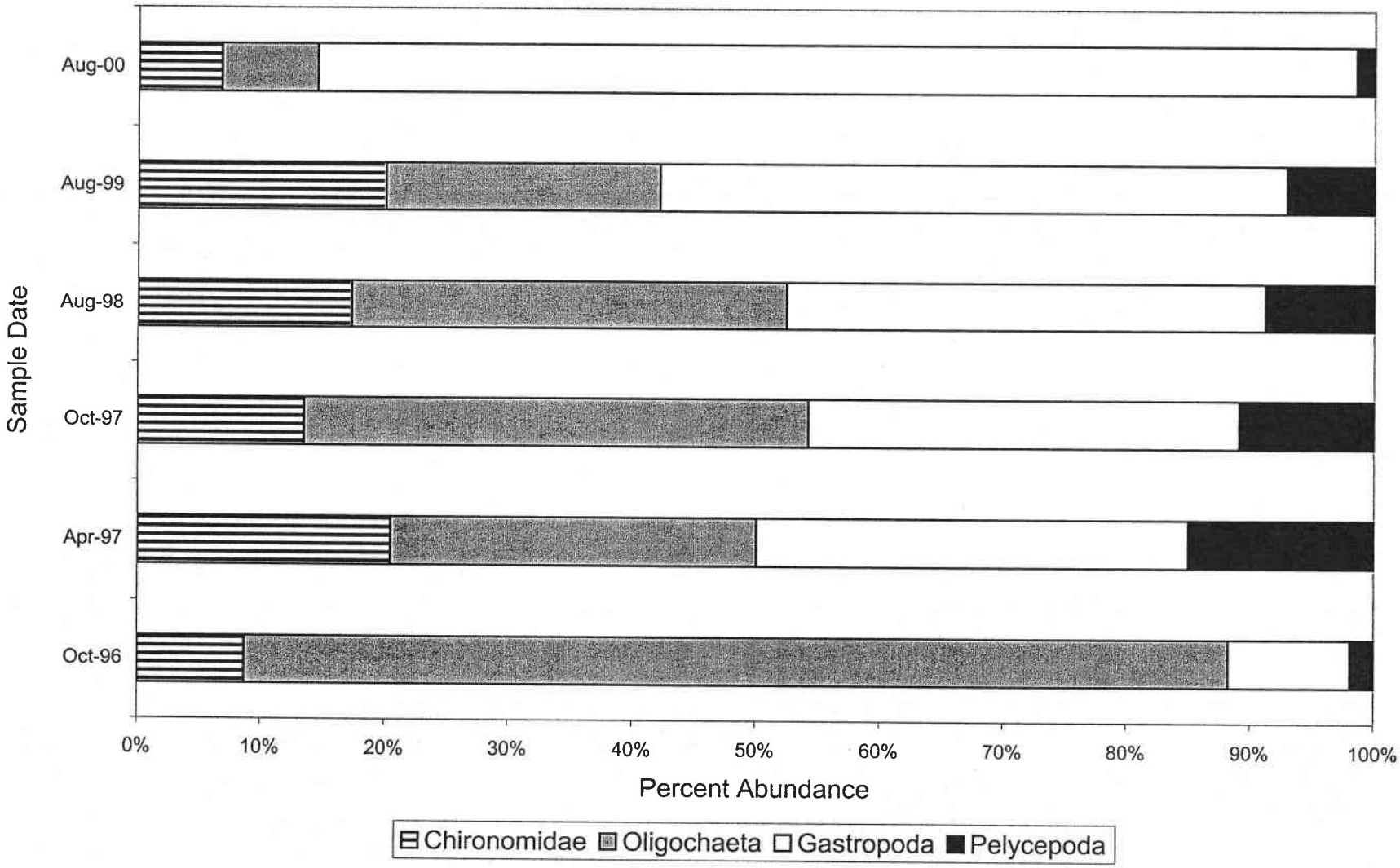
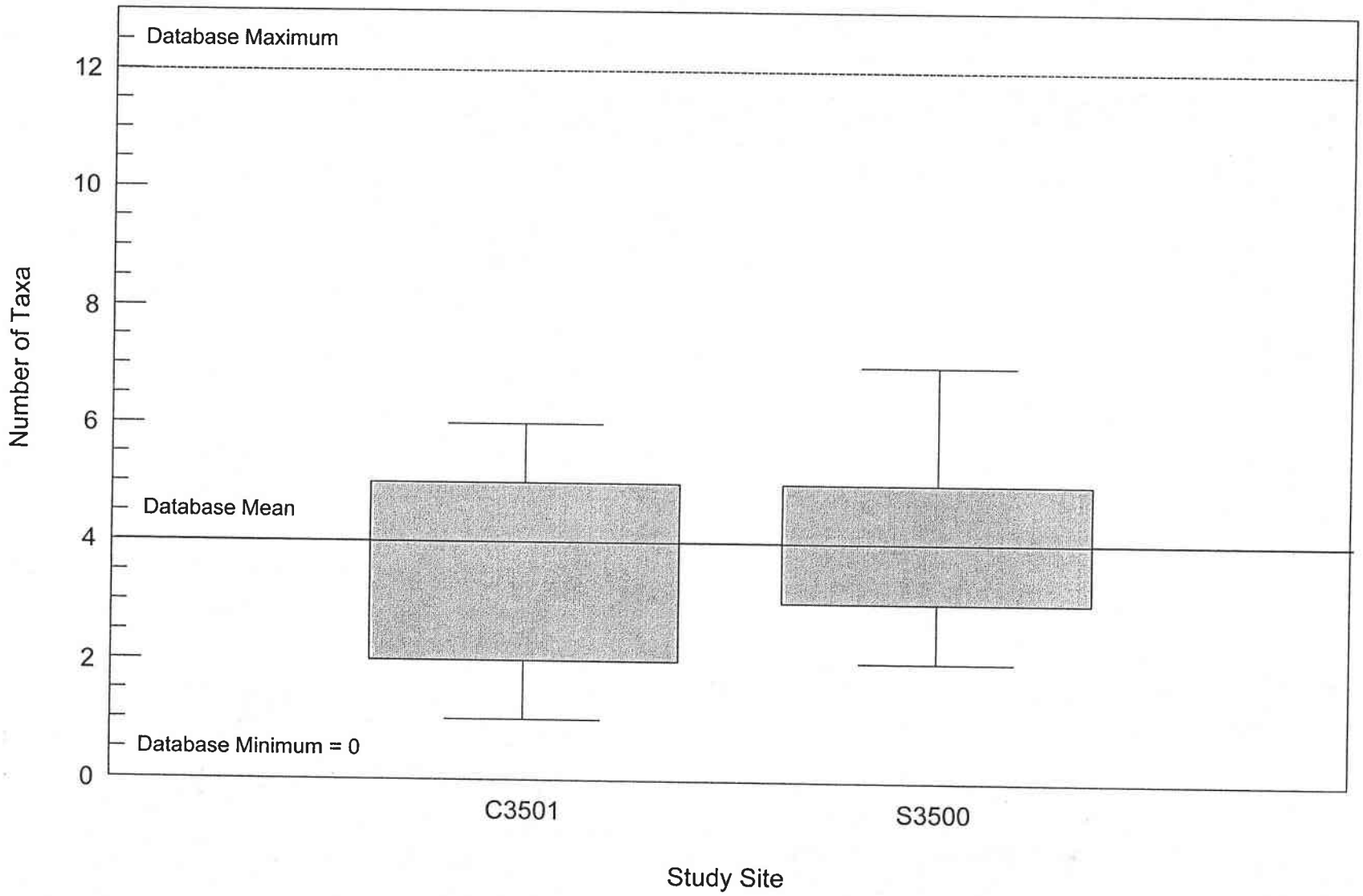


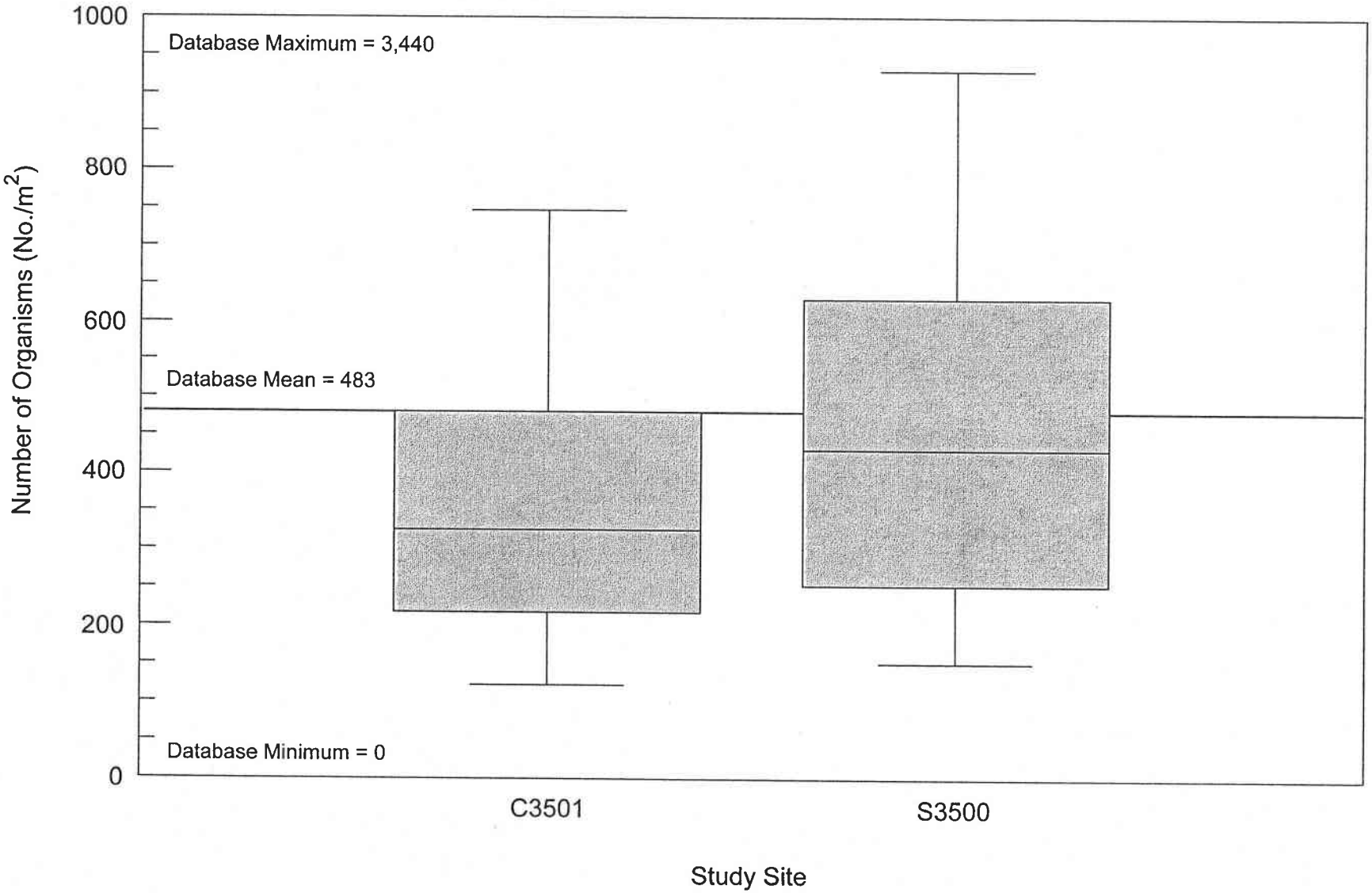
**FIGURE 4-3b. BENTHOS MEAN SPRING/FALL RELATIVE ABUNDANCE**
**LAKE MICHIGAN SITE C3501**



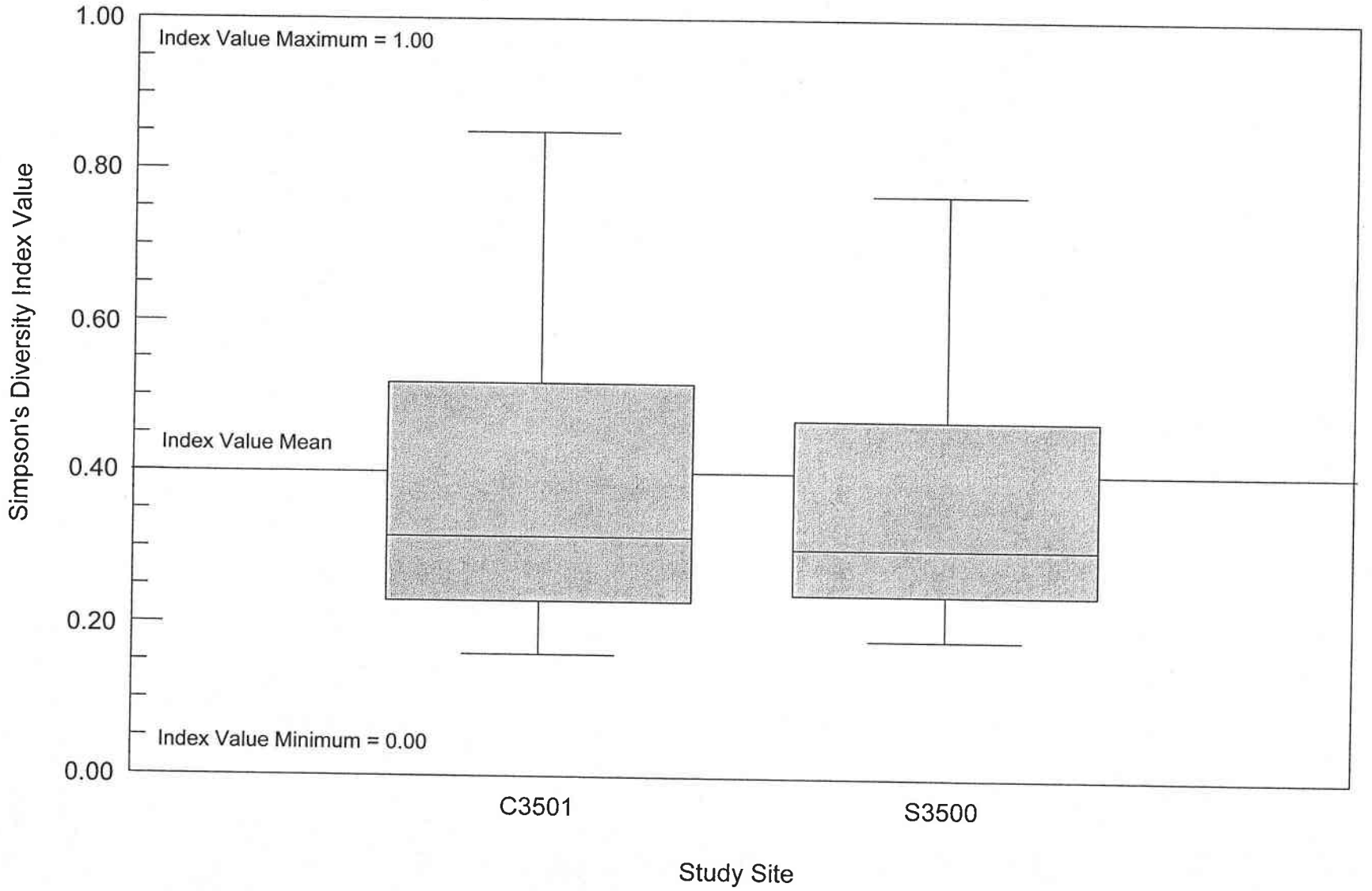
## FIGURE 4-4. BENTHOS RICHNESS LAKE MICHIGAN 1995-2000



## FIGURE 4-5. BENTHOS DENSITY LAKE MICHIGAN 1995-2000

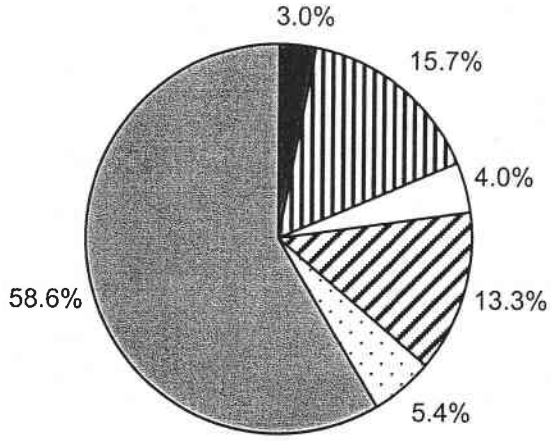


## FIGURE 4-6. BENTHOS DIVERSITY LAKE MICHIGAN 1995-2000

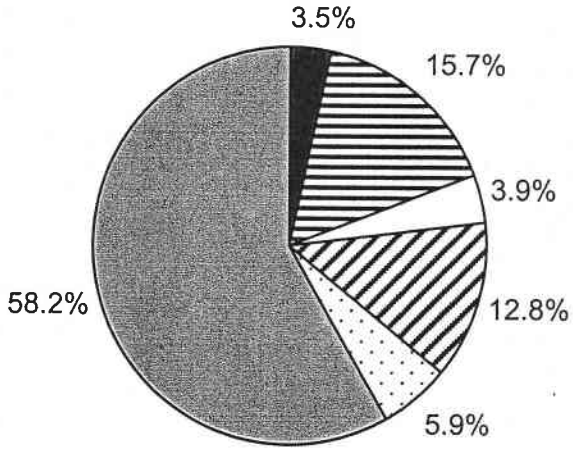


## FIGURE 4-7. LAKE MICHIGAN PHYTOPLANKTON RELATIVE MEAN ABUNDANCE BY MAJOR ALGAE GROUP

**SITE S3500**




**SITE C3501**




| | | |
|---|---|---|
| Pyrrophyta | Chlorophyta | Cyanophyta |
| Chrysophyta | Other | Bacillariophyta |

## FIGURE 4-8. DIATOM RICHNESS LAKE MICHIGAN 1995-2000

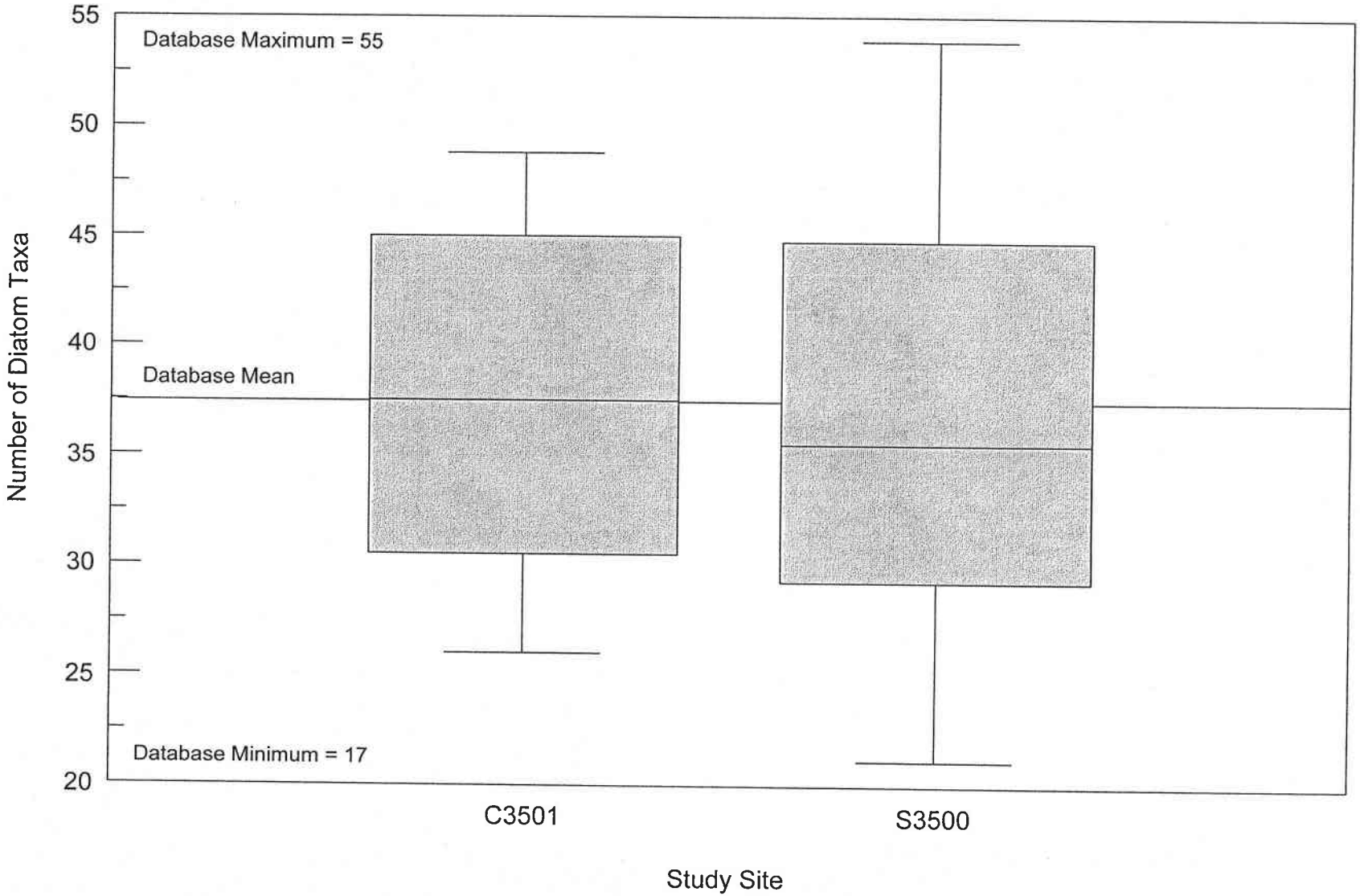


**FIGURE 4-9. PHYTOPLANKTON DENSITY LAKE MICHIGAN 1995-2000**

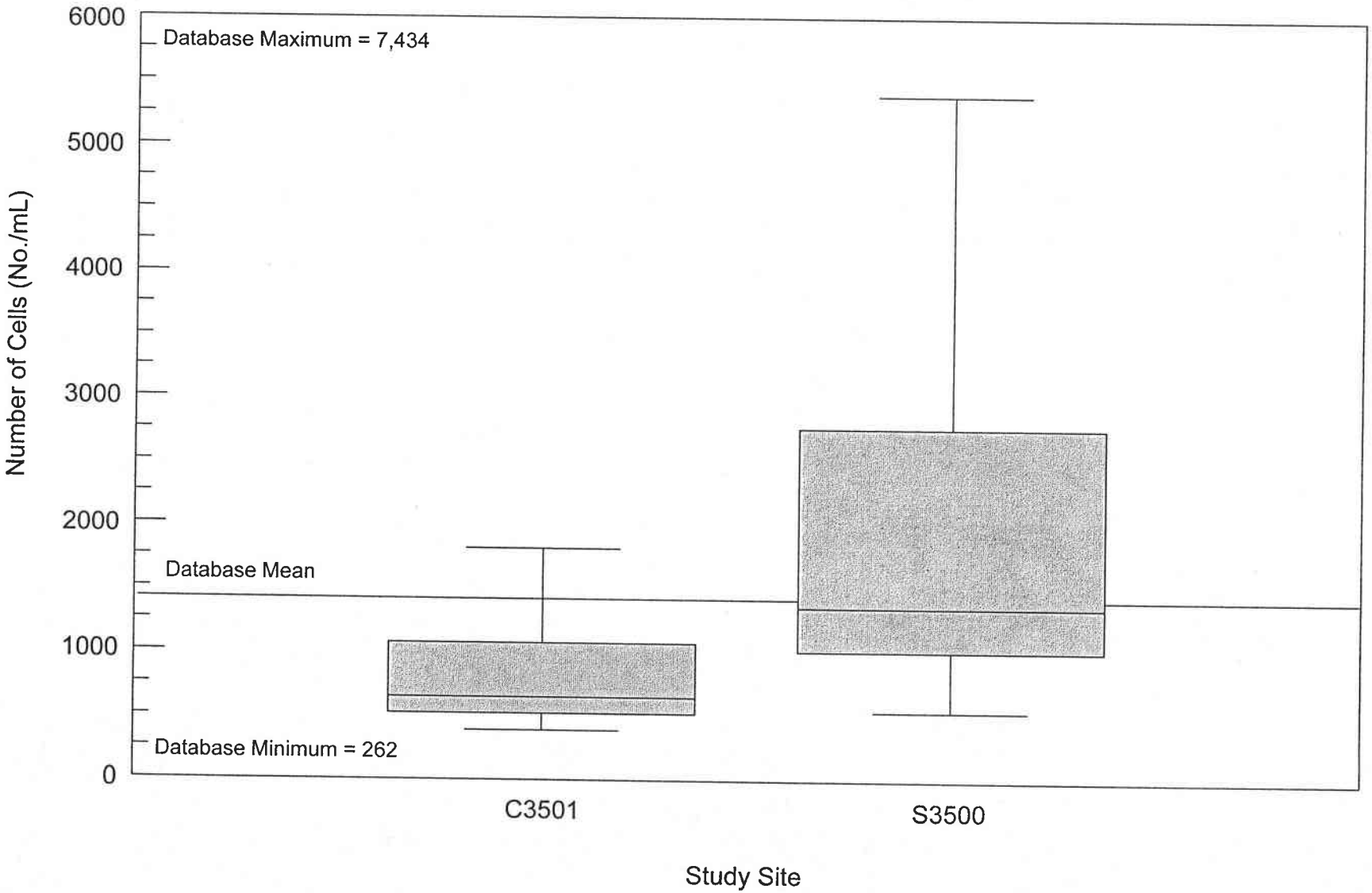


**FIGURE 4-10. COMBINED SITE PHYTOPLANKTON STANDING CROP**
**LAKE MICHIGAN 1997 & 1998**

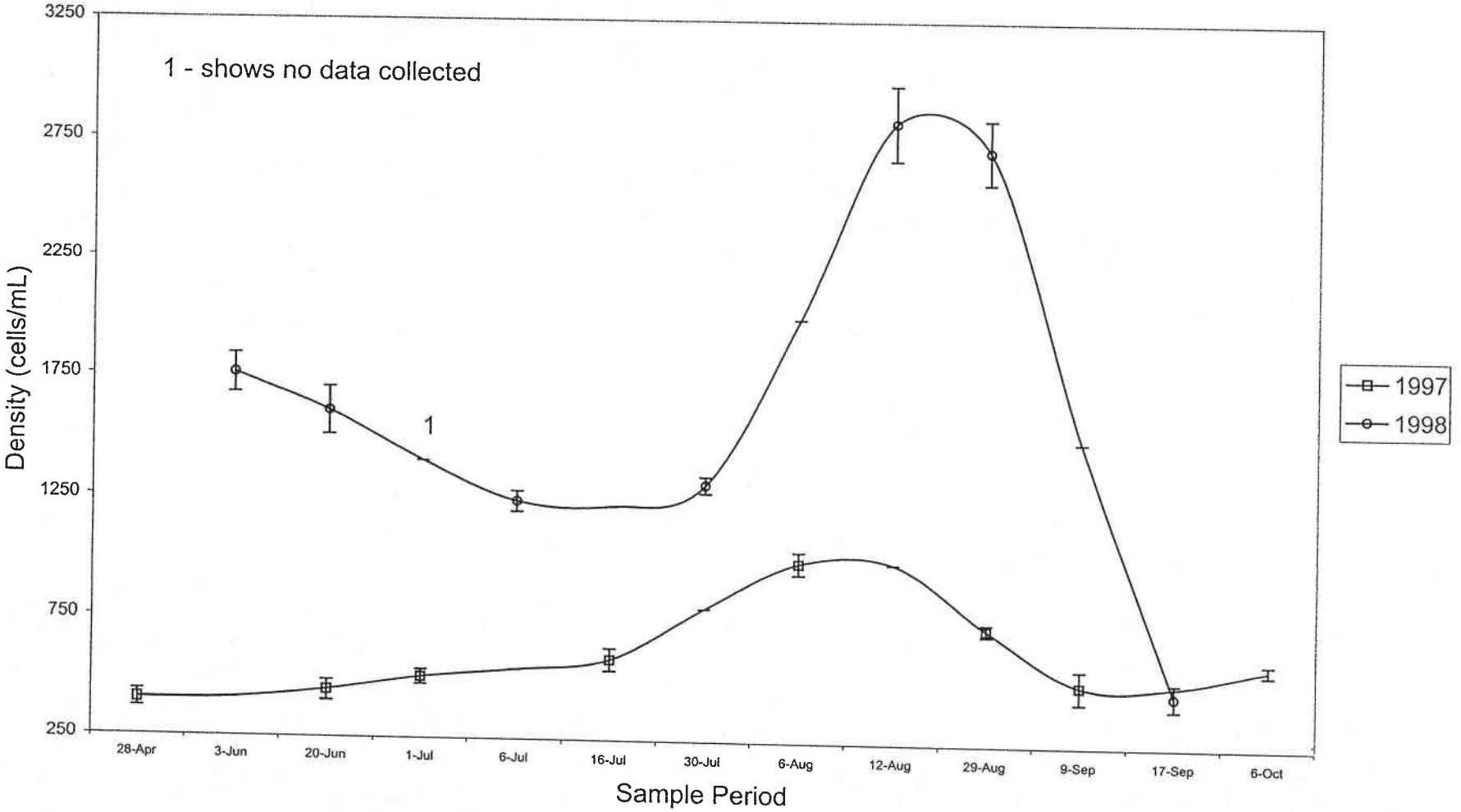


**FIGURE 4-11. DIATOM DIVERSITY LAKE MICHIGAN 1995-2000**

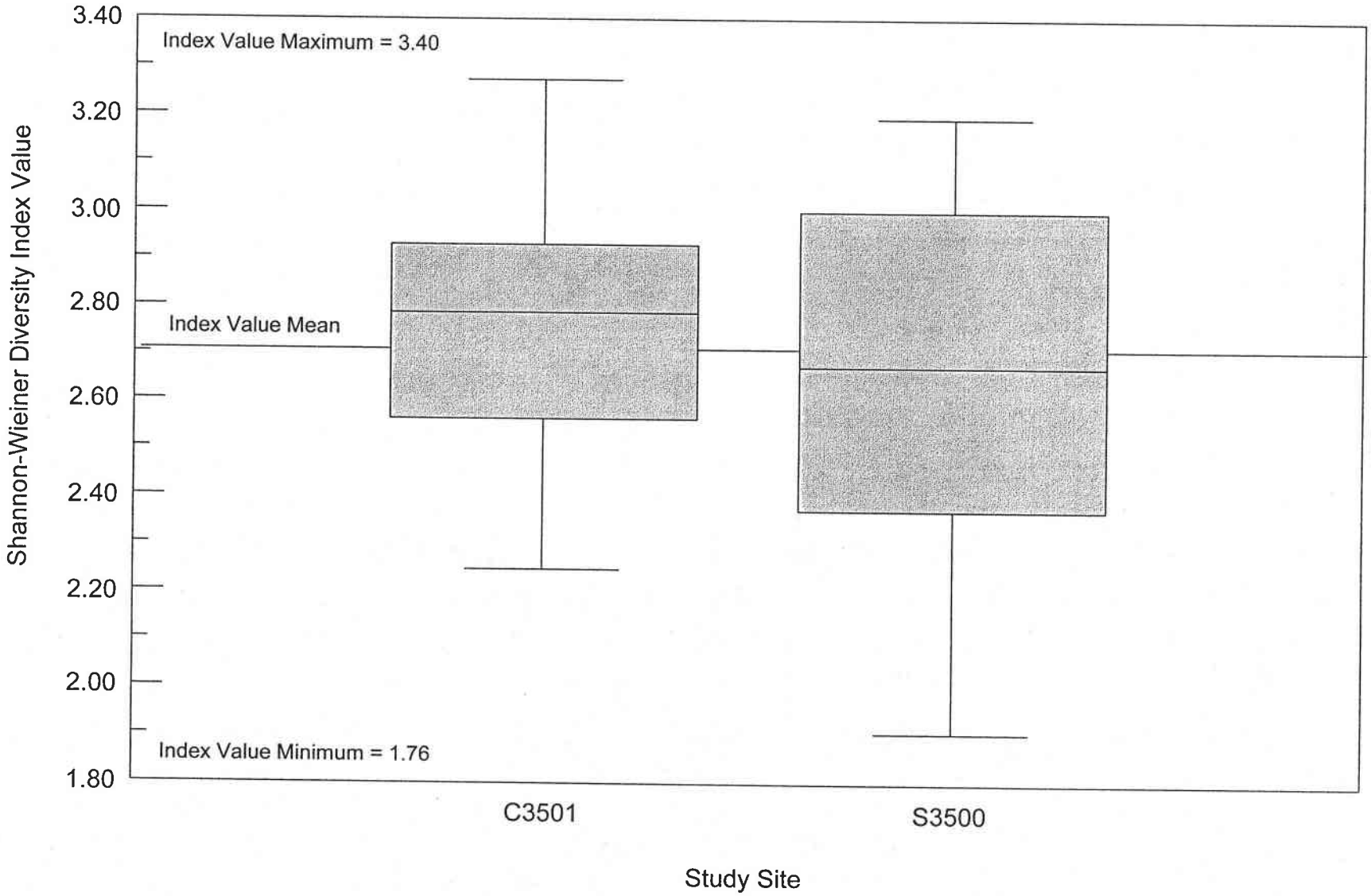


**FIGURE 4-12a. PHYTOPLANKTON MEAN SPRING/FALL RELATIVE ABUNDANCE**
**LAKE MICHIGAN SITE S3500**

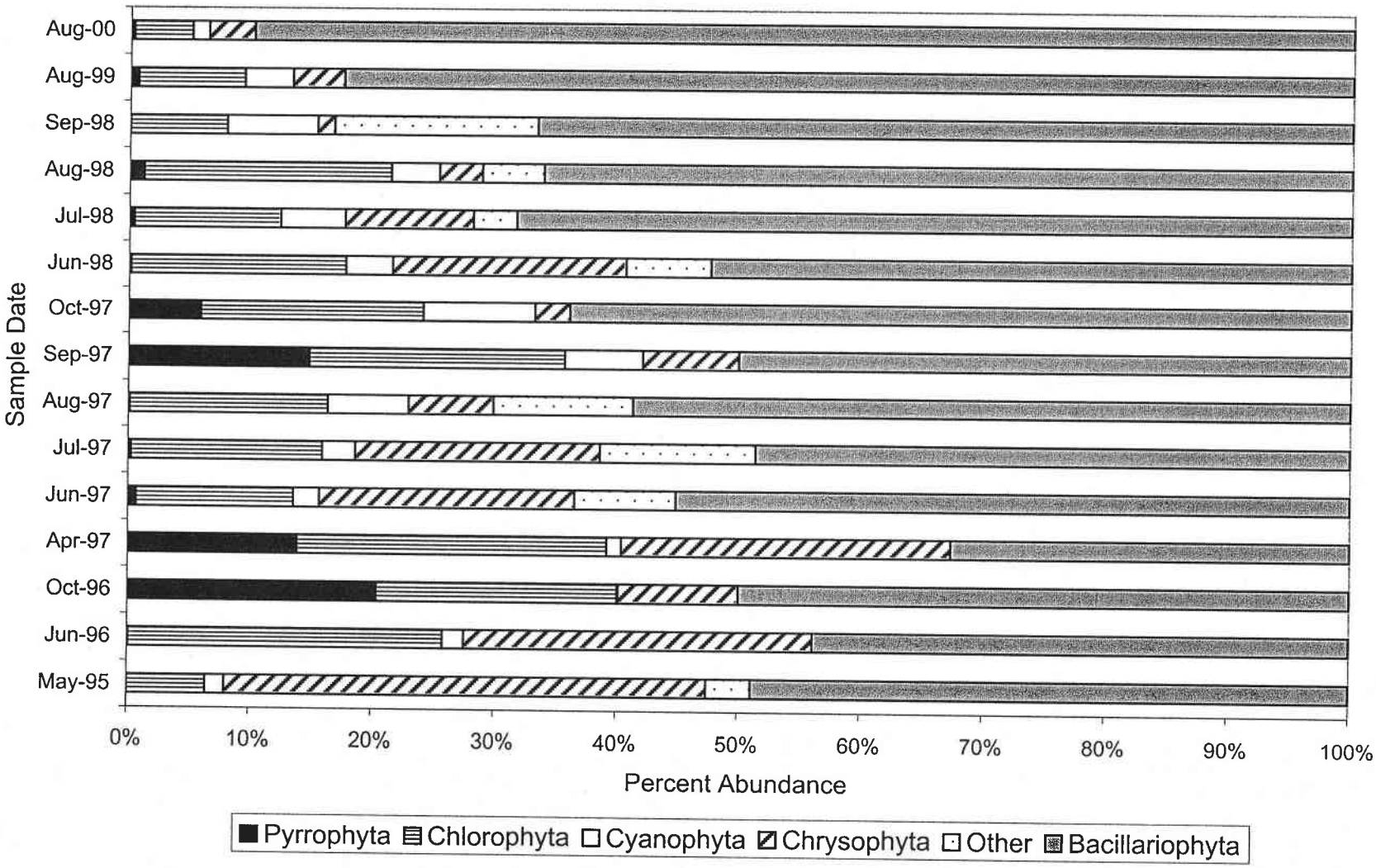
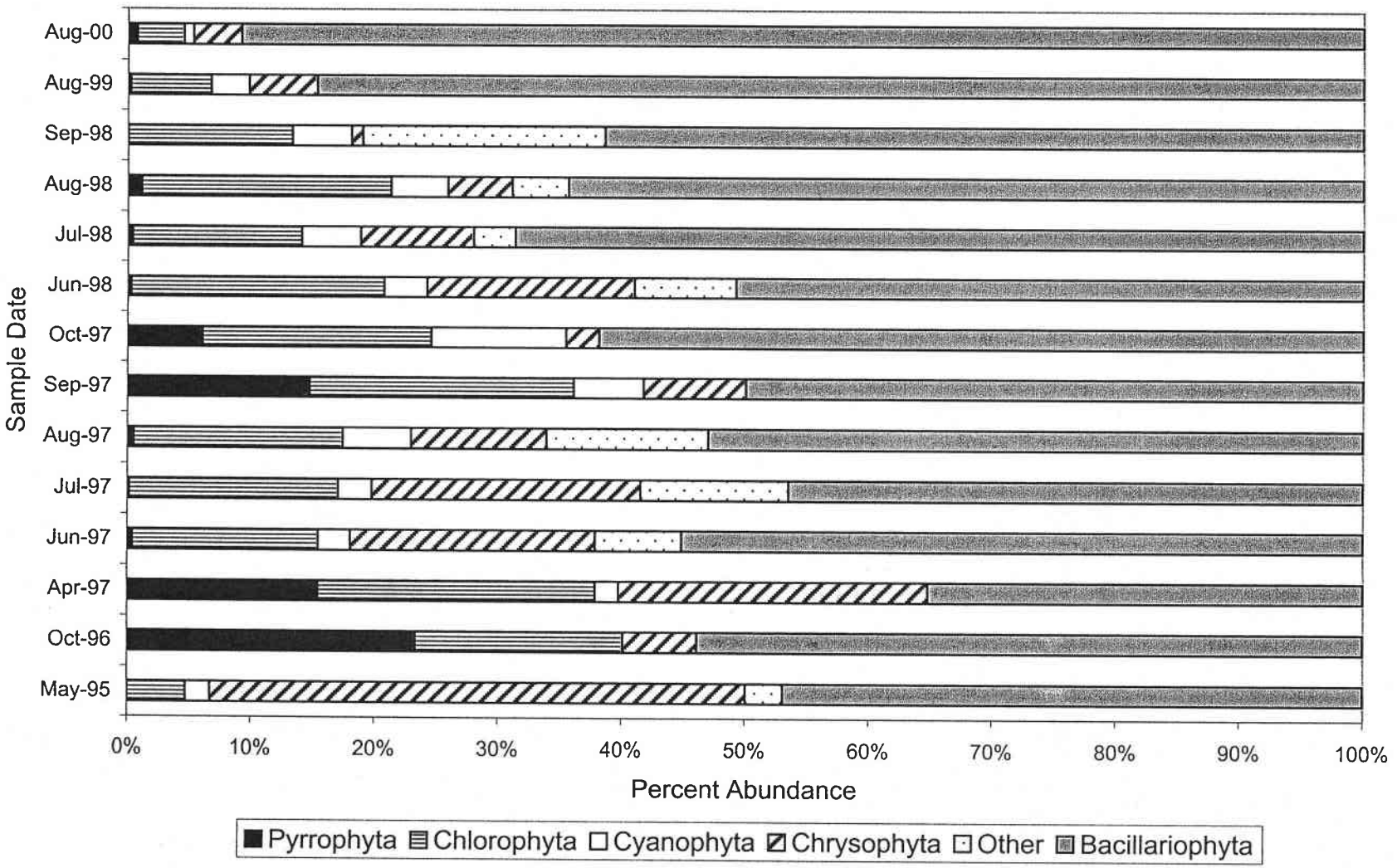


**FIGURE 4-12b. PHYTOPLANKTON MEAN SPRING/FALL RELATIVE ABUNDANCE**
**LAKE MICHIGAN SITE C3501**



## FIGURE 4-13. ZOOPLANKTON RICHNESS LAKE MICHIGAN 1995-2000

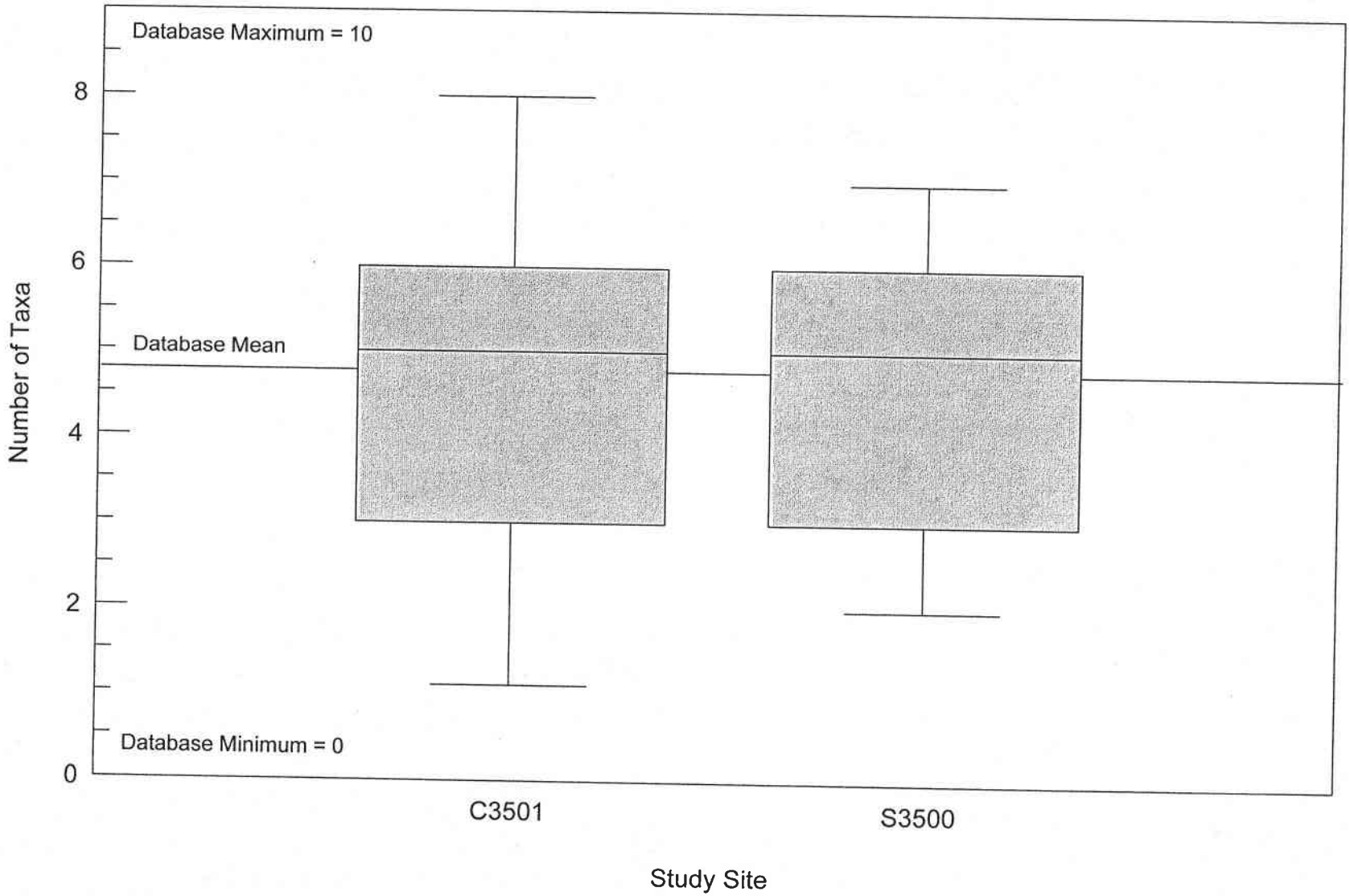
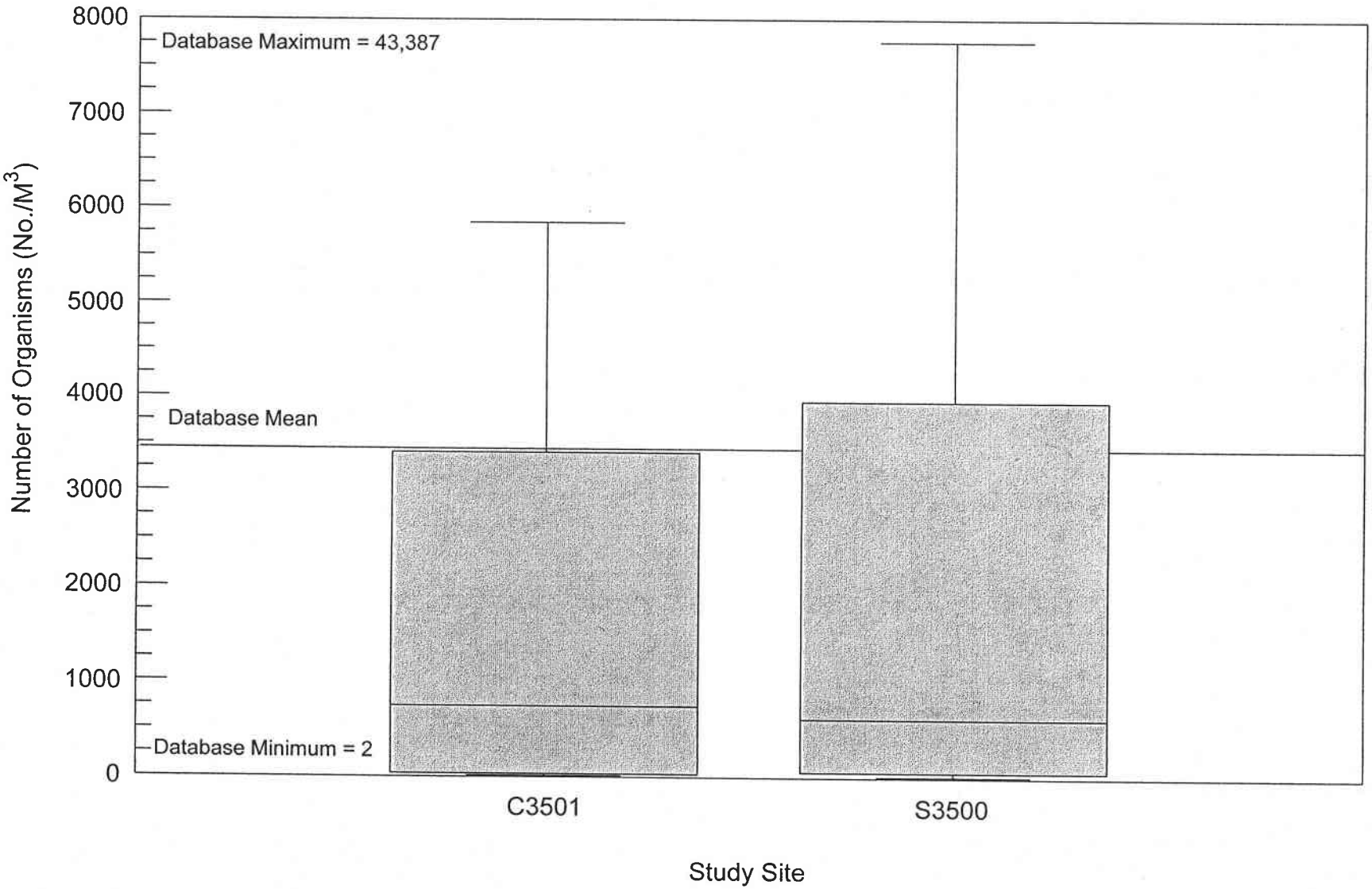


FIGURE 4-14a. ZOOPLANKTON DENSITY LAKE MICHIGAN 1995-1999



## FIGURE 4-14b. ZOOPLANKTON DENSITY LAKE MICHIGAN 1995-1999 AND 2000

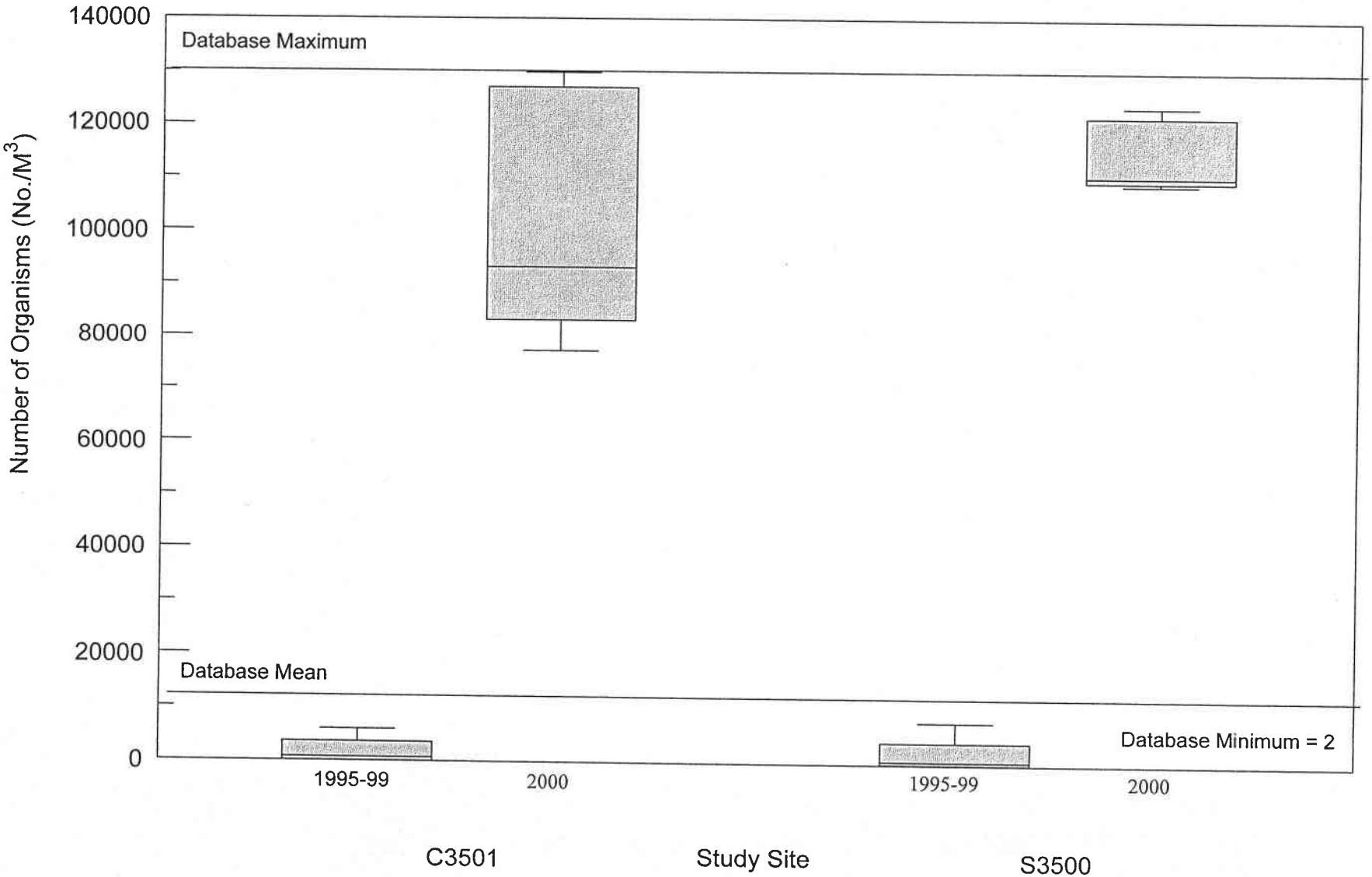
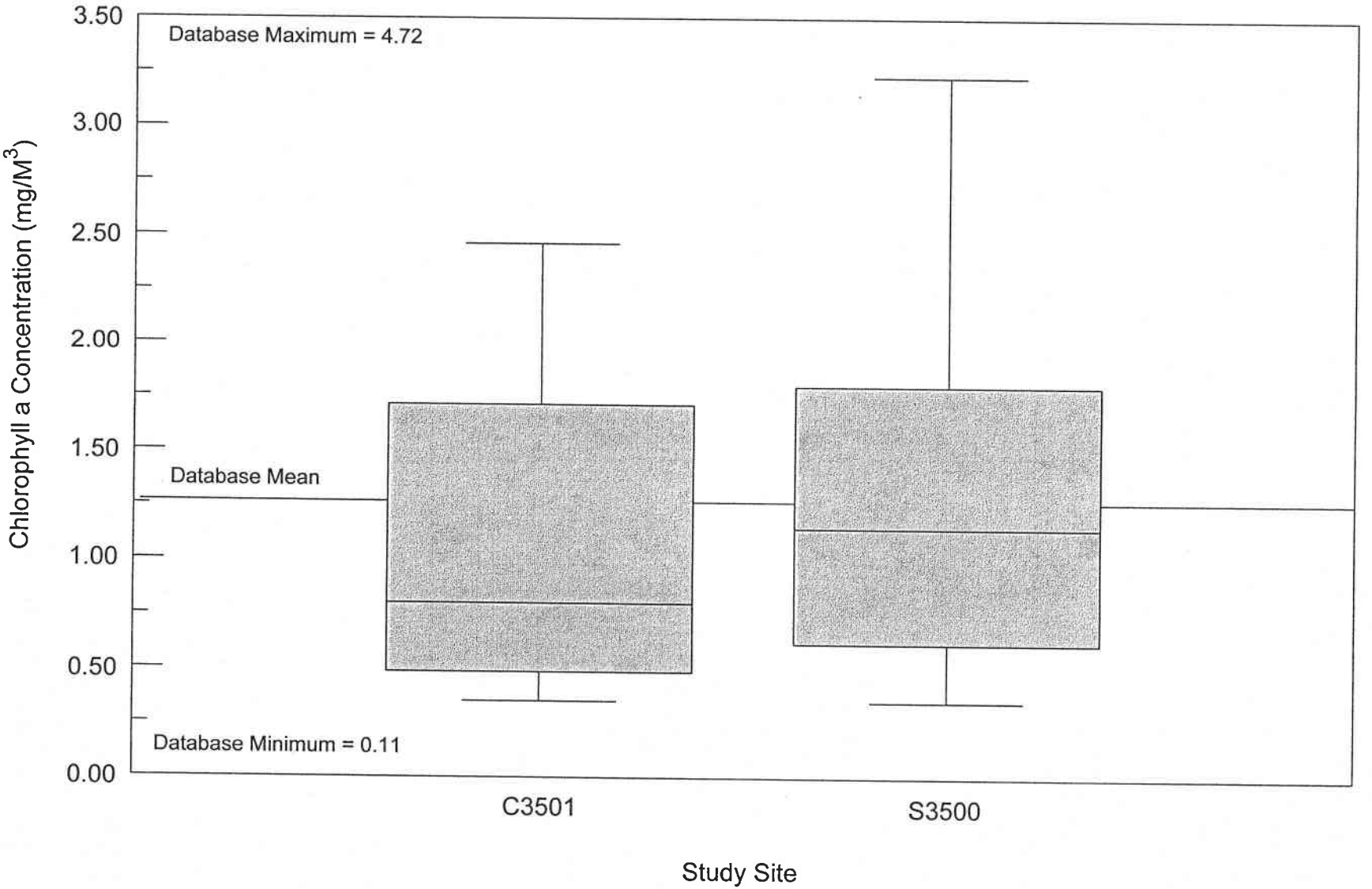


**FIGURE 4-15. CHLOROPHYLL A CONCENTRATION LAKE MICHIGAN 1995-2000**



# Appendix A
# Sediment

# APPENDIX A. PROPOSED DIFFUSER SITE SEDIMENT CORE DATA

| Date | Location | Site | Pct. Clay | Pct. Gravel | Pct. Sand | Pct. Silt |
|---|---|---|---|---|---|---|
| Nov-95 | S3500 | A-25 | 4.49 | 0.00 | 85.76 | 9.75 |
| Nov-95 | S3500 | B+125 | 4.65 | 0.00 | 81.71 | 13.64 |
| Nov-95 | S3500 | B+250 | 4.64 | 0.30 | 78.76 | 16.30 |
| Nov-95 | S3500 | B+25 | 4.01 | 0.05 | 82.40 | 13.54 |
| Nov-95 | S3500 | B+500 | 4.01 | 0.00 | 75.35 | 20.64 |
| Nov-95 | S3500 | B+750 | 2.72 | 0.10 | 75.53 | 21.65 |
| Nov-95 | S3500 | B+75 | 2.56 | 0.00 | 84.31 | 13.13 |
| Nov-95 | S3500 | B-125 | 4.49 | 0.60 | 67.18 | 27.73 |
| Nov-95 | S3500 | B-250 | 3.20 | 0.00 | 77.94 | 18.86 |
| Nov-95 | S3500 | B-25 | 4.81 | 0.85 | 67.86 | 26.47 |
| Nov-95 | S3500 | B-500 | 4.17 | 0.60 | 70.15 | 25.08 |
| Nov-95 | S3500 | B-750 | 4.17 | 0.00 | 79.89 | 15.94 |
| Nov-95 | S3500 | B-75 | 3.52 | 0.00 | 70.18 | 26.30 |
| Nov-95 | S3500 | B0 | 3.20 | 0.00 | 79.59 | 17.21 |
| Nov-95 | S3500 | C+25 | 4.68 | 0.05 | 78.33 | 16.94 |
| Nov-95 | S3500 | A-25 | 2.24 | 0.10 | 78.55 | 19.11 |
| Nov-95 | S3500 | B+125 | 3.68 | 0.00 | 69.84 | 26.48 |
| Nov-95 | S3500 | B+250 | 2.56 | 0.45 | 83.33 | 13.66 |
| Nov-95 | S3500 | B+25 | 2.24 | 0.00 | 81.90 | 15.86 |
| Nov-95 | S3500 | B+500 | 4.17 | 0.00 | 77.43 | 18.40 |
| Nov-95 | S3500 | B+750 | 1.60 | 0.00 | 76.51 | 21.89 |
| Nov-95 | S3500 | B+75 | 2.88 | 0.00 | 80.36 | 16.76 |
| Nov-95 | S3500 | B-125 | 3.20 | 0.00 | 78.79 | 18.01 |
| Nov-95 | S3500 | B-250 | 1.92 | 0.30 | 85.34 | 12.44 |
| Nov-95 | S3500 | B-25 | 3.04 | 0.25 | 81.57 | 15.14 |
| Nov-95 | S3500 | B-500 | 2.88 | 0.20 | 79.37 | 17.55 |
| Nov-95 | S3500 | B-750 | 4.49 | 0.00 | 77.17 | 18.34 |
| Nov-95 | S3500 | B-75 | 2.56 | 0.10 | 82.51 | 14.83 |
| Nov-95 | S3500 | B0 | 4.81 | 0.40 | 74.65 | 20.14 |
| Nov-95 | S3500 | C+25 | 1.60 | 0.80 | 78.47 | 19.13 |
| Nov-95 | S3500 | A-25 | 4.81 | 0.05 | 80.93 | 14.21 |
| Nov-95 | S3500 | B+750 | 1.76 | 5.36 | 79.71 | 13.17 |
| Nov-95 | S3500 | B0 | 3.20 | 0.05 | 84.02 | 12.73 |
| Nov-95 | S3500 | C+25 | 4.81 | 0.00 | 72.24 | 22.95 |
| Jun-96 | S3500 | A0 | 3.37 | 11.36 | 73.26 | 12.01 |
| Jun-96 | S3500 | B+125 | 2.11 | 0.00 | 77.66 | 20.23 |
| Jun-96 | S3500 | B+250 | 1.98 | 0.98 | 68.69 | 28.35 |
| Jun-96 | S3500 | B+500 | 1.01 | 0.00 | 85.22 | 13.77 |
| Jun-96 | S3500 | B+75 | 2.64 | 0.00 | 79.47 | 17.89 |
| Jun-96 | S3500 | B+750 | 0.91 | 0.00 | 80.91 | 18.18 |
| Jun-96 | S3500 | B-125 | 0.90 | 0.45 | 80.28 | 18.37 |
| Jun-96 | S3500 | B-250 | 0.99 | 0.00 | 80.41 | 18.60 |
| Jun-96 | S3500 | B-500 | 2.79 | 0.30 | 81.57 | 15.34 |
| Jun-96 | S3500 | B-75 | 2.17 | 0.10 | 78.86 | 18.87 |
| Jun-96 | S3500 | B-750 | 1.20 | 0.00 | 81.30 | 17.50 |
| Jun-96 | S3500 | B0 | 1.19 | 0.00 | 84.44 | 14.37 |
| Jun-96 | S3500 | C0 | 1.85 | 0.00 | 75.86 | 22.29 |
| Jun-96 | S3500 | D+125 | 0.95 | 0.00 | 82.73 | 16.32 |
| Jun-96 | S3500 | D+250 | 1.87 | 0.05 | 74.63 | 23.45 |

## APPENDIX A. PROPOSED DIFFUSER SITE SEDIMENT CORE DATA

| Date | Location | Site | Pct. Clay | Pct. Gravel | Pct. Sand | Pct. Silt |
|---|---|---|---|---|---|---|
| Jun-96 | S3500 | D+500 | 1.69 | 0.00 | 71.11 | 27.20 |
| Jun-96 | S3500 | D+75 | 2.00 | 0.00 | 84.55 | 13.45 |
| Jun-96 | S3500 | D+750 | 0.85 | 0.00 | 77.89 | 21.26 |
| Oct-96 | S3500 | A0 | 0.36 | 0.40 | 71.36 | 27.88 |
| Oct-96 | S3500 | B+125 | 0.66 | 0.00 | 68.51 | 30.83 |
| Oct-96 | S3500 | B+250 | 1.41 | 0.00 | 72.86 | 25.73 |
| Oct-96 | S3500 | B+500 | 2.00 | 0.25 | 71.58 | 26.17 |
| Oct-96 | S3500 | B+75 | 2.01 | 0.00 | 75.88 | 22.11 |
| Oct-96 | S3500 | B+750 | 1.63 | 0.50 | 74.45 | 23.42 |
| Oct-96 | S3500 | B-125 | 2.10 | 0.00 | 75.99 | 21.91 |
| Oct-96 | S3500 | B-250 | 1.34 | 0.00 | 75.04 | 23.62 |
| Oct-96 | S3500 | B-500 | 2.10 | 0.10 | 73.31 | 24.49 |
| Oct-96 | S3500 | B-75 | 2.32 | 0.00 | 77.07 | 20.61 |
| Oct-96 | S3500 | B-750 | 1.51 | 0.00 | 75.41 | 23.08 |
| Oct-96 | S3500 | B0 | 1.98 | 0.20 | 71.22 | 26.60 |
| Oct-96 | S3500 | C0 | 2.35 | 0.00 | 74.84 | 22.81 |
| Oct-96 | S3500 | D+125 | 1.99 | 0.00 | 75.41 | 22.60 |
| Oct-96 | S3500 | D+250 | 1.14 | 0.35 | 82.40 | 16.11 |
| Oct-96 | S3500 | D+500 | 2.65 | 0.00 | 79.57 | 17.78 |
| Oct-96 | S3500 | D+75 | 2.17 | 0.00 | 71.97 | 25.86 |
| Oct-96 | S3500 | D+750 | 2.07 | 0.00 | 72.77 | 25.16 |
| Oct-96 | C3501 | A0 | 0.90 | 0.00 | 56.87 | 42.23 |
| Oct-96 | C3501 | B+125 | 1.54 | 0.30 | 69.23 | 28.93 |
| Oct-96 | C3501 | B+250 | 4.71 | 0.00 | 69.42 | 25.87 |
| Oct-96 | C3501 | B+500 | 2.51 | 0.00 | 77.40 | 20.09 |
| Oct-96 | C3501 | B+75 | 1.52 | 0.10 | 77.73 | 20.65 |
| Oct-96 | C3501 | B+750 | 1.62 | 0.00 | 90.95 | 7.43 |
| Oct-96 | C3501 | B-125 | 0.78 | 0.00 | 61.06 | 38.16 |
| Oct-96 | C3501 | B-250 | 1.62 | 0.00 | 76.14 | 22.24 |
| Oct-96 | C3501 | B-500 | 1.66 | 0.00 | 77.13 | 21.21 |
| Oct-96 | C3501 | B-75 | 0.70 | 0.00 | 60.04 | 39.26 |
| Oct-96 | C3501 | B-750 | 1.65 | 0.00 | 78.88 | 19.47 |
| Oct-96 | C3501 | B0 | 4.27 | 0.00 | 69.09 | 29.64 |
| Oct-96 | C3501 | C0 | 1.95 | 0.00 | 70.62 | 27.43 |
| Oct-96 | C3501 | D+125 | 1.82 | 0.00 | 73.72 | 24.46 |
| Oct-96 | C3501 | D+250 | 1.15 | 0.00 | 69.58 | 29.27 |
| Oct-96 | C3501 | D+500 | 1.74 | 0.00 | 75.16 | 23.10 |
| Oct-96 | C3501 | D+75 | 1.11 | 0.00 | 61.87 | 37.02 |
| Oct-96 | C3501 | D+750 | 1.15 | 0.00 | 90.92 | 7.93 |
| Apr-97 | S3500 | A0 | 2.00 | 0.10 | 84.60 | 13.30 |
| Apr-97 | S3500 | B+125 | 0.85 | 0.35 | 78.09 | 20.71 |
| Apr-97 | S3500 | B+250 | 0.85 | 0.20 | 78.49 | 20.45 |
| Apr-97 | S3500 | B+500 | 2.34 | 0.10 | 74.78 | 22.78 |
| Apr-97 | S3500 | B+75 | 1.48 | 0.00 | 72.90 | 25.62 |
| Apr-97 | S3500 | B+750 | 2.14 | 0.00 | 71.52 | 26.34 |
| Apr-97 | S3500 | B-125 | 2.49 | 0.00 | 77.15 | 20.36 |
| Apr-97 | S3500 | B-250 | 2.91 | 0.00 | 83.37 | 13.72 |
| Apr-97 | S3500 | B-500 | 1.45 | 0.05 | 72.11 | 26.39 |
| Apr-97 | S3500 | B-75 | 3.85 | 0.20 | 74.11 | 21.85 |

## APPENDIX A. PROPOSED DIFFUSER SITE SEDIMENT CORE DATA

| Date | Location | Site | Pct. Clay | Pct. Gravel | Pct. Sand | Pct. Silt |
|---|---|---|---|---|---|---|
| Apr-97 | S3500 | B-750 | 2.04 | 0.00 | 69.75 | 28.21 |
| Apr-97 | S3500 | B0 | 1.89 | 0.25 | 82.31 | 15.55 |
| Apr-97 | S3500 | C0 | 2.71 | 0.05 | 69.64 | 27.60 |
| Apr-97 | S3500 | D+125 | 2.46 | 0.20 | 76.68 | 20.65 |
| Apr-97 | S3500 | D+250 | 2.26 | 0.55 | 72.90 | 24.32 |
| Apr-97 | S3500 | D+500 | 2.96 | 0.00 | 84.01 | 13.03 |
| Apr-97 | S3500 | D+75 | 1.40 | 0.00 | 70.89 | 27.71 |
| Apr-97 | S3500 | D+750 | 2.55 | 0.00 | 77.98 | 19.47 |
| Apr-97 | C3501 | A0 | 2.50 | 0.10 | 77.55 | 19.83 |
| Apr-97 | C3501 | B+125 | 2.41 | 0.00 | 75.92 | 21.67 |
| Apr-97 | C3501 | B+250 | 3.36 | 0.25 | 49.08 | 50.30 |
| Apr-97 | C3501 | B+500 | 1.75 | 0.24 | 64.60 | 33.41 |
| Apr-97 | C3501 | B+75 | 2.31 | 0.00 | 74.25 | 23.44 |
| Apr-97 | C3501 | B+750 | 4.04 | 0.30 | 76.12 | 19.53 |
| Apr-97 | C3501 | B-125 | 1.11 | 0.00 | 89.28 | 9.61 |
| Apr-97 | C3501 | B-250 | 1.76 | 0.00 | 70.91 | 27.33 |
| Apr-97 | C3501 | B-500 | 2.90 | 0.00 | 72.08 | 25.02 |
| Apr-97 | C3501 | B-75 | 2.89 | 0.00 | 84.40 | 12.72 |
| Apr-97 | C3501 | B-750 | 0.74 | 0.72 | 72.79 | 25.75 |
| Apr-97 | C3501 | B0 | 2.59 | 0.00 | 78.63 | 18.78 |
| Apr-97 | C3501 | C0 | 1.98 | 0.00 | 84.11 | 13.91 |
| Apr-97 | C3501 | D+125 | 0.94 | 0.00 | 82.16 | 16.90 |
| Apr-97 | C3501 | D+250 | 0.93 | 0.71 | 81.69 | 16.67 |
| Apr-97 | C3501 | D+500 | 0.62 | 0.00 | 66.77 | 32.60 |
| Apr-97 | C3501 | D+75 | 0.92 | 0.05 | 81.15 | 17.88 |
| Apr-97 | C3501 | D+750 | 3.06 | 0.10 | 85.50 | 11.34 |
| Oct-97 | C3501 | A0 | 1.55 | 0.00 | 74.41 | 24.04 |
| Oct-97 | C3501 | B+75 | 1.83 | 0.05 | 81.05 | 17.06 |
| Oct-97 | C3501 | B+125 | 0.00 | 0.20 | 88.30 | 11.47 |
| Oct-97 | C3501 | B+250 | 1.80 | 1.00 | 89.74 | 7.46 |
| Oct-97 | C3501 | B+500 | 3.71 | 0.15 | 80.46 | 15.68 |
| Oct-97 | C3501 | B+750 | 18.72 | 0.95 | 58.11 | 22.22 |
| Oct-97 | C3501 | B-75 | 1.58 | 2.25 | 79.33 | 16.84 |
| Oct-97 | C3501 | B-125 | 2.13 | 0.00 | 71.24 | 26.63 |
| Oct-97 | C3501 | B-250 | 1.54 | 0.20 | 82.91 | 15.35 |
| Oct-97 | C3501 | B-500 | 1.12 | 0.60 | 89.26 | 9.03 |
| Oct-97 | C3501 | B-750 | 1.04 | 0.05 | 86.40 | 12.51 |
| Oct-97 | C3501 | B0 | 1.23 | 0.00 | 74.11 | 24.66 |
| Oct-97 | C3501 | C0 | 1.07 | 0.65 | 87.61 | 10.67 |
| Oct-97 | C3501 | D+75 | 1.36 | 0.05 | 83.25 | 15.34 |
| Oct-97 | C3501 | D+125 | 1.01 | 0.05 | 85.21 | 13.73 |
| Oct-97 | C3501 | D+250 | 0.90 | 0.00 | 80.35 | 18.75 |
| Oct-97 | C3501 | D+500 | 1.32 | 0.00 | 88.76 | 9.92 |
| Oct-97 | C3501 | D+750 | 3.66 | 0.00 | 93.42 | 2.92 |
| Oct-97 | S3500 | A0 | 1.19 | 0.16 | 92.50 | 6.15 |
| Oct-97 | S3500 | B+75 | 3.05 | 0.05 | 91.63 | 5.27 |
| Oct-97 | S3500 | B+125 | 1.75 | 0.05 | 77.34 | 20.86 |
| Oct-97 | S3500 | B+250 | 2.70 | 0.10 | 89.78 | 7.42 |
| Oct-97 | S3500 | B+500 | 2.23 | 0.10 | 89.36 | 8.31 |

## APPENDIX A. PROPOSED DIFFUSER SITE SEDIMENT CORE DATA

| Date | Location | Site | Pct. Clay | Pct. Gravel | Pct. Sand | Pct. Silt |
|---|---|---|---|---|---|---|
| Oct-97 | S3500 | B+750 | 2.46 | 0.00 | 82.38 | 15.16 |
| Oct-97 | S3500 | B-75 | 2.80 | 0.00 | 72.61 | 24.59 |
| Oct-97 | S3500 | B-125 | 2.60 | 0.00 | 86.36 | 11.04 |
| Oct-97 | S3500 | B-250 | 1.51 | 0.30 | 73.50 | 24.69 |
| Oct-97 | S3500 | B-500 | 2.07 | 0.00 | 82.03 | 15.90 |
| Oct-97 | S3500 | B-750 | 2.30 | 0.00 | 90.84 | 6.86 |
| Oct-97 | S3500 | B0 | 7.90 | 0.00 | 77.18 | 14.92 |
| Oct-97 | S3500 | C0 | 1.28 | 0.00 | 87.27 | 11.45 |
| Oct-97 | S3500 | D+75 | 1.12 | 0.35 | 89.70 | 8.83 |
| Oct-97 | S3500 | D+125 | 1.99 | 0.00 | 80.50 | 17.51 |
| Oct-97 | S3500 | D+250 | 2.06 | 0.00 | 85.82 | 12.12 |
| Oct-97 | S3500 | D+500 | 1.76 | 0.15 | 69.69 | 28.40 |
| Oct-97 | S3500 | D+750 | 1.32 | 0.00 | 82.28 | 16.40 |
| Aug-98 | C3501 | B-750A | 2.90 | 1.57 | 83.22 | 12.31 |
| Aug-98 | C3501 | B-500A | 1.10 | 0.27 | 88.63 | 10.00 |
| Aug-98 | C3501 | B-250A | 1.11 | 0.00 | 89.34 | 9.55 |
| Aug-98 | C3501 | B-125A | 1.24 | 1.27 | 94.26 | 3.22 |
| Aug-98 | C3501 | **B-75A** | 1.80 | 3.24 | 80.24 | 14.72 |
| Aug-98 | C3501 | B0A | 1.00 | 3.07 | 84.41 | 11.52 |
| Aug-98 | C3501 | B+75A | 1.74 | 0.05 | 79.02 | 19.09 |
| Aug-98 | C3501 | B+125A | 2.26 | 2.97 | 90.09 | 4.67 |
| Aug-98 | C3501 | B+250A | 1.66 | 5.19 | 77.20 | 15.95 |
| Aug-98 | C3501 | B+500A | 1.14 | 0.20 | 90.36 | 8.30 |
| Aug-98 | C3501 | B+750A | 1.87 | 6.77 | 81.72 | 9.64 |
| Aug-98 | C3501 | D+750A | 1.18 | 0.00 | 91.90 | 6.85 |
| Aug-98 | C3501 | D+500A | 2.10 | 0.25 | 86.75 | 10.90 |
| Aug-98 | C3501 | D+250A | 1.01 | 0.00 | 85.06 | 13.93 |
| Aug-98 | C3501 | D+125A | 5.57 | 0.00 | 78.36 | 16.07 |
| Aug-98 | C3501 | D+75A | 5.23 | 2.71 | 82.59 | 9.46 |
| Aug-98 | C3501 | C0A | 2.07 | 0.00 | 86.07 | 11.86 |
| Aug-98 | C3501 | A0A | 1.17 | 0.15 | 91.41 | 7.27 |
| Aug-98 | S3500 | B-750A | 2.17 | 1.50 | 88.09 | 8.24 |
| Aug-98 | S3500 | B-500A | 2.17 | 0.00 | 88.24 | 9.59 |
| Aug-98 | S3500 | B-250A | 2.07 | 0.00 | 86.14 | 11.79 |
| Aug-98 | S3500 | B-125A | 1.90 | 1.93 | 82.46 | 13.71 |
| Aug-98 | S3500 | B-75A | 2.09 | 0.00 | 86.44 | 11.47 |
| Aug-98 | S3500 | B0A | 2.89 | 0.00 | 83.11 | 14.00 |
| Aug-98 | S3500 | B+75A | 0.99 | 0.00 | 84.31 | 14.70 |
| Aug-98 | S3500 | B+125A | 4.04 | 5.88 | 85.03 | 5.05 |
| Aug-98 | S3500 | B+250A | 2.96 | 0.58 | 92.10 | 4.36 |
| Aug-98 | S3500 | B+500A | 1.79 | 0.69 | 80.22 | 17.30 |
| Aug-98 | S3500 | B+750A | 3.05 | 0.00 | 93.51 | 3.44 |
| Aug-98 | S3500 | D+750A | 2.12 | 0.00 | 87.22 | 10.66 |
| Aug-98 | S3500 | D+500A | 2.39 | 1.62 | 92.48 | 3.51 |
| Aug-98 | S3500 | D+250A | 1.09 | 0.00 | 88.50 | 10.40 |
| Aug-98 | S3500 | D+125A | 3.23 | 0.00 | 87.84 | 8.93 |
| Aug-98 | S3500 | D+75A | 3.12 | 0.05 | 86.26 | 10.57 |
| Aug-98 | S3500 | C0A | 2.23 | 0.00 | 89.31 | 8.46 |
| Aug-98 | S3500 | A0A | 4.11 | 0.00 | 91.66 | 4.23 |

## APPENDIX A. PROPOSED DIFFUSER SITE SEDIMENT CORE DATA

| Date | Location | Site | Pct. Clay | Pct. Gravel | Pct. Sand | Pct. Silt |
|---|---|---|---|---|---|---|
| Aug-99 | C3501 | B+250 | 3.20 | 1.30 | 86.80 | 10.00 |
| Aug-99 | C3501 | B+125A | 2.40 | 0.20 | 83.30 | 14.20 |
| Aug-99 | C3501 | B+75 | 1.10 | 0.00 | 88.90 | 10.00 |
| Aug-99 | C3501 | BO | 1.80 | 0.90 | 79.90 | 18.30 |
| Aug-99 | C3501 | B-75 | 3.00 | 1.80 | 84.00 | 13.10 |
| Aug-99 | C3501 | B-125A | 2.70 | 0.50 | 88.10 | 9.20 |
| Aug-99 | C3501 | B-250 | 3.40 | 0.00 | 90.20 | 6.40 |
| Aug-99 | C3501 | D75 | 4.50 | 0.00 | 84.70 | 10.80 |
| Aug-99 | C3501 | D125 | 3.80 | 0.00 | 88.00 | 8.30 |
| Aug-99 | C3501 | D250 | 3.40 | 2.00 | 83.80 | 12.70 |
| Aug-99 | S3500 | B+250 | 5.10 | 0.00 | 90.20 | 4.70 |
| Aug-99 | S3500 | B+125A | 3.30 | 0.20 | 88.90 | 7.80 |
| Aug-99 | S3500 | B+75 | 2.80 | 0.10 | 89.20 | 8.00 |
| Aug-99 | S3500 | BO | 3.70 | 0.00 | 87.10 | 9.20 |
| Aug-99 | S3500 | B-75 | 4.00 | 0.10 | 90.30 | 5.70 |
| Aug-99 | S3500 | B-125A | 3.20 | 0.10 | 87.00 | 9.80 |
| Aug-99 | S3500 | B-250 | 2.30 | 0.00 | 91.30 | 6.40 |
| Aug-99 | S3500 | D75 | 3.00 | 0.10 | 85.40 | 11.60 |
| Aug-99 | S3500 | D125 | 4.10 | 0.10 | 85.20 | 10.70 |
| Aug-99 | S3500 | D250 | 2.30 | 0.10 | 91.10 | 6.60 |
| Aug-00 | C3501 | B+25A | 4.90 | 1.60 | 77.80 | 17.30 |
| Aug-00 | C3501 | B+25B | 2.80 | 0.40 | 82.10 | 15.10 |
| Aug-00 | C3501 | B-25A | 3.10 | 0.40 | 79.90 | 17.00 |
| Aug-00 | C3501 | B-25B | 2.00 | 1.70 | 76.20 | 21.80 |
| Aug-00 | C3501 | D25A | 3.20 | 2.20 | 71.80 | 25.00 |
| Aug-00 | C3501 | D25B | 3.30 | 0.40 | 76.60 | 20.10 |
| Aug-00 | S3500 | B+25A | 6.10 | 0.00 | 78.70 | 15.20 |
| Aug-00 | S3500 | B+25B | 4.30 | 0.20 | 82.40 | 13.40 |
| Aug-00 | S3500 | B-25A | 6.20 | 0.00 | 79.50 | 14.40 |
| Aug-00 | S3500 | B-25B | 2.90 | 0.30 | 77.40 | 19.70 |
| Aug-00 | S3500 | D25A | 5.00 | 0.00 | 89.40 | 5.60 |
| Aug-00 | S3500 | D25B | 3.60 | 0.10 | 79.90 | 16.60 |

# Appendix B
# Biological Data

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** |
| **Location** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** |
| **Site** | **B+75** | **B-75** | **B+250** | **B-250** | **B+750** | **D+75** | **D+500** | **B0** | **B-75** | **B-125** | **B-250** | **B-500** |
| Chironomidae | | | | | | | | | | | | |
| immature | | 80 | | | | | | 40 | 100 | | | 40 |
| Chironomini | | | | | | | | | | | | |
| *Chironomus* | | | | | 30 | | | | | | | |
| *Cryptochironomus* | | | | | | | | | 50 | | | |
| *Eukiefferiella* | | | | | | | | | | | | |
| *Harnischia* | | | | | | | | | | | | |
| *Phaenopsectra* | 40 | | | | | | | | | | | |
| *Polypedilum* | | | | | | 50 | | | | | | |
| *Pseudochironomus* | | | | | | | | | | | | |
| *Sergentia* | | | | | | | | | | | | |
| *Tanytarsus* | | | | | | | | | | | | |
| *Thienemannimyia* | | | | | | | | | | | | |
| Orthocladiinae | | | 150 | 40 | | 200 | | | | | | |
| *Corynoneura* | | | | | 30 | | | | | | | |
| *Diplocladius* | | | | | | | | | | | | |
| *Nanocladius* | | | | | | | | | | | | |
| *Orthocladius* | | | | | | | | | | | | |
| *Procladius* | | | | | | | | | | | | |
| *Psectrocladius* | | | | | | | | | | | | |
| *Stilocladius* | | | | | | | | | | | | |
| *Zalutschia* | | | | | | | | | | | | |
| Diamesinae | | | | | | | | | | | | |
| Oligochaeta | | | | | | | | | | | | |
| Lumbriculidae | | | | | | | | | | | | |
| Tubificid immature | 320 | 240 | 300 | 320 | 420 | | | | 150 | 300 | 60 | 280 |
| Tubificidae | | | | | | | | | | | | |
| *Potomothrix* | | | | | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Nov-95** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** |
| **Location** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** |
| **Site** | **B+75** | **B-75** | **B+250** | **B-250** | **B+750** | **D+75** | **D+500** | **B0** | **B-75** | **B-125** | **B-250** | **B-500** |
| Hirudinae | | | | | | | | | | | | |
| *Marvinmeyeria* | | | | | | | | | | | | |
| Gastropoda | | | | | | | | | | | | |
| *Pseudosuccinea* | | 40 | | | | | | | | | | |
| *Amnicola pilsbryi* | | 80 | | 40 | | | 50 | 40 | | | | |
| *Bulimnea* | | | | | | | | | | | | |
| *Elimia* | | | | | | | | | | | | |
| *Fossaria* | | | | | | | | | | | | |
| *Marstonia* | | | | | | | | | | | | |
| *Physella* | | | 50 | | | | | | | | | |
| *Pleurocera* | | | | | | | | | | | | |
| *Radix* | | | | | | | | | | | | |
| *Valvata* | | 40 | 50 | | | | | | | | | |
| *Valvata bicarinata* | | | | | | | | 40 | | | | |
| Pelecypoda | | | | | | | | | | | | |
| *Dreissena polymorpha* | | 40 | | | 30 | | | | | 50 | | |
| *Pisidium* | 40 | 80 | 200 | 80 | 30 | | 150 | | 50 | | | |
| Turbellaria | | | | | | | | | | | | |
| Amphipoda | | | | | | | | | | | | |
| *Pontoporeia hoyi* | | | | | | 50 | | | | | | |
| | | | | | | | | | | | | |
| **Density** | **400** | **600** | **750** | **480** | **540** | **300** | **200** | **120** | **350** | **350** | **60** | **320** |
| **Richness** | **3** | **7** | **5** | **4** | **5** | **3** | **2** | **3** | **4** | **2** | **1** | **2** |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 | Jun-96 |
| Location | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 |
| Site | B-750 | B+75 | B+125 | B+250 | B+500 | B+750 | D+75 | D+125 | D+250 | D+500 | D+750 | A0 |
| Chironomidae | | | | | | | | | | | | |
| immature | | | | | 40 | 120 | 50 | | | 30 | | |
| Chironomini | | | | | | | | | | | | |
| *Chironomus* | | | | | | | | | | | | |
| *Cryptochironomus* | | | | | | | | | | | | |
| *Eukiefferiella* | | | | | | | | | | 30 | | |
| *Harnischia* | | | | | | | | | | | | |
| *Phaenopsectra* | | 40 | | | | | | | | | | |
| *Polypedilum* | | | | 70 | | | | | | | | |
| *Pseudochironomus* | | | | | | | | | | | | |
| *Sergentia* | | | | | | | | | | | | |
| *Tanytarsus* | | | | | | | | | | | | |
| *Thienemannimyia* | | | | | | | | | | | | |
| Orthocladiinae | | | | | | | | | | | | |
| *Corynoneura* | | | | | | | | | | | | |
| *Diplocladius* | | | | | | | | | | | | |
| *Nanocladius* | | | | | | | | | | | | |
| *Orthocladius* | | | | | | | | | | | | |
| *Procladius* | | | | | | | | | | | | |
| *Psectrocladius* | | | | | | | | | | | | |
| *Stilocladius* | | | | | | | | | | | | |
| *Zalutschia* | | | | | | | | | | | | |
| Diamesinae | | | | | | | | | | | | |
| Oligochaeta | | | | | | | | | | | | |
| Lumbriculidae | | | | | | | | | | | | |
| Tubificid immature | 190 | 470 | 230 | 70 | 320 | | 300 | 530 | 300 | 120 | 40 | |
| Tubificidae | | | | | | | | | | | | |
| *Potomothrix* | | | | | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** | **Jun-96** |
| **Location** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** |
| **Site** | **B-750** | **B+75** | **B+125** | **B+250** | **B+500** | **B+750** | **D+75** | **D+125** | **D+250** | **D+500** | **D+750** | **A0** |
| Hirudinae | | | | | | | | | | | | |
| *Marvinmeyeria* | | | | | | | | | | | | |
| Gastropoda | | | | | | | | | | | | |
| *Pseudosuccinea* | | | | | | | 110 | | | | | |
| *Amnicola pilsbryi* | | 40 | | | | | 110 | | | 60 | 40 | |
| *Bulimnea* | | | | | | | | | | | | |
| *Elimia* | | | | | | | | | | | | |
| *Fossaria* | | | | | | | | | | | | |
| *Marstonia* | | | | | | | | | | | | |
| *Physella* | | | | | | | | | | | | |
| *Pleurocera* | | | | | | | | | | | | |
| *Radix* | | | | | | | | | | | | |
| *Valvata* | | | | | | | 50 | | | | | |
| *Valvata bicarinata* | | | | | | | | | | 60 | | |
| Pelecypoda | | | | | | | | | | | | |
| *Dreissena polymorpha* | | | 40 | 280 | | | | | | | | |
| *Pisidium* | | | | | | | 2610 | | 60 | 30 | 40 | |
| Turbellaria | | | | | | | | | | | | |
| Amphipoda | | | | | | | | | | | | |
| *Pontoporeia hoyi* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Density** | **190** | **550** | **270** | **420** | **360** | **120** | **3230** | **530** | **360** | **330** | **120** | **0** |
| **Richness** | **1** | **3** | **2** | **3** | **2** | **1** | **6** | **1** | **2** | **6** | **3** | **0** |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Jun-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 |
| Location | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 |
| Site | C0 | B+750a | B+750b | B+500a | B+500b | B+250a | B+250b | B+125a | B+125b | B+75a | B+75b | B0a |
| Chironomidae | | | | | | | | | | | | |
| immature | 40 | | | | | | | | | | | |
| Chironomini | | | | 40 | | | | | | | 40 | |
| *Chironomus* | | | | | | | | | | | | |
| *Cryptochironomus* | | | 40 | | 40 | | | 30 | | 30 | 40 | |
| *Eukiefferiella* | | | | | | | | | | | | |
| *Harnischia* | | | | | | | | | | | | |
| *Phaenopsectra* | | | | | | | | | | | | |
| *Polypedilum* | | 40 | 80 | 80 | | | | | | | 40 | |
| *Pseudochironomus* | | | | | | | | | | | | |
| *Sergentia* | | | | | | | | | | | | |
| *Tanytarsus* | | | | | | | | | | | | |
| *Thienemannimyia* | | | | | | | | | | | | |
| Orthocladiinae | | | | | | | | | | | | |
| *Corynoneura* | | | | | | | | | | | | |
| *Diplocladius* | | | | | | | | | | | | |
| *Nanocladius* | | | | 40 | | | | | | | | |
| *Orthocladius* | | | | | | | | | | | | |
| *Procladius* | | | | | | | | | | | | |
| *Psectrocladius* | | | | | | | | | | | | |
| *Stilocladius* | | | | | | | | | | | | |
| *Zalutschia* | | | | | | | | | | | | |
| Diamesinae | | | | | | | | | | | | |
| Oligochaeta | | 240 | 200 | 320 | 440 | 600 | 210 | 150 | 280 | 180 | 320 | 90 |
| Lumbriculidae | | | | | | | | | | | | |
| Tubificid immature | | | | | | | | | | | | |
| Tubificidae | | | | | | | | | | | | |
| *Potomothrix* | | | | | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Jun-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** |
| **Location** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** |
| **Site** | **C0** | **B+750a** | **B+750b** | **B+500a** | **B+500b** | **B+250a** | **B+250b** | **B+125a** | **B+125b** | **B+75a** | **B+75b** | **B0a** |
| Hirudinae | | | | | | | | | | | | |
| *Marvinmeyeria* | | | | | | | | | | | | |
| Gastropoda | | | | | | | | | | | | |
| *Pseudosuccinea* | | | | 160 | | | | | | | | |
| *Amnicola pilsbryi* | | | | 240 | | | | | | | | |
| *Bulimnea* | | | | | | | | | | | | |
| *Elimia* | | | | | | | | | | | | |
| *Fossaria* | | | | 40 | | | | | | | | |
| *Marstonia* | | | | | | | | | | | | |
| *Physella* | | | | 40 | | | | | | | | |
| *Pleurocera* | | | | | | | | | | | | |
| *Radix* | | | | | | | | | | | | |
| *Valvata* | 40 | | 80 | 160 | | | | 60 | | | | |
| *Valvata bicarinata* | | | | | | | | | | | | |
| Pelecypoda | | | | | | | | | | | | |
| *Dreissena polymorpha* | 40 | 240 | 120 | | | | | | | | | |
| *Pisidium* | | | | 120 | | | | | | | | |
| Turbellaria | | | | | | | | | | | | |
| Amphipoda | | | | | | | | | | | | |
| *Pontoporeia hoyi* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Density** | **120** | **520** | **520** | **1240** | **480** | **600** | **210** | **240** | **280** | **210** | **440** | **90** |
| **Richness** | **3** | **3** | **5** | **10** | **2** | **1** | **1** | **3** | **1** | **2** | **4** | **1** |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** |
| **Location** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** |
| **Site** | **B0b** | **B-75a** | **B-75b** | **B-125a** | **B-125b** | **B-250a** | **B-250b** | **B-500a** | **B-500b** | **B-750a** | **B-750b** | **D+75a** |
| Chironomidae | | | | | | | | | | | | |
| immature | | | | | | | | | | | | |
| Chironomini | | | | | | | | | | | | |
| *Chironomus* | | | | | | | | | | | | |
| *Cryptochironomus* | | 30 | | | | | | 30 | 60 | 90 | 80 | 80 |
| *Eukiefferiella* | | | | | | | | | | | | |
| *Harnischia* | | | | | | | | | | | | |
| *Phaenopsectra* | | | | | | | | | | | | |
| *Polypedilum* | | 30 | | | 30 | | | | | 30 | 80 | |
| *Pseudochironomus* | | | | | | | | | | | | |
| *Sergentia* | | | | | | | | | | | | |
| *Tanytarsus* | | | | | | | | | | | | |
| *Thienemannimyia* | | | | | | | | | | | | |
| Orthocladiinae | | | | | | | | | | 30 | 40 | |
| *Corynoneura* | | | | | | | | | | | | |
| *Diplocladius* | | | | | | | | 30 | | | | |
| *Nanocladius* | | 30 | | | | | | | | | | |
| *Orthocladius* | | | | | | | | | | | | |
| *Procladius* | | | | | | | | | | | | |
| *Psectrocladius* | | | | | | | | | | | | |
| *Stilocladius* | | | | | | | | | | | | |
| *Zalutschia* | | | | | | | | | | | | |
| Diamesinae | | | | | | | | | | | | |
| Oligochaeta | 160 | 90 | 150 | 240 | 120 | 200 | 400 | 150 | 600 | 270 | 440 | 240 |
| Lumbriculidae | | | | | | | | | | | | |
| Tubificid immature | | | | | | | | | | | | |
| Tubificidae | | | | | | | | | | | | |
| *Potomothrix* | | | | | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** |
| **Location** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** |
| **Site** | **B0b** | **B-75a** | **B-75b** | **B-125a** | **b-125b** | **B-250a** | **B-250b** | **B-500a** | **B-500b** | **B-750a** | **B-750b** | **D+75a** |
| Hirudinae | | | | | | | | | | | | |
| *Marvinmeyeria* | | | | | | | | | | | | |
| Gastropoda | | | | | | | | | | | | |
| *Pseudosuccinea* | 40 | 60 | 30 | | | | | | | 30 | | |
| *Amnicola pilsbryi* | | | 30 | | | 80 | 80 | 30 | | 120 | 80 | 80 |
| *Bulimnea* | | | | | | | | | | | | |
| *Elimia* | | | | | | | | | | | | |
| *Fossaria* | | | | | | | | | | | | |
| *Marstonia* | | | | | | | | | | | | |
| *Physella* | | | | | | | | | | | | |
| *Pleurocera* | | | | | | | | | | | | |
| *Radix* | | | | | | | | | | | | |
| *Valvata* | 320 | | | | 30 | 120 | 80 | 120 | | 120 | 120 | 80 |
| *Valvata bicarinata* | | | | | | | | | | | | |
| Pelecypoda | | | | | | | | | | | | |
| *Dreissena polymorpha* | | 120 | 60 | | | | | | | | | |
| *Pisidium* | | 90 | 60 | | | 200 | | 60 | 60 | 60 | 40 | 80 |
| Turbellaria | | | | | | | | | | | | |
| Amphipoda | | | | | | | | | | | | |
| *Pontoporeia hoyi* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Density** | **520** | **450** | **330** | **240** | **180** | **600** | **560** | **420** | **720** | **750** | **880** | **560** |
| **Richness** | **3** | **7** | **5** | **1** | **3** | **4** | **3** | **6** | **3** | **8** | **7** | **5** |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 | Oct-96 |
| Location | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 |
| Site | D+75b | D+125a | D+125b | D+250a | D+250b | D+500a | D+500b | D+750a | D+750b | A0a | A0b | C0a |
| Chironomidae | | | | | | | | | | | | |
| immature | | | | | | | | | | | | |
| Chironomini | | | | | | | | | | | | |
| *Chironomus* | | | | | | | | | | | | |
| *Cryptochironomus* | 30 | | | | | | | | | | | 30 |
| *Eukiefferiella* | | | | | | | | | | | | |
| *Harnischia* | | | | | | | | | | | | |
| *Phaenopsectra* | | | | | | | | | | | | |
| *Polypedilum* | 180 | | | | 150 | | | | 80 | | 40 | |
| *Pseudochironomus* | | | | | | | | | | | | |
| *Sergentia* | | | | | | | | | | | | |
| *Tanytarsus* | | | | | | | | | | | | |
| *Thienemannimyia* | | | | | | | | | | | | |
| Orthocladiinae | | | | | | | | | | | | |
| *Corynoneura* | | | | | | | | | | | | |
| *Diplocladius* | | | | | | | | | | | | |
| *Nanocladius* | | | | | | | | | | | | |
| *Orthocladius* | | | | | | | | | | | | |
| *Procladius* | | | | | | | | | | | | |
| *Psectrocladius* | | | | | | | | | | | | |
| *Stilocladius* | | | | | | | | | | | | |
| *Zalutschia* | | | | | | | | | | | | |
| Diamesinae | | | | | | | | | | | | |
| Oligochaeta | 390 | 360 | 80 | 160 | 50 | 30 | 150 | 240 | 320 | 210 | 120 | 210 |
| Lumbriculidae | | | | | | | | | | | | |
| Tubificid immature | | | | | | | | | | | | |
| Tubificidae | | | | | | | | | | | | |
| *Potomothrix* | | | | | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** |
| **Location** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** |
| **Site** | **D+75b** | **D+125a** | **D+125b** | **D+250a** | **D+250b** | **D+500a** | **D+500b** | **D+750a** | **D+750b** | **A0a** | **A0b** | **C0a** |
| Hirudinae | | | | | | | | | | | | |
| *Marvinmeyeria* | | | | | | | | | | | | |
| Gastropoda | | | | | | | | | | | | |
| *Pseudosuccinea* | 30 | | | | | | | | | | | |
| *Amnicola pilsbryi* | | 40 | | | | 30 | | | 40 | | | |
| *Bulimnea* | | | | | | | | | | | | |
| *Elimia* | | | | | | | | | | | | |
| *Fossaria* | | | | | | | | | | | | |
| *Marstonia* | | | | | | | | | | | | |
| *Physella* | | | | | | | | | | | | |
| *Pleurocera* | | | | | | | | | | | | |
| *Radix* | | | | | | | | | | | | |
| *Valvata* | | 80 | 40 | 80 | | | 50 | | | | 40 | |
| *Valvata bicarinata* | | | | | | | | | | | | |
| Pelecypoda | | | | | | | | | | | | |
| *Dreissena polymorpha* | 30 | | | | 50 | 30 | | | | 30 | | |
| *Pisidium* | 60 | | 40 | 80 | 50 | 60 | 50 | | | 30 | | |
| Turbellaria | | | | | | | | | | | | |
| Amphipoda | | | | | | | | | | | | |
| *Pontoporeia hoyi* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Density** | **720** | **480** | **160** | **320** | **300** | **150** | **250** | **240** | **440** | **270** | **200** | **240** |
| **Richness** | **6** | **3** | **3** | **3** | **4** | **4** | **3** | **1** | **3** | **3** | **3** | **2** |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** |
| **Location** | **S3500** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** |
| **Site** | **C0b** | **B+750a** | **B+750b** | **B+500a** | **B+500b** | **B+250a** | **B+250b** | **B+125a** | **B+125b** | **B+75a** | **B+75b** | **B0a** |
| Chironomidae | | | | | | | | | | | | |
| immature | | | | | | | | | | | | |
| Chironomini | | | | | | | | | | | | |
| *Chironomus* | | | | | | | | | | | | |
| *Cryptochironomus* | | | | 40 | | 30 | | | | | 40 | |
| *Eukiefferiella* | | | | | | | | | | | | |
| *Harnischia* | | | | | | | | | | | | |
| *Phaenopsectra* | | | | | | | | | | | | |
| *Polypedilum* | | | | 120 | 40 | 30 | | | | | | 50 |
| *Pseudochironomus* | | | | | | | | | | | | |
| *Sergentia* | | | | | | | | | | | | |
| *Tanytarsus* | | | | | | | | | | | | |
| *Thienemannimyia* | | | | | | | | | | | | |
| Orthocladiinae | | | | | | | | | | | | |
| *Corynoneura* | | | | | | | | | | | | |
| *Diplocladius* | | | | | | | | | | | | |
| *Nanocladius* | | | | | | | | | | | | |
| *Orthocladius* | | | | | | | | | | | | |
| *Procladius* | | | | | | | | | | | | |
| *Psectrocladius* | | | | | | | | | | | | |
| *Stilocladius* | | | | | | | | | | | | |
| *Zalutschia* | | | | | | | | | | | | |
| Diamesinae | | | | | | | | | | | | |
| Oligochaeta | 280 | | | 320 | 360 | 240 | 240 | 150 | 240 | 400 | 160 | 100 |
| Lumbriculidae | | | | | | | | | | | | |
| Tubificid immature | | | | | | | | | | | | |
| Tubificidae | | | | | | | | | | | | |
| *Potomothrix* | | | | | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE BENTHOS DATA

| Number of Benthos Organisms per Square Meter ($m^2$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** |
| **Location** | **S3500** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** | **C3501** |
| **Site** | **C0b** | **B+750a** | **B+750b** | **B+500a** | **B+500b** | **B+250a** | **B+250b** | **B+125a** | **B+125b** | **B+75a** | **B+75b** | **B0a** |
| Hirudinae | | | | | | | | | | | | |
| *Marvinmeyeria* | | | | | | | | | | | | |
| Gastropoda | | | | | | | | | | | | |
| *Pseudosuccinea* | | | | | | | | | | | | |
| *Amnicola pilsbryi* | | | | | | | | 30 | | | | 100 |
| *Bulimnea* | | | | | | | | | | | | |
| *Elimia* | | | | | | | | | | | | |
| *Fossaria* | | | | | | | | | | | | |
| *Marstonia* | | | | | | | | | | | | |
| *Physella* | | | | | | | | | | | | |
| *Pleurocera* | | | | | | | | | | | | |
| *Radix* | | | | | | | | | | | | |
| *Valvata* | 160 | | | 40 | | | | 60 | | | | 50 |
| *Valvata bicarinata* | | | | | | | | | | | | |
| Pelecypoda | | | | | | | | | | | | |
| *Dreissena polymorpha* | | | | | | | | | | 40 | | |
| *Pisidium* | 80 | | | | | | | | | | | |
| Turbellaria | | | | | | | | | | | | |
| Amphipoda | | | | | | | | | | | | |
| *Pontoporeia hoyi* | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Density** | **520** | **0** | **0** | **520** | **400** | **300** | **240** | **240** | **240** | **440** | **200** | **300** |
| **Richness** | **3** | **0** | **0** | **4** | **2** | **3** | **1** | **3** | **1** | **2** | **2** | **4** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Aug-98 | Aug-98 | Aug-98 | Aug-98 | Aug-98 | Aug-98 | Aug-98 | Aug-98 |
| Location | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| Chlorophyta | | | | | | | | |
| *Actinastrum hantzschii* Lagerheim | | | | | | | | |
| *Ankistrodesmus sp.* | | | | | | | | 7 |
| *Ankistrodesmus braunii* (Naeg.) Brunthaller | | | | | | | | |
| *Ankistrodesmus falcatus* var. *mirabilis* G.S. West | | 14 | | 7 | 11 | | | |
| *Chlamydomonas sp.* Ehrenberg | | | | | | 64 | 49 | 46 |
| *Chlamydomonas globosa* Snow | 102 | 194 | 131 | 134 | 92 | | | |
| *Chlorella/Chlorococcum humicola* (Naeg.) Rabenhorst | 258 | 364 | 237 | 237 | 261 | | | |
| *Chlorococcum sp.* | | | | | | | | |
| *Chlorococcum/Palmella* | | | | | | 258 | 215 | 184 |
| *Closterium sp.* | | | | | | | | |
| *Coelastrum sp.* | | | | | | 7 | 4 | |
| *Coelastrum* c.f. *microporum* Nageli. | 7 | 4 | | | 7 | | | |
| *Cosmarium sp.* Corda | | | | | | | | |
| *Crucigenia sp.* | | | | | | | | |
| *Crucigenia tetrapedia* (Kirch.) West & West | | | 1 | 1 | | | | |
| *Elakatotrhix viridis* (Snow) Printz | | | | | | | | |
| *Gloeocystis sp.* | | | | | | | 4 | 14 |
| *Gloeocystis gigas* Kutzing. | 35 | 14 | 21 | 11 | 4 | | | |
| *Gloeocystis planktonica* (West & West) Lemmerman | 104 | 161 | 99 | 96 | 111 | | | |
| *Golenkinia paucispina* West & West | | | | | | | | |
| *Gonatozygon sp.* | | | | | | | | |
| *Gonium sp.* | | | | | | 21 | 14 | 7 |
| *Gonium c.f. sociale* (Duj.) Warming | 64 | 102 | 60 | 80 | 60 | | | |
| *Gonium pectorale* Mueller | | | | 5 | | | | |
| *Hyalotheca sp.* | | | | | | | | |
| *Hyalotheca dissiliens* | | | 7 | | | | | |
| *Microspora sp.* | | | | | | 18 | | |
| *Microspora* c.f. *quadrata* Hazen | 18 | 11 | 7 | | 35 | | | |
| *Oedogonium sp.* Link | | | | | | | | |
| *Oocystis sp.* Naegeli in A. Brown | | | | | | | | |
| *Pediastrum sp.* | | | | | | | 11 | |
| *Pediastrum boryanum* (Turp.) Meneghini | | | | | | | | |
| *Pediastrum c.f. duplex* Meyen | | | | | | | | |
| *Pediastrum simplex* (Meyen) Lemmermann | 11 | 7 | 11 | 4 | | | | |
| *Planktosphaeria sp.* | | | | | | | | |
| *Planktosphaeria gelatinosa* G.M Smith | 4 | 11 | 7 | | 21 | | | |
| *Scenedesmus bijuga* (Turp.) Lagerheim | 20 | 24 | 16 | 28 | 48 | | | |
| *Scenedesmus brasiliensis* Bohlin | | | | | | | | |
| *Scenedesmus quadricauda* (Turp.) deBrebisson | 58 | 64 | 62 | 110 | 86 | | | |
| *Scenedesmus II* | | | | | | | | |
| *Scenedesmus sp.* Meyen | | | | | | 92 | 56 | 64 |
| *Selenastrum sp.* | | | | | | | 11 | |
| *Selenastrum minutum* (Naeg.) Collins | | | | | | | | |
| *Selenastrum westii* G.M. Smith | | 4 | | | | | | |
| *Sphaerocystis schroeteri* Chodat | | | | | | | | |
| *Spyrogyra sp.* | | | | | | | | |
| *Staurastrum sp.* Meyen | | | 1 | | | 4 | 14 | |
| *Tetraspora sp.* | 27 | 40 | 25 | 24 | 13 | 4 | 7 | |
| *Tetraspora c.f. lacustris* Lemmermann | | | | | | | | |
| Unknown green spheres | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** |
| **Location** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** |
| Cyanophyta | | | | | | | | |
| *Agmenellum sp.* | | | | | | 11 | 7 | |
| *Agmenellum tenuissima* Lemmermann | 21 | 4 | 11 | 11 | | | | |
| *Anabaena sp.* | | | 11 | 4 | | | | 4 |
| *Anacystis sp.* | | | | | | 21 | 11 | 7 |
| *Aphanocapsa delicatissima* West & West | | | | | | | | |
| *Chroococcus sp.* | | | | | | 81 | 106 | 127 |
| *Chroococcus limneticus* Lemmermann | | | | | | | | |
| *Chroococcus major* | | | | | | | | |
| *Chroococcus minor* (Kuetz.) Naegeli | 116 | 113 | 74 | 32 | 14 | | | |
| *Gomphosphaeria sp.* | | | | | | | | |
| *Gomphosphaeria lacustris* Chodat | | | | | | | | |
| *Lyngbya sp.* Agardh | | | | | | | | |
| *Microcystis sp.* | | | | | | | | |
| *Microcystis aeruginosa* Kuetz. *amend* Elenkin | 14 | 7 | 18 | 11 | 21 | | | |
| *Microcystis incerta* Lemmermann | | | | | | | | |
| *Oscillatoria sp.* | | | | | | 14 | | |
| *Oscillatoria angustissima* West & West | | | | | | | | |
| *Oscillatoria limnetica* Vaucher | | | 7 | 18 | | | | |
| *Scytonema sp.* | | | | | | | | |
| *Synechococcus sp.* | | | | | | | 4 | |
| Chrysophyta | | | | | | | | |
| *Chromulina sp.* | | | | | | | | |
| *Cladomonas fruticulosa* Stein | | | | | | | | |
| *Dinobryon sp.* | | | | | | 92 | 42 | 64 |
| *Dinobryon cylindricum* Imhoff *ex.* Ahistrom | 11 | 62 | 32 | 4 | 24 | | | |
| *Dinobryon sociale* var. *americum* (Brunn.) Bachmann | 84 | 233 | 59 | 107 | 84 | | | |
| *Mallomonas caudata* Iwanoff | 35 | 52 | 35 | 25 | 35 | | | |
| *Mallomonas sp.* Perty | | | | | | 18 | 14 | 7 |
| Pyrrhophyta | | | | | | | | |
| *Ceratium sp.* | | | | | | | | 4 |
| *Ceratium hirudinella* (OFM) Schrank | 7 | 4 | | 4 | 4 | | | |
| *Glenodinium pulvisculus* (Ehr.) stein | 32 | 32 | 28 | 11 | 39 | | | |
| *Peridinium sp.* Ehrenberg | | | | | | 21 | 32 | 42 |
| Cryptophyta | | | | | | | | |
| *Chroomonas sp.* | | | | | | 173 | 28 | 78 |
| *Chroomonas nordstedtii* Hansgirg. | 205 | 162 | 180 | 145 | 187 | | | |
| *Cryptomonas erosa* Ehrenberg | | | | | | | | |
| Euglenophyta | | | | | | | | |
| *Euglena sp.* Ehrenberg | | | | | | | | |
| Unknown cells | | | | | | | | |
| | | | | | | | | |
| **Total Non-Diatom Algae Density (cells/mL)** | **1,233** | **1,683** | **1,140** | **1,109** | **1,157** | **897** | **629** | **653** |
| **Sample Richness** | **21** | **23** | **24** | **23** | **20** | **16** | **18** | **14** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Aug-98 | Aug-98 | Aug-98 | Sep-98 | Sep-98 | Sep-98 | Sep-98 | Sep-98 |
| Location | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 |
| Chlorophyta | | | | | | | | |
| *Actinastrum hantzschii* Lagerheim | | | | | | | | |
| *Ankistrodesmus sp.* | 11 | 11 | 14 | | | 7 | | 4 |
| *Ankistrodesmus braunii* (Naeg.) Brunthaller | | | | | | | | |
| *Ankistrodesmus falcatus* var. *mirabilis* G.S. West | | | | | | | | |
| *Chlamydomonas sp.* Ehrenberg | 46 | 28 | 46 | | 4 | 4 | | |
| *Chlamydomonas globosa* Snow | | | | | | | | |
| *Chlorella/Chlorococcum humicola* (Naeg.) Rabenhorst | | | | | | | | |
| *Chlorococcum sp.* | | | | | | | | |
| *Chlorococcum/Palmella* | 215 | 106 | 219 | 11 | 46 | 64 | | 28 |
| *Closterium sp.* | | | | | | | | |
| *Coelastrum sp.* | 7 | | 7 | | | | | |
| *Coelastrum* c.f. *microporum* Nageli. | | | | | | | | |
| *Cosmarium sp.* Corda | | | | | | | | |
| *Crucigenia sp.* | | | 11 | | | | | |
| *Crucigenia tetrapedia* (Kirch.) West & West | | | | | | | | |
| *Elakatotrhix viridis* (Snow) Printz | | | | | | | | |
| *Gloeocystis sp.* | | 11 | 4 | 7 | | | | |
| *Gloeocystis gigas* Kutzing. | | | | | | | | |
| *Gloeocystis planktonica* (West & West) Lemmerman | | | | | | | | |
| *Golenkinia paucispina* West & West | | | | | | | | |
| *Gonatozygon sp.* | | | | | | | | |
| *Gonium sp.* | 11 | 7 | 14 | | | | | |
| *Gonium c.f. sociale* (Duj.) Warming | | | | | | | | |
| *Gonium pectorale* Mueller | | | | | | | | |
| *Hyalotheca sp.* | | | | | | | | |
| *Hyalotheca dissiliens* | | | | | | | | |
| *Microspora sp.* | | 14 | 7 | | | | | |
| *Microspora* c.f. *quadrata* Hazen | | | | | | | | |
| *Oedogonium sp.* Link | | | | | | | | |
| *Oocystis sp.* Naegeli in A. Brown | | | | | | | | |
| *Pediastrum sp.* | 11 | | 7 | | 4 | | | |
| *Pediastrum boryanum* (Turp.) Meneghini | | | | | | | | |
| *Pediastrum c.f. duplex* Meyen | | | | | | | | |
| *Pediastrum simplex* (Meyen) Lemmermann | | | | | | | | |
| *Planktosphaeria sp.* | | 7 | | | | | | |
| *Planktosphaeria gelatinosa* G.M Smith | | | | | | | | |
| *Scenedesmus bijuga* (Turp.) Lagerheim | | | | | | | | |
| *Scenedesmus brasiliensis* Bohlin | | | | | | | | |
| *Scenedesmus quadricauda* (Turp.) deBrebisson | | | | | | | | |
| *Scenedesmus II* | | | | | | | | |
| *Scenedesmus sp.* Meyen | 60 | 67 | 99 | 7 | 32 | 4 | 7 | 14 |
| *Selenastrum sp.* | | | | | | | | 4 |
| *Selenastrum minutum* (Naeg.) Collins | | | | | | | | |
| *Selenastrum westii* G.M. Smith | | | | | | | | |
| *Sphaerocystis schroeteri* Chodat | | | | | | | | |
| *Spyrogyra sp.* | | | | 4 | | | | 14 |
| *Staurastrum sp.* Meyen | 21 | 4 | | | | | | |
| *Tetraspora sp.* | 11 | 7 | | | | | | |
| *Tetraspora c.f. lacustris* Lemmermann | | | | | | | | |
| Unknown green spheres | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date** | **Aug-98** | **Aug-98** | **Aug-98** | **Sep-98** | **Sep-98** | **Sep-98** | **Sep-98** | **Sep-98** |
| **Location** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** |
| Cyanophyta | | | | | | | | |
| *Agmenellum sp.* | 21 | 7 | | | 11 | | 11 | |
| *Agmenellum tenuissima* Lemmermann | | | | | | | | |
| *Anabaena sp.* | 14 | | 7 | | 4 | | | |
| *Anacystis sp.* | | 11 | 42 | | 7 | | | |
| *Aphanocapsa delicatissima* West & West | | | | | | | | |
| *Chroococcus sp.* | 92 | 49 | 152 | | 25 | 18 | 4 | 39 |
| *Chroococcus limneticus* Lemmermann | | | | | | | | |
| *Chroococcus major* | | | | | | | | |
| *Chroococcus minor* (Kuetz.) Naegeli | | | | | | | | |
| *Gomphosphaeria sp.* | | | | | | | | |
| *Gomphosphaeria lacustris* Chodat | | | | | | | | |
| *Lyngbya sp.* Agardh | | | | | | | | |
| *Microcystis sp.* | | | | | | | | |
| *Microcystis aeruginosa* Kuetz. *amend* Elenkin | | | | | | | | |
| *Microcystis incerta* Lemmermann | | | | | | | | |
| *Oscillatoria sp.* | | 4 | | 7 | 4 | | 21 | 4 |
| *Oscillatoria angustissima* West & West | | | | | | | | |
| *Oscillatoria limnetica* Vaucher | | | | | | | | |
| *Scytonema sp.* | | | | | | | | |
| *Synechococcus sp.* | | | 7 | | | | | |
| Chrysophyta | | | | | | | | |
| *Chromulina sp.* | | | | | | | | |
| *Cladomonas fruticulosa* Stein | | | | | | | | |
| *Dinobryon sp.* | 53 | 32 | 11 | | | | | |
| *Dinobryon cylindricum* Imhoff *ex.* Ahistrom | | | | | | | | |
| *Dinobryon sociale* var. *americum* (Brunn.) Bachmann | | | | | | | | |
| *Mallomonas caudata* Iwanoff | | | | | | | | |
| *Mallomonas sp.* Perty | 21 | 14 | 25 | 7 | 4 | | 4 | 11 |
| Pyrrhophyta | | | | | | | | |
| *Ceratium sp.* | | | | | | | | |
| *Ceratium hirudinella* (OFM) Schrank | | | | | | | | |
| *Glenodinium pulvisculus* (Ehr.) stein | | | | | | | | |
| *Peridinium sp.* Ehrenberg | 32 | 21 | 46 | | | | | |
| Cryptophyta | | | | | | | | |
| *Chroomonas sp.* | 106 | 99 | 85 | 71 | 109 | 92 | 39 | 116 |
| *Chroomonas nordstedtii* Hansgirg. | | | | | | | | |
| *Cryptomonas erosa* Ehrenberg | | | | | | | | |
| Euglenophyta | | | | | | | | |
| *Euglena sp.* Ehrenberg | | | | | | | | |
| Unknown cells | | | | | | | | |
| | | | | | | | | |
| **Total Non-Diatom Algae Density (cells/mL)** | **730** | **497** | **801** | **112** | **247** | **187** | **85** | **233** |
| **Sample Richness** | **16** | **18** | **18** | **7** | **11** | **6** | **6** | **9** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Sep-98 | Aug-99 | Aug-99 | Aug-99 | Aug-99 | Aug-99 | Aug-99 | Aug-00 |
| Location | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 |
| Chlorophyta | | | | | | | | |
| *Actinastrum hantzschii* Lagerheim | | | | | | | | |
| *Ankistrodesmus sp.* | 4 | | | | | | | 8 |
| *Ankistrodesmus braunii* (Naeg.) Brunthaller | | | | | | | | |
| *Ankistrodesmus falcatus* var. *mirabilis* G.S. West | | | 3 | | 2 | 3 | | |
| *Chlamydomonas sp.* Ehrenberg | 7 | | | | | | | 49 |
| *Chlamydomonas globosa* Snow | | 12 | 22 | 14 | 19 | 7 | 19 | |
| *Chlorella/Chlorococcum humicola* (Naeg.) Rabenhorst | | 14 | 15 | 19 | 30 | 12 | 19 | |
| *Chlorococcum sp.* | | | | | | | | 37 |
| *Chlorococcum/Palmella* | 28 | | | | | | | |
| *Closterium sp.* | | | | | | | | |
| *Coelastrum sp.* | | | | | | | | |
| *Coelastrum* c.f. *microporum* Nageli. | | | | | | | | |
| *Cosmarium sp.* Corda | | | | | | | | 4 |
| *Crucigenia sp.* | | | | | | | | |
| *Crucigenia tetrapedia* (Kirch.) West & West | | | | | | | | |
| *Elakatotrhix viridis* (Snow) Printz | | | | | | | | |
| *Gloeocystis sp.* | | | | | | | | |
| *Gloeocystis gigas* Kutzing. | | | | | | | | |
| *Gloeocystis planktonica* (West & West) Lemmerman | | | 2 | | 3 | | 7 | |
| *Golenkinia paucispina* West & West | | | | | | | | |
| *Gonatozygon sp.* | | | | | | | | |
| *Gonium sp.* | | | | | | | | |
| *Gonium c.f. sociale* (Duj.) Warming | | | | | | | 2 | |
| *Gonium pectorale* Mueller | | | | | | | | |
| *Hyalotheca sp.* | | | | | | | | |
| *Hyalotheca dissiliens* | | | | | | | | |
| *Microspora sp.* | | | | | | | | |
| *Microspora* c.f. *quadrata* Hazen | | | | | | | | |
| *Oedogonium sp.* Link | | | | | | | | |
| *Oocystis sp.* Naegeli in A. Brown | | | | | | | 2 | |
| *Pediastrum sp.* | | | | | | | | 4 |
| *Pediastrum boryanum* (Turp.) Meneghini | | | | | | | | |
| *Pediastrum c.f. duplex* Meyen | | 3 | | 2 | 3 | 3 | 2 | |
| *Pediastrum simplex* (Meyen) Lemmermann | | 1 | | | | 1 | 2 | |
| *Planktosphaeria sp.* | | | | | | | | |
| *Planktosphaeria gelatinosa* G.M Smith | | | | 5 | | | | |
| *Scenedesmus bijuga* (Turp.) Lagerheim | | 3 | 5 | 2 | 5 | | 2 | |
| *Scenedesmus brasiliensis* Bohlin | | | | | | | | |
| *Scenedesmus quadricauda* (Turp.) deBrebisson | | | 5 | 10 | 38 | 12 | 10 | 4 |
| *Scenedesmus II* | | | | | | | | |
| *Scenedesmus sp.* Meyen | 14 | | | | | | | |
| *Selenastrum sp.* | | | | | | | | |
| *Selenastrum minutum* (Naeg.) Collins | | | | | | | | |
| *Selenastrum westii* G.M. Smith | | 2 | 2 | 2 | 5 | 5 | | |
| *Sphaerocystis schroeteri* Chodat | | | | | | | | |
| *Spyrogyra sp.* | | | | | | | | |
| *Staurastrum sp.* Meyen | | | | 2 | | 3 | 2 | |
| *Tetraspora sp.* | | | | | | | | |
| *Tetraspora c.f. lacustris* Lemmermann | | 2 | 2 | | 3 | 2 | | |
| Unknown green spheres | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date** | **Sep-98** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-00** |
| **Location** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** |
| Cyanophyta | | | | | | | | |
| *Agmenellum sp.* | 4 | | | | | | | 4 |
| *Agmenellum tenuissima* Lemmermann | | 3 | 10 | 7 | 7 | 3 | 7 | |
| *Anabaena sp.* | | | | | | | | 4 |
| *Anacystis sp.* | 4 | | | | | | | |
| *Aphanocapsa delicatissima* West & West | | | | | | | | |
| *Chroococcus sp.* | | | | | | | | |
| *Chroococcus limneticus* Lemmermann | | 3 | 2 | 2 | 2 | 5 | | |
| *Chroococcus major* | | | | | | | | |
| *Chroococcus minor* (Kuetz.) Naegeli | | | 9 | 14 | 5 | 15 | 7 | 8 |
| *Gomphosphaeria sp.* | | | | | | | | 8 |
| *Gomphosphaeria lacustris* Chodat | | | 2 | 7 | 3 | | 5 | |
| *Lyngbya sp.* Agardh | | | | | | | | |
| *Microcystis sp.* | | | | | | | | 4 |
| *Microcystis aeruginosa* Kuetz. *amend* Elenkin | | | 5 | 5 | 5 | 2 | 2 | |
| *Microcystis incerta* Lemmermann | | | | | | | | |
| *Oscillatoria sp.* | | | | | | | | |
| *Oscillatoria angustissima* West & West | | | 2 | | 5 | 5 | 7 | |
| *Oscillatoria limnetica* Vaucher | | 2 | | 2 | 3 | | 5 | |
| *Scytonema sp.* | | | | | | | | |
| *Synechococcus sp.* | | | | | | | | |
| Chrysophyta | | | | | | | | |
| *Chromulina sp.* | | | | | | | | 202 |
| *Cladomonas fruticulosa* Stein | | | | | | | | |
| *Dinobryon sp.* | | | | | | | | 37 |
| *Dinobryon cylindricum* Imhoff *ex.* Ahistrom | | | | | | | | |
| *Dinobryon sociale* var. *americum* (Brunn.) Bachmann | | 2 | 2 | | 3 | 2 | | |
| *Mallomonas caudata* Iwanoff | | 9 | 2 | 2 | 11 | | 2 | |
| *Mallomonas sp.* Perty | 4 | | | | | | | 29 |
| Pyrrhophyta | | | | | | | | |
| *Ceratium sp.* | | | | | | | | |
| *Ceratium hirudinella* (OFM) Schrank | | | 2 | | 3 | | | |
| *Glenodinium pulvisculus* (Ehr.) stein | | | | | | | | |
| *Peridinium sp.* Ehrenberg | | | 3 | | 14 | | 2 | 8 |
| Cryptophyta | | | | | | | | |
| *Chroomonas sp.* | 81 | | | | | | | |
| *Chroomonas nordstedtii* Hansgirg. | | 55 | 22 | 17 | 49 | 29 | 10 | |
| *Cryptomonas erosa* Ehrenberg | | | | | | | | |
| Euglenophyta | | | | | | | | |
| *Euglena sp.* Ehrenberg | | | | | | | | |
| Unknown cells | | | | | | | | |
| | | | | | | | | |
| **Total Non-Diatom Algae Density (cells/mL)** | **145** | **111** | **117** | **115** | **219** | **111** | **117** | **412** |
| **Sample Richness** | **8** | **13** | **19** | **16** | **21** | **16** | **19** | **15** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Aug-00 | Aug-00 | Aug-00 | Aug-00 | Aug-00 | | | |
| Location | C3501 | C3501 | S3500 | S3500 | S3500 | | | |
| Chlorophyta | | | | | | | | |
| *Actinastrum hantzschii* Lagerheim | | | | | | | | |
| *Ankistrodesmus sp.* | 16 | 12 | 10 | 5 | 4 | | | |
| *Ankistrodesmus braunii* (Naeg.) Brunthaller | | | | | | | | |
| *Ankistrodesmus falcatus* var. *mirabilis* G.S. West | | | | | | | | |
| *Chlamydomonas sp.* Ehrenberg | 161 | 161 | 216 | 206 | 115 | | | |
| *Chlamydomonas globosa* Snow | | | | | | | | |
| *Chlorella/Chlorococcum humicola* (Naeg.) Rabenhorst | | | | | | | | |
| *Chlorococcum sp.* | 95 | 37 | 96 | 98 | 33 | | | |
| *Chlorococcum/Palmella* | | | | | | | | |
| *Closterium sp.* | | | | 10 | | | | |
| *Coelastrum sp.* | | | | | | | | |
| *Coelastrum* c.f. *microporum* Nageli. | | | | | | | | |
| *Cosmarium sp.* Corda | | | | | | | | |
| *Crucigenia sp.* | | | | | | | | |
| *Crucigenia tetrapedia* (Kirch.) West & West | | | | | | | | |
| *Elakatotrhix viridis* (Snow) Printz | | | | | | | | |
| *Gloeocystis sp.* | | | | | | | | |
| *Gloeocystis gigas* Kutzing. | | | | | | | | |
| *Gloeocystis planktonica* (West & West) Lemmerman | | | | | | | | |
| *Golenkinia paucispina* West & West | | | | | | | | |
| *Gonatozygon sp.* | | | | | | | | |
| *Gonium sp.* | | | | | | | | |
| *Gonium c.f. sociale* (Duj.) Warming | | | | | | | | |
| *Gonium pectorale* Mueller | | | | | | | | |
| *Hyalotheca sp.* | | | | | | | | |
| *Hyalotheca dissiliens* | | | | | | | | |
| *Microspora sp.* | | | | | | | | |
| *Microspora* c.f. *quadrata* Hazen | | | | | | | | |
| *Oedogonium sp.* Link | | | 10 | | | | | |
| *Oocystis sp.* Naegeli in A. Brown | | | | | | | | |
| *Pediastrum sp.* | | 4 | 3 | 10 | | | | |
| *Pediastrum boryanum* (Turp.) Meneghini | | | | | | | | |
| *Pediastrum c.f. duplex* Meyen | | | | | | | | |
| *Pediastrum simplex* (Meyen) Lemmermann | | | | | | | | |
| *Planktosphaeria sp.* | | | | | | | | |
| *Planktosphaeria gelatinosa* G.M Smith | | | | | | | | |
| *Scenedesmus bijuga* (Turp.) Lagerheim | | | | | | | | |
| *Scenedesmus brasiliensis* Bohlin | | | | | | | | |
| *Scenedesmus quadricauda* (Turp.) deBrebisson | 16 | 12 | 21 | 15 | 12 | | | |
| *Scenedesmus II* | | | 3 | 5 | 4 | | | |
| *Scenedesmus sp.* Meyen | | | | | | | | |
| *Selenastrum sp.* | | 8 | | | 4 | | | |
| *Selenastrum minutum* (Naeg.) Collins | | | | | | | | |
| *Selenastrum westii* G.M. Smith | | | | | | | | |
| *Sphaerocystis schroeteri* Chodat | | | | | | | | |
| *Spyrogyra sp.* | | | | | | | | |
| *Staurastrum sp.* Meyen | | | | | | | | |
| *Tetraspora sp.* | | | | | | | | |
| *Tetraspora c.f. lacustris* Lemmermann | | | | | | | | |
| Unknown green spheres | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date** | **Aug-00** | **Aug-00** | **Aug-00** | **Aug-00** | **Aug-00** | | | |
| **Location** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | | | |
| Cyanophyta | | | | | | | | |
| *Agmenellum sp.* | 8 | | | | 12 | | | |
| *Agmenellum tenuissima* Lemmermann | | | | | | | | |
| *Anabaena sp.* | 4 | | | | | | | |
| *Anacystis sp.* | | | | | | | | |
| *Aphanocapsa delicatissima* West & West | | | | | | | | |
| *Chroococcus sp.* | | | | | | | | |
| *Chroococcus limneticus* Lemmermann | | | | | | | | |
| *Chroococcus major* | | | 3 | 10 | 25 | | | |
| *Chroococcus minor* (Kuetz.) Naegeli | 54 | 25 | 41 | 31 | 33 | | | |
| *Gomphosphaeria sp.* | 4 | 4 | 14 | 10 | 21 | | | |
| *Gomphosphaeria lacustris* Chodat | | | | | | | | |
| *Lyngbya sp.* Agardh | | | | | | | | |
| *Microcystis sp.* | | | 17 | 21 | 8 | | | |
| *Microcystis aeruginosa* Kuetz. *amend* Elenkin | | | | | | | | |
| *Microcystis incerta* Lemmermann | | | | | | | | |
| *Oscillatoria sp.* | | | | | | | | |
| *Oscillatoria angustissima* West & West | | | | | | | | |
| *Oscillatoria limnetica* Vaucher | | | | | | | | |
| *Scytonema sp.* | | | | | | | | |
| *Synechococcus sp.* | | | | | | | | |
| Chrysophyta | | | | | | | | |
| *Chromulina sp.* | 206 | 115 | 161 | 252 | 173 | | | |
| *Cladomonas fruticulosa* Stein | | | | | | | | |
| *Dinobryon sp.* | 29 | 29 | 10 | 15 | 45 | | | |
| *Dinobryon cylindricum* Imhoff *ex.* Ahistrom | | | | | | | | |
| *Dinobryon sociale* var. *americum* (Brunn.) Bachmann | | | | | | | | |
| *Mallomonas caudata* Iwanoff | | | | | | | | |
| *Mallomonas sp.* Perty | 37 | 37 | 7 | 41 | 25 | | | |
| Pyrrhophyta | | | | | | | | |
| *Ceratium sp.* | | | | | | | | |
| *Ceratium hirudinella* (OFM) Schrank | | | | | | | | |
| *Glenodinium pulvisculus* (Ehr.) stein | | | | | | | | |
| *Peridinium sp.* Ehrenberg | | 8 | | 5 | 4 | | | |
| Cryptophyta | | | | | | | | |
| *Chroomonas sp.* | | | | | | | | |
| *Chroomonas nordstedtii* Hansgirg. | | | | | | | | |
| *Cryptomonas erosa* Ehrenberg | | | | | | | | |
| Euglenophyta | | | | | | | | |
| *Euglena sp.* Ehrenberg | | | | | | | | |
| Unknown cells | | | | | | | | |
| | | | | | | | | |
| **Total Non-Diatom Algae Density (cells/mL)** | **630** | **453** | **615** | **736** | **520** | | | |
| **Sample Richness** | **11** | **12** | **14** | **15** | **15** | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | May-95 | | | | | | Jun-96 | | | Oct-96 | | |
| Site | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Achnanthes affinis* (Grunow) | | | | | | | | | | | | |
| *Achnanthes exigua* Grun. In Cleve & Grunow | | | | | | | | 1 | 2 | | | |
| *Achnanthes exigua* var. *heterovalvata* Krasske | | | | | | | | | | 2 | 1 | 3 |
| *Achnanthes clevei* var. *rostrata* Hustedt | | | | | 1 | | | | | | | |
| *Achnanthes flexella* Kutzing | | | | | | | | | 1 | | | |
| *Achnanthes hauckiana* Grun. | | | | | | | | | | | | |
| *Achnanthes lanceolata* var. *dubia* Grun. | | | | | | | | | | | | |
| *Achnanthes lanceolata* var. *rostrata* (Ostrup.) Hustedt | | | | | | | | | | | | |
| *Achnanthes linearis* W. Smith | | | | | | | | | | | | |
| *Achnanthes microcephala* Kutzing | | | | | | | | | | 1 | | 1 |
| *Achnanthes minutissima* Kutzing | | 1 | | | 3 | 3 | 1 | 1 | 1 | 9 | 1 | 7 |
| *Achnanthes pellucida* Kutzing | | | | | | | | | | | | |
| *Amphipleura pellucida* Kutzing | | | | | | | | | | | | |
| *Amphora ovalis* var. *affinis* (Kutz.) E.H. *ex* DeT. | | | | | | | | | | | | |
| *Amphora pediculus* Kutzing | 1 | 1 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Amphora perpusilla* (Grun.) Grunow | | 2 | 1 | 1 | 3 | 1 | | 1 | 1 | 1 | 1 | 1 |
| *Anomoeoneis serians* var. *brachysira* (deBreb.) Husted | | | | | | | | | | 1 | | |
| *Anomoeoneis vitrea* (Grun.) Ross | | | | | | | | | | 6 | 1 | 2 |
| *Asterionella formosa* Hassal | 44 | 36 | 16 | 17 | 26 | 45 | 19 | 8 | 25 | 9 | 19 | 3 |
| *Aulacoseira ambigua* (Grun.) Simonsen | | | | | | | | | | | | |
| *Aulacoseira distans* var. *lirata* | | | | 3 | 7 | 9 | | | | | | |
| *Aulacoseira granulata* (Ehr.) Simonson | | | | | | | 2 | 1 | 1 | | | |
| *Aulacoseira islandica* (O. Muller) Simonson | | | | | | 6 | | | | | | |
| *Aulacoseira italica* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* var. *tenuissima* (Grun.) Simonson | | | | | | | | 1 | 1 | 1 | 1 | |
| *Caloneis bacillum* (Grun.) Meresch. | | | | | | 1 | | | | | | |
| *Caloneis ventricosa* (Ehr.) Meister | | | | | | | | | | | | |
| *Cocconeis pediculus* Ehrenberg | | | | | | | | | | | | 3 |
| *Cocconeis placentula* var. *euglypta* (Ehr.) Cleve | | | | | | | 1 | | 2 | 4 | 4 | 4 |
| *Cocconeis placentula* var. *lineata* Cleve | 3 | 6 | 3 | 3 | 3 | 5 | | | | | | |
| *Cocconeis thumensis* A. Mayer | | | | 1 | 1 | 1 | | | | | | |
| *Cyclotella atomus* Hust. | | | | | | | | | | | | |
| *Cyclotella comensis* Grunow | | | | | | | | | | | | |
| *Cyclotella compta* (Ehr.) Kutzing | | | | | | | | | | 2 | 1 | 2 |
| *Cyclotella kutzingiana* var. *planetophora* Fricke | | | | | | | | | | | | |
| *Cyclotella meneghiniana* Kutzing | | | | | | | | | | | | |
| *Cyclotella michiginiana* Skv. | 5 | 3 | 1 | 6 | 9 | 8 | | | | 10 | 8 | 12 |
| *Cyclotella ocellata* Pant. | | | | | | | 1 | 1 | 3 | 49 | 15 | 44 |
| *Cyclotella pseudostelligera* Husted | | | | | | | 1 | 1 | 1 | | | |
| *Cyclotella socialis* Schutt | | | | | | | | | | 3 | | 2 |
| *Cyclotella stelligera* (Cleve et Grun.) V.H. | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 1 | 4 | 11 | 11 | 20 |
| *Cymatopleura elliptica* (deBreb.) W. Smith | | | | | | | | | | | | |
| *Cymatopleura solea* (deBreb.) W. Smith | | | | | 1 | | | | | | | |
| *Cymbella affinis* Kutzing | | | | | | | | | | 6 | | 1 |
| *Cymbella amphicephala* Naegeli | | | | | | | | | | | | |
| *Cymbella cuspidata* Kutzing | | 1 | 1 | 1 | 3 | 1 | | | | | | |
| *Cymbella hauckii* V. Heurck | | | | | | | | | | | | |
| *Cymbella microcephala* Grunow | | | | | | | | | | 2 | | 1 |
| *Cymbella minuta* var. *pseudogracilis* (Choln.) Reim | | | | | | 1 | | | | | | |
| *Cymbella naviculiformis* Auerswald | | | | | | | | | | | 1 | |
| *Cymbella parva* (W. Smith) Cleve | | | | | | | | | | | | |
| *Cymbella perpusilla* A. Cleve | | | | | | | | | | 7 | | 1 |
| *Cymbella prostata* (Berkeley) Cleve | | | | | | | | | | 1 | | 2 |
| *Cymbella ventricosa* Kutzing | | | | | | | | | | 1 | | 3 |
| *Diatoma anceps* (Ehr.) Grunow | | 1 | | | | | | | | | | |
| *Diatoma tenuis* Agardh | 44 | 71 | 46 | 68 | 72 | 90 | 35 | 25 | 40 | 4 | 1 | 1 |
| *Diatoma tenuis* var. *elongatum* Lyngbye | 78 | 90 | 39 | 54 | 55 | 79 | 92 | 70 | 98 | | | |
| *Diatoma vulgare* Bory | | | | | | | | | | | | |
| *Diatoma vulgare* var. Breve | 1 | 6 | 2 | 5 | 5 | 6 | 1 | 1 | 3 | | | |
| *Diploneis ovalis* (Hilse.) Cleve | | | | | | | | | | | | |
| *Diploneis puella* (Schumann) Cleve | | | | | | 1 | | | | | | |
| *Encyonema minutum* (Hilse in Rabenhorst) Mann | | | | | | | | | | | | |
| *Epithemia emarginata* Andrews | 1 | | | | | | | | | | | |
| *Fragilaria brevistriata* Grunow | | | | | | | | | | 1 | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | May-95 | | | | | | Jun-96 | | | Oct-96 | | |
| Site | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Fragilaria capucina* Desmzeires | | | 1 | | | 4 | | | | | | |
| *Fragilaria capucina* var. *gracilis* (Oestr.) Hustedt | 25 | 39 | 17 | 40 | 39 | 33 | | | | | | |
| *Fragilaria capucina* var. *mesolepta* (Rabh.) Grunow | 26 | 36 | 11 | 18 | 19 | 33 | | | | | | |
| *Fragilaria capucina* var. *rumpens* (Kutz.) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria capucina* var. *vaucheriae* (Kutz.) Lange-Bertalot | 49 | 45 | 18 | 21 | 7 | 16 | | 1 | | | | |
| *Fragilaria construens* (Ehr.) Grunow | | | | | | | | | | | | 1 |
| *Fragilaria construens* var. *binodis* (Ehr.) Grunow | 6 | 10 | 20 | 48 | 67 | 85 | | | | | | |
| *Fragilaria construens* var. *venter* (Ehr.) Grunow | | 3 | 5 | 32 | 28 | 37 | | | | 4 | 1 | 1 |
| *Fragilaria crotonensis* Kitton | | 6 | 4 | | | 15 | | | 9 | 4 | 8 | 3 |
| *Fragilaria delicatissima* (W. smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria famelica* (Kutz.) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria intermedia* Grunow | | | | | | | | | | 1 | 2 | 3 |
| *Fragilaria pinnata* Ehrenberg | 1 | 2 | 2 | 9 | 5 | 6 | | | | | | |
| *Fragilaria tenera* (W. Smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria virescens* Ralfs | | | | | | | 21 | 29 | 44 | 7 | 3 | 17 |
| *Gomphonema angustatum* var. *producta* Grunow | | | | | | | | | | 3 | | 2 |
| *Gomphonema gracile* Ehr. | | | | | | | | | | | | |
| *Gomphonema intricatum* Kutzing | | | | | | | | | | | 1 | |
| *Gomphonema olivaceum* (Lyngbye) Kutzing | | | | | | | | 1 | | | | |
| *Gomphonema parvulum* (Kutz.) Grunow | | | | | | | | | | | | |
| *Gyrosigma acuminatum* (Kutz.) Rabh. | | | 1 | | | | | | | | | |
| *Melosira varians* C.A. Agardh | 1 | 2 | 1 | 1 | 3 | 4 | | | | | | |
| *Navicula 2* | 1 | 1 | | | | | | | | | | |
| *Navicula arvensis* Hust. | | | 1 | 1 | 5 | 2 | | | | | 1 | |
| *Navicula capitata* Ehrenberg | 1 | 7 | 2 | 4 | 6 | 3 | | | | | | |
| *Navicula capitata* var. *lunebergensis* (Grun.) Patrick | | | | | | | | | | | | |
| *Navicula c.f. dicephala* (Ehr.) W. Smith | | | | | | | | | | | | |
| *Navicula cincta* (Ehr.) Kutzing | | | | | | | | | | | | |
| *Navicula cocconeiformis* Greg. | | | | | | | | | | | | |
| *Navicula cohnii* (Hilse.) Grunow | | | | | | | | | | 2 | | 1 |
| *Navicula contenta* Grunow | | | | | | | | | | | | |
| *Navicula cryptocephala* Kutzing | 1 | 4 | 2 | 9 | 11 | 6 | 1 | | 1 | 2 | 2 | 4 |
| *Navicula cryptocephala* var. *exilis* Kutzing | | | | | | | | 1 | | | | |
| *Navicula dicephala* (Ehr.) W. Smith | | | | | | | | | | | | |
| *Navicula frugalis* Hustedt | | | | | | | | | | | | |
| *Navicula gastrum* (Ehr.) Donkin | | | | | | | 1 | 1 | 1 | | | |
| *Navicula gracilis* Ehrenberg | | | | | | | | | | | | |
| *Navicula hungarica* Grunow | | | | | | | | 1 | 1 | 3 | | 3 |
| *Navicula lacustris* Gregory | 1 | 1 | | | 1 | 1 | | | | | | |
| *Navicula lanaceolata* (Agardh.) Kutz. | | | | | | | | | | | | |
| *Navicula latissima* Gregory | | | | | | | | | | | | |
| *Navicula menisculus* Schumann | | | | | | | | | | 1 | 2 | 1 |
| *Navicula minima* Grun. | | 1 | 1 | | 1 | | | | | | 1 | 1 |
| *Navicula minuscula* Grun. | | | | | | | | | | | | |
| *Navicula mutica* Kutzing | | | | | | | | | | | | |
| *Navicula nitrophila* B. Petersen | | | | | | | | 1 | | | | |
| *Navicula perpusilla* Grunow | | | | | | | | | | | | |
| *Navicula pseudoreinhardtii* Patrick | 1 | 3 | 1 | 1 | 3 | 2 | | | | | | |
| *Navicula pupula* Kutzing | | | | 1 | 1 | | 1 | | | | | |
| *Navicula pupula* var. *mutata* (Krasske) Hustedt | 1 | 1 | | | | | | | | | | |
| *Navicula pusio* Cleve | 1 | 1 | 3 | 1 | 3 | 3 | | | | | | |
| *Navicula radiosa* Kutzing | | | | 1 | | 1 | | 1 | 1 | | 1 | 2 |
| *Navicula radiosa* var. *tenella* (deBreb. ex Katz.) Grunow | | | | | 1 | 1 | | | | | | |
| *Navicula schmassmannii* Hustedt | | | | | | | | | | | | |
| *Navicula seminulum* Grunow | | | | | | | | | | 2 | 1 | |
| *Navicula sp.* Bory | | | | | | | | | | | | |
| *Navicula 1* | | | | | | | | | | 1 | | |
| *Navicula subtilissima* Cleve | 1 | | | | | | | | | | | |
| *Navicula symmetrica* Patrick | | 1 | 2 | | 1 | 3 | | | | | | |
| *Navicula tripunctata* var. *schizonemoides* | | | | | | | | | | | | |
| *Navicula variostrata* Krasske | | | | | | | | | | | 1 | |
| *Neidium dubium* (Ehr.) Cleve | | | | | | | | 1 | | | | |
| *Neidium dubuim* var. *constrictum* A.V. Heurck | | | | | | | | | | | | |
| *Nitzschia (longissima?)* (deBreb.) Ralfs | | | | | | | | | 11 | | | |
| *Nitzschia acicularis* W. smith | 15 | 10 | 1 | 5 | 5 | 7 | 7 | 2 | 5 | 1 | | |
| *Nitzschia amphibia* Grunow | | | | 1 | | | | | | | | |
| *Nitzschia angustata* (W. Smith) Grunow | 1 | 1 | 2 | 2 | 2 | 6 | | | | | | |
| *Nitzschia constricta* (Kutz.) Ralfs. | | | | | | | | | | | | |
| *Nitzschia denticula* Grunow | | | | | | | | | | 1 | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | May-95 | | | | | | Jun-96 | | | Oct-96 | | |
| Site | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Nitzschia dissipata* (Kutz.) Grunow | 10 | 4 | 3 | 9 | 5 | 4 | | | | | | |
| *Nitzschia fonticola* Grunow | 3 | 8 | 2 | 2 | 3 | 6 | | | | | | |
| *Nitzschia frustulum* Grunow | | 3 | | 1 | | | 2 | 1 | 1 | 30 | 11 | 31 |
| *Nitzschia frustulum* Kutz. | | | | | | | | | | | | |
| *Nitzschia GLRD 1* | | | 1 | 4 | 1 | 4 | | | | | | |
| *Nitzschia gracilis* Hantzsch. | 10 | 11 | 9 | 9 | 13 | 23 | | | 3 | | | |
| *Nitzschia linearis* W. Smith | | | | 4 | 5 | 6 | | 1 | 1 | 3 | 1 | 3 |
| *Nitzschi palea* var. *debilis* (Kutz.) Grunow | | | | | | | | | | | | |
| *Nitzschia paleacea* Grunow | 6 | 5 | 1 | 5 | 3 | 4 | | | | 64 | 48 | 64 |
| *Nitzschia romana* Grunow | | | | | | | | | | 61 | 30 | 33 |
| *Nitzschia stagnorum* Rabh. | | | | | | | | | | | | |
| *Nitzschia subcapitellata* Hust. | | | | | | | | | | | | |
| *Nitzschia sublinearis* Hustedt | 13 | 13 | 5 | 5 | 17 | 15 | | | | | | |
| *Nitzschia thermalis* Kutzing | | | 1 | | | | | | | | | |
| *Nitzschia tryblionella* var. *debilis* (Arnott) A. Mayer | | | | | | | | | | | | |
| *Rhizosolenia eriensis* H.L. Smith | | | | | | | 1 | 1 | 3 | | | |
| *Rhizosolenia sp.* Ehrenberg | | | | | | | | | | | | |
| *Rhoicosphenia curvata* (Kutz.) Grunow | 2 | 1 | 1 | 2 | 3 | 1 | | | | | | |
| *Sellophora bacillum* (Ehr.) D. Mann | | 1 | | | | | | | | | | |
| *Stauroneis smithii* Grun. | | | | | | | | | | | | |
| *Stephanodiscus alpinus* Hust. | | | | | | | 2 | 3 | 5 | 25 | 17 | 22 |
| *Stephanodiscus hantzschii* Grun. In Cleve & Grunow | 46 | 45 | 17 | 30 | 40 | 29 | 20 | 18 | 22 | 43 | 47 | 76 |
| *Stephanodiscus hantzschii* var. *tenuis* (Hust.) Hankansson & Stoermer | | | | | | | 10 | 6 | 16 | 33 | 35 | 55 |
| *Stephanodiscus niagarae* Ehrenberg | | | | | | | | | | 3 | | 1 |
| *Stephanodiscus parvus* Stoermer & Hakansson | 13 | 17 | 6 | 5 | 6 | 4 | 3 | 2 | 1 | | | |
| *Surirella didyma* Kutzing | | 1 | 1 | 2 | 1 | 1 | | | | | | |
| *Surirella linearis* W. Smith | | | | | | | | | | 4 | 1 | 2 |
| *Surirella ovata* Kutzing | 1 | | | 1 | 1 | | | | | | | |
| *Surirella ovata* var. *pinnata* W. Smith | | | | | | | | | | | 1 | 1 |
| *Surirella sp.* Turpin | | | | | | | | | | | | |
| *Synedra acus* var. *angustissima* Grunow | | | | | | | 9 | 11 | 17 | 4 | 2 | 6 |
| *Synedra acus* var. *radians* (Kutz.) Grunow | | | | | | | | | | | | |
| *Synedra delicatissima* W. Smith | 13 | 8 | 7 | 11 | 10 | 11 | 10 | 9 | 23 | | | |
| *Synedra nana* Meister | | | | | | | 4 | 1 | | | | |
| *Synedra pulchella* Kutzing | | | 1 | | | | | | | | | |
| *Synedra radians* Kutz. | | | | | | | | | | | | |
| *Synedra ulna* (Nitz.) Ehrenberg | 2 | 2 | 2 | 1 | 2 | 1 | | | | 2 | | 1 |
| *Synedra ulna* var. *chaseana* Thomas | 11 | 6 | 4 | 5 | 9 | 10 | | 1 | 2 | | | |
| *Synedra ulna* var. *danica* (Kutz.) Grunow | | | | | | | 5 | 4 | 5 | | | |
| *Tabellaria fenestrata* (Lyngb.) Kutz. | | | | | | | | | | | | |
| *Tabellaria flocculosa* (Roth) Kutzing | | 1 | | | 1 | 1 | | | | | | |
| *Tabellaria quadriseptata* Knudson | 1 | 1 | 1 | 1 | 1 | 2 | | 2 | | 1 | 1 | 2 |
| | | | | | | | | | | | | |
| **Total Diatom Density (cells/mL)** | **440** | **523** | **265** | **455** | **518** | **654** | **253** | **210** | **359** | **437** | **284** | **450** |
| **Richness** | **38** | **47** | **45** | **46** | **50** | **54** | **26** | **36** | **35** | **47** | **37** | **45** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Oct-96 | | | Apr-97 | | | | | | Oct-97 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Achnanthes affinis* (Grunow) | | | | | | | | | 1 | | | |
| *Achnanthes exigua* Grun. In Cleve & Grunow | | | | | | | | | | | | |
| *Achnanthes exigua* var. *heterovalvata* Krasske | 3 | | | | | | | | | 1 | 6 | |
| *Achnanthes clevei* var. *rostrata* Hustedt | | | | | | | | | | | | |
| *Achnanthes flexella* Kutzing | | | | | | | | | | | 1 | |
| *Achnanthes hauckiana* Grun. | | | | | | | | | | 1 | 1 | |
| *Achnanthes lanceolata* var. *dubia* Grun. | | | | | | | | | | | | |
| *Achnanthes lanceolata* var. *rostrata* (Ostrup.) Hustedt | | | | | | | 1 | 1 | | | | |
| *Achnanthes linearis* W. Smith | | | | 1 | | | | | 1 | | | |
| *Achnanthes microcephala* Kutzing | | | 2 | | | | | | | | | |
| *Achnanthes minutissima* Kutzing | 3 | 3 | 6 | 2 | 2 | | 1 | 1 | 1 | 1 | 3 | 7 |
| *Achnanthes pellucida* Kutzing | | | | | | | | | | | | |
| *Amphipleura pellucida* Kutzing | | | | | | | | | | | | |
| *Amphora ovalis* var. *affinis* (Kutz.) E.H. *ex* DeT. | | | | | | | | | | | | |
| *Amphora pediculus* Kutzing | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | | 8 | 3 |
| *Amphora perpusilla* (Grun.) Grunow | 3 | 2 | | 1 | 2 | 1 | 1 | 1 | 1 | 4 | 1 | 3 |
| *Anomoeoneis serians* var. *brachysira* (deBreb.) Husted | | 2 | | | | | | | | | | |
| *Anomoeoneis vitrea* (Grun.) Ross | | 7 | 4 | | | | | | | | | |
| *Asterionella formosa* Hassal | 10 | 5 | 8 | 1 | 2 | 1 | 1 | 1 | 1 | 7 | 8 | 13 |
| *Aulacoseira ambigua* (Grun.) Simonsen | | | | 1 | 1 | | | 1 | 1 | 1 | | |
| *Aulacoseira distans* var. *lirata* | | | | | | | | | | | | |
| *Aulacoseira granulata* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira islandica* (O. Muller) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* var. *tenuissima* (Grun.) Simonson | | 2 | 1 | | | | | | | | | |
| *Caloneis bacillum* (Grun.) Meresch. | | | 1 | | | | | | | | | |
| *Caloneis ventricosa* (Ehr.) Meister | | | | | | | | | | | 1 | |
| *Cocconeis pediculus* Ehrenberg | 1 | 1 | | | | | | | | | | |
| *Cocconeis placentula* var. *euglypta* (Ehr.) Cleve | 3 | 3 | 5 | 3 | 2 | 1 | 1 | 3 | 2 | 8 | 8 | 13 |
| *Cocconeis placentula* var. *lineata* Cleve | | | | 1 | 1 | 1 | | 1 | 1 | | | |
| *Cocconeis thumensis* A. Mayer | | | | | 1 | 1 | 1 | 1 | 1 | | | |
| *Cyclotella atomus* Hust. | | | | | | | | | | | | |
| *Cyclotella comensis* Grunow | | | | | | | | | | | | |
| *Cyclotella compta* (Ehr.) Kutzing | | | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Cyclotella kutzingiana* var. *planetophora* Fricke | | | | | | | | | | | | |
| *Cyclotella meneghiniana* Kutzing | | | | 1 | 1 | 1 | | 1 | 1 | 3 | | |
| *Cyclotella michiginiana* Skv. | 11 | 9 | 11 | | | | | | | | | |
| *Cyclotella ocellata* Pant. | 14 | 42 | 45 | 10 | 3 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| *Cyclotella pseudostelligera* Husted | | | | | | | | | | | | |
| *Cyclotella socialis* Schutt | 3 | 1 | 4 | | | | | | | | | |
| *Cyclotella stelligera* (Cleve et Grun.) V.H. | 4 | 7 | 12 | 14 | 22 | 17 | 8 | 15 | 16 | 9 | 14 | |
| *Cymatopleura elliptica* (deBreb.) W. Smith | | | | 1 | 1 | | 1 | | | | | |
| *Cymatopleura solea* (deBreb.) W. Smith | | | | | | | | | | | | |
| *Cymbella affinis* Kutzing | | 3 | | | | | | | | 1 | 3 | |
| *Cymbella amphicephala* Naegeli | | | | | 1 | | 1 | 1 | 1 | | | |
| *Cymbella cuspidata* Kutzing | | | | | | | | | | | | 2 |
| *Cymbella hauckii* V. Heurck | | | | | | | | | | | | |
| *Cymbella microcephala* Grunow | | 3 | | 1 | 1 | 1 | 1 | | 1 | | | |
| *Cymbella minuta* var. *pseudogracilis* (Choln.) Reim | | | | | | | | | | | | |
| *Cymbella naviculiformis* Auerswald | | | | | | | | | | | | |
| *Cymbella parva* (W. Smith) Cleve | | | | | | | 1 | | | | | |
| *Cymbella perpusilla* A. Cleve | | 4 | | | | | | | | | | |
| *Cymbella prostata* (Berkeley) Cleve | | | | | | | | | | | | |
| *Cymbella ventricosa* Kutzing | 4 | 2 | 1 | 1 | | 1 | 1 | 1 | 1 | | | |
| *Diatoma anceps* (Ehr.) Grunow | | | | | | | | | | | | |
| *Diatoma tenuis* Agardh | 3 | 1 | 2 | 3 | 4 | 5 | 1 | 3 | 3 | 6 | 6 | 19 |
| *Diatoma tenuis* var. *elongatum* Lyngbye | | | | | | | | | | 7 | 1 | 10 |
| *Diatoma vulgare* Bory | | | | 2 | 1 | 3 | 2 | 3 | 3 | 1 | | |
| *Diatoma vulgare* var. Breve | | 1 | 1 | | | | | | | | | |
| *Diploneis ovalis* (Hilse.) Cleve | | | | | | 1 | | | | | | |
| *Diploneis puella* (Schumann) Cleve | | | | | | | | | | | | |
| *Encyonema minutum* (Hilse in Rabenhorst) Mann | | | | | | | | | | 1 | 1 | |
| *Epithemia emarginata* Andrews | | | | | | | | | | | | |
| *Fragilaria brevistriata* Grunow | | | 1 | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Oct-96 | | | Apr-97 | | | | | | Oct-97 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Fragilaria capucina* Desmzeires | | | | 5 | 1 | 3 | 1 | 2 | 2 | | | |
| *Fragilaria capucina* var. *gracilis* (Oestr.) Hustedt | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Fragilaria capucina* var. *mesolepta* (Rabh.) Grunow | | | | | | | | | | | | |
| *Fragilaria capucina* var. *rumpens* (Kutz.) Lange-Bertalot | | | | | | | | | | 36 | 57 | 60 |
| *Fragilaria capucina* var. *vaucheriae* (Kutz.) Lange-Bertalot | | | | 8 | 6 | 5 | 4 | 6 | 4 | 3 | 1 | 2 |
| *Fragilaria construens* (Ehr.) Grunow | | | 1 | 4 | 5 | 1 | 1 | 3 | 3 | 11 | 9 | 5 |
| *Fragilaria construens* var. *binodis* (Ehr.) Grunow | | | | | | | | | | | | |
| *Fragilaria construens* var. *venter* (Ehr.) Grunow | 3 | 3 | 9 | 1 | 3 | 2 | 1 | 1 | 1 | 5 | 7 | 11 |
| *Fragilaria crotonensis* Kitton | | | | | | | | | | 87 | 89 | 112 |
| *Fragilaria delicatissima* (W. smith) Lange-Bertalot | | | | 1 | 1 | 1 | 1 | | 1 | | | |
| *Fragilaria famelica* (Kutz.) Lange-Bertalot | | | | | | | | | | 15 | 27 | 33 |
| *Fragilaria intermedia* Grunow | | 6 | | | | | | | | | | |
| *Fragilaria pinnata* Ehrenberg | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | |
| *Fragilaria tenera* (W. Smith) Lange-Bertalot | | | | | 1 | | | | | | | |
| *Fragilaria virescens* Ralfs | 25 | 17 | 6 | | | | | | | | | |
| *Gomphonema angustatum* var. *producta* Grunow | | 2 | 2 | | | | | | 1 | | | |
| *Gomphonema gracile* Ehr. | | | | | | | | | | 1 | 1 | 3 |
| *Gomphonema intricatum* Kutzing | | | | | | | | | | | | |
| *Gomphonema olivaceum* (Lyngbye) Kutzing | | | | | | | | | | | | |
| *Gomphonema parvulum* (Kutz.) Grunow | | | | 1 | | | | | | | | |
| *Gyrosigma acuminatum* (Kutz.) Rabh. | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Melosira varians* C.A. Agardh | | | | | 1 | | 1 | 1 | | | | |
| *Navicula 2* | | | | | | | | | | | | |
| *Navicula arvensis* Hust. | | | | 1 | | | 1 | 1 | | | | |
| *Navicula capitata* Ehrenberg | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Navicula capitata* var. *lunebergensis* (Grun.) Patrick | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Navicula c.f. dicephala* (Ehr.) W. Smith | | | | | | | | | | | | |
| *Navicula cincta* (Ehr.) Kutzing | | | | | | | 1 | 1 | | | | |
| *Navicula cocconeiformis* Greg. | | | | | | | | | | 1 | | |
| *Navicula cohnii* (Hilse.) Grunow | | 2 | | 1 | | 1 | 1 | 1 | 1 | | | |
| *Navicula contenta* Grunow | | | | | | | | | | | | |
| *Navicula cryptocephala* Kutzing | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| *Navicula cryptocephala* var. *exilis* Kutzing | | | | | | | | | | | | |
| *Navicula dicephala* (Ehr.) W. Smith | | | | | | | | | | | | |
| *Navicula frugalis* Hustedt | | | | | | | | 1 | | | | |
| *Navicula gastrum* (Ehr.) Donkin | | | | 1 | 1 | 1 | | 1 | | | | |
| *Navicula gracilis* Ehrenberg | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Navicula hungarica* Grunow | | 1 | 1 | | | | | | | | 1 | 2 |
| *Navicula lacustris* Gregory | | | | | 1 | 1 | | 1 | 1 | | | |
| *Navicula lanaceolata* (Agardh.) Kutz. | | | | | | | | | | 3 | 3 | 2 |
| *Navicula latissima* Gregory | | | | | | | | | | | | |
| *Navicula menisculus* Schumann | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | |
| *Navicula minima* Grun. | | | | | 1 | 1 | 1 | 1 | 1 | 3 | | |
| *Navicula minuscula* Grun. | | | | | | | | | | | | |
| *Navicula mutica* Kutzing | | | | | | | | | | | | |
| *Navicula nitrophila* B. Petersen | | | | | | | | | | | | |
| *Navicula perpusilla* Grunow | | | | | | | | | | | | |
| *Navicula pseudoreinhardtii* Patrick | | | | | | | | | | | | |
| *Navicula pupula* Kutzing | | | | | | | | | | | | 2 |
| *Navicula pupula* var. *mutata* (Krasske) Hustedt | | | | | | | | | | | | |
| *Navicula pusio* Cleve | | | | | | | | | | | | |
| *Navicula radiosa* Kutzing | 2 | | | | | | | | | | | |
| *Navicula radiosa* var. *tenella* (deBreb. ex Katz.) Grunow | | | | 1 | | 1 | 1 | 1 | 1 | | | |
| *Navicula schmassmannii* Hustedt | | 1 | | | | | | | | | | |
| *Navicula seminulum* Grunow | | | 3 | 1 | | 1 | 1 | | 1 | | | |
| *Navicula sp.* Bory | | | | | | | | | | | | |
| *Navicula 1* | 3 | | 1 | | | | | | | | | |
| *Navicula subtilissima* Cleve | | | | | | | 1 | | | | | |
| *Navicula symmetrica* Patrick | | | | | | | | | | | | |
| *Navicula tripunctata* var. *schizonemoides* | | | | | | | | | | | | |
| *Navicula variostrata* Krasske | | | | 1 | 1 | 1 | 1 | 1 | 3 | | | |
| *Neidium dubium* (Ehr.) Cleve | | | | | | | 1 | | 1 | 1 | | |
| *Neidium dubuim* var. *constrictum* A.V. Heurck | | | | | | | | | | | | |
| *Nitzschia (longissima?)* (deBreb.) Ralfs | | | | | | | | | | | | |
| *Nitzschia acicularis* W. smith | | | 1 | 3 | 4 | 2 | 1 | 1 | 1 | | | |
| *Nitzschia amphibia* Grunow | | | | | 1 | 1 | 1 | 1 | | | | |
| *Nitzschia angustata* (W. Smith) Grunow | | | | | | | | | | | | |
| *Nitzschia constricta* (Kutz.) Ralfs. | | | | | | | | | | | 1 | |
| *Nitzschia denticula* Grunow | | | | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Oct-96 | | | Apr-97 | | | | | | Oct-97 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Nitzschia dissipata* (Kutz.) Grunow | | | 1 | 2 | 1 | 1 | 1 | 1 | | 1 | 1 | |
| *Nitzschia fonticola* Grunow | | | | | | | | | | | | |
| *Nitzschia frustulum* Grunow | 35 | 21 | 24 | 1 | 1 | 1 | | | 1 | 11 | 11 | 2 |
| *Nitzschia frustulum* Kutz. | | | | | | | | | | | | |
| *Nitzschia GLRD 1* | | | | | | | | | | | | |
| *Nitzschia gracilis* Hantzsch. | | | | | | | | | | 9 | 3 | 5 |
| *Nitzschia linearis* W. Smith | 1 | | 1 | | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 |
| *Nitzschi palea* var. *debilis* (Kutz.) Grunow | | | | | | | | | | | | |
| *Nitzschia paleacea* Grunow | 47 | 51 | 64 | 19 | 19 | 7 | 4 | 4 | 11 | 27 | 16 | 18 |
| *Nitzschia romana* Grunow | 6 | 21 | 42 | 9 | 11 | 2 | 1 | 1 | 3 | | | |
| *Nitzschia stagnorum* Rabh. | | | | | | | | | | | | |
| *Nitzschia subcapitellata* Hust. | | | | | | | | | | | | |
| *Nitzschia sublinearis* Hustedt | | | | | | | | | | | | |
| *Nitzschia thermalis* Kutzing | | | | | | | | | | | | |
| *Nitzschia tryblionella* var. *debilis* (Arnott) A. Mayer | | | | | | | | | | | | |
| *Rhizosolenia eriensis* H.L. Smith | | | | | | | | | | | | |
| *Rhizosolenia sp.* Ehrenberg | | | | | | | | | | | | |
| *Rhoicosphenia curvata* (Kutz.) Grunow | 3 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | |
| *Sellophora bacillum* (Ehr.) D. Mann | | | | 1 | 1 | | 1 | 1 | | | | |
| *Stauroneis smithii* Grun. | | | | | | | | | | | 1 | |
| *Stephanodiscus alpinus* Hust. | 25 | 24 | 41 | 8 | 7 | 6 | 2 | 4 | 5 | 1 | 7 | 2 |
| *Stephanodiscus hantzschii* Grun. In Cleve & Grunow | 37 | 48 | 50 | 44 | 35 | 29 | 12 | 21 | 26 | 31 | 28 | 16 |
| *Stephanodiscus hantzschii* var. *tenuis* (Hust.) Hankansson & Stoermer | 24 | 29 | 38 | 23 | 14 | 9 | 6 | 8 | 12 | 9 | 3 | 7 |
| *Stephanodiscus niagarae* Ehrenberg | 2 | 2 | 3 | | | | | | | | | |
| *Stephanodiscus parvus* Stoermer & Hakansson | | | | | | | | | | 3 | 11 | 3 |
| *Surirella didyma* Kutzing | | | | | | | | | | | | |
| *Surirella linearis* W. Smith | | | 3 | | | | | | | | | |
| *Surirella ovata* Kutzing | | | | | | | | | | | | |
| *Surirella ovata* var. *pinnata* W. Smith | 2 | | 6 | 1 | 1 | 1 | 1 | | 1 | | | 2 |
| *Surirella sp.* Turpin | | | | | | | | | | | | |
| *Synedra acus* var. *angustissima* Grunow | 3 | 4 | 1 | 3 | 1 | 2 | 1 | 1 | 3 | 3 | 5 | 4 |
| *Synedra acus* var. *radians* (Kutz.) Grunow | | | | | | | | | | | | |
| *Synedra delicatissima* W. Smith | | | | | | | | | | | | |
| *Synedra nana* Meister | | | | | | | | | | | | |
| *Synedra pulchella* Kutzing | | | | | | | | | | | | |
| *Synedra radians* Kutz. | | | | | | | | | | | | |
| *Synedra ulna* (Nitz.) Ehrenberg | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Synedra ulna* var. *chaseana* Thomas | | | | | | | | | | | | |
| *Synedra ulna* var. *danica* (Kutz.) Grunow | | | | | | | | | | | | |
| *Tabellaria fenestrata* (Lyngb.) Kutz. | | | | | | | | | | | | |
| *Tabellaria flocculosa* (Roth) Kutzing | | | | | | | | | | | | |
| *Tabellaria quadriseptata* Knudson | 4 | | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | |
| | | | | | | | | | | | | |
| **Total Diatom Density (cells/mL)** | **289** | **335** | **410** | **185** | **176** | **124** | **82** | **111** | **132** | **325** | **365** | **368** |
| **Richness** | **30** | **36** | **38** | **52** | **53** | **49** | **55** | **53** | **54** | **41** | **41** | **30** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Oct-97 | | | Sep-97 | | | | | | Aug-98 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Achnanthes affinis* (Grunow) | | | | | | | | | | | | |
| *Achnanthes exigua* Grun. In Cleve & Grunow | | | | | | | | | | | | |
| *Achnanthes exigua* var. *heterovalvata* Krasske | 3 | 2 | 4 | 1 | | | | | | | | |
| *Achnanthes clevei* var. *rostrata* Hustedt | | | | | | | | | | | | |
| *Achnanthes flexella* Kutzing | | | | 2 | 1 | 3 | | 1 | | 14 | | 5 |
| *Achnanthes hauckiana* Grun. | | | | 1 | | 2 | 2 | | | | | |
| *Achnanthes lanceolata* var. *dubia* Grun. | | | 1 | 2 | 1 | 1 | 1 | | 2 | | | |
| *Achnanthes lanceolata* var. *rostrata* (Ostrup.) Hustedt | | | | | | | | | | | | |
| *Achnanthes linearis* W. Smith | | | | | | | | | | | | |
| *Achnanthes microcephala* Kutzing | | | | | | | | | | 14 | | |
| *Achnanthes minutissima* Kutzing | 7 | 6 | 4 | | | | 1 | | | 14 | | 10 |
| *Achnanthes pellucida* Kutzing | | | | | | | | | | | | |
| *Amphipleura pellucida* Kutzing | | | | | | | | | | | | |
| *Amphora ovalis* var. *affinis* (Kutz.) E.H. *ex* DeT. | | | | | | | | | | | | |
| *Amphora pediculus* Kutzing | 3 | 2 | | 3 | 16 | 18 | 4 | 15 | 11 | | | |
| *Amphora perpusilla* (Grun.) Grunow | 2 | 1 | 1 | 2 | 10 | 2 | 6 | 12 | 3 | 14 | 15 | |
| *Anomoeoneis serians* var. *brachysira* (deBreb.) Husted | | | | | | | | | | | | |
| *Anomoeoneis vitrea* (Grun.) Ross | | | | | | | | | | | | |
| *Asterionella formosa* Hassal | 19 | 16 | 7 | | | 8 | 7 | 1 | | 14 | 10 | 10 |
| *Aulacoseira ambigua* (Grun.) Simonsen | 2 | | 1 | | | 4 | | | | 7 | 10 | |
| *Aulacoseira distans* var. *lirata* | | | | | | | | | | | | |
| *Aulacoseira granulata* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira islandica* (O. Muller) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* var. *tenuissima* (Grun.) Simonson | | | | | | | | | | | | |
| *Caloneis bacillum* (Grun.) Meresch. | | | | | | | | | | | | |
| *Caloneis ventricosa* (Ehr.) Meister | | | | | 2 | 2 | | | | | | |
| *Cocconeis pediculus* Ehrenberg | | | | | | | | | | | | |
| *Cocconeis placentula* var. *euglypta* (Ehr.) Cleve | 10 | 19 | 11 | | | | | | | 21 | 10 | 10 |
| *Cocconeis placentula* var. *lineata* Cleve | | | | | | | | | | | | |
| *Cocconeis thumensis* A. Mayer | | | | | | | | | | | | |
| *Cyclotella atomus* Hust. | | | | | | | | | | | | |
| *Cyclotella comensis* Grunow | | | | | | | | | | | | |
| *Cyclotella compta* (Ehr.) Kutzing | | | | | | | | | | | | |
| *Cyclotella kutzingiana* var. *planetophora* Fricke | | | | | | | | | | | | |
| *Cyclotella meneghiniana* Kutzing | | | 1 | 8 | 18 | 20 | 15 | 26 | 12 | 361 | 332 | 258 |
| *Cyclotella michiginiana* Skv. | | | | | | | | | | | | |
| *Cyclotella ocellata* Pant. | 3 | 7 | 3 | 1 | 7 | 1 | 1 | 2 | 1 | 194 | 87 | 89 |
| *Cyclotella pseudostelligera* Husted | | | | | | | | | | | | |
| *Cyclotella socialis* Schutt | | | | | | | | | | | | |
| *Cyclotella stelligera* (Cleve et Grun.) V.H. | 19 | 9 | 7 | 2 | 7 | 8 | 1 | 1 | | 35 | 41 | 99 |
| *Cymatopleura elliptica* (deBreb.) W. Smith | | | | | | | | | | | | |
| *Cymatopleura solea* (deBreb.) W. Smith | | | | 5 | 21 | 17 | 9 | 13 | 7 | | | |
| *Cymbella affinis* Kutzing | 3 | | 1 | | | | | | | | | |
| *Cymbella amphicephala* Naegeli | | | | | | | | | | | | |
| *Cymbella cuspidata* Kutzing | | | 1 | | | | | | | | | |
| *Cymbella hauckii* V. Heurck | | | | | | | | | | | | |
| *Cymbella microcephala* Grunow | | | | | | | 1 | 1 | | | | |
| *Cymbella minuta* var. *pseudogracilis* (Choln.) Reim | | | | | | | | | | | | |
| *Cymbella naviculiformis* Auerswald | | | | | | | | | | | | |
| *Cymbella parva* (W. Smith) Cleve | | | | | | | | | | | | |
| *Cymbella perpusilla* A. Cleve | | | | | | | | | | | | |
| *Cymbella prostata* (Berkeley) Cleve | | | | | | | | | | | | |
| *Cymbella ventricosa* Kutzing | | | | | | | | | | | | |
| *Diatoma anceps* (Ehr.) Grunow | | | | | | | | | | | | |
| *Diatoma tenuis* Agardh | 2 | 17 | 7 | | 2 | 3 | 1 | | | | | |
| *Diatoma tenuis* var. *elongatum* Lyngbye | 15 | | 12 | | | | | | 1 | 14 | 10 | 10 |
| *Diatoma vulgare* Bory | | | | 6 | 16 | 12 | 10 | 9 | 10 | | | |
| *Diatoma vulgare* var. Breve | | | | | | | | | | | | |
| *Diploneis ovalis* (Hilse.) Cleve | | 2 | | | 2 | | | | | | | |
| *Diploneis puella* (Schumann) Cleve | | | | | | | | | | | | |
| *Encyonema minutum* (Hilse in Rabenhorst) Mann | 2 | | 1 | | 1 | | 2 | | 2 | | | |
| *Epithemia emarginata* Andrews | | | | | | | | | | | | |
| *Fragilaria brevistriata* Grunow | | | | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Oct-97 | | | Sep-97 | | | | | | Aug-98 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Fragilaria capucina* Desmzeires | | | | | | | | | | | 10 | 15 |
| *Fragilaria capucina* var. *gracilis* (Oestr.) Hustedt | | | | | | | | | | | | |
| *Fragilaria capucina* var. *mesolepta* (Rabh.) Grunow | | | | | | | | | | | | |
| *Fragilaria capucina* var. *rumpens* (Kutz.) Lange-Bertalot | 3 | 3 | 16 | | | | | 1 | 1 | | 5 | 10 |
| *Fragilaria capucina* var. *vaucheriae* (Kutz.) Lange-Bertalot | 17 | 9 | 20 | 1 | 2 | 1 | 1 | 2 | 2 | | | |
| *Fragilaria construens* (Ehr.) Grunow | | 15 | 7 | | 5 | 2 | 9 | | 3 | | | |
| *Fragilaria construens* var. *binodis* (Ehr.) Grunow | | | | | | | | | | | | |
| *Fragilaria construens* var. *venter* (Ehr.) Grunow | 10 | 4 | 3 | 2 | 11 | 6 | 13 | 2 | 6 | | | |
| *Fragilaria crotonensis* Kitton | 101 | 109 | 105 | | 17 | 9 | 22 | 17 | 10 | 83 | 15 | 25 |
| *Fragilaria delicatissima* (W. smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria famelica* (Kutz.) Lange-Bertalot | 26 | 55 | 41 | 5 | 6 | 7 | 3 | | 1 | | | |
| *Fragilaria intermedia* Grunow | | | | | | | | | | | | |
| *Fragilaria pinnata* Ehrenberg | 3 | 2 | | | 43 | 27 | 29 | 24 | 34 | | | |
| *Fragilaria tenera* (W. Smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria virescens* Ralfs | | | | | | | | | | | | |
| *Gomphonema angustatum* var. *producta* Grunow | | | | | | | | | | | | |
| *Gomphonema gracile* Ehr. | | | 4 | | 14 | 8 | 2 | 3 | 2 | | | |
| *Gomphonema intricatum* Kutzing | | | | | | | | | | | | |
| *Gomphonema olivaceum* (Lyngbye) Kutzing | | | | | | | | | | | | |
| *Gomphonema parvulum* (Kutz.) Grunow | | | | | | | | | | | | |
| *Gyrosigma acuminatum* (Kutz.) Rabh. | | | | | | | 3 | 2 | 2 | | | |
| *Melosira varians* C.A. Agardh | | | | | | | | | | | | |
| *Navicula 2* | | | | | | | | | | | | |
| *Navicula arvensis* Hust. | | | | | | | | | | | 10 | 5 |
| *Navicula capitata* Ehrenberg | | | | | | | | | | | | |
| *Navicula capitata* var. *lunebergensis* (Grun.) Patrick | | | | | | | | | | | | |
| *Navicula c.f. dicephala* (Ehr.) W. Smith | | | | | | | | | | | | |
| *Navicula cincta* (Ehr.) Kutzing | | | | | | | | | | | | |
| *Navicula cocconeiformis* Greg. | | | | | | | 1 | 1 | | | | |
| *Navicula cohnii* (Hilse.) Grunow | | | | | | | | | | | | |
| *Navicula contenta* Grunow | | | | | | | | | | | | |
| *Navicula cryptocephala* Kutzing | | | | 1 | 5 | 10 | 1 | 6 | 2 | 21 | | 15 |
| *Navicula cryptocephala* var. *exilis* Kutzing | | | | | | | | | | | | |
| *Navicula dicephala* (Ehr.) W. Smith | | | | | | | | | | | | |
| *Navicula frugalis* Hustedt | | | | | | | | | | | | |
| *Navicula gastrum* (Ehr.) Donkin | | | | | | | | | | | | |
| *Navicula gracilis* Ehrenberg | | | | | | | | | | | | |
| *Navicula hungarica* Grunow | 7 | | 4 | 1 | 4 | 3 | 1 | 2 | 2 | 21 | 10 | |
| *Navicula lacustris* Gregory | | | | | | | | | | | | |
| *Navicula lanaceolata* (Agardh.) Kutz. | | 2 | 3 | 2 | | 1 | 1 | | 1 | | | |
| *Navicula latissima* Gregory | | | | | 2 | | | | 1 | | | |
| *Navicula menisculus* Schumann | | 2 | 1 | 3 | 7 | 14 | 7 | 3 | 5 | 56 | 20 | 20 |
| *Navicula minima* Grun. | 2 | 4 | 1 | | 3 | 4 | 1 | 2 | | 14 | | 10 |
| *Navicula minuscula* Grun. | | | | | | | | | | | | |
| *Navicula mutica* Kutzing | | | | | | | | | | | | |
| *Navicula nitrophila* B. Petersen | | | | | | | | | | | | |
| *Navicula perpusilla* Grunow | | | | | | | | | | | | |
| *Navicula pseudoreinhardtii* Patrick | | | | | | | | | | | | |
| *Navicula pupula* Kutzing | 2 | 2 | 1 | | 7 | | 1 | | | | | |
| *Navicula pupula* var. *mutata* (Krasske) Hustedt | | | | | | | | | | | | |
| *Navicula pusio* Cleve | | | | 1 | | 7 | | 1 | 1 | | | |
| *Navicula radiosa* Kutzing | 6 | 6 | 3 | 1 | 6 | 2 | 1 | 2 | 3 | | 15 | 10 |
| *Navicula radiosa* var. *tenella* (deBreb. ex Katz.) Grunow | | | 1 | 4 | | 7 | 5 | 2 | | 28 | | 10 |
| *Navicula schmassmannii* Hustedt | | | | | | | | | | | | |
| *Navicula seminulum* Grunow | | | | | | | | | | | | |
| *Navicula sp.* Bory | | | | | | | | | | | | |
| *Navicula 1* | | | | | | | | | | | | |
| *Navicula subtilissima* Cleve | | | | | | | | | | | | |
| *Navicula symmetrica* Patrick | | | | | | | | | | | | |
| *Navicula tripunctata* var. *schizonemoides* | | | | | | | | | | | | |
| *Navicula variostrata* Krasske | | | | | | | | | | | | |
| *Neidium dubium* (Ehr.) Cleve | | | 1 | | | | | | | | | |
| *Neidium dubuim* var. *constrictum* A.V. Heurck | | | | | | | | | | | | |
| *Nitzschia (longissima?)* (deBreb.) Ralfs | | | | | | | | | | | | |
| *Nitzschia acicularis* W. smith | | | | | | | | | | | | |
| *Nitzschia amphibia* Grunow | | | | | | | | | | | | |
| *Nitzschia angustata* (W. Smith) Grunow | | | | | | | | | | | | |
| *Nitzschia constricta* (Kutz.) Ralfs. | | | | | 2 | | 1 | 2 | 2 | | 10 | |
| *Nitzschia denticula* Grunow | | 2 | | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Oct-97 | | | Sep-97 | | | | | | Aug-98 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Nitzschia dissipata* (Kutz.) Grunow | | 2 | 1 | 3 | 5 | 5 | 4 | 2 | 2 | | | |
| *Nitzschia fonticola* Grunow | | | | | | | | | | | | |
| *Nitzschia frustulum* Grunow | 5 | 15 | 3 | 2 | 6 | 5 | 6 | 11 | 4 | | | |
| *Nitzschia frustulum* Kutz. | | | | | | | | | | | | |
| *Nitzschia GLRD 1* | | | | | | | | | | | | |
| *Nitzschia gracilis* Hantzsch. | 2 | 3 | 9 | 6 | 19 | 18 | 1 | 13 | 12 | | | |
| *Nitzschia linearis* W. Smith | 4 | | 2 | 1 | 5 | 6 | 5 | 11 | 3 | 21 | 10 | 10 |
| *Nitzschi palea* var. *debilis* (Kutz.) Grunow | | | | | | | | | | | | |
| *Nitzschia paleacea* Grunow | 19 | 21 | 9 | 12 | 32 | 31 | 14 | 22 | 14 | 21 | 26 | 30 |
| *Nitzschia romana* Grunow | | | | | | | | | | | | |
| *Nitzschia stagnorum* Rabh. | | | | | | | | | | | | |
| *Nitzschia subcapitellata* Hust. | | | | | | | | | | | | |
| *Nitzschia sublinearis* Hustedt | | | | | | | | | | | | |
| *Nitzschia thermalis* Kutzing | | | | | | | | | | | | |
| *Nitzschia tryblionella* var. *debilis* (Arnott) A. Mayer | | | | | | | | | | | | |
| *Rhizosolenia eriensis* H.L. Smith | | | | | | | | | | | | |
| *Rhizosolenia sp.* Ehrenberg | | | | 5 | 24 | 7 | 10 | | 5 | | | |
| *Rhoicosphenia curvata* (Kutz.) Grunow | | 4 | 4 | 2 | 3 | 5 | 5 | 2 | 2 | 14 | 10 | 20 |
| *Sellophora bacillum* (Ehr.) D. Mann | | | | | | | | | | | | |
| *Stauroneis smithii* Grun. | | | | | | | | | | | | |
| *Stephanodiscus alpinus* Hust. | 7 | 7 | 4 | 2 | 9 | 5 | 7 | 8 | 5 | 14 | 10 | 35 |
| *Stephanodiscus hantzschii* Grun. In Cleve & Grunow | 41 | 49 | 25 | 8 | 31 | 26 | 13 | 16 | 10 | 292 | 128 | 124 |
| *Stephanodiscus hantzschii* var. *tenuis* (Hust.) Hankansson & Stoermer | 5 | 10 | 5 | 2 | 7 | 8 | 9 | 4 | 1 | 694 | 536 | 471 |
| *Stephanodiscus niagarae* Ehrenberg | | | | | | | | | | | | |
| *Stephanodiscus parvus* Stoermer & Hakansson | 2 | 4 | 4 | 1 | 3 | 2 | 1 | 1 | 1 | 14 | | 5 |
| *Surirella didyma* Kutzing | | | | | | | | | | | | |
| *Surirella linearis* W. Smith | | | | | | | | | | | 10 | |
| *Surirella ovata* Kutzing | | | | | | | | | | | | |
| *Surirella ovata* var. *pinnata* W. Smith | | | | | | | | | | | | |
| *Surirella sp.* Turpin | | | | | | | | | | | | |
| *Synedra acus* var. *angustissima* Grunow | 2 | 4 | 4 | | | | | | | 14 | 20 | 15 |
| *Synedra acus* var. *radians* (Kutz.) Grunow | | | | 4 | 19 | 10 | 11 | 11 | 4 | 49 | 51 | 55 |
| *Synedra delicatissima* W. Smith | | | | | | | | | | | | |
| *Synedra nana* Meister | | | | | | | | | | | | |
| *Synedra pulchella* Kutzing | | | | | | | | | | | | |
| *Synedra radians* Kutz. | | | | | | | | | | | | |
| *Synedra ulna* (Nitz.) Ehrenberg | | | | | 1 | | | | | | | |
| *Synedra ulna* var. *chaseana* Thomas | | | | | | | | | | | | |
| *Synedra ulna* var. *danica* (Kutz.) Grunow | | | | | | | | | | | | |
| *Tabellaria fenestrata* (Lyngb.) Kutz. | | | | | | | | | | | | |
| *Tabellaria flocculosa* (Roth) Kutzing | | | | | | | | | | | | |
| *Tabellaria quadriseptata* Knudson | | | | 1 | 1 | | 1 | | 2 | | | |
| | | | | | | | | | | | | |
| **Total Diatom Density (cells/mL)** | **352** | **417** | **350** | **107** | **403** | **336** | **248** | **256** | **192** | **2,055** | **1,415** | **1,373** |
| **Richness** | **32** | **33** | **41** | **34** | **43** | **42** | **46** | **38** | **39** | **26** | **25** | **26** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Aug-98 | | | Aug-99 | | | | | | Aug-00 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Achnanthes affinis* (Grunow) | | | | | | | | | | | | |
| *Achnanthes exigua* Grun. In Cleve & Grunow | | | | | | | | | | | | |
| *Achnanthes exigua* var. *heterovalvata* Krasske | | | | | | | | | | | | |
| *Achnanthes clevei* var. *rostrata* Hustedt | | | | | | | | | | | | |
| *Achnanthes flexella* Kutzing | | | | | | | | | | | | |
| *Achnanthes hauckiana* Grun. | | | | | | | | | | | | |
| *Achnanthes lanceolata* var. *dubia* Grun. | | | | | | | | | | | | |
| *Achnanthes lanceolata* var. *rostrata* (Ostrup.) Hustedt | | | | | | | | | | | | |
| *Achnanthes linearis* W. Smith | | | | | | | | | | | | |
| *Achnanthes microcephala* Kutzing | | | | | | | | | | | | |
| *Achnanthes minutissima* Kutzing | | 16 | | 10 | | 6 | 7 | 7 | | | 18 | |
| *Achnanthes pellucida* Kutzing | | | | | | | | | | | | |
| *Amphipleura pellucida* Kutzing | | | | | | | | | | | | |
| *Amphora ovalis* var. *affinis* (Kutz.) E.H. *ex* DeT. | | | | | 5 | 8 | | | | 20 | 54 | |
| *Amphora pediculus* Kutzing | | | | | | | | | | | | |
| *Amphora perpusilla* (Grun.) Grunow | | 33 | | 5 | | | 7 | 11 | 7 | 20 | 18 | 36 |
| *Anomoeoneis serians* var. *brachysira* (deBreb.) Husted | | | | | | | | | | | | |
| *Anomoeoneis vitrea* (Grun.) Ross | | | | | | | | | | | | |
| *Asterionella formosa* Hassal | | | | 5 | | | | | | 171 | 198 | 217 |
| *Aulacoseira ambigua* (Grun.) Simonsen | 3 | | | | | | | | | | | |
| *Aulacoseira distans* var. *lirata* | | | | | | | | | | | | |
| *Aulacoseira granulata* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira islandica* (O. Muller) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* var. *tenuissima* (Grun.) Simonson | | | | | | | | | | | | |
| *Caloneis bacillum* (Grun.) Meresch. | | | | | | | | | | | | |
| *Caloneis ventricosa* (Ehr.) Meister | | | | | | | | | | | | |
| *Cocconeis pediculus* Ehrenberg | | | | | | | | | | | | |
| *Cocconeis placentula* var. *euglypta* (Ehr.) Cleve | 10 | 25 | | | | | | | | | | |
| *Cocconeis placentula* var. *lineata* Cleve | | | | | | | | | | | | |
| *Cocconeis thumensis* A. Mayer | | | | | | | | | | | | |
| *Cyclotella atomus* Hust. | | | | | 5 | 6 | | 9 | 7 | 30 | 36 | 48 |
| *Cyclotella comensis* Grunow | | | | 134 | 187 | 245 | 244 | 164 | 221 | | | |
| *Cyclotella compta* (Ehr.) Kutzing | | | | | | | | | | | | |
| *Cyclotella kutzingiana* var. *planetophora* Fricke | | | | 83 | 114 | 119 | 183 | 101 | 99 | 262 | 27 | 96 |
| *Cyclotella meneghiniana* Kutzing | 131 | 444 | 300 | | | | | | | | | |
| *Cyclotella michiginiana* Skv. | | | | 6 | 11 | 13 | 12 | 9 | 13 | 20 | | 12 |
| *Cyclotella ocellata* Pant. | 85 | 156 | 54 | 28 | 64 | 80 | 9 | 31 | 55 | 282 | 504 | 385 |
| *Cyclotella pseudostelligera* Husted | | | | 3 | 4 | 16 | 21 | 5 | 10 | | | |
| *Cyclotella socialis* Schutt | | | | | | | | | | | | |
| *Cyclotella stelligera* (Cleve et Grun.) V.H. | 72 | 107 | 39 | | | 6 | 18 | 5 | 10 | 70 | 81 | 96 |
| *Cymatopleura elliptica* (deBreb.) W. Smith | | | | | | | | | | | | |
| *Cymatopleura solea* (deBreb.) W. Smith | | | | | | | | | 7 | 10 | | |
| *Cymbella affinis* Kutzing | | | | | | | | | | | | |
| *Cymbella amphicephala* Naegeli | | | | | | | | | | | | |
| *Cymbella cuspidata* Kutzing | 3 | 16 | | | | | | | | | | |
| *Cymbella hauckii* V. Heurck | | | | 5 | | | | | | | 18 | |
| *Cymbella microcephala* Grunow | | | | 5 | | 6 | | | 7 | | | 12 |
| *Cymbella minuta* var. *pseudogracilis* (Choln.) Reim | | | | | | | | | | | | |
| *Cymbella naviculiformis* Auerswald | | | | | | | | | | | | |
| *Cymbella parva* (W. Smith) Cleve | | | | | | | | | | | | |
| *Cymbella perpusilla* A. Cleve | | | | | | | | | | | | |
| *Cymbella prostata* (Berkeley) Cleve | | | | | | | | | | | | |
| *Cymbella ventricosa* Kutzing | | | | | | | | | | | | |
| *Diatoma anceps* (Ehr.) Grunow | | | | | | | | | | | | |
| *Diatoma tenuis* Agardh | | | | | 5 | 6 | 7 | | 7 | 20 | | |
| *Diatoma tenuis* var. *elongatum* Lyngbye | | | | 5 | | | | 5 | 7 | | | |
| *Diatoma vulgare* Bory | | | | | | | | | | | | |
| *Diatoma vulgare* var. Breve | | | | | | | | | | | | |
| *Diploneis ovalis* (Hilse.) Cleve | | | | | | | 7 | 5 | | | | |
| *Diploneis puella* (Schumann) Cleve | | | | | 5 | | | | | 20 | 18 | 24 |
| *Encyonema minutum* (Hilse in Rabenhorst) Mann | | | | | | 6 | | | | 20 | 54 | |
| *Epithemia emarginata* Andrews | | | | | | | | | | | | |
| *Fragilaria brevistriata* Grunow | | | | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Aug-98 | | | Aug-99 | | | | | | Aug-00 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Fragilaria capucina* Desmzeires | 7 | | 10 | 5 | 11 | 10 | 7 | 5 | 16 | 60 | 54 | 48 |
| *Fragilaria capucina* var. *gracilis* (Oestr.) Hustedt | | | | | | | | | | | | |
| *Fragilaria capucina* var. *mesolepta* (Rabh.) Grunow | | | | | | | | | | | | |
| *Fragilaria capucina* var. *rumpens* (Kutz.) Lange-Bertalot | | 16 | 10 | 3 | 15 | 13 | | 5 | | 282 | 468 | 530 |
| *Fragilaria capucina* var. *vaucheriae* (Kutz.) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria construens* (Ehr.) Grunow | | | | | | | | | | | | |
| *Fragilaria construens* var. *binodis* (Ehr.) Grunow | | | | | | | | | | | | |
| *Fragilaria construens* var. *venter* (Ehr.) Grunow | | | | | | 6 | | | 10 | 20 | | |
| *Fragilaria crotonensis* Kitton | 43 | 49 | | 21 | 24 | 41 | 76 | 36 | 42 | 1119 | 1236 | 1386 |
| *Fragilaria delicatissima* (W. smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria famelica* (Kutz.) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria intermedia* Grunow | | | | | | | | | | | | |
| *Fragilaria pinnata* Ehrenberg | | | | | | | | | | 10 | 9 | 24 |
| *Fragilaria tenera* (W. Smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria virescens* Ralfs | | | | | | | | | | | | |
| *Gomphonema angustatum* var. *producta* Grunow | | | | | | | | | | | | |
| *Gomphonema gracile* Ehr. | | | | | | | | | | | | |
| *Gomphonema intricatum* Kutzing | | | | | | | | | | | 9 | |
| *Gomphonema olivaceum* (Lyngbye) Kutzing | | | | | | | | | | | | |
| *Gomphonema parvulum* (Kutz.) Grunow | | | | | | | | | | | | |
| *Gyrosigma acuminatum* (Kutz.) Rabh. | | | | | | | | | | | | |
| *Melosira varians* C.A. Agardh | | | | | | | | | | | | |
| *Navicula 2* | | | | | | | | | | | | |
| *Navicula arvensis* Hust. | 7 | 8 | | | | 6 | | | | | 18 | |
| *Navicula capitata* Ehrenberg | | | | | | | | | | | | |
| *Navicula capitata* var. *lunebergensis* (Grun.) Patrick | | | | | | | | | | | | |
| *Navicula c.f. dicephala* (Ehr.) W. Smith | | | | 9 | 7 | 6 | 7 | 5 | 7 | | | |
| *Navicula cincta* (Ehr.) Kutzing | | | | | | | | | | | | |
| *Navicula cocconeiformis* Greg. | | | | | | | | | | | | |
| *Navicula cohnii* (Hilse.) Grunow | | | | | | | | | | | | |
| *Navicula contenta* Grunow | | | | | | | | | 7 | 20 | 18 | 24 |
| *Navicula cryptocephala* Kutzing | | | | 7 | 7 | 10 | 7 | 5 | 7 | 30 | 18 | 96 |
| *Navicula cryptocephala* var. *exilis* Kutzing | | | | | | | | | | | | |
| *Navicula dicephala* (Ehr.) W. Smith | | | | | | | | | | 20 | 72 | 72 |
| *Navicula frugalis* Hustedt | | | | | | | | | | | | |
| *Navicula gastrum* (Ehr.) Donkin | | | | | | | | | | | | |
| *Navicula gracilis* Ehrenberg | | | | | | | | | | | | |
| *Navicula hungarica* Grunow | | | 10 | 12 | 13 | 13 | 21 | 5 | 13 | 30 | 36 | 36 |
| *Navicula lacustris* Gregory | | | | | | | | | | | | |
| *Navicula lanaceolata* (Agardh.) Kutz. | | | | | | | | | | | | |
| *Navicula latissima* Gregory | | | | | | | | | | | | |
| *Navicula menisculus* Schumann | 7 | 16 | 10 | 3 | 5 | 18 | 7 | 5 | 10 | | | |
| *Navicula minima* Grun. | | | | | | | 7 | 7 | | | 9 | 12 |
| *Navicula minuscula* Grun. | | | | | | | | | | 10 | 36 | 24 |
| *Navicula mutica* Kutzing | | | | | | | | | | | | |
| *Navicula nitrophila* B. Petersen | | | | | | | | | | | | |
| *Navicula perpusilla* Grunow | | | | | | | | | | | | |
| *Navicula pseudoreinhardtii* Patrick | | | | | | | | | | | | |
| *Navicula pupula* Kutzing | | | | | | | | | | | | |
| *Navicula pupula* var. *mutata* (Krasske) Hustedt | | | | | | | | | | | | |
| *Navicula pusio* Cleve | | | | | | | | | | | | |
| *Navicula radiosa* Kutzing | 13 | 66 | 20 | 5 | | 6 | | 5 | | | | |
| *Navicula radiosa* var. *tenella* (deBreb. ex Katz.) Grunow | | 16 | | | | | | | | | | |
| *Navicula schmassmannii* Hustedt | | | | | | | | | | | | |
| *Navicula seminulum* Grunow | | | | | | | | | | | | |
| *Navicula sp.* Bory | | | | 5 | 5 | | | 5 | 7 | | | |
| *Navicula 1* | | | | | | | | | | | | |
| *Navicula subtilissima* Cleve | | | | | | | | | | | | |
| *Navicula symmetrica* Patrick | | | | | | | | | | | | |
| *Navicula tripunctata* var. *schizonemoides* | | | | | | | | | | 30 | 18 | 24 |
| *Navicula variostrata* Krasske | | | | | | | | | | | | |
| *Neidium dubium* (Ehr.) Cleve | | | | | | | | | 7 | 30 | 18 | |
| *Neidium dubuim* var. *constrictum* A.V. Heurck | | | | | | 6 | | | | | | |
| *Nitzschia (longissima?)* (deBreb.) Ralfs | | | | | | | | | | | | |
| *Nitzschia acicularis* W. smith | | | | | 7 | 6 | | | | | | |
| *Nitzschia amphibia* Grunow | | | | | | | | | | | | |
| *Nitzschia angustata* (W. Smith) Grunow | | | | | | | | | | | | |
| *Nitzschia constricta* (Kutz.) Ralfs. | 7 | | | | | | | | | | | |
| *Nitzschia denticula* Grunow | | | | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Aug-98 | | | Aug-99 | | | | | | Aug-00 | | |
| Site | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | C3501 | C3501 | C3501 |
| *Nitzschia dissipata* (Kutz.) Grunow | 13 | 16 | 10 | | 5 | 6 | | 5 | | | | |
| *Nitzschia fonticola* Grunow | | | | | | | | | | | | |
| *Nitzschia frustulum* Grunow | | | | | | | | | | | | |
| *Nitzschia frustulum* Kutz. | | | | | | | | | | | 54 | |
| *Nitzschia GLRD 1* | | | | | | | | | | | | |
| *Nitzschia gracilis* Hantzsch. | | | | | | | | | | | | |
| *Nitzschia linearis* W. Smith | | | | | | | | | | 30 | 36 | 24 |
| *Nitzschi palea* var. *debilis* (Kutz.) Grunow | | | | 12 | 24 | 5 | 18 | 14 | 13 | | | |
| *Nitzschia paleacea* Grunow | 7 | 16 | 10 | 13 | 24 | 16 | 27 | 5 | 8 | 121 | 54 | 72 |
| *Nitzschia romana* Grunow | | | | 13 | 44 | 34 | 46 | 14 | 34 | 161 | 63 | 156 |
| *Nitzschia stagnorum* Rabh. | | | | | | | | | | 20 | 36 | 24 |
| *Nitzschia subcapitellata* Hust. | | | | 5 | 7 | 6 | 7 | 5 | 7 | | | |
| *Nitzschia sublinearis* Hustedt | | | | | | | | | | | | |
| *Nitzschia thermalis* Kutzing | | | | | | | | | | | | |
| *Nitzschia tryblionella* var. *debilis* (Arnott) A. Mayer | | | | | 7 | | | | | 20 | | 12 |
| *Rhizosolenia eriensis* H.L. Smith | | | | | | | | | | | | |
| *Rhizosolenia sp.* Ehrenberg | | | | | | | | | | | | |
| *Rhoicosphenia curvata* (Kutz.) Grunow | 7 | | | | | | | | | | | 24 |
| *Sellophora bacillum* (Ehr.) D. Mann | | | | | | | | | | | | |
| *Stauroneis smithii* Grun. | | | | | | | | | | | | |
| *Stephanodiscus alpinus* Hust. | 7 | 41 | 5 | | | | | | | | | |
| *Stephanodiscus hantzschii* Grun. In Cleve & Grunow | 243 | 214 | 182 | | | | | | | 151 | 243 | 96 |
| *Stephanodiscus hantzschii* var. *tenuis* (Hust.) Hankansson & Stoermer | 591 | 823 | 516 | 19 | 22 | 28 | 7 | 13 | 65 | 565 | 668 | 795 |
| *Stephanodiscus niagarae* Ehrenberg | | | | | | | | | | | | |
| *Stephanodiscus parvus* Stoermer & Hakansson | 30 | 25 | 5 | 33 | 13 | 16 | 24 | 13 | 18 | 60 | 99 | 48 |
| *Surirella didyma* Kutzing | | | | | | | | | | | | |
| *Surirella linearis* W. Smith | | | | | | | | | | 30 | | |
| *Surirella ovata* Kutzing | | | | | | | | | | | | |
| *Surirella ovata* var. *pinnata* W. Smith | | | | | | | | | | | | |
| *Surirella sp.* Turpin | | | | 5 | | | | | 7 | | | |
| *Synedra acus* var. *angustissima* Grunow | 7 | 115 | 29 | | | | | | | | | |
| *Synedra acus* var. *radians* (Kutz.) Grunow | 16 | | 25 | | | | | | | | | |
| *Synedra delicatissima* W. Smith | | | | 15 | 15 | 28 | 9 | 5 | 21 | 382 | 405 | 397 |
| *Synedra nana* Meister | | | | | | | | | | | | |
| *Synedra pulchella* Kutzing | | | | | | | | | | | | |
| *Synedra radians* Kutz. | | | | 5 | 9 | 6 | | | 7 | 141 | 432 | 373 |
| *Synedra ulna* (Nitz.) Ehrenberg | 7 | 16 | 10 | | | | | | | | | |
| *Synedra ulna* var. *chaseana* Thomas | | | | | | | | | | | | |
| *Synedra ulna* var. *danica* (Kutz.) Grunow | | | | | | | | | | | | |
| *Tabellaria fenestrata* (Lyngb.) Kutz. | | | | | | | | | | | 18 | 12 |
| *Tabellaria flocculosa* (Roth) Kutzing | | | | | | | | | | | | |
| *Tabellaria quadriseptata* Knudson | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Total Diatom Density (cells/mL)** | **1,314** | **2,238** | **1,243** | **477** | **663** | **811** | **786** | **506** | **749** | **4,287** | **5,153** | **5,235** |
| **Richness** | **22** | **21** | **17** | **29** | **28** | **33** | **24** | **29** | **31** | **35** | **36** | **32** |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Aug-00 | | | | | | | | | | | |
| Site | S3500 | S3500 | S3500 | | | | | | | | | |
| *Achnanthes affinis* (Grunow) | | | | | | | | | | | | |
| *Achnanthes exigua* Grun. In Cleve & Grunow | | | | | | | | | | | | |
| *Achnanthes exigua* var. *heterovalvata* Krasske | | | | | | | | | | | | |
| *Achnanthes clevei* var. *rostrata* Hustedt | | | | | | | | | | | | |
| *Achnanthes flexella* Kutzing | | | | | | | | | | | | |
| *Achnanthes hauckiana* Grun. | | | | | | | | | | | | |
| *Achnanthes lanceolata* var. *dubia* Grun. | | | | | | | | | | | | |
| *Achnanthes lanceolata* var. *rostrata* (Ostrup.) Hustedt | | | | | | | | | | | | |
| *Achnanthes linearis* W. Smith | | | | | | | | | | | | |
| *Achnanthes microcephala* Kutzing | | | | | | | | | | | | |
| *Achnanthes minutissima* Kutzing | | | | | | | | | | | | |
| *Achnanthes pellucida* Kutzing | | | | | | | | | | | | |
| *Amphipleura pellucida* Kutzing | 12 | | 22 | | | | | | | | | |
| *Amphora ovalis* var. *affinis* (Kutz.) E.H. *ex* DeT. | | | 22 | | | | | | | | | |
| *Amphora pediculus* Kutzing | | | | | | | | | | | | |
| *Amphora perpusilla* (Grun.) Grunow | 35 | | 34 | | | | | | | | | |
| *Anomoeoneis serians* var. *brachysira* (deBreb.) Husted | | | | | | | | | | | | |
| *Anomoeoneis vitrea* (Grun.) Ross | | | | | | | | | | | | |
| *Asterionella formosa* Hassal | 244 | 250 | 236 | | | | | | | | | |
| *Aulacoseira ambigua* (Grun.) Simonsen | | | | | | | | | | | | |
| *Aulacoseira distans* var. *lirata* | | | | | | | | | | | | |
| *Aulacoseira granulata* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira islandica* (O. Muller) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* (Ehr.) Simonson | | | | | | | | | | | | |
| *Aulacoseira italica* var. *tenuissima* (Grun.) Simonson | | | | | | | | | | | | |
| *Caloneis bacillum* (Grun.) Meresch. | | | | | | | | | | | | |
| *Caloneis ventricosa* (Ehr.) Meister | | | | | | | | | | | | |
| *Cocconeis pediculus* Ehrenberg | | | | | | | | | | | | |
| *Cocconeis placentula* var. *euglypta* (Ehr.) Cleve | | 36 | | | | | | | | | | |
| *Cocconeis placentula* var. *lineata* Cleve | | | | | | | | | | | | |
| *Cocconeis thumensis* A. Mayer | | | | | | | | | | | | |
| *Cyclotella atomus* Hust. | 105 | 143 | 22 | | | | | | | | | |
| *Cyclotella comensis* Grunow | | | | | | | | | | | | |
| *Cyclotella compta* (Ehr.) Kutzing | | | | | | | | | | | | |
| *Cyclotella kutzingiana* var. *planetophora* Fricke | 197 | | 169 | | | | | | | | | |
| *Cyclotella meneghiniana* Kutzing | | | | | | | | | | | | |
| *Cyclotella michiginiana* Skv. | | 18 | | | | | | | | | | |
| *Cyclotella ocellata* Pant. | 360 | 304 | 337 | | | | | | | | | |
| *Cyclotella pseudostelligera* Husted | | | | | | | | | | | | |
| *Cyclotella socialis* Schutt | | | | | | | | | | | | |
| *Cyclotella stelligera* (Cleve et Grun.) V.H. | | 125 | 124 | | | | | | | | | |
| *Cymatopleura elliptica* (deBreb.) W. Smith | | | | | | | | | | | | |
| *Cymatopleura solea* (deBreb.) W. Smith | 23 | 18 | 22 | | | | | | | | | |
| *Cymbella affinis* Kutzing | | | | | | | | | | | | |
| *Cymbella amphicephala* Naegeli | | | | | | | | | | | | |
| *Cymbella cuspidata* Kutzing | | | | | | | | | | | | |
| *Cymbella hauckii* V. Heurck | | | | | | | | | | | | |
| *Cymbella microcephala* Grunow | | | 11 | | | | | | | | | |
| *Cymbella minuta* var. *pseudogracilis* (Choln.) Reim | | | | | | | | | | | | |
| *Cymbella naviculiformis* Auerswald | | | | | | | | | | | | |
| *Cymbella parva* (W. Smith) Cleve | | | | | | | | | | | | |
| *Cymbella perpusilla* A. Cleve | | | | | | | | | | | | |
| *Cymbella prostata* (Berkeley) Cleve | | | | | | | | | | | | |
| *Cymbella ventricosa* Kutzing | | | | | | | | | | | | |
| *Diatoma anceps* (Ehr.) Grunow | | | | | | | | | | | | |
| *Diatoma tenuis* Agardh | | 36 | | | | | | | | | | |
| *Diatoma tenuis* var. *elongatum* Lyngbye | 23 | | | | | | | | | | | |
| *Diatoma vulgare* Bory | | | | | | | | | | | | |
| *Diatoma vulgare* var. Breve | | | | | | | | | | | | |
| *Diploneis ovalis* (Hilse.) Cleve | | | | | | | | | | | | |
| *Diploneis puella* (Schumann) Cleve | 46 | 107 | 22 | | | | | | | | | |
| *Encyonema minutum* (Hilse in Rabenhorst) Mann | | 36 | 34 | | | | | | | | | |
| *Epithemia emarginata* Andrews | | | | | | | | | | | | |
| *Fragilaria brevistriata* Grunow | | | | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Aug-00 | | | | | | | | | | | |
| Site | S3500 | S3500 | S3500 | | | | | | | | | |
| *Fragilaria capucina* Desmzeires | 93 | | | | | | | | | | | |
| *Fragilaria capucina* var. *gracilis* (Oestr.) Hustedt | | | | | | | | | | | | |
| *Fragilaria capucina* var. *mesolepta* (Rabh.) Grunow | | | | | | | | | | | | |
| *Fragilaria capucina* var. *rumpens* (Kutz.) Lange-Bertalot | 302 | 339 | 67 | | | | | | | | | |
| *Fragilaria capucina* var. *vaucheriae* (Kutz.) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria construens* (Ehr.) Grunow | | | | | | | | | | | | |
| *Fragilaria construens* var. *binodis* (Ehr.) Grunow | | | | | | | | | | | | |
| *Fragilaria construens* var. *venter* (Ehr.) Grunow | 23 | | 90 | | | | | | | | | |
| *Fragilaria crotonensis* Kitton | 1383 | 2142 | 1308 | | | | | | | | | |
| *Fragilaria delicatissima* (W. smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria famelica* (Kutz.) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria intermedia* Grunow | | | | | | | | | | | | |
| *Fragilaria pinnata* Ehrenberg | | 36 | 22 | | | | | | | | | |
| *Fragilaria tenera* (W. Smith) Lange-Bertalot | | | | | | | | | | | | |
| *Fragilaria virescens* Ralfs | | | | | | | | | | | | |
| *Gomphonema angustatum* var. *producta* Grunow | | | | | | | | | | | | |
| *Gomphonema gracile* Ehr. | | | | | | | | | | | | |
| *Gomphonema intricatum* Kutzing | 23 | 36 | 11 | | | | | | | | | |
| *Gomphonema olivaceum* (Lyngbye) Kutzing | | | | | | | | | | | | |
| *Gomphonema parvulum* (Kutz.) Grunow | | | | | | | | | | | | |
| *Gyrosigma acuminatum* (Kutz.) Rabh. | | | | | | | | | | | | |
| *Melosira varians* C.A. Agardh | | | | | | | | | | | | |
| *Navicula 2* | | | | | | | | | | | | |
| *Navicula arvensis* Hust. | 23 | 18 | 11 | | | | | | | | | |
| *Navicula capitata* Ehrenberg | | | | | | | | | | | | |
| *Navicula capitata* var. *lunebergensis* (Grun.) Patrick | | | | | | | | | | | | |
| *Navicula c.f. dicephala* (Ehr.) W. Smith | | | | | | | | | | | | |
| *Navicula cincta* (Ehr.) Kutzing | | | | | | | | | | | | |
| *Navicula cocconeiformis* Greg. | | | | | | | | | | | | |
| *Navicula cohnii* (Hilse.) Grunow | | | | | | | | | | | | |
| *Navicula contenta* Grunow | | 71 | 22 | | | | | | | | | |
| *Navicula cryptocephala* Kutzing | 46 | 36 | 67 | | | | | | | | | |
| *Navicula cryptocephala* var. *exilis* Kutzing | | | | | | | | | | | | |
| *Navicula dicephala* (Ehr.) W. Smith | 58 | 161 | 34 | | | | | | | | | |
| *Navicula frugalis* Hustedt | | | | | | | | | | | | |
| *Navicula gastrum* (Ehr.) Donkin | | | | | | | | | | | | |
| *Navicula gracilis* Ehrenberg | | | | | | | | | | | | |
| *Navicula hungarica* Grunow | 46 | 36 | 22 | | | | | | | | | |
| *Navicula lacustris* Gregory | | | | | | | | | | | | |
| *Navicula lanaceolata* (Agardh.) Kutz. | | | | | | | | | | | | |
| *Navicula latissima* Gregory | | | | | | | | | | | | |
| *Navicula menisculus* Schumann | | | | | | | | | | | | |
| *Navicula minima* Grun. | 23 | 18 | 22 | | | | | | | | | |
| *Navicula minuscula* Grun. | 12 | 89 | 67 | | | | | | | | | |
| *Navicula mutica* Kutzing | | | | | | | | | | | | |
| *Navicula nitrophila* B. Petersen | | | | | | | | | | | | |
| *Navicula perpusilla* Grunow | | | | | | | | | | | | |
| *Navicula pseudoreinhardtii* Patrick | | | | | | | | | | | | |
| *Navicula pupula* Kutzing | | | | | | | | | | | | |
| *Navicula pupula* var. *mutata* (Krasske) Hustedt | | | | | | | | | | | | |
| *Navicula pusio* Cleve | | | | | | | | | | | | |
| *Navicula radiosa* Kutzing | | | | | | | | | | | | |
| *Navicula radiosa* var. *tenella* (deBreb. ex Katz.) Grunow | | | | | | | | | | | | |
| *Navicula schmassmannii* Hustedt | | | | | | | | | | | | |
| *Navicula seminulum* Grunow | | | | | | | | | | | | |
| *Navicula sp.* Bory | | | | | | | | | | | | |
| *Navicula 1* | | | | | | | | | | | | |
| *Navicula subtilissima* Cleve | | | | | | | | | | | | |
| *Navicula symmetrica* Patrick | | | | | | | | | | | | |
| *Navicula tripunctata* var. *schizonemoides* | | | 22 | | | | | | | | | |
| *Navicula variostrata* Krasske | | | | | | | | | | | | |
| *Neidium dubium* (Ehr.) Cleve | 23 | 36 | | | | | | | | | | |
| *Neidium dubuim* var. *constrictum* A.V. Heurck | | | | | | | | | | | | |
| *Nitzschia (longissima?)* (deBreb.) Ralfs | | | | | | | | | | | | |
| *Nitzschia acicularis* W. smith | | | | | | | | | | | | |
| *Nitzschia amphibia* Grunow | | | | | | | | | | | | |
| *Nitzschia angustata* (W. Smith) Grunow | | | | | | | | | | | | |
| *Nitzschia constricta* (Kutz.) Ralfs. | | | | | | | | | | | | |
| *Nitzschia denticula* Grunow | | | | | | | | | | | | |

# APPENDIX B. PROPOSED DIFFUSER SITE PHYTOPLANKTON DIATOM DATA

| Number of Cells per milliliter (No./mL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Aug-00 | | | | | | | | | | | |
| Site | S3500 | S3500 | S3500 | | | | | | | | | |
| *Nitzschia dissipata* (Kutz.) Grunow | | | | | | | | | | | | |
| *Nitzschia fonticola* Grunow | | | | | | | | | | | | |
| *Nitzschia frustulum* Grunow | | | | | | | | | | | | |
| *Nitzschia frustulum* Kutz. | 23 | 36 | 45 | | | | | | | | | |
| *Nitzschia GLRD 1* | | | | | | | | | | | | |
| *Nitzschia gracilis* Hantzsch. | | | | | | | | | | | | |
| *Nitzschia linearis* W. Smith | 46 | 71 | 22 | | | | | | | | | |
| *Nitzschi palea* var. *debilis* (Kutz.) Grunow | | | | | | | | | | | | |
| *Nitzschia paleacea* Grunow | 186 | 89 | 112 | | | | | | | | | |
| *Nitzschia romana* Grunow | 46 | 143 | 11 | | | | | | | | | |
| *Nitzschia stagnorum* Rabh. | 23 | | | | | | | | | | | |
| *Nitzschia subcapitellata* Hust. | | | | | | | | | | | | |
| *Nitzschia sublinearis* Hustedt | | | | | | | | | | | | |
| *Nitzschia thermalis* Kutzing | | | | | | | | | | | | |
| *Nitzschia tryblionella* var. *debilis* (Arnott) A. Mayer | | 36 | 22 | | | | | | | | | |
| *Rhizosolenia eriensis* H.L. Smith | | | | | | | | | | | | |
| *Rhizosolenia sp.* Ehrenberg | | | | | | | | | | | | |
| *Rhoicosphenia curvata* (Kutz.) Grunow | | | 22 | | | | | | | | | |
| *Sellophora bacillum* (Ehr.) D. Mann | | | | | | | | | | | | |
| *Stauroneis smithii* Grun. | 12 | 18 | 11 | | | | | | | | | |
| *Stephanodiscus alpinus* Hust. | | | | | | | | | | | | |
| *Stephanodiscus hantzschii* Grun. In Cleve & Grunow | 70 | 214 | 146 | | | | | | | | | |
| *Stephanodiscus hantzschii* var. *tenuis* (Hust.) Hankansson & Stoermer | 790 | 875 | 778 | | | | | | | | | |
| *Stephanodiscus niagarae* Ehrenberg | | | | | | | | | | | | |
| *Stephanodiscus parvus* Stoermer & Hakansson | 70 | 143 | 67 | | | | | | | | | |
| *Surirella didyma* Kutzing | | | | | | | | | | | | |
| *Surirella linearis* W. Smith | | 36 | | | | | | | | | | |
| *Surirella ovata* Kutzing | | | | | | | | | | | | |
| *Surirella ovata* var. *pinnata* W. Smith | 23 | 71 | | | | | | | | | | |
| *Surirella sp.* Turpin | | | | | | | | | | | | |
| *Synedra acus* var. *angustissima* Grunow | | | | | | | | | | | | |
| *Synedra acus* var. *radians* (Kutz.) Grunow | | | | | | | | | | | | |
| *Synedra delicatissima* W. Smith | 453 | 625 | 665 | | | | | | | | | |
| *Synedra nana* Meister | | | | | | | | | | | | |
| *Synedra pulchella* Kutzing | | | | | | | | | | | | |
| *Synedra radians* Kutz. | 70 | 250 | 214 | | | | | | | | | |
| *Synedra ulna* (Nitz.) Ehrenberg | | | | | | | | | | | | |
| *Synedra ulna* var. *chaseana* Thomas | | | | | | | | | | | | |
| *Synedra ulna* var. *danica* (Kutz.) Grunow | | | | | | | | | | | | |
| *Tabellaria fenestrata* (Lyngb.) Kutz. | | | 11 | | | | | | | | | |
| *Tabellaria flocculosa* (Roth) Kutzing | | | | | | | | | | | | |
| *Tabellaria quadriseptata* Knudson | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Total Diatom Density (cells/mL)** | **4,912** | **6,698** | **4,946** | | | | | | | | | |
| **Richness** | **33** | **35** | **38** | | | | | | | | | |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **May-95** | **May-95** | **May-95** | **May-95** | **May-95** | **May-95** | **Jun-96** | **Jun-96** | **Jun-96** | **Oct-96** | **Oct-96** |
| **Location** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** |
| Rotifera | 1726 | 2474 | 1540 | 588 | 629 | 400 | | | | | |
| *Ascormorpha ovalis* | | | | | | | | | | | |
| *Asplanchna priodonta* | | | | | | | | | | | |
| *Asplanchna herricki* | | | | | | | 1218 | 1654 | 1231 | | |
| *Asplanchna sp.* | | | | | | | | | | | |
| *Brachionus sp.* | | | | | | | | | | | |
| *Kellicottia longispina* | | | | | | | | | | | |
| *Keratella cochlearis* | | | | | | | | | | 6 | |
| *Keratella crassa* | | | | | | | | | | | 9 |
| *Ploesoma truncatum* | | | | | | | | | | | |
| *Polyarthra vulgaris* | | | | | | | | | | | |
| *Polyarthra* | | | | | | | | | | 211 | 307 |
| *Tricocerca cylindrica* | | | | | | | | | | | |
| Crustacea | | | | | | | | | | | |
| Cladocera | 66 | 112 | 145 | 63 | 218 | 248 | | | | | |
| *Bosmina longirostris* | | | | | | | 26 | | 13 | 508 | 567 |
| *Bythotrephes sp.* | | | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | | | | | | | |
| *Daphnia* | | | | | | | | | | | |
| *Microcyclops varicans rubellus* | | | | | | | 77 | 173 | 231 | | |
| Copepoda | 21 | 33 | 12 | 11 | 30 | 19 | | | | | |
| *Diacyclops bicuspidatus thomasi* | | | | | | | | | | 483 | 697 |
| *Diaptomus* | | | | | | | 667 | 1808 | 1065 | 2693 | 3409 |
| *Mesocyclops edax* | | | | | | | | | | 19 | 19 |
| *Mesocyclops sp.* | | | | | | | | | | | |
| *Tropocyclops prasinus* | | | | | | | | | | | |
| Copepodids | 1115 | 1412 | 1099 | 696 | 1173 | 799 | 179 | | 114 | | |
| Nauplii | 487 | 772 | 578 | 422 | 540 | 666 | 2038 | 1058 | 526 | 539 | 957 |
| | | | | | | | | | | | |
| **Density** | **3,416** | **4,803** | **3,374** | **1,780** | **2,590** | **2,131** | **4,205** | **4,693** | **3,180** | **4,459** | **5,965** |
| **Richness** | **3** | **3** | **3** | **3** | **3** | **3** | **4** | **3** | **4** | **6** | **6** |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Oct-96** | **Oct-96** | **Oct-96** | **Oct-96** | **Apr-97** | **Apr-97** | **Apr-97** | **Apr-97** | **Apr-97** | **Apr-97** | **Sep-97** |
| **Location** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** |
| Rotifera | | | | | | | | | | | |
| *Ascormorpha ovalis* | | | | | 26 | | 33 | 44 | 48 | 37 | 880 |
| *Asplanchna priodonta* | | | | | 70 | 73 | 16 | 18 | 88 | 19 | 126 |
| *Asplanchna herricki* | | | | | | | | | | | |
| *Asplanchna sp.* | | | | | | | | | | | |
| *Brachionus sp.* | | | | | | | | | | | |
| *Kellicottia longispina* | | | | | | | | | | | |
| *Keratella cochlearis* | | 9 | | | 9 | | | | | | 42 |
| *Keratella crassa* | 9 | | | | | | | 44 | | | 545 |
| *Ploesoma truncatum* | | | | | | | 8 | | 16 | 19 | |
| *Polyarthra vulgaris* | | | | | | | | | | | |
| *Polyarthra* | 437 | 297 | 223 | 266 | 9 | | | 9 | | 28 | 4106 |
| *Tricocerca cylindrica* | | | | | | | | | | | |
| Crustacea | | | | | | | | | | | |
| Cladocera | | | | | | | | | | | |
| *Bosmina longirostris* | 325 | 604 | 455 | 415 | 35 | 21 | 24 | 18 | 8 | | 503 |
| *Bythotrephes sp.* | | | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | | | | | | | |
| *Daphnia* | | | | | | | 8 | | | | |
| *Microcyclops varicans rubellus* | | | | | | | | | | | |
| Copepoda | | | | | | | | | | | |
| *Diacyclops bicuspidatus thomasi* | 362 | 1161 | 994 | 994 | | | | | | | |
| *Diaptomus* | 2619 | 5006 | 3873 | 3873 | 150 | 42 | 49 | 88 | 120 | 65 | 754 |
| *Mesocyclops edax* | | 19 | 9 | | | | | | | | |
| *Mesocyclops sp.* | | | | | | | | | | | |
| *Tropocyclops prasinus* | | | | | | | | | | | 419 |
| Copepodids | | 56 | 93 | 93 | 18 | | 8 | 9 | 32 | 19 | 2933 |
| Nauplii | 446 | 762 | 734 | 734 | 3507 | 2681 | 1502 | 4123 | 5235 | 2233 | 8590 |
| | | | | | | | | | | | |
| **Density** | **4,198** | **7,914** | **6,381** | **6,375** | **3,824** | **2,817** | **1,648** | **4,353** | **5,547** | **2,420** | **18,897** |
| **Richness** | **5** | **7** | **6** | **5** | **6** | **3** | **6** | **6** | **5** | **5** | **8** |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Sep-97** | **Sep-97** | **Sep-97** | **Sep-97** | **Sep-97** | **Jun-98** | **Jun-98** | **Jun-98** | **Jun-98** | **Jun-98** | **Jun-98** |
| **Location** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** |
| Rotifera | | | | | | | | | | | |
| *Ascormorpha ovalis* | 2044 | 2137 | 2232 | 2931 | 2515 | | | | | | |
| *Asplanchna priodonta* | 168 | 84 | | 458 | 314 | | | | | | |
| *Asplanchna herricki* | | | | | | | | | | | |
| *Asplanchna sp.* | | | | | | | | | | | |
| *Brachionus sp.* | | | | | | | | | | | |
| *Kellicottia longispina* | | | | | | | | | | 3 | |
| *Keratella cochlearis* | | 42 | 50 | 275 | | | | | 3 | 3 | |
| *Keratella crassa* | 532 | 461 | 248 | 137 | 236 | | | | | | |
| *Ploesoma truncatum* | | | | | | | | | | | |
| *Polyarthra vulgaris* | | | | | | | | | | | |
| *Polyarthra* | 4396 | 5363 | 5902 | 9481 | 7703 | 101 | 15 | 17 | 30 | 64 | 23 |
| *Tricocerca cylindrica* | | | | | | | | | | 3 | 2 |
| Crustacea | | | | | | | | | | | |
| Cladocera | | | | | | | | | | | |
| *Bosmina longirostris* | 448 | 377 | 496 | 595 | 707 | | | | 3 | 3 | |
| *Bythotrephes sp.* | | | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | 79 | | | | | | |
| *Daphnia* | 28 | | | | | | | | | | |
| *Microcyclops varicans rubellus* | | | | | | | | | | | |
| Copepoda | | | | | | | | | | | |
| *Diacyclops bicuspidatus thomasi* | | | | | | | | | | | |
| *Diaptomus* | 252 | 503 | 1141 | 1008 | 2515 | 3 | 3 | 13 | 3 | 20 | 7 |
| *Mesocyclops edax* | | | | | | | | | | | |
| *Mesocyclops sp.* | | | | | | | | | | | |
| *Tropocyclops prasinus* | 308 | 377 | 347 | 366 | 1022 | 3 | | | 3 | 3 | 2 |
| Copepodids | 2576 | 2891 | 3571 | 1008 | 8567 | | | | 3 | | 2 |
| Nauplii | 6860 | 9595 | 10069 | 1282 | 19729 | 13 | 13 | 3 | 10 | 23 | 8 |
| | | | | | | | | | | | |
| **Density** | **17,612** | **21,830** | **24,056** | **17,541** | **43,387** | **120** | **30** | **33** | **57** | **124** | **43** |
| **Richness** | **8** | **8** | **7** | **8** | **8** | **3** | **2** | **2** | **5** | **7** | **4** |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Jun-98** | **Jun-98** | **Jun-98** | **Jun-98** | **Jun-98** | **Jun-98** | **Jul-98** | **Jul-98** | **Jul-98** | **Jul-98** | **Jul-98** |
| **Location** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** |
| Rotifera | | | | | | | | | | | |
| *Ascormorpha ovalis* | | | | | | | | | | | |
| *Asplanchna priodonta* | 3 | 3 | 2 | 2 | | 3 | | 3 | | 3 | 3 |
| *Asplanchna herricki* | | | | | | | | | | | |
| *Asplanchna sp.* | | | | | | | | | | | |
| *Brachionus sp.* | | | | | | | | | | | |
| *Kellicottia longispina* | 2 | 2 | 12 | 2 | 2 | 2 | | | | | |
| *Keratella cochlearis* | | | | | | | | 94 | 85 | 151 | 151 |
| *Keratella crassa* | | | | | | | | | | | |
| *Ploesoma truncatum* | | | | | | | | | | | |
| *Polyarthra vulgaris* | | | | | | | | | | | |
| *Polyarthra* | 5 | 5 | 8 | 5 | 8 | 3 | | 5 | 3 | 6 | 10 |
| *Tricocerca cylindrica* | | | | | | | | | | | |
| Crustacea | | | | | | | | | | | |
| Cladocera | | | | | | | | | | | |
| *Bosmina longirostris* | 95 | 96 | 115 | 82 | 47 | 78 | | 2 | 3 | | 3 |
| *Bythotrephes sp.* | | | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | | | | | | | |
| *Daphnia* | | | | | | | | | | | |
| *Microcyclops varicans rubellus* | | | | | | | | | | | |
| Copepoda | | | | | | | | | | | |
| *Diacyclops bicuspidatus thomasi* | | | | | | | | | | | |
| *Diaptomus* | 7 | 2 | 7 | 20 | 2 | 8 | | | 2 | | |
| *Mesocyclops edax* | | | | | | | | | | | |
| *Mesocyclops sp.* | | | | | | | | | | | |
| *Tropocyclops prasinus* | | | | | | 2 | | | | | |
| Copepodids | 3 | 5 | 14 | 8 | 2 | 3 | | | | | 2 |
| Nauplii | 17 | 12 | 15 | 22 | 13 | 13 | | 3 | 7 | | 3 |
| | | | | | | | | | | | |
| **Density** | **132** | **125** | **172** | **140** | **74** | **114** | **0** | **107** | **100** | **160** | **172** |
| **Richness** | **5** | **5** | **5** | **5** | **4** | **6** | ** | **4** | **4** | **3** | **4** |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Jul-98** | **Jul-98** | **Jul-98** | **Jul-98** | **Jul-98** | **Jul-98** | **Jul-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** |
| **Location** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** |
| Rotifera | | | | | | | | | | | |
| *Ascormorpha ovalis* | | | | | | | | | | | |
| *Asplanchna priodonta* | | | | | | | | 13 | 7 | 28 | |
| *Asplanchna herricki* | | | | | | | | | | | |
| *Asplanchna sp.* | | | | | | | | | | | |
| *Brachionus sp.* | | | | | | | | | | | |
| *Kellicottia longispina* | | | | | | | | 13 | 13 | 14 | |
| *Keratella cochlearis* | 170 | 3 | 7 | 20 | 17 | 7 | 15 | 13 | 7 | 7 | 13 |
| *Keratella crassa* | | 7 | 3 | 3 | 17 | 3 | 8 | 1617 | 1683 | 1343 | 705 |
| *Ploesoma truncatum* | | | | | | | | | | | |
| *Polyarthra vulgaris* | | | | | | | | | | | |
| *Polyarthra* | 13 | 3 | | | | | | 53 | 26 | 53 | 13 |
| *Tricocerca cylindrica* | | | | | | | | 22 | 10 | 7 | |
| Crustacea | | | | | | | | | | | |
| Cladocera | | | | | | | | | | | |
| *Bosmina longirostris* | | 3 | 10 | 3 | | 13 | | 648 | 989 | 675 | 274 |
| *Bythotrephes sp.* | | | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | | | | | | | |
| *Daphnia* | | | | | | | | | | | |
| *Microcyclops varicans rubellus* | | | | | | | | | | | |
| Copepoda | | | | | | | | | | | |
| *Diacyclops bicuspidatus thomasi* | | | | | | | | 47 | 8 | 60 | 15 |
| *Diaptomus* | | 3 | | | | | 3 | 127 | 120 | 87 | 127 |
| *Mesocyclops edax* | | | | | | | | | | | |
| *Mesocyclops sp.* | | | | | | | | | | | |
| *Tropocyclops prasinus* | | | | | | | | | | | |
| Copepodids | | 13 | | | 10 | 10 | 3 | 95 | 80 | 95 | 53 |
| Nauplii | 13 | 23 | 13 | 13 | 23 | 30 | 25 | 307 | 381 | 394 | 261 |
| | | | | | | | | | | | |
| **Density** | **196** | **57** | **33** | **40** | **67** | **64** | **53** | **2,956** | **3,324** | **2,762** | **1,461** |
| **Richness** | **2** | **5** | **3** | **3** | **2** | **3** | **3** | **9** | **9** | **9** | **6** |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Aug-98** | **Sep-98** | **Sep-98** | **Sep-98** |
| **Location** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** |
| Rotifera | | | | | | | | | | | |
| *Ascormorpha ovalis* | | | | | | | | | | | |
| *Asplanchna priodonta* | 5 | | | | | | | | | | |
| *Asplanchna herricki* | | | | | | | | | | | |
| *Asplanchna sp.* | | | | | | | | | | | |
| *Brachionus sp.* | | | | | | | | | | | |
| *Kellicottia longispina* | 21 | | | | | | | | | | |
| *Keratella cochlearis* | 12 | 20 | | | | | | | | | |
| *Keratella crassa* | 1200 | 1129 | 11 | 10 | 2 | 17 | 22 | 7 | 2 | 187 | 18 |
| *Ploesoma truncatum* | | | | | | | | | | | |
| *Polyarthra vulgaris* | | | | | | | | | | | |
| *Polyarthra* | 35 | 53 | | | | | 3 | | | 5 | |
| *Tricocerca cylindrica* | 20 | | | | | | | | | | |
| Crustacea | | | | | | | | | | | |
| Cladocera | | | | | | | | | | | |
| *Bosmina longirostris* | 350 | 401 | | | 5 | 3 | | 5 | | 41 | |
| *Bythotrephes sp.* | | | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | | | | | | | |
| *Daphnia* | | | | | | | | | | | |
| *Microcyclops varicans rubellus* | | | | | | | | | | | |
| Copepoda | | | | | | | | | | | |
| *Diacyclops bicuspidatus thomasi* | 30 | 63 | 11 | 2 | | 3 | 3 | 2 | | | |
| *Diaptomus* | 265 | 140 | | 3 | 2 | 7 | 2 | | | | |
| *Mesocyclops edax* | 5 | | | | | | | | | | |
| *Mesocyclops sp.* | | | | | | | | | | | |
| *Tropocyclops prasinus* | | | | | | | | | | | |
| Copepodids | 120 | 174 | | | | | | | | | |
| Nauplii | 290 | 254 | | | | | 5 | 5 | | 2 | |
| | | | | | | | | | | | |
| **Density** | **2,353** | **2,234** | **23** | **15** | **8** | **30** | **35** | **18** | **2** | **235** | **18** |
| **Richness** | **10** | **6** | **2** | **3** | **3** | **4** | **4** | **3** | **1** | **3** | **1** |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Sep-98** | **Sep-98** | **Sep-98** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-99** | **Aug-00** | **Aug-00** |
| **Location** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** | **C3501** | **S3500** | **S3500** | **S3500** | **C3501** | **C3501** |
| Rotifera | | | | | | | | | | | |
| *Ascormorpha ovalis* | | | | | | | | | | | |
| *Asplanchna priodonta* | | | | 11 | 22 | | | 5 | 11 | | |
| *Asplanchna herricki* | | | | | | | | | | | |
| *Asplanchna sp.* | | | | | | | | | | | 783 |
| *Brachionus sp.* | | | | | | | | | | 1044 | |
| *Kellicottia longispina* | | | | | | | | | | | |
| *Keratella cochlearis* | | | | | | | | | | 113257 | 67282 |
| *Keratella crassa* | | 5 | 7 | 1172 | 809 | 885 | 629 | 195 | 1172 | | |
| *Ploesoma truncatum* | | | | | | | | | | | |
| *Polyarthra vulgaris* | | | | | | | | | | 1305 | 522 |
| *Polyarthra* | | | | 3 | 8 | 11 | | 4 | | | |
| *Tricocerca cylindrica* | | | | | | | | | | | |
| Crustacea | | | | | | | | | | | |
| Cladocera | | | | | | | | | | | |
| *Bosmina longirostris* | 7 | 8 | 5 | 78 | 120 | 306 | 104 | 53 | 197 | 9656 | 2349 |
| *Bythotrephes sp.* | | | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | 3 | | | | | | |
| *Daphnia* | | | | | | | | | | 261 | |
| *Microcyclops varicans rubellus* | | | | | | | | | | | |
| Copepoda | | | | | | | | | | | |
| *Diacyclops bicuspidatus thomasi* | | | | | | | | | | | |
| *Diaptomus* | | | | 33 | 33 | 44 | 15 | 12 | 57 | 1566 | 1044 |
| *Mesocyclops edax* | | | | 3 | 3 | 3 | 2 | 1 | 8 | | |
| *Mesocyclops sp.* | | | | | | | | | | 783 | |
| *Tropocyclops prasinus* | | | | 5 | 11 | 22 | 30 | 7 | 16 | | |
| Copepodids | | | | 26 | 87 | 120 | 39 | 22 | 107 | 522 | 522 |
| Nauplii | | 2 | | 56 | 142 | 66 | 59 | 37 | 164 | 3392 | 783 |
| | | | | | | | | | | | |
| **Density** | **7** | **15** | **12** | **1,387** | **1,238** | **1,456** | **877** | **337** | **1,732** | **######** | **73,284** |
| **Richness** | **1** | **2** | **2** | **7** | **8** | **6** | **5** | **7** | **6** | **7** | **5** |

## APPENDIX B. PROPOSED DIFFUSER SITE ZOOPLANKTON DATA

| Number of Zooplankton per Cubic Meter (No./M$^3$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Aug-00** | **Aug-00** | **Aug-00** | **Aug-00** | | | | | | | |
| **Location** | **C3501** | **S3500** | **S3500** | **S3500** | | | | | | | |
| Rotifera | | | | | | | | | | | |
| *Ascormorpha ovalis* | | | | | | | | | | | |
| *Asplanchna priodonta* | | | | | | | | | | | |
| *Asplanchna herricki* | | | | | | | | | | | |
| *Asplanchna sp.* | | | | | | | | | | | |
| *Brachionus sp.* | | 435 | 652 | 652 | | | | | | | |
| *Kellicottia longispina* | 522 | 435 | | 435 | | | | | | | |
| *Keratella cochlearis* | 102818 | 101304 | 100870 | 115870 | | | | | | | |
| *Keratella crassa* | | | | | | | | | | | |
| *Ploesoma truncatum* | | | | | | | | | | | |
| *Polyarthra vulgaris* | 783 | 1087 | 652 | | | | | | | | |
| *Polyarthra* | | | | | | | | | | | |
| *Tricocerca cylindrica* | | | | | | | | | | | |
| Crustacea | | | | | | | | | | | |
| Cladocera | | | | | | | | | | | |
| *Bosmina longirostris* | 2871 | 3043 | 587 | 1318 | | | | | | | |
| *Bythotrephes sp.* | | 217 | | | | | | | | | |
| *Daiphanosoma brachyurum* | | | | | | | | | | | |
| *Daphnia* | | 217 | | | | | | | | | |
| *Microcyclops varicans rubellus* | | | | | | | | | | | |
| Copepoda | | | | | | | | | | | |
| *Diacyclops bicuspidatus thomasi* | | | | | | | | | | | |
| *Diaptomus* | 1566 | 2609 | 435 | 1739 | | | | | | | |
| *Mesocyclops edax* | | | | | | | | | | | |
| *Mesocyclops sp.* | 522 | 652 | 1739 | | | | | | | | |
| *Tropocyclops prasinus* | | | | | | | | | | | |
| Copepodids | 261 | 435 | 1087 | 1087 | | | | | | | |
| Nauplii | 3653 | 1957 | 2609 | 3913 | | | | | | | |
| | | | | | | | | | | | |
| **Density** | ###### | ###### | ###### | ###### | | | | | | | |
| **Richness** | **6** | **9** | **6** | **5** | | | | | | | |

# Appendix C

# Chlorophyll *a*/Water Quality/Water Chemistry

# APPENDIX C. CHLOROPHYLL *A* DETERMINATIONS

| Date | 23-May-95 | | 5-Jun-96 | 21-Oct-96 | | 28-Apr-97 | | 20-Jun-97 | |
|---|---|---|---|---|---|---|---|---|---|
| Location | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 |
| Replicate 1 | 0.72 | 1.04 | 0.80 | 1.60 | 1.80 | 0.64 | 0.53 | 0.34 | 0.40 |
| Replicate 2 | 0.32 | 1.44 | 0.67 | 2.50 | 2.20 | 0.64 | 0.73 | n/a | n/a |
| Replicate 3 | 0.40 | 1.28 | 0.80 | 2.50 | 1.20 | 0.75 | 0.53 | n/a | n/a |
| Replicate 4 | 1.20 | 1.44 | 0.53 | n/a | n/a | n/a | n/a | n/a | n/a |
| Replicate 5 | 0.64 | 1.12 | 0.67 | n/a | n/a | n/a | n/a | n/a | n/a |
| Replicate 6 | n/a | n/a | 0.40 | n/a | n/a | n/a | n/a | n/a | n/a |

| Date | 1-Jul-97 | | 16-Jul-97 | | 6-Aug-97 | | 29-Aug-97 | | 8-Sep-97 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Location | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 |
| Replicate 1 | 0.47 | 0.47 | 0.64 | 0.53 | 0.43 | 0.96 | 0.43 | 0.53 | 1.07 | 1.71 |
| Replicate 2 | n/a | n/a | 0.85 | 0.64 | 0.53 | 0.75 | 0.53 | 0.53 | 1.50 | 1.39 |
| Replicate 3 | n/a | n/a | 0.53 | 0.85 | 0.43 | 0.64 | 1.60 | 0.32 | 1.39 | 1.28 |

| Date | 6-Oct-97 | | 3-Jun-98 | | 19-Jun-98 | | 6-Jul-98 | | 30-Jul-98 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Location | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 |
| Replicate 1 | 2.03 | 1.92 | 1.71 | 2.03 | 2.46 | 3.31 | 1.71 | 1.82 | 0.64 | 1.71 |
| Replicate 2 | 2.03 | 1.17 | 2.46 | 3.84 | 2.94 | 3.54 | 1.53 | 1.73 | 0.75 | 1.07 |
| Replicate 3 | 2.03 | 1.71 | 2.24 | 3.31 | 2.46 | 4.13 | 1.53 | 1.60 | 0.96 | 0.75 |

| Date | 12-Aug-98 | | 27-Aug-98 | | 17-Sep-98 | | 12-Aug-99 | | 23-Aug-00 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Location | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 |
| Replicate 1 | 3.18 | 2.35 | 0.64 | 0.32 | 0.75 | 1.28 | 0.35 | 0.70 | 0.35 | 0.35 |
| Replicate 2 | 2.56 | 4.27 | 2.35 | 0.11 | 0.43 | 1.50 | 1.04 | 1.91 | 0.39 | 0.35 |
| Replicate 3 | 2.99 | 2.35 | 0.85 | 2.14 | 0.53 | 0.64 | 0.35 | 0.61 | 0.17 | 0.17 |

Notes:
n/a - Not Sampled

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| Temperature (°C) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 5/23/95 | 5/24/95 | 5/25/95 | 5/23/95 | 5/24/95 | 5/25/95 | 6/5/96 | 10/21/96 | 10/24/96 | 10/21/96 | 10/22/96 | 4/28/97 | 4/28/91 | 4/29/97 | 6/20/97 | 6/20/97 | 7/1/97 |
| Location | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 13.3 | 13.3 | 13.7 | 14.0 | 13.3 | 13.5 | 15.0 | 14.8 | 13.6 | 14.7 | 15.1 | 9.7 | 10.7 | 8.5 | 10.0 | 10.6 | 12.0 |
| 1 to 3 | n/a | n/a | 13.7 | 14.0 | n/a | n/a | 15.0 | 14.8 | 13.6 | 14.7 | 15.1 | 9.7 | 10.7 | 8.5 | 10.0 | 10.6 | 12.5 |
| 5 to 6 | 13.3 | 13.3 | 13.7 | 13.3 | 13.3 | 13.5 | 15.0 | 14.8 | 13.6 | 14.7 | 15.0 | 9.1 | 10.7 | 8.5 | 9.9 | 10.6 | 12.2 |
| 8 to 9 | n/a | n/a | 13.7 | 13.2 | n/a | 13.5 | 14.0 | 14.6 | 13.6 | 14.7 | 14.7 | 8.4 | 8.9 | 8.5 | 9.9 | 10.0 | 12.6 |
| 10 to 12 | 13.3 | 13.3 | 13.7 | 13.0 | 13.3 | 13.5 | 14.0 | 14.5 | 13.6 | 14.4 | 14.5 | 8.2 | 8.4 | 8.4 | 10.0 | 10.0 | 12.2 |
| 14 to 15 | 13.3 | 13.3 | 13.7 | 13.0 | 13.3 | 13.5 | 14.0 | 14.5 | 13.6 | 14.4 | 14.3 | 8.0 | 8.2 | 8.4 | 10.1 | 9.9 | 12.2 |
| 17 to 18 | n/a | n/a | 13.7 | 13.0 | n/a | 13.5 | 14.0 | 14.4 | 13.6 | 14.4 | 14.2 | 7.9 | 8.1 | 8.3 | 10.0 | 9.9 | 12.0 |
| 20 to 21 | 13.3 | 13.3 | 13.7 | 12.7 | 13.3 | 13.5 | 14.0 | 14.4 | 13.6 | 14.4 | 14.2 | 7.9 | 8.0 | 8.3 | 9.9 | 9.9 | 12.2 |
| 24 to 25 | n/a | n/a | 13.7 | 12.5 | n/a | 13.5 | 13.0 | 14.4 | 13.6 | 14.3 | 14.2 | 7.8 | 7.9 | 8.3 | 9.9 | 10.0 | 11.9 |
| 27 to 28 | 13.3 | 13.3 | 13.7 | 12.2 | 13.3 | 13.5 | 13.0 | 14.4 | 13.6 | 14.4 | 14.2 | 7.9 | 7.8 | 8.3 | 10.3 | 9.9 | 12.0 |

| Temperature (°C) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/1/97 | 7/16/97 | 7/16/97 | 8/4/97 | 8/4/97 | 8/6/97 | 8/6/97 | 8/29/97 | 8/29/97 | 9/9/97 | 9/9/97 | 9/9/97 | 9/9/97 | 6/19/98 | 6/19/98 | 7/6/98 | 7/6/98 |
| Location | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | C3501 | S3500 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 12.5 | 15.8 | 16.8 | 17.0 | 17.6 | 17.3 | 17.0 | 18.5 | 18.9 | 21.8 | 21.3 | 22.5 | 21.8 | 21.0 | 21.0 | 21.8 | 21.4 |
| 1 to 3 | 11.0 | 15.8 | 15.9 | 17.5 | 17.0 | 17.2 | 17.0 | 18.8 | 18.8 | 21.8 | 21.5 | 21.3 | 21.7 | 21.0 | 20.8 | 21.4 | 21.0 |
| 5 to 6 | 12.2 | 15.8 | 15.9 | 17.4 | 17.3 | 17.3 | 17.2 | 19.0 | 18.8 | 21.4 | 21.2 | 21.2 | 21.2 | 20.2 | 20.8 | 21.0 | 21.0 |
| 8 to 9 | 12.5 | 15.8 | 16.0 | 17.6 | 17.0 | 17.3 | 17.0 | 18.8 | 18.7 | 21.1 | 21.1 | 21.1 | 21.1 | 20.0 | 20.2 | 20.8 | 20.8 |
| 10 to 12 | 12.5 | 15.8 | 15.8 | 17.3 | 17.3 | 17.2 | 17.2 | 18.8 | 18.8 | 21.1 | 21.1 | 21.1 | 21.1 | 20.0 | 20.0 | 20.8 | 20.0 |
| 14 to 15 | 12.5 | 15.8 | 15.8 | 17.0 | 17.5 | 17.0 | 17.3 | 18.5 | 18.8 | 21.0 | 21.0 | 21.0 | 21.0 | 19.8 | 20.0 | 19.8 | 20.0 |
| 17 to 18 | 11.9 | 15.8 | 15.8 | 17.0 | 17.5 | 17.3 | 17.0 | 18.5 | 18.9 | 20.9 | 20.9 | 20.9 | 20.9 | 19.8 | 19.8 | 20.8 | 20.8 |
| 20 to 21 | 11.9 | 15.8 | 15.8 | 17.2 | 17.6 | 17.0 | 17.5 | 18.5 | 18.9 | 20.8 | 20.9 | 20.9 | 20.5 | 20.0 | 20.0 | 20.0 | 20.6 |
| 24 to 25 | 11.9 | 15.8 | 15.9 | 17.0 | 17.7 | 17.2 | 17.0 | 18.5 | 18.9 | 20.8 | 20.9 | 20.9 | 20.9 | 19.8 | 19.8 | 20.0 | 21.0 |
| 27 to 28 | 11.9 | 15.8 | 15.9 | 17.0 | 17.8 | 17.0 | 17.1 | 18.5 | 18.9 | 20.8 | 20.9 | 20.8 | 20.9 | 19.8 | 19.8 | bottom | 20.8 |

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| Temperature (°C) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/30/98 | 7/30/98 | 8/12/98 | 8/12/98 | 8/13/98 | 8/13/98 | 8/27/98 | 8/27/98 | 9/17/98 | 9/17/98 | 8/12/99 | 8/12/99 | 8/12/99 | 8/12/99 | 8/23/00 | 8/23/00 |
| Location | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | |
| surface | 24.5 | 24.1 | 23.9 | 23.8 | 23.6 | 23.7 | 25.6 | 25.0 | 23.4 | 23.6 | 24.3 | 23.9 | 24.1 | 23.8 | 23.3 | 23.3 |
| 1 to 3 | 24.0 | 24.0 | 23.9 | 23.8 | 23.6 | 23.7 | 25.4 | 25.4 | 23.6 | 23.0 | 24.2 | 23.9 | 24.1 | 23.8 | 23.3 | 23.3 |
| 5 to 6 | 24.8 | 24.0 | 23.8 | 23.8 | 23.6 | 23.7 | 25.6 | 25.0 | 23.6 | 23.4 | 24.2 | 23.9 | 24.0 | 23.8 | 23.1 | 23.3 |
| 8 to 9 | 25.0 | 24.2 | 23.8 | 23.7 | 23.5 | 23.6 | 26.0 | 25.0 | 23.4 | 23.0 | 24.1 | 23.8 | 24.0 | 23.8 | 23.1 | 23.2 |
| 10 to 12 | 24.5 | 23.0 | 23.6 | 23.5 | 23.5 | 23.5 | 25.4 | 24.8 | 23.4 | 23.6 | 23.9 | 23.6 | 23.8 | 23.8 | 22.9 | 22.9 |
| 14 to 15 | 24.5 | 23.8 | 23.5 | 23.4 | 23.4 | 23.4 | 25.4 | 25.0 | 23.2 | 23.8 | 23.7 | 23.8 | 23.3 | 23.6 | 22.8 | 22.8 |
| 17 to 18 | 24.5 | 24.0 | 23.4 | 23.4 | 23.4 | 23.3 | 25.4 | 24.6 | 23.8 | 23.4 | 23.1 | 23.5 | 23.1 | 23.2 | 22.8 | 22.7 |
| 20 to 21 | 24.5 | 24.0 | 23.0 | 23.3 | 23.3 | 23.2 | 24.8 | 24.8 | 24.0 | 23.4 | 23.1 | 23.2 | 23.1 | 23.1 | 22.8 | 22.7 |
| 24 to 25 | 23.9 | 23.2 | 23.1 | 23.1 | 23.0 | 23.1 | 24.5 | 24.8 | 23.4 | 23.4 | 23.1 | 23.2 | 23.1 | 23.1 | 22.8 | 22.7 |
| 27 to 28 | 23.1 | 23.8 | bottom | bottom | bottom | bottom | 24.5 | 24.6 | 23.2 | 23.0 | bottom | bottom | bottom | bottom | bottom | bottom |

Notes:
n/a - Not Measured

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| Dissolved Oxygen (mg/L) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 5/23/95 | 5/24/95 | 5/25/95 | 5/23/95 | 5/24/95 | 5/25/95 | 6/5/96 | 10/21/96 | 10/24/96 | 10/21/96 | 10/22/96 | 4/28/97 | 4/28/91 | 4/29/97 | 6/20/97 | 6/20/97 | 7/1/97 |
| Location | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 11.0 | 12.5 | 12.0 | 10.9 | 12.6 | 12.0 | 10.3 | 9.6 | 9.9 | 9.6 | 9.7 | 11.6 | 11.3 | 12.7 | 9.9 | 10.2 | 10.1 |
| 1 to 3 | n/a | n/a | 12.0 | 10.9 | n/a | 12.0 | 10.3 | 9.6 | 9.8 | 9.6 | 9.7 | 11.5 | 11.3 | 12.7 | 9.9 | 10.3 | 10.0 |
| 5 to 6 | 11.1 | 12.6 | 12.0 | 11.0 | 12.6 | 12.0 | 10.3 | 9.6 | 9.8 | 9.6 | 9.6 | 11.6 | 11.2 | 12.6 | 10.2 | 9.9 | 10.3 |
| 8 to 9 | n/a | n/a | 12.0 | 11.1 | n/a | 12.0 | 10.3 | 9.6 | 9.8 | 9.6 | 9.6 | 12.1 | 11.7 | 12.6 | 10.3 | 9.5 | 9.7 |
| 10 to 12 | 11.1 | 12.6 | 12.0 | 11.1 | 12.6 | 12.0 | 10.4 | 9.6 | 9.8 | 9.5 | 9.5 | 12.1 | 11.7 | 13.3 | 10.0 | 9.9 | 9.9 |
| 14 to 15 | 11.2 | 12.6 | 12.0 | 11.1 | 12.6 | 12.0 | 10.4 | 9.7 | 9.8 | 9.5 | 9.7 | 12.2 | 12.1 | 12.8 | 10.3 | 8.8 | 10.0 |
| 17 to 18 | n/a | n/a | 12.0 | 11.1 | n/a | 12.0 | 10.6 | 9.7 | 9.8 | 9.5 | 9.7 | 12.2 | 12.2 | 12.8 | 10.3 | 9.1 | 10.0 |
| 20 to 21 | 11.1 | 12.6 | 12.0 | 11.1 | 12.6 | 12.0 | 10.6 | 9.7 | 9.9 | 9.5 | 9.7 | 12.2 | 12.2 | 12.8 | 10.0 | 10.0 | 9.9 |
| 24 to 25 | n/a | n/a | n/a | 11.4 | n/a | n/a | 10.6 | 9.6 | 9.8 | 9.5 | 9.7 | 12.2 | 12.2 | 12.8 | 10.0 | 10.0 | 10.0 |
| 27 to 28 | 11.5 | 12.6 | 12.0 | 11.5 | 12.6 | 12.0 | 10.6 | 9.7 | 9.8 | 9.5 | 9.7 | 12.2 | 12.3 | 12.7 | 9.9 | 10.1 | 10.0 |

| Dissolved Oxygen (mg/L) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/1/97 | 7/16/97 | 7/16/97 | 8/4/97 | 8/4/97 | 8/6/97 | 8/6/97 | 8/29/97 | 8/29/97 | 9/9/97 | 9/9/97 | 9/9/97 | 9/9/97 | 6/19/98 | 6/19/98 | 7/6/98 | 7/6/98 |
| Location | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | C3501 | S3500 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 10.2 | 10.0 | 10.3 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.2 | 9.7 | 7.8 | 9.7 | 8.1 | 10.0 | 10.0 | 10.0 | 10.0 |
| 1 to 3 | 10.2 | 10.0 | 10.0 | 10.0 | 9.9 | 10.0 | 10.0 | 10.2 | 10.2 | 9.7 | 8.1 | 9.6 | 8.1 | 9.9 | 10.0 | 10.0 | 10.0 |
| 5 to 6 | 10.0 | 9.9 | 9.8 | 10.0 | 10.0 | 9.8 | 10.1 | 10.3 | 9.9 | 9.7 | 8.0 | 9.6 | 8.1 | 10.0 | 10.0 | 10.0 | 10.3 |
| 8 to 9 | 10.0 | 10.0 | 10.0 | 10.0 | 9.9 | 10.0 | 10.0 | 10.0 | 9.9 | 9.8 | 8.0 | 9.5 | 8.1 | 10.0 | 9.9 | 9.8 | 10.0 |
| 10 to 12 | 9.9 | 10.0 | 10.1 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 9.9 | 9.8 | 8.0 | 9.4 | 8.0 | 10.0 | 9.4 | 9.9 | 10.0 |
| 14 to 15 | 10.1 | 10.0 | 9.9 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 9.9 | 9.8 | 8.0 | 9.4 | 8.0 | 9.4 | 9.4 | 10.0 | 9.8 |
| 17 to 18 | 10.0 | 9.9 | 10.0 | 9.8 | 10.0 | 10.0 | 10.0 | 10.2 | 10.0 | 9.8 | 8.0 | 9.7 | 7.9 | 9.8 | 10.0 | 10.0 | 9.9 |
| 20 to 21 | 9.9 | 10.0 | 10.1 | 9.9 | 10.0 | 9.9 | 10.0 | 10.3 | 10.0 | 9.9 | 8.0 | 9.8 | 7.9 | 9.8 | 10.0 | 9.8 | 9.0 |
| 24 to 25 | 9.7 | 10.0 | 10.2 | 9.9 | 10.0 | 9.9 | 10.0 | 10.0 | 10.0 | 9.9 | 8.0 | 9.8 | 7.9 | 10.0 | 10.0 | 9.8 | 8.8 |
| 27 to 28 | 9.7 | 9.8 | 10.2 | 10.0 | 9.8 | 9.9 | 9.7 | 10.0 | 10.0 | 10.1 | 8.0 | 9.9 | 7.9 | 9.8 | 10.0 | bottom | 9.0 |

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| Dissolved Oxygen (mg/L) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/30/98 | 7/30/98 | 8/12/98 | 8/12/98 | 8/13/98 | 8/13/98 | 8/27/98 | 8/27/98 | 9/17/98 | 9/17/98 | 8/12/99 | 8/12/99 | 8/12/99 | 8/12/99 | 8/23/00 | 8/23/00 |
| Location | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | |
| surface | 9.8 | 9.8 | 8.8 | 8.6 | 8.5 | 8.8 | 10.0 | 9.9 | 10.0 | 10.0 | 9.5 | 7.8 | 7.6 | n/a | 8.7 | n/a |
| 1 to 3 | 9.8 | 9.4 | 8.8 | 8.6 | 8.4 | 8.8 | 10.0 | 9.8 | 9.9 | 10.0 | 7.8 | 7.7 | 7.6 | 7.7 | 8.7 | 8.7 |
| 5 to 6 | 9.9 | 9.4 | 8.9 | 8.7 | 8.4 | 8.7 | 10.0 | 10.0 | 9.9 | 10.0 | 7.8 | 7.7 | 7.4 | 7.6 | 8.8 | 8.7 |
| 8 to 9 | 10.0 | 9.4 | 9.0 | 8.7 | 8.3 | 8.6 | 9.9 | 9.9 | 9.9 | 9.9 | 7.7 | 7.7 | 7.2 | 7.6 | 8.8 | 8.7 |
| 10 to 12 | 10.0 | 9.4 | 8.9 | 8.6 | 8.4 | 8.6 | 9.8 | 9.8 | 10.0 | 10.0 | 7.5 | 7.7 | 7.1 | 7.5 | 8.9 | 8.6 |
| 14 to 15 | 10.0 | 9.9 | 9.0 | 8.6 | 8.5 | 8.6 | 9.8 | 9.8 | 10.0 | 9.8 | 7.2 | 7.4 | 7.1 | 7.2 | 9.0 | 8.6 |
| 17 to 18 | 9.4 | 10.0 | 8.9 | 8.6 | 8.6 | 8.6 | 10.0 | 9.9 | 10.0 | 9.8 | 7.2 | 7.2 | 7.2 | 7.2 | 8.8 | 8.6 |
| 20 to 21 | 9.9 | 9.8 | 8.9 | 8.6 | 8.6 | 8.6 | 10.3 | 10.0 | 9.8 | 9.8 | 7.2 | 7.3 | 7.2 | 7.2 | 8.9 | 8.7 |
| 24 to 25 | 9.8 | 9.4 | 8.8 | 8.6 | 8.3 | 8.4 | 9.8 | 9.9 | 9.8 | 9.9 | 7.2 | 7.4 | 7.3 | 7.2 | 9.8 | 8.7 |
| 27 to 28 | 10.0 | 9.9 | bottom | bottom | bottom | bottom | 10.0 | 9.8 | 9.7 | 9.8 | bottom | bottom | bottom | bottom | bottom | bottom |

Notes:
n/a - Not Measured

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| Conductivity (µmhol/cm) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 5/23/95 | 5/24/95 | 5/25/95 | 5/23/95 | 5/24/95 | 5/25/95 | 6/5/96 | 10/21/96 | 10/24/96 | 10/21/96 | 10/22/96 | 4/28/97 | 4/28/91 | 4/29/97 | 6/20/97 | 6/20/97 | 7/1/97 |
| Location | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 301 | 295 | 298 | 301 | 291 | 289 | 300 | 308 | 294 | 306 | 299 | 313 | 318 | 291 | 300 | 295 | 300 |
| 1 to 3 | n/a | n/a | 290 | 299 | n/a | n/a | 301 | 308 | 294 | 309 | 298 | 313 | 317 | 286 | 302 | 297 | 287 |
| 5 to 6 | 296 | 292 | 290 | 296 | 298 | 289 | 304 | 308 | 291 | 305 | 298 | 311 | 315 | 287 | 305 | 296 | 295 |
| 8 to 9 | n/a | n/a | 291 | 296 | n/a | 290 | 297 | 306 | 294 | 305 | 297 | 303 | 306 | 291 | 310 | 301 | 296 |
| 10 to 12 | 289 | 289 | 292 | 295 | 301 | 290 | 305 | 305 | 298 | 301 | 294 | 303 | 303 | 290 | 312 | 302 | 298 |
| 14 to 15 | 305 | 293 | 291 | 296 | 300 | 292 | 300 | 305 | 294 | 304 | 292 | 301 | 304 | 290 | 310 | 304 | 301 |
| 17 to 18 | n/a | n/a | 294 | 297 | n/a | 289 | 300 | 304 | 294 | 301 | 289 | 301 | 303 | 278 | 320 | 296 | 300 |
| 20 to 21 | 300 | 301 | 293 | 296 | 297 | 296 | 300 | 300 | 288 | 302 | 289 | 300 | 300 | 290 | 325 | 300 | 298 |
| 24 to 25 | n/a | n/a | 293 | 294 | n/a | 294 | 300 | 300 | 289 | 300 | 289 | 300 | 298 | 294 | 320 | 297 | 316 |
| 27 to 28 | 306 | 301 | 292 | 294 | 297 | 280 | 302 | 300 | 294 | 300 | 289 | 300 | 298 | 297 | 350 | 300 | 315 |

| Conductivity (µmhol/cm) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/1/97 | 7/16/97 | 7/16/97 | **8/4/97** | 8/4/97 | 8/6/97 | 8/6/97 | 8/29/97 | 8/29/97 | 9/9/97 | 9/9/97 | 9/9/97 | 9/9/97 | 6/19/98 | 6/19/98 | 7/6/98 | 7/6/98 |
| Location | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | C3501 | S3500 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 313 | 310 | 295 | 297 | 285 | 300 | 299 | 282 | 295 | 303 | 301 | 299 | 291 | 540 | 310 | 440 | 450 |
| 1 to 3 | 295 | 300 | 297 | 298 | 279 | 300 | 295 | 300 | 295 | 305 | 288 | 297 | 291 | 450 | 300 | 320 | 441 |
| 5 to 6 | 297 | 296 | 295 | 298 | 275 | 301 | 300 | 290 | 295 | 298 | 287 | 296 | 288 | 360 | 309 | 316 | 316 |
| 8 to 9 | 300 | 301 | 301 | 298 | 278 | 305 | 301 | 295 | 295 | 297 | 285 | 295 | 287 | 316 | 309 | 318 | 315 |
| 10 to 12 | 298 | 310 | 297 | 295 | 280 | 300 | 305 | 295 | 299 | 293 | 285 | 294 | 280 | 315 | 309 | 100 | 312 |
| 14 to 15 | 299 | 314 | 300 | 296 | 285 | 298 | 313 | 297 | 295 | 299 | 284 | 294 | 283 | 316 | 296 | 372 | 315 |
| 17 to 18 | 302 | 312 | 310 | 299 | 286 | 305 | 300 | 295 | 297 | 292 | 284 | 291 | 283 | 316 | 296 | 330 | 330 |
| 20 to 21 | 305 | 310 | 312 | 297 | 285 | 310 | 301 | 289 | 300 | 295 | 283 | 291 | 282 | 441 | 302 | 370 | 309 |
| 24 to 25 | 305 | 310 | 314 | 301 | 290 | 310 | 300 | 298 | 300 | 293 | 283 | 293 | 281 | 282 | 313 | 285 | 315 |
| 27 to 28 | 310 | 300 | 320 | 305 | 290 | 315 | 300 | 297 | 295 | 291 | 287 | 292 | 286 | 291 | 316 | bottom | 290 |

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| Conductivity (µmhol/cm) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/30/98 | 7/30/98 | 8/12/98 | 8/12/98 | 8/13/98 | 8/13/98 | 8/27/98 | 8/27/98 | 9/17/98 | 9/17/98 | 8/12/99 | 8/12/99 | 8/12/99 | 8/12/99 | 8/23/00 | 8/23/00 |
| Location | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | |
| surface | 320 | 315 | 286 | 285 | 285 | 287 | 331 | 380 | 310 | 440 | 281 | 280 | 279 | 272 | 293 | 291 |
| 1 to 3 | 315 | 316 | 287 | 284 | 281 | 285 | 320 | 320 | 300 | 441 | 278 | 277 | 275 | 275 | 293 | 289 |
| 5 to 6 | 320 | 315 | 284 | 286 | 286 | 285 | 320 | 330 | 374 | 370 | 281 | 283 | 275 | 276 | 287 | 292 |
| 8 to 9 | 320 | 330 | 287 | 284 | 284 | 287 | 316 | 320 | 318 | 320 | 281 | 273 | 277 | 274 | 293 | 291 |
| 10 to 12 | 316 | 300 | 287 | 282 | 282 | 286 | 320 | 330 | 316 | 330 | 279 | 279 | 277 | 277 | 291 | 290 |
| 14 to 15 | 320 | 316 | 285 | 284 | 283 | 285 | 320 | 315 | 330 | 370 | 278 | 277 | 271 | 276 | 287 | 284 |
| 17 to 18 | 320 | 316 | 278 | 283 | 280 | 284 | 380 | 316 | 330 | 330 | 270 | 274 | 272 | 275 | 285 | 285 |
| 20 to 21 | 33 | 330 | 278 | 282 | 281 | 286 | 320 | 320 | 316 | 330 | 276 | 274 | 268 | 272 | 289 | 287 |
| 24 to 25 | 315 | 313 | 284 | 281 | 278 | 282 | 370 | 330 | n/a | 330 | 277 | 273 | 275 | 271 | 296 | 283 |
| 27 to 28 | 320 | 330 | bottom | bottom | bottom | bottom | 360 | 360 | bottom | 330 | bottom | bottom | bottom | bottom | bottom | bottom |

Notes:
n/a - Not Measured

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| pH (s.u.) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 5/23/95 | 5/24/95 | 5/25/95 | 5/23/95 | 5/24/95 | 5/25/95 | 6/5/96 | 10/21/96 | 10/24/96 | 10/21/96 | 10/22/96 | 4/28/97 | 4/28/91 | 4/29/97 | 6/20/97 | 6/20/97 | 7/1/97 |
| Location | C3501 | C3501 | C3501 | S3500 | S3500 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.1 | 8.1 | 8.2 | 8.2 | 8.2 | 7.9 | 7.9 | 7.4 | 8.0 | 7.9 | 8.0 |
| 1 to 3 | n/a | n/a | 8.2 | 8.2 | n/a | n/a | 8.1 | 8.1 | 8.2 | 8.2 | 8.2 | 7.9 | 7.9 | 7.4 | 8.0 | 8.0 | 7.7 |
| 5 to 6 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.1 | 8.1 | 8.1 | 8.2 | 8.2 | 8.2 | 7.9 | 7.9 | 7.3 | 7.7 | 8.0 | 7.8 |
| 8 to 9 | n/a | n/a | 8.2 | 8.2 | n/a | 8.1 | 8.1 | 8.1 | 8.2 | 8.2 | 8.2 | 7.9 | 8.0 | 7.3 | 7.9 | 8.0 | 8.0 |
| 10 to 12 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.1 | 8.1 | 8.1 | 8.2 | 8.2 | 8.2 | 7.9 | 8.0 | 7.2 | 7.9 | 7.9 | 7.9 |
| 14 to 15 | 8.2 | 8.2 | 8.2 | 8.2 | 8.1 | 8.1 | 8.1 | 8.1 | 8.2 | 8.2 | 8.1 | 7.9 | 8.0 | 7.1 | 8.0 | 7.9 | 7.8 |
| 17 to 18 | n/a | n/a | 8.2 | 8.2 | n/a | 8.1 | 8.1 | 8.0 | 8.2 | 8.2 | 8.1 | 7.9 | 8.0 | 7.0 | 8.2 | 7.7 | 8.1 |
| 20 to 21 | 8.2 | 8.2 | 8.2 | 8.2 | 8.1 | 8.1 | 8.1 | 8.0 | 8.2 | 8.2 | 8.1 | 7.9 | 8.0 | 6.9 | 8.2 | 8.0 | 8.1 |
| 24 to 25 | n/a | n/a | 8.2 | 8.2 | n/a | 8.1 | 8.1 | 8.0 | 8.1 | 8.2 | 8.1 | 7.9 | 8.0 | 9.8 | 7.8 | 8.0 | 8.0 |
| 27 to 28 | 8.2 | 8.1 | 8.1 | 8.2 | 8.1 | 8.1 | 8.1 | 8.0 | 8.1 | 8.3 | 8.1 | 7.9 | 8.0 | 6.7 | 8.0 | 7.9 | 8.0 |

| pH (s.u.) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/1/97 | 7/16/97 | 7/16/97 | 8/4/97 | 8/4/97 | 8/6/97 | 8/6/97 | 8/29/97 | 8/29/97 | 9/9/97 | 9/9/97 | 9/9/97 | 9/9/97 | 6/19/98 | 6/19/98 | 7/6/98 | 7/6/98 |
| Location | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | C3501 | S3500 |
| Depth (ft) | | | | | | | | | | | | | | | | | |
| surface | 7.8 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.1 | 8.1 | n/a | n/a | n/a | n/a | 7.5 | 7.8 | 7.8 | 7.3 |
| 1 to 3 | 7.8 | 7.9 | 7.9 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.2 | n/a | n/a | n/a | n/a | 7.7 | 7.7 | 7.5 | 7.7 |
| 5 to 6 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.1 | 8.1 | 8.0 | 8.0 | n/a | n/a | n/a | n/a | 7.8 | 7.7 | 8.0 | 8.0 |
| 8 to 9 | 8.0 | 8.0 | 8.0 | 8.0 | 8.1 | 8.0 | 8.0 | 8.1 | 8.0 | n/a | n/a | n/a | n/a | 8.0 | 7.8 | 8.0 | 8.0 |
| 10 to 12 | 8.1 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | n/a | n/a | n/a | n/a | 8.0 | 8.0 | 7.7 | 8.0 |
| 14 to 15 | 8.0 | 8.0 | 8.0 | 8.1 | 8.0 | 8.0 | 7.9 | 8.0 | 8.0 | n/a | n/a | n/a | n/a | 8.0 | 8.0 | 7.9 | 8.0 |
| 17 to 18 | 8.0 | 8.0 | 7.9 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.1 | n/a | n/a | n/a | n/a | 8.0 | 8.0 | 7.9 | 8.0 |
| 20 to 21 | 7.9 | 8.0 | 8.0 | 8.0 | 7.6 | 8.0 | 8.0 | 8.0 | 8.1 | n/a | n/a | n/a | n/a | 8.0 | 7.8 | 7.9 | 7.8 |
| 24 to 25 | 7.8 | 8.0 | 8.0 | 8.0 | 8.0 | 8.1 | 7.9 | 8.0 | 8.0 | n/a | n/a | n/a | n/a | 8.0 | 8.0 | 7.9 | 7.8 |
| 27 to 28 | 7.8 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 7.9 | 8.0 | 8.0 | n/a | n/a | n/a | n/a | 8.0 | 7.8 | bottom | 7.8 |

# APPENDIX C. LAKE MICHIGAN *IN SITU* WATER QUALITY DETERMINATIONS

| pH (s.u.) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 7/30/98 | 7/30/98 | 8/12/98 | 8/12/98 | 8/13/98 | 8/13/98 | 8/27/98 | 8/27/98 | 9/17/98 | 9/17/98 | 8/12/99 | 8/12/99 | 8/12/99 | 8/12/99 | 8/23/00 | 8/23/00 |
| Location | C3501 | S3500 | C3501 | S3500 | C3501 | S3500 | S3500 | C3501 | C3501 | S3500 | S3500 | C3501 | S3500 | C3501 | S3500 | C3501 |
| Depth (ft) | | | | | | | | | | | | | | | | |
| surface | 7.5 | 7.7 | 8.3 | 8.2 | 8.2 | 8.2 | 8.0 | 7.7 | 7.8 | 8.0 | 8.3 | 8.3 | 8.3 | 8.3 | 8.4 | 8.4 |
| 1 to 3 | 7.5 | 7.7 | 8.4 | 8.2 | 8.2 | 8.2 | 7.8 | 7.8 | 8.0 | 8.0 | 8.3 | 8.3 | 8.3 | 8.3 | 8.4 | 8.4 |
| 5 to 6 | 7.8 | 7.7 | 8.4 | 8.2 | 8.2 | 8.2 | 8.0 | 7.8 | 8.0 | 7.5 | 8.3 | 8.3 | 8.3 | 8.3 | 8.4 | 8.4 |
| 8 to 9 | 7.5 | 7.7 | 8.4 | 8.2 | 8.2 | 8.2 | 7.8 | 7.9 | 7.9 | 7.8 | 8.3 | 8.3 | 8.3 | 8.3 | 8.4 | 8.4 |
| 10 to 12 | 7.5 | 7.7 | 8.4 | 8.2 | 8.2 | 8.2 | 7.5 | 8.0 | 7.7 | 7.9 | 8.3 | 8.3 | 8.3 | 8.3 | 8.4 | 8.4 |
| 14 to 15 | 7.8 | 7.5 | 8.4 | 8.2 | 8.2 | 8.2 | 7.8 | 7.7 | 7.5 | 7.9 | 8.3 | 8.3 | 8.2 | 8.3 | 8.3 | 8.4 |
| 17 to 18 | 8.0 | 7.9 | 8.4 | 8.2 | 8.2 | 8.2 | 7.8 | 7.8 | 7.8 | 7.9 | 8.2 | 8.2 | 8.2 | 8.3 | 8.3 | 8.3 |
| 20 to 21 | 7.8 | 7.9 | 8.4 | 8.2 | 8.2 | 8.2 | 7.7 | 8.0 | 7.7 | 7.8 | 8.2 | 8.2 | 8.2 | 8.2 | 8.3 | 8.3 |
| 24 to 25 | 7.5 | 7.9 | 8.4 | 8.1 | 8.1 | 8.2 | 7.8 | 7.7 | 7.7 | 8.0 | 8.2 | 8.2 | 8.2 | 8.2 | 8.3 | 8.3 |
| 27 to 28 | 7.7 | 7.8 | bottom | bottom | bottom | bottom | 7.7 | 7.6 | bottom | 7.8 | bottom | bottom | bottom | bottom | bottom | bottom |

Notes:
n/a - Not Measured

## APPENDIX C. LAKE MICHIGAN WATER CHEMISTRY DATA

| Parameter | Units | May-95 | | Jun-96 | | Oct-96 | | Apr-97 | |
|---|---|---|---|---|---|---|---|---|---|
| | | C3501 | S3500 | S3500 | S3500 | C3501 | S3500 | C3501 | S3500 |
| pH | s.u. | n/a | n/a | 7.0 | 6.9 | 8.1 | 8.1 | 8.5 | 8.3 |
| Total Suspended Solids (TSS) | mg/L | 2.0 | 3.0 | 0.9 | 0.9 | 2.5 | 2.0 | 0.9 | 0.9 |
| Total Dissolved Solids (TDS) | mg/L | 188 | 198 | 194 | 188 | 148 | 140 | 160 | 160 |
| Alkalinity as $CaCO_3$ | mg/L | 110 | 110 | n/a | n/a | n/a | n/a | n/a | n/a |
| Chloride | mg/L | 14.0 | 14.0 | 12.7 | 13.2 | 12.5 | 14.0 | 17.0 | 17.0 |
| Total Organic Carbon (TOC) | mg/L | 3.2 | 3.2 | 4.3 | 4.5 | 2.5 | 2.6 | 14.0 | 20.0 |
| Hardness as $CaCO_3$ | mg/L | 158 | 133 | 147 | 150 | 155 | 150 | 150 | 160 |
| Total Kjeldahl Nitrogen (TKN) | mg/L | 1.1 | 1.9 | n/a | n/a | 0.4 | 0.4 | 0.4 | 0.4 |
| Nitrate/Nitrite | mg/L | 1.50 | 0.29 | 0.35 | 0.34 | 0.30 | 0.40 | 0.34 | 0.09 |
| Total Nitrogen | mg/L | n/a | n/a | 1.74 | 1.56 | n/a | n/a | n/a | n/a |
| Total Phosphorus | mg/L | 0.100 | 0.120 | 0.009 | 0.009 | 0.020 | 0.020 | 0.200 | 0.200 |
| Ortho-Phosphorus | mg/L | 0.009 | 0.050 | 0.009 | 0.009 | 0.020 | 0.020 | 0.200 | 0.200 |
| Silica | mg/L | 0.50 | 0.60 | 0.70 | 0.65 | 0.50 | 0.38 | 0.60 | 0.59 |
| Sulfate | mg/L | 25 | 26 | n/a | n/a | n/a | n/a | n/a | n/a |
| Total Calcium | mg/L | 85 | 54 | n/a | n/a | n/a | n/a | n/a | n/a |
| Total Magnesium | mg/L | 12 | 12 | n/a | n/a | n/a | n/a | n/a | n/a |
| Total Sodium | mg/L | 7.7 | 7.0 | n/a | n/a | n/a | n/a | n/a | n/a |
| Total Potassium | mg/L | 0.3 | 3.3 | n/a | n/a | n/a | n/a | n/a | n/a |

| Parameter | Units | Oct-97 | | Aug-98 | | Aug-99 | | Aug-00 | |
|---|---|---|---|---|---|---|---|---|---|
| | | C3501 | S3500 | S3500 | S3500 | C3501 | S3500 | C3501 | S3500 |
| pH | s.u. | 8.30 | 8.20 | 8.30 | 8.20 | 7.90 | 7.80 | 8.70 | 8.70 |
| Total Suspended Solids (TSS) | mg/L | 1.00 | 2.00 | 7.00 | 3.00 | 2.50 | 2.50 | 6.25 | 6.00 |
| Total Dissolved Solids (TDS) | mg/L | 150.00 | 150.00 | 170.00 | 180.00 | 170.00 | 160.00 | 180.00 | 165.00 |
| Chloride | mg/L | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 15.00 | 12.00 | 12.00 |
| Total Organic Carbon (TOC) | mg/L | 2.50 | 2.50 | 2.60 | 2.50 | 2.00 | 3.00 | 2.00 | 2.00 |
| Hardness as $CaCO_3$ | mg/L | 150.00 | 140.00 | 140.00 | 140.00 | 142.00 | 143.00 | 138.00 | 137.00 |
| Total Kjeldahl Nitrogen (TKN) | mg/L | 0.50 | 0.50 | 0.50 | 0.50 | 0.30 | 0.40 | 0.13 | 1.60 |
| Nitrate/Nitrite | mg/L | 0.26 | 0.31 | 0.40 | 0.46 | 0.25 | 0.27 | 0.27 | 0.27 |
| Total Phosphorus | mg/L | 0.025 | 0.025 | 0.025 | 0.025 | 0.020 | 0.020 | 0.020 | 0.020 |
| Ortho-Phosphorus | mg/L | 0.025 | 0.027 | 0.025 | 0.025 | 0.003 | 0.003 | 0.003 | 0.003 |
| Silica | mg/L | 0.13 | 0.16 | 0.25 | 0.22 | 0.80 | 0.80 | 0.50 | 0.60 |
| Dissolved Calcium | mg/L | n/a | n/a | n/a | n/a | 37.50 | 37.90 | 36.10 | 36.00 |
| Dissolved Magnesium | mg/L | n/a | n/a | n/a | n/a | 11.70 | 11.80 | 11.70 | 11.60 |

Notes:
n/a - Not Analyzed

# Appendix D

# Lake Michigan Dunes Sites

# APPENDIX D. LAKE MICHIGAN DUNES SITE

## 1.0 INTRODUCTION

The Dunes, an offshore section of Lake Michigan positioned parallel to the Indiana Dunes National Lakeshore, Indiana, was sampled in June 1996 to represent a minimally impacted southern Lake Michigan habitat with physical and chemical characteristics similar to S3500 and C3501. The Dunes data further augment the long-term biomonitoring database by documenting the existing background conditions in order to better evaluate and identify potential effects of the BP treated effluent on the waters and biota of Lake Michigan.

## 2.0 STUDY SITES

The Dunes consist of six sample sites representing what is believed to be high-quality water and sediment conditions located parallel to the shore of Indiana Dunes State Park. Each sample site was separated by approximately 1.0 mile (1.6 km) for a distance of six miles along the shoreline and in 28 feet (8.5 meters) of water. Figure D-1 shows the Dunes sample locations and their corresponding latitude and longitudes.

## 3.0 METHODS

The following collections were made at the Dunes sites:

- Sediment;
- Benthic macroinvertebrates; and,
- Water quality.

### 3.1 Sediment and Benthos

Sediment and benthic macroinvertebrates were collected at the Dunes sites using methods as described in Sections 3.1 and 3.2 of the Summary Report. All sites at the Dunes location were sampled (sites 1, 2, 3, 4, 5, and 6).

### 3.2 Water Quality

A Series III multi-parameter probe and transmitter (Hydrolab, Inc.) was used to determine depth profiles for pH (s.u.), conductivity (µmhos/cm), water temperature (°C), and dissolved oxygen (mg/L) at the Dunes sites. Water quality measurements at each site were made in 5 foot (3.0 meter) intervals from the lake bottom to the surface.

## 4.0 RESULTS

### 4.1 Sediment Composition and Benthos

Sand is the characteristic component of the sediment at the Dunes sites. Sand represented 98% of the sediment composition at the Dunes and ranged from 96.3% to 99.2% composition. Figures D-2a through D-2d show the relative percent composition of each particle size for the Dunes sites, as well as their respective compositions at both S3500 and C3501. A goodness-

of-fit model indicated a statistical difference in percent composition among size categories between S3500, C3501, and the Dunes sites ($G = 18{,}6$; $\chi^2_{0.05(3)} = 7.8$; $G > \chi^2 = P < 0.05$). At the Dunes sites, sand-sized particles represented a statistically higher proportion of particles than at either S3500 or C3501. In contrast, silt-sized particles comprised a significantly smaller proportion of the sediments at the Dunes sites than at either S3500 or C3501. Clay and gravel-sized particles, however, were minimal with respect to sediment composition at all three sites. Table D-1 lists the mean, minimum, and maximum percent contributions of each particle size to the sediment at the Dunes sites.

Three different taxa were identified in the Dunes benthos samples. Species observed included aquatic flies *Phaenopsectra* spp., the snail *Valvata perdepressa*, the zebra mussel *Dreissena polymorpha*, and several unidentified early-instar Chironomidae. None of the samples contained all three identified taxa. Table D-2 provides the Dunes sites community summary. A taxonomic listing and abundance data for the Dunes benthos samples are presented in Table D-3.

Benthos richness ranged from zero organisms at Dunes 1 and Dunes 6 samples to 2 taxa at Dunes 2 and Dunes 4. Chironomids were observed at three of the six Dunes sites and also represented the taxa with the highest observed density (80 orgs/m$^2$). Total organism density ranged from zero (Dunes 1 and Dunes 6) to 120 orgs/m$^2$ at Dunes 4 where both chironomids and zebra mussels were observed (Table D-3).

### 4.2 Water Quality

The *in situ* water quality measurements at the Dunes indicated a well-mixed water column. A 1.0 to 1.5 degree vertical temperature gradient was observed through the water column at each sampling location. The range of values for the *in situ* parameters measured were well within the range observed at S3500 and C3501, although temperatures were approximately 1 degree cooler. Table D-4 lists the pH, dissolved oxygen, conductivity, and temperature at depth for Dunes 1, 2, 4, 5, and 6. Dunes site 3 data was not recorded because a vertical profile could not be obtained due to anchorage problems and boat drifting.

## 5.0 CONCLUSIONS

### 5.1 Sediment Composition and Benthos

Sediment samples from the Dunes sites indicated a higher percentage of sand and a lower percentage of silt in the sediments than at either S3500 or C3501. Sand-sized particles dominated the profile of the Dunes sediments as at S3500 and C3501, and the pattern of sediment composition (% sand > % clay > % silt > % gravel) was nearly identical to S3500 and C3501. The dominance of sand-sized particles may be due in part to both physical differences in source material and exposure to lake-wide currents and disruption. In contrast, S3500 and C3501 appear to be comparatively sheltered from these factors. A more uniform and less physically complex substrate matrix such as sand, plus an increased potential for physical disruption of the substrate material, would tend to favor organisms that are less impacted or injured by physical disruption and abrasion.

The high uniformity of the sediment physical structure may be limiting to benthos richness and density at the Dunes sites. Continuous or heavy disruption of the surficial sediments would likely favor the presence of robust organisms unaffected by shifting substrates, or organisms that have the ability to burrow into the sediments below the level of physical disturbance. The

presence of many crayfish (reported by divers) and fingernail clams at the Dunes sites are examples of organisms more resistant than soft-bodied organisms to shifting sand, and that have the ability to burrow into the sediments.

The most notable difference between the benthic macroinvertebrate collections of S3500, C3501, and the Dunes sites was the paucity of Oligochaeta in the Dunes sites collections. It is quite possible that these organisms were buried deeper within the sediments than sampled. However, it is highly unlikely that the absence of Oligochaeta is an indication of higher quality water at the Dunes sites than at S3500 and C3501, as Oligochaetes have been collected in a variety of environments both oligotrophic and eutrophic in nature. It is more plausible that the physical conditions at the Dunes sites limit the presence of these soft-bodied organisms.

### 5.2 *In situ* Water Quality

The Dunes sites water column was well-mixed, and the water quality did not differ from that found at either S3500 or C3501. The overall difference in temperature (1°) between the Dunes sites and S3500 and C3501 can be attributed to the greater exposure of the Dunes sites to deeper, open waters, localized differences in lake currents, and daily meteorological fluctuations.

TABLE D-1. LAKE MICHIGAN DUNES SEDIMENT SUMMARY

| Substrate | Units | Dunes sites | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | Mean |
| Sand | Percent | 99.00 | 98.65 | 99.20 | 96.87 | 98.81 | 96.28 | 98.14 |
| Silt | Percent | 0.00 | 0.00 | 0.00 | 0.45 | 0.78 | 2.24 | 0.58 |
| Clay | Percent | 1.37 | 1.35 | 0.82 | 0.79 | 0.41 | 1.29 | 1.01 |
| Gravel | Percent | 0.00 | 0.00 | 0.00 | 1.89 | 0.00 | 0.20 | 0.35 |

## TABLE D-2. LAKE MICHIGAN DUNES BENTHOS SUMMARY

| Parameter | Units | Dunes Min. | Dunes Max. | Dunes Mean |
|---|---|---|---|---|
| Total Density | No./$m^2$ | 0 | 120 | 55 |
| Richness | Number | 0 | 2 | 1 |
| Simpson's Diversity | Value | 0.00 | 1.00 | 0.58 |
| Shannon-Wiener Diversity | Value | 0.00 | 0.69 | 0.33 |
| Percent Oligochaetes | Percent | 0.0 | 0.0 | 0.0 |
| Percent Snails | Percent | 0.0 | 50.0 | 8.3 |
| Percent Clams and Mussels | Percent | 0.0 | 50.0 | 13.8 |
| Percent Chironomids | Percent | 0.0 | 100 | 44.5 |

**TABLE D-3. LAKE MICHIGAN DUNES BENTHIC MACROINVERTEBRATE SPECIES LIST**

| TAXA | Units | Dunes sites (organisms/m$^2$) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Chironomidae | No./m$^2$ | | | | | | |
| Early instars | No./m$^2$ | | | 80 | | | |
| *Phaenopsectra spp.* | No./m$^2$ | | | | 80 | 50 | |
| Gastropoda | No./m$^2$ | | | | | | |
| *Valvata perdepressa* | No./m$^2$ | | 40 | | | | |
| Pelycepoda | No./m$^2$ | | | | | | |
| *Dreissena polymorpha* | No./m$^2$ | | 40 | | 40 | | |
| Total Density | No./m$^2$ | 0 | 80 | 80 | 120 | 50 | 0 |
| Richness | Number | 0 | 2 | 1 | 2 | 1 | 0 |

## TABLE D-4. LAKE MICHIGAN DUNES *IN SITU* WATER QUALITY DETERMINATIONS

| Temperature (°C) | | | | | | |
|---|---|---|---|---|---|---|
| Date | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 |
| Location | Dunes 1 | Dunes 2 | Dunes 3 | Dunes 4 | Dunes 5 | Dunes 6 |
| Depth (ft) | | | | | | |
| surface | 13.3 | 13.2 | n/a | 13.7 | 13.8 | 13.7 |
| 1 to 3 | 13.3 | 13.3 | n/a | n/a | n/a | n/a |
| 5 to 6 | 13.3 | n/a | n/a | 13.7 | 13.8 | 13.7 |
| 8 to 9 | 13.2 | 13.4 | n/a | n/a | n/a | n/a |
| 10 to 12 | 13.2 | n/a | n/a | 13.6 | 13.7 | 13.6 |
| 14 to 15 | 13.1 | 13.2 | n/a | 13.9 | 13.7 | 13.6 |
| 17 to 18 | 13.1 | 13.2 | n/a | n/a | n/a | n/a |
| 20 to 21 | 13.0 | 13.1 | n/a | 13.4 | 13.6 | 13.6 |
| 24 to 25 | 12.7 | 13.1 | n/a | 13.2 | 13.5 | 13.3 |
| 27 to 28 | 12.4 | 12.7 | n/a | 12.7 | n/a | 12.9 |
| 29+ | bottom | 12.5 | bottom | bottom | 13.3 | bottom |

| Dissolved Oxygen (mg/L) | | | | | | |
|---|---|---|---|---|---|---|
| Date | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 |
| Location | Dunes 1 | Dunes 2 | Dunes 3 | Dunes 4 | Dunes 5 | Dunes 6 |
| Depth (ft) | | | | | | |
| surface | 10.7 | 10.8 | n/a | 10.7 | 10.6 | 10.7 |
| 1 to 3 | 10.7 | 10.8 | n/a | n/a | n/a | n/a |
| 5 to 6 | 10.8 | n/a | n/a | 10.7 | 10.6 | 10.7 |
| 8 to 9 | 10.8 | 10.8 | n/a | n/a | n/a | n/a |
| 10 to 12 | 10.8 | n/a | n/a | 10.7 | 10.6 | 10.7 |
| 14 to 15 | 10.8 | 10.8 | n/a | 10.7 | 10.6 | 10.7 |
| 17 to 18 | 10.8 | 10.8 | n/a | n/a | n/a | n/a |
| 20 to 21 | 10.7 | 10.8 | n/a | 10.7 | 10.6 | 10.7 |
| 24 to 25 | 10.7 | 10.8 | n/a | 10.7 | 10.6 | 10.9 |
| 27 to 28 | 10.6 | 10.6 | n/a | 10.7 | n/a | 10.9 |
| 29+ | bottom | 10.5 | bottom | bottom | 10.6 | bottom |

## TABLE D-4. LAKE MICHIGAN DUNES *IN SITU* WATER QUALITY DETERMINATIONS

| Conductivity (µmhol/cm) | | | | | | |
|---|---|---|---|---|---|---|
| Date | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 |
| Location | Dunes 1 | Dunes 2 | Dunes 3 | Dunes 4 | Dunes 5 | Dunes 6 |
| Depth (ft) | | | | | | |
| surface | 302 | 302 | n/a | 301 | 300 | 300 |
| 1 to 3 | 303 | 301 | n/a | n/a | n/a | n/a |
| 5 to 6 | 303 | n/a | n/a | 300 | 299 | 302 |
| 8 to 9 | 302 | 303 | n/a | n/a | n/a | n/a |
| 10 to 12 | 305 | n/a | n/a | 301 | 304 | 300 |
| 14 to 15 | 304 | 304 | n/a | 304 | 306 | 299 |
| 17 to 18 | 303 | 301 | n/a | n/a | n/a | n/a |
| 20 to 21 | 301 | 302 | n/a | 302 | 303 | 294 |
| 24 to 25 | 306 | 301 | n/a | 303 | 297 | 300 |
| 27 to 28 | 302 | 301 | n/a | 294 | n/a | 304 |
| 29+ | bottom | 297 | bottom | bottom | 310 | bottom |

| pH (s.u.) | | | | | | |
|---|---|---|---|---|---|---|
| Date | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 | 6/6/96 |
| Location | Dunes 1 | Dunes 2 | Dunes 3 | Dunes 4 | Dunes 5 | Dunes 6 |
| Depth (ft) | | | | | | |
| surface | 8.2 | 8.3 | n/a | 8.3 | 8.3 | 8.3 |
| 1 to 3 | 8.2 | 8.3 | n/a | n/a | n/a | n/a |
| 5 to 6 | 8.2 | n/a | n/a | 8.3 | 8.3 | 8.3 |
| 8 to 9 | 8.2 | 8.3 | n/a | n/a | n/a | n/a |
| 10 to 12 | 8.2 | n/a | n/a | 8.3 | 8.3 | 8.3 |
| 14 to 15 | 8.2 | 8.2 | n/a | 8.3 | 8.3 | 8.3 |
| 17 to 18 | 8.2 | 8.2 | n/a | n/a | n/a | n/a |
| 20 to 21 | 8.2 | 8.2 | n/a | 8.3 | 8.3 | 8.3 |
| 24 to 25 | 8.2 | 8.2 | n/a | 8.3 | 8.3 | 8.3 |
| 27 to 28 | 8.1 | 8.2 | n/a | 8.2 | n/a | 8.3 |
| 29+ | bottom | 8.2 | bottom | bottom | 8.3 | bottom |

Notes:
n/a - Not Measured

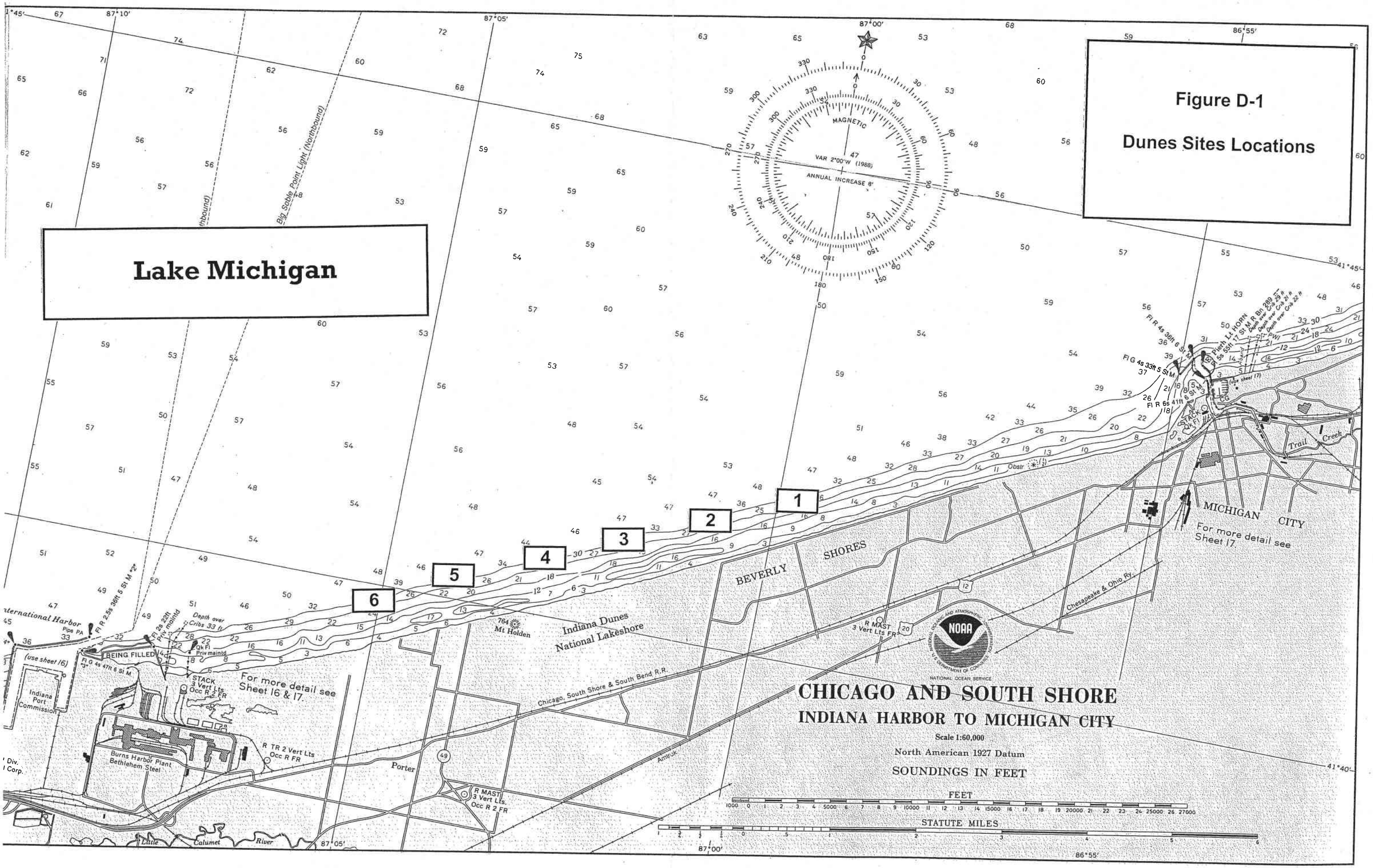
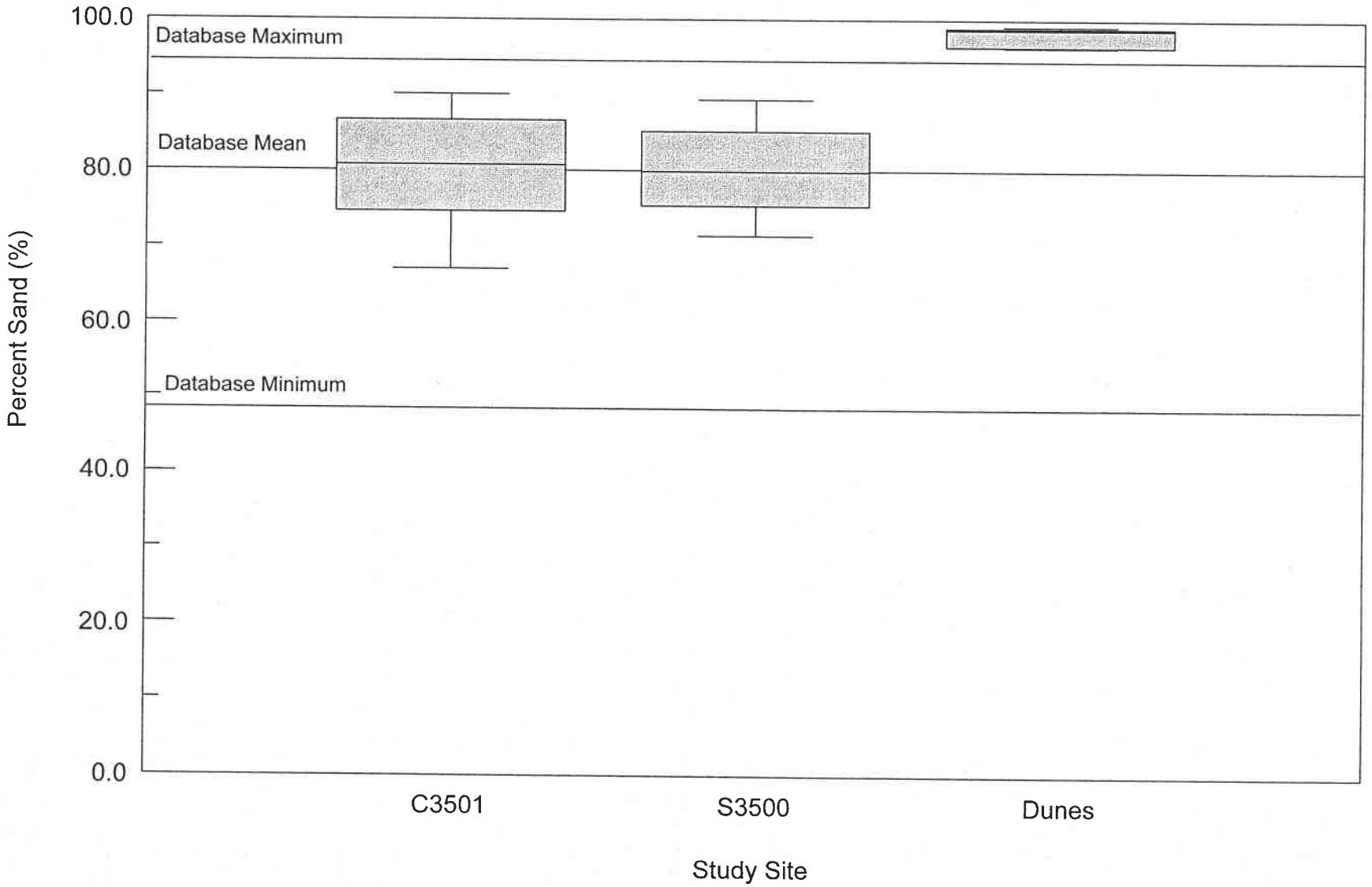


Figure D-1
Dunes Sites Locations
Lake Michigan
1
2
3
4
5
6
MAGNETIC
VAR 2°00'W (1988)
ANNUAL INCREASE 8'
Big Sable Point Light (Northbound)
Fl R 4s 38ft 6 St M
Fl G 4s 33ft 5 St M
Fl R 6s 41ft
Fl R 2.5s 36ft 5 St M
Fl G 4s 47ft 6 St M
Fl R 2s 22ft
Depth over Cribs 33 ft
Depth over Crib 29 ft
Depth over Crib 21 ft
Depth over Crib 22 ft
Obstr
Trail Creek
MICHIGAN CITY
For more detail see Sheet 17.
BEVERLY SHORES
Chesapeake & Ohio Ry.
R MAST 3 Vert Lts FR
Indiana Dunes National Lakeshore
764 Mt Holden
International Harbor
Pipe PA
BEING FILLED
(use sheet 16)
Indiana Port Commission
STACK 3 Vert Lts Occ R 2 FR
For more detail see Sheet 16 & 17.
Chicago, South Shore & South Bend R.R.
R TR 2 Vert Lts Occ R FR
Burns Harbor Plant Bethlehem Steel
Porter
Amtrak
R MAST 3 Vert Lts Occ R 2 FR
Little Calumet River
NOAA
NATIONAL OCEAN SERVICE
CHICAGO AND SOUTH SHORE
INDIANA HARBOR TO MICHIGAN CITY
Scale 1:60,000
North American 1927 Datum
SOUNDINGS IN FEET
FEET
STATUTE MILES
87°05'
87°00'
86°55'
41°45'
41°40'

**FIGURE D-2a. PERCENT SAND IN SEDIMENT LAKE MICHIGAN DATABASE AND DUNES SITES**



## FIGURE D-2b. PERCENT SILT IN SEDIMENT LAKE MICHIGAN DATABASE AND DUNES SITES

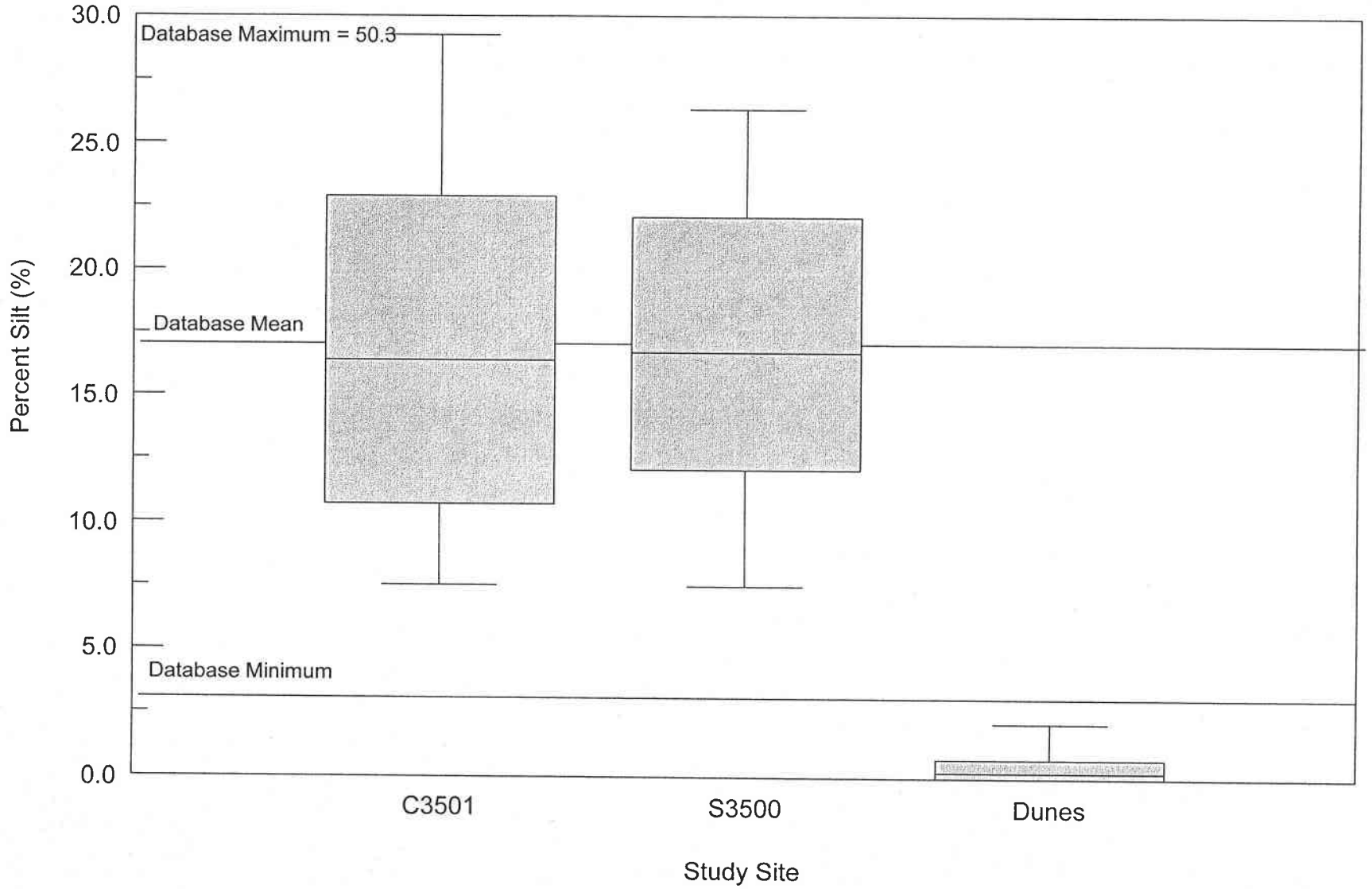


**FIGURE D-2c. PERCENT CLAY IN SEDIMENT LAKE MICHIGAN DATABASE AND DUNES SITES**

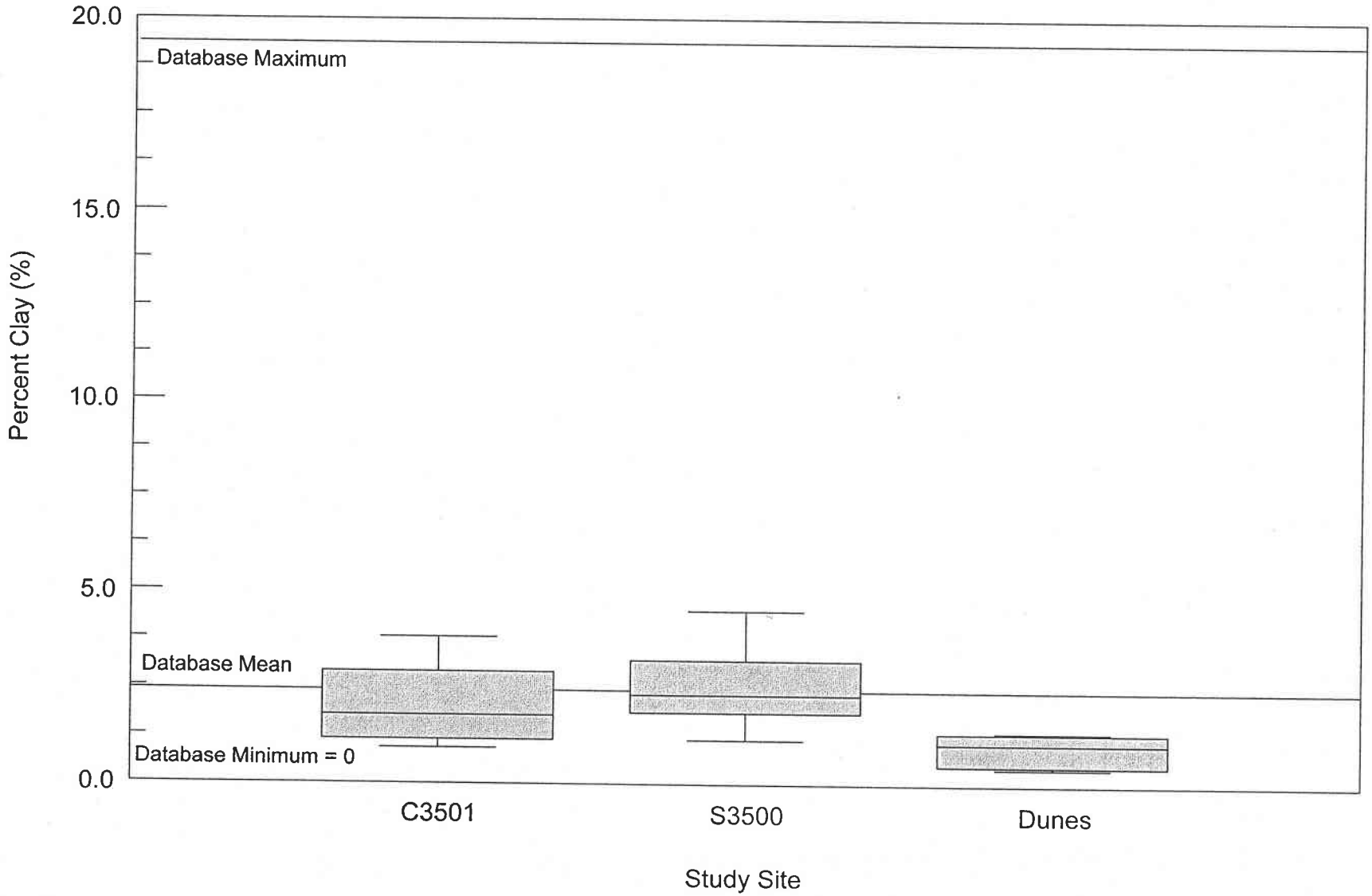


FIGURE D-2d. PERCENT GRAVEL IN SEDIMENT LAKE MICHIGAN DATABASE AND DUNES SITES

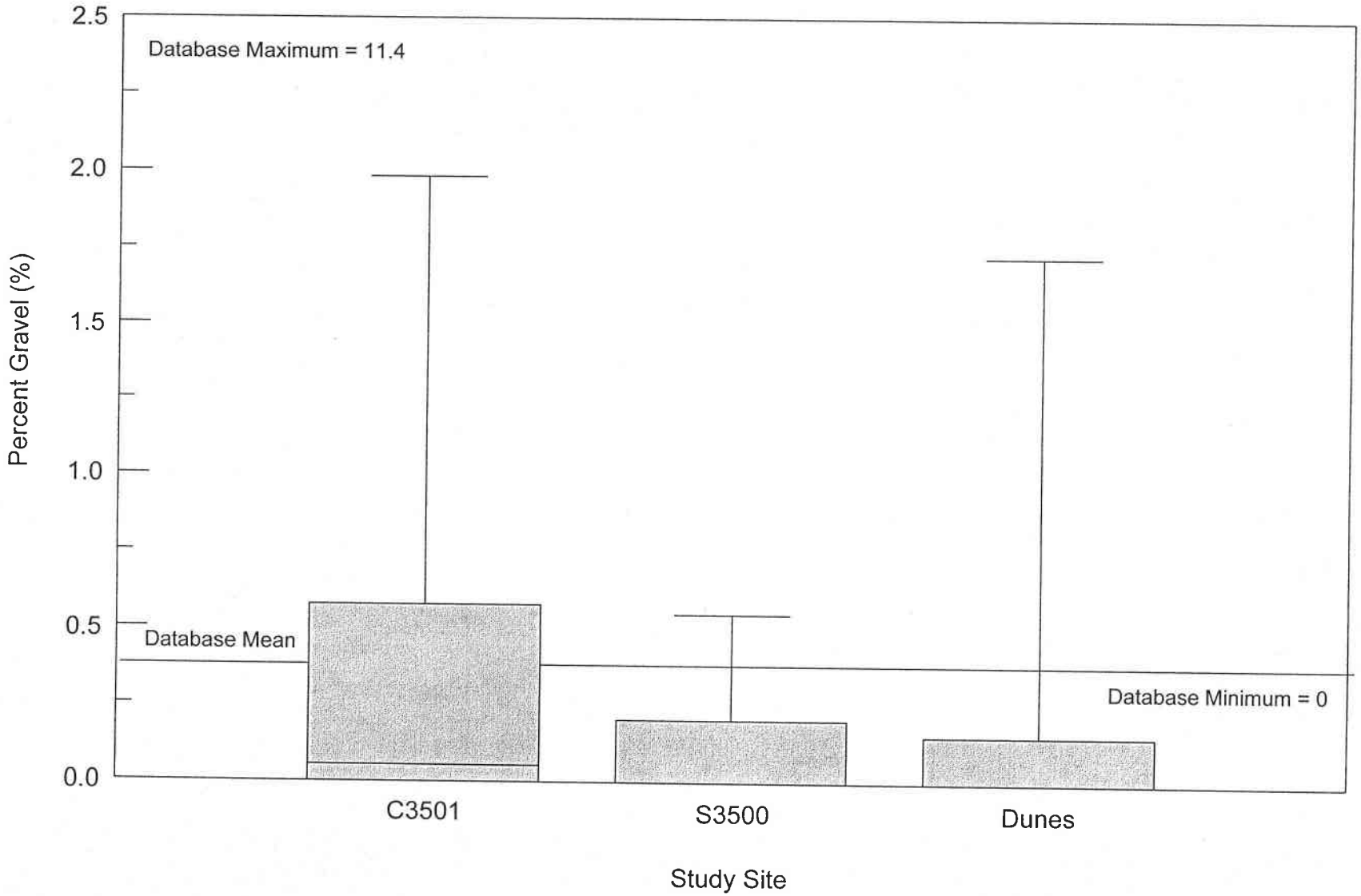
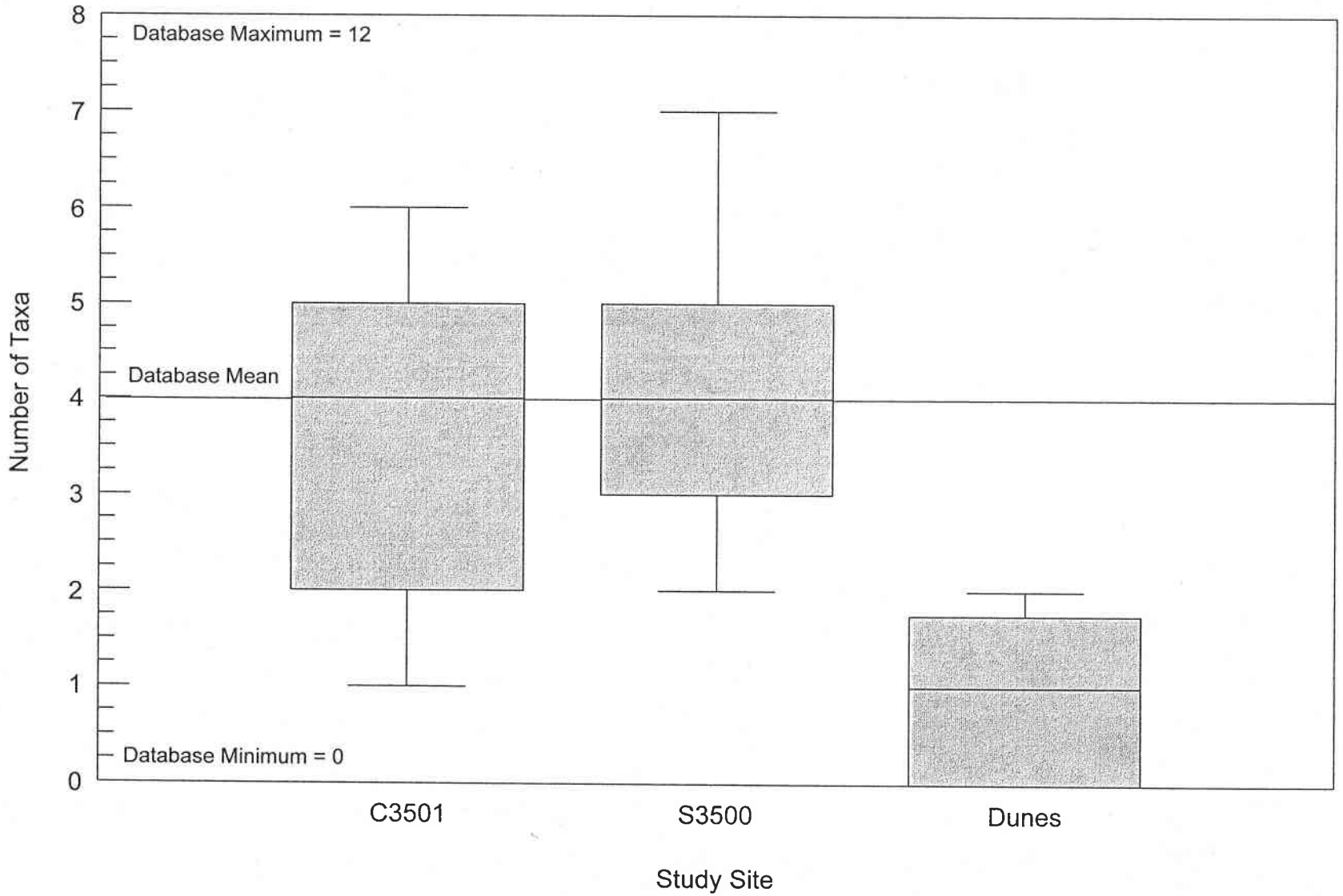


**FIGURE D-3. BENTHOS RICHNESS LAKE MICHIGAN DATABASE AND DUNES SITES**



## FIGURE D-4. BENTHOS DENSITY LAKE MICHIGAN DATABASE AND DUNES SITES

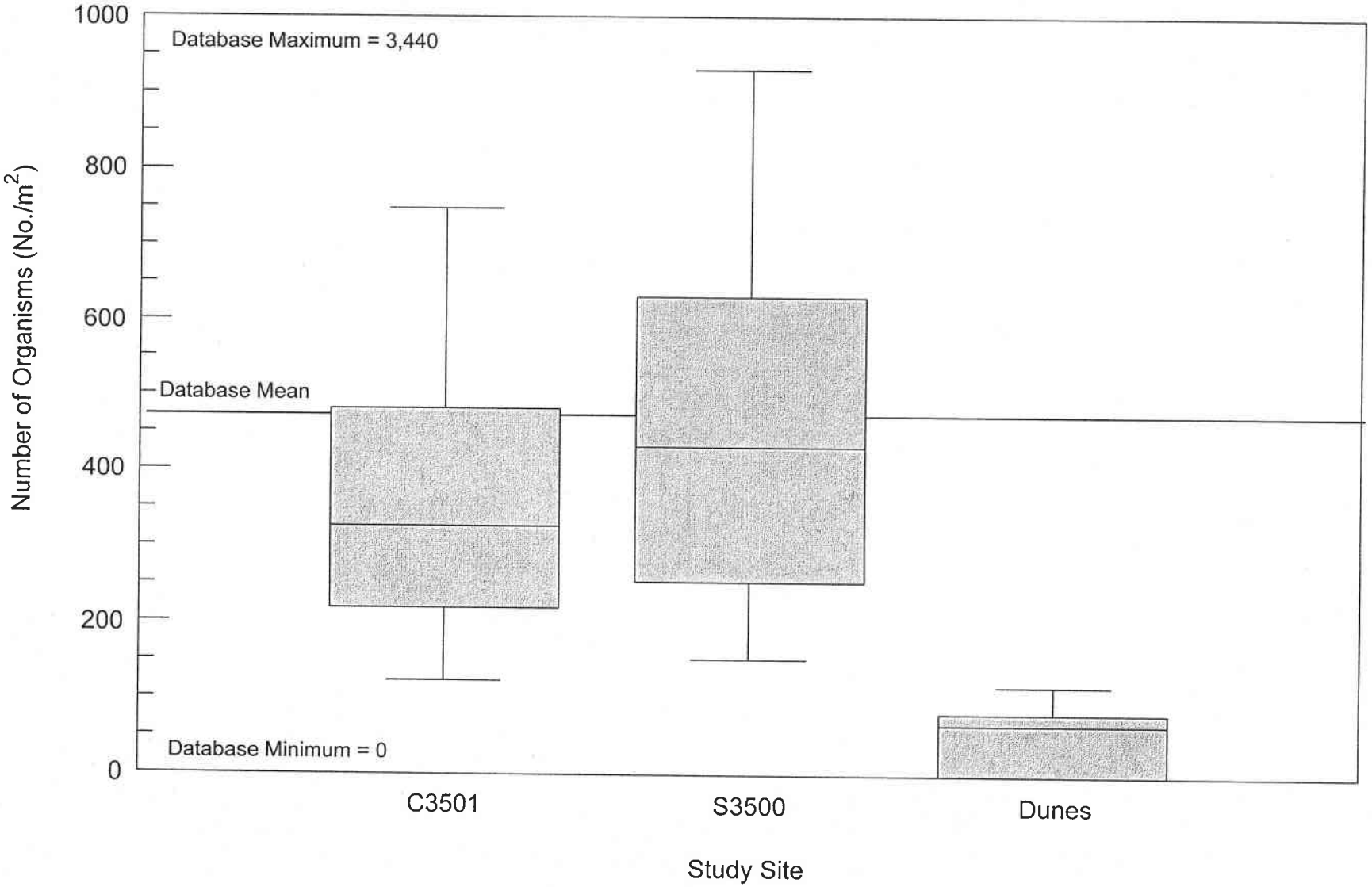
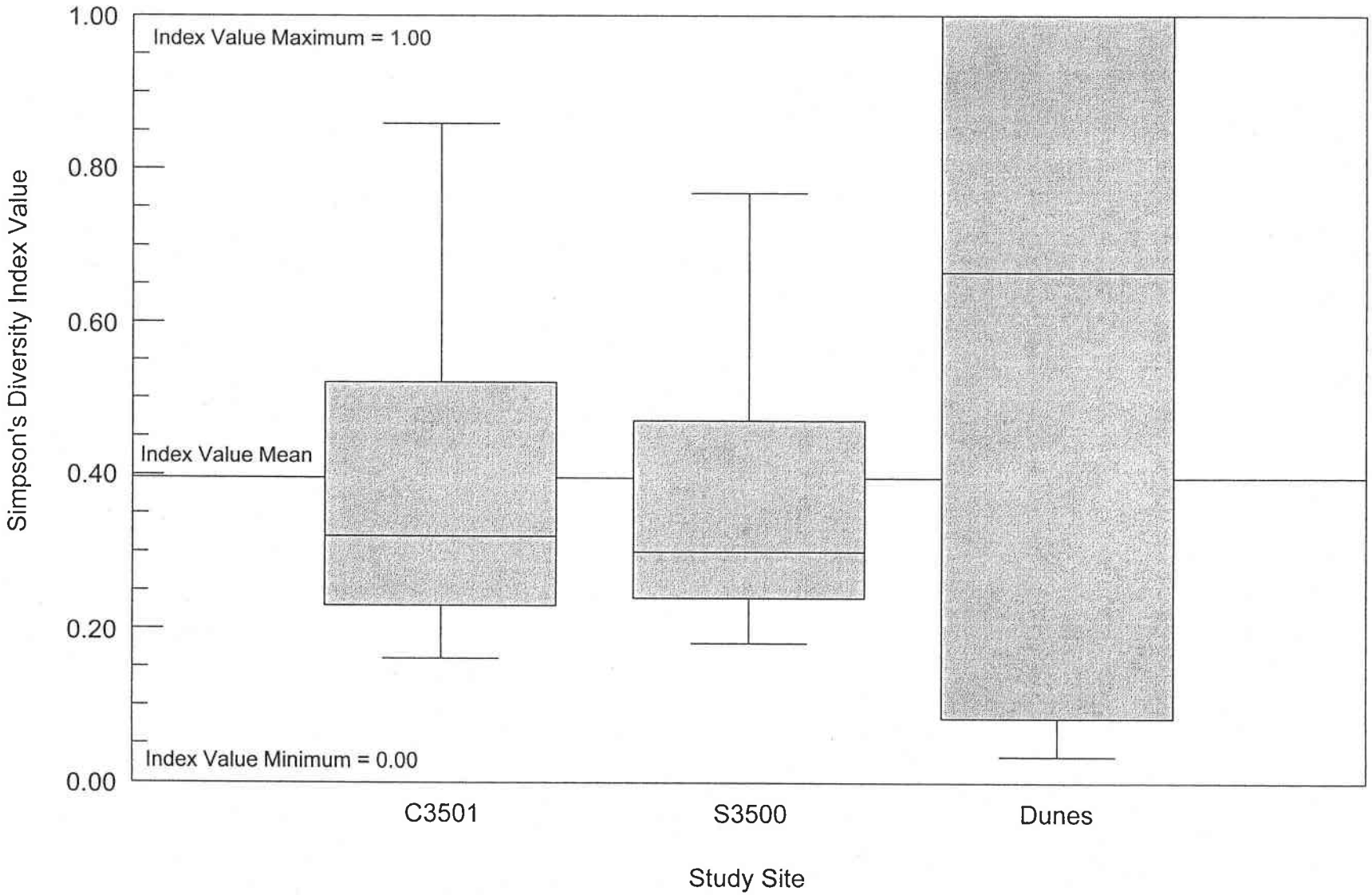



FIGURE D-5. BENTHOS DIVERSITY LAKE MICHIGAN DATABASE AND DUNES SITES