D R A F T - 10/2/2001 CHAPTER 12: MASS-BALANCE MODELING

12.1 INTRODUCTION

The development and structure of a mass-balance modeling framework for Onondaga Lake is described in the 1999 lake monitoring report (Ecologic, 2000). The associated software facilitates computation and analysis of mass balances for nutrients and other water-quality components using hydrologic and water quality data collected in the Lake and its tributaries since 1986 (Figure 12-1). Computed phosphorus and nitrogen mass-balances are linked to en empirical model network for predicting eutrophication-related water quality variables (Figure 12-2). These models provide a basis for predicting summer-average lake responses to reductions in external phosphorus and nitrogen loads resulting from future implementation of point-source and nonpoint-source control measures.

This chapter updates the mass-balance framework to include 1986-2000 data. Recent mass balances for key water quality components are summarized. Long-term trends in total loads (point, nonpoint), inflow concentrations, and outflow concentrations are documented. The eutrophication model network is recalibrated to 1996-2000 data. Data from 1986-1995 are used for model testing. To enable forecasting of lake outflow concentrations for use in Seneca River modeling, the model network is augmented to include predictions of organic nitrogen, inorganic nitrogen, organic carbon, and conservative water-quality components (e.g., chloride, sodium).

12.2 REFINEMENTS TO MASS-BALANCE FRAMEWORK

The mass-balance software (Figure 12-1) computes lake outflow loads using flows estimated from a water balance and three alternative sources of concentration data (Outlet

2-ft, Outlet 12-ft, and Lake South Epilimnion¹). Detailed comparisons of 1991-2000 data from these three sources have been performed in preparing datasets for use in the Seneca River modeling effort (Walker, 2001). Good correlations are apparent between the Lake South Epilimnion and Outlet 12-ft samples for all major water quality components. Figure 12-3 shows results for chloride, total phosphorus, and ammonia nitrogen. Samples collected between 0 and 3 meters are assumed to represent the upper mixed layer, which is typically used and to approximate the epilimnion average. Concentrations in the Outlet 2-ft samples are frequently below those in the 12-ft and Lake South samples, apparently because of backflows from the River. The Outlet 12-ft samples are collected year-round and are therefore more suitable than the Lake South samples for annual budget calculations. Based upon these results, mass-balances are reported below using the Outlet 12-ft samples to compute outflow loads. For comparison purposes, results using the other data sets are also reported in the summary output (e.g., Tables 12-2, 3, & 4).

The existing framework does not consider exchange between the Lake and River as a component of the lake mass balance. Depending upon whether river concentrations are greater than or less than lake concentrations, hydraulic exchange would represent an additional net input or output from the Lake, respectively. Based upon concentration differences shown in Figure 12-3 and assuming that Outlet 2-foot samples are influenced by the River, the exchange term would represent an additional net outflow from the Lake in the case of chloride and ammonia nitrogen, but have little influence on the lake phosphorus budget under 1991-2000 conditions. With future reductions in lake

¹ Although labeled "epilimnion" the Lake South values are the averages of 0 to 3 meter samples. These provide estimates of concentrations in the upper mixed layer, which are typically used in empirical eutrophication models (Walker, 1996). Computation of the true epilimnetic average would require consideration of variations in thermocline depth with sampling date. The 0-3 m averages approximate the epilimnetic averages to the extent that vertical variations in concentration above the thermocline are small.

phosphorus concentrations, however, exchange with the River may become a more important source of phosphorus.

Lack of long-term data on the magnitude of the exchange flow and year-round variations in River concentrations currently precludes consideration of the exchange term in the existing mass-balance software. Exchange would be sensitive to density differences, wind, lake elevations, and river elevations. The River hydraulic model currently under development (Chapter 11) may provide a basis for estimating exchange flows. Future analysis of the magnitude and potential significance of this term is recommended.

12.3 LOADING & CONCENTRATION TRENDS

The following figures show trends in each water quality component over the entire period of record (1986-2000):

- Figure 12-6 Total Inflow & Outflow Concentrations
- Figure 12-7 Total Inflow & Outflow Loads
- Figure 12-8 Total NonPoint & Total Metro Loads

Ten-year (1991-2000) trends in concentration and load for each mass-balance term and water quality component are summarized in Table 12-1. Trends are tested using a linear regression of flow-weighted-mean concentration or load against year. Trend slopes that are significantly different from zero (p < .10) are listed.

For total inflows, decreasing trends in concentration and/or load are indicated for alkalinity, calcium, ammonia, nitrite, soluble reactive phosphorus, total Kjeldahl nitrogen, total organic carbon, total inorganic carbon, and total phosphorus, while an increasing trend is indicated for nitrate nitrogen. Corresponding results for the Metro and Total Municipal (Metro+Bypass) terms suggest that Metro improvements are primarily responsible for the long-term trends in total inflows to the Lake. For the lake outflow, significant decreasing trends in concentration and/or load are indicated for alkalinity, calcium, 5-Day BOD, ammonia nitrogen, total organic carbon, total inorganic carbon, total nitrogen, and total phosphorus.

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Flows for Crucible Steel (Trib 5A) increased by about a factor of five in 2000, relative to values reported in previous five years (mean = 3.7 cfs vs. 0.7 cfs). The increase was apparently associated with a change in flow measurement methodology. Flows prior to 2000 were based upon reports provided by the industry. Flows in 2000 were metered directly by the County. It is unclear whether this discrepancy reflects an actual change in flows, errors in the historical values, or errors in the metered flows. This issue should be resolved because it influences the accuracy of the mass balances, model calibrations, and lake outflows used in the Seneca River modeling effort.

12.4 CHLORIDE BALANCES

The 1996-2000 average mass balance for chloride is listed in Table 12-2. Calculations have been performed using procedures described in the 1998 and 1999 annual reports. The average outflow chloride load in Water Years 1996-2000 exceeded the inflow load by 16 ± 3 %. In contrast, inflow and outflow loads for 1995-1999 (as presented in the 1999 Monitoring Report) differed by 1%. The divergence occurs when the 12-foot Outlet (or Lake Epilimnion) samples are used to compute outflow loads, instead of the Outlet 2-foot samples, as assumed in the 1999 Report. For reasons discussed above, the 12-foot Outlet samples are now considered to be more representative of flows leaving the lake. Figure 12-4 compares yearly inflow and outflow (12-ft) loads for chloride, sodium, and calcium for the 1986-2000 period. When evaluated on a yearly basis (Figure 12-4), outflow loads exceed inflow loads by ~10-20% in most years for chloride and sodium, but not for calcium. Results suggest the existence of an additional source of chloride and sodium that is not considered in the existing mass-balance framework.

Given the consistent year-to-year pattern and the precision of the load estimates, it is unlikely that the deviations reflect random variations in sampling and load computations for individual monitored streams. It is possible that loads from the ungauged portion of

the watershed (~5% of the total drainage area) are under-estimated. Ungauged loads are estimated by multiplying the gauged nonpoint loads by the ratio of the ungauged to the gauged drainage areas. This procedure assumes that unit area loading rates (reflecting land use, etc.) are uniform across the watershed. Given the greater intensity of development around the shore of the Lake, as compared with the watershed as a whole, it is possible that this procedure under-estimates ungauged loads for some water quality components.

Variations in the drainage area estimates for each tributary is another factor contributing to uncertainty in ungauged loadings. Drainage areas reported by the USGS at stream gauging stations are not entirely consistent with results derived from recent GIS databases (see Table 1.2). For example, the USGS reports a drainage area of 115 km² at the Ninemile Creek flow gauge at Lakeland, as compared with 110 km² reported in Table 1.2 for the entire watershed. Given the potential importance of nonpoint loads in evaluating existing and future scenarios for the Lake, refinements to the procedure for estimating ungauged loads are recommended. Placing the existing monitoring network (flow & water quality stations) on a GIS layer would enable delineation of drainage areas (and corresponding land uses) above and below each monitoring point. This would permit more accurate estimation of ungauged flows & loads.

It is possible that chloride loads resulting from application of deicing salts to roads and parking lots in the urbanized areas around the lake shoreline may not be reflected in the existing estimates. Chloride spikes occasionally observed in the Metro effluent, Ley Creek, & Harbor Brook during winter and early spring months may reflect road salt contributions. Significant spikes may escape detection under the biweekly sampling program. Regardless of sampling frequency, the unit loads of road salts from areas below the monitoring gauge on each watershed may be higher because of the greater density of roads and parking lots. The potential importance of deicing salts could be further evaluated by compiling local data on application rates and road/parking lot surfaces in each subwatershed.

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Ungauged groundwater inputs could also contribute to the divergence in the sodium and chloride budgets. This explanation is consistent with the existence of a saline groundwater wedge flowing north in the Onondaga Creek watershed, as documented by the USGS (ref, ???). In Water Years 1996-2000, the unit area chloride load for the Onondaga Creek watershed between the Dorwin Avenue and Kirkpatrick/Spencer monitoring stations was 702 mtons/km²/yr, as compared with 59 mtons/km²-yr above Dorwin Ave and (Table 12-2). Corresponding values for sodium are 459 mtons/km²-yr and 35 mtons/km²-yr, respectively. The ratio of sodium to chloride inputs in this river reach (0.65) is similar to the Na/Cl ratio of sodium chloride (0.66). Future analysis of USGS results may provide a basis for estimating groundwater inflows and associated sodium chloride loads potentially resulting from this mechanism. Consideration of groundwater inputs in the mass-balance framework would require monitoring of groundwater quality.

12.5 EUTROPHICATION MODEL

This section describes refinements and updates to the empirical eutrophication models described in the 1999 Lake Monitoring Report (Ecologic, 2000). To support the Seneca River modeling effort, the model network is expanded to include predictions of organic carbon, organic nitrogen, and inorganic nitrogen (Figure 12-2). Data from the last 5 years (1996-2000) are used for model calibration. Hindcasts of 1986-1995 data are used for model testing. Average phosphorus and nitrogen balances during the model calibration period are listed in Tables 12-3 and 12-4, respectively. Relevant input and observed data listed in Table 12-5. Updated model coefficients and equations are listed in Table 12-6. Model derivations and assumptions are described in the 1999 Lake Monitoring Report (Ecologic, 2000).

The model network is driven by hydrologic and nutrient loading time series formulated on a water-year basis (Figure 12-5). Total precipitation in WY 2000 (33.1 inches) was slightly below the 15-year average (37.7 inches). Total phosphorus loads generally declined over the 1986-2000 period, with the exception of 1993, when Metro bypass

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flows were relatively high. Total nitrogen loads declined steadily over the 1996-2000 period. As discussed above, Metro improvements were primarily responsible for reductions in phosphorus & nitrogen loads.

Empirical eutrophication models generally assume that algal growth is limited by phosphorus. Figure 12-9 shows total and soluble reactive phosphorus (SRP) concentrations in the epilimnion (July-September means, 0-6 m, Lake South) between 1986 and 2000. Relatively high SRP concentrations prior to ~1996 indicate that phosphorus was not limiting algal growth. It is likely that factors such as light and zooplankton grazing were controlling. The Lake approached a phosphorus-limited condition in recent years as the concentration of total phosphorus reached 50-60 ppb and SRP levels dropped below 5 ppb (< 2 ppb in 1999-2000). Given the increasingly P-limited conditions, it is likely that trophic state indicators (chlorophyll-a, transparency) will respond to future P reductions more dramatically than they have to historical P reductions.

By using data from 1996-2000 for calibration, the model network is tuned to a phosphorus-limited condition. When applied to data from years prior to ~1996, concentrations of chlorophyll-a, organic nitrogen, organic carbon, and oxygen depletion rate tend to be over-predicted (and transparency, under-predicted) because factors other than phosphorus were limiting algal growth. This does not restrict use the models to evaluate management strategies, however, because the Lake is expected to become increasing phosphorus limited with further reductions in phosphorus loads associated with future scenarios. Given the empirical nature of the models, periodic recalibration will be appropriate as the degree of phosphorus limitation increases with continued improvements in lake water quality.

Model equations and parameter estimates are updated in Table 12-6. Observed & predicted values of variables previously included in the model network shown in the following figures:

- 12-10 Observed & Predicted Time Series All Variables
- 12-11 Observed & Predicted Annual Outflow Total P Concentrations
- 12-12 Observed & Predicted Summer Total P Concentrations
- 12-13 Observed & Predicted Annual Outflow Total N Concentrations
- 12-14 Observed & Predicted Summer Total N Concentrations
- 12-15 Observed & Predicted Mean Chlorophyll-a
- 12-16 Algal Bloom Frequencies vs. Observed Mean Chlorophyll-a
- 12-17 Algal Bloom Frequencies vs. Predicted Total Phosphorus
- 12-18 Algal Bloom Frequencies vs. Year
- 12-19 Calibration of Secchi Depth Model
- 12-20 Observed & Predicted Secchi Depths
- 12-21 Secchi Interval Frequencies vs. Mean Secchi
- 12-22 Observed & Predicted Frequency of Secchi < 1.2 meters
- 12-23 Observed & Predicted Frequency of Secchi < 2 meters
- 12-24 Observed & Predicted Hypolimnetic Oxygen Depletion Rate

Generally, recalibration to 1996-2000 data has relatively small effects on the model coefficients, relative to the previous 1995-1999 calibrations (Ecologic, 2000). Reductions in the phosphorus settling rate from 22.9 to 19.9 m/yr (Figure 12-11) and in the total nitrogen settling rate from 24.0 to 14.2 m/yr (Figure 12-13) primarily reflect switching from 2-foot to 12-foot samples as measures of lake outflow concentration. With this change, the standard error of summer epilimnetic total nitrogen concentration decreases from 0.10 to 0.05 (Figure 12-14), while the standard error of total phosphorus concentration is unchanged (0.08, Figure 12-12).

Concentrations of organic nitrogen and organic carbon in the epilimnion reflect direct inputs from the watershed and primary productivity within the lake. The latter converts inorganic nutrients to organic nutrients associated with live & dead algal cells, zooplankton, detritus, dissolved organics, etc. Predictions based upon phosphorus concentrations or loads assume direct inputs from the watershed are relatively constant or small relative to inputs from lake primary productivity (Walker, 1983; 1985; 1996). The

importance of external inputs would depend upon the their removal rates (sedimentation, decomposition) relative the flushing rate of the epilimnion during the summer (~0.01 day ⁻¹). It is likely that the lake outflow contains both watershed-derived forms (e.g., dissolved or colloidal species relatively resistant to decomposition), as well as dissolved and particulate species generated as a result of primary production within the Lake. The relative importance of the latter can be assessed based upon correlations with chlorophyll-a and/or total phosphorus. Consistent with other trophic response variables, correlations with total phosphorus would apply after 1995, when the lake approached a phosphorus-limited condition.

Figure 12-25 plots organic carbon and organic nitrogen concentrations against chlorophyll-a concentrations predicted by the model network (Figure 12-2). Linear regressions explain 92% and 54% of the variance in the 1996-2000 data, with residual standard errors of 4% and 22%, respectively. The data are compared with regression models previously calibrated to various nationwide data sets (Walker, 1983; 1985; 1996). Results are also compared with estimated organic nutrient fractions associated with algal cells using typical algal stoichiometry (Redfield ratios) reported by Chapra (2001). The 1996-2000 regression slopes are near the upper ends of ranges expected based upon algal stoichiometry. This is consistent with the fact that portions of the organic nutrient pools are associated with algal detritus, zooplankton, and decomposition products that reflect algal productivity but are not directly associated with algal cells.

Lake organic nitrogen concentrations in recent years are reasonably consistent with predictions of an empirical model derived a nationwide reservoir dataset (Walker, 1985). TOC levels are significantly below predictions of a model derived from a different nationwide dataset (Walker, 1983). This suggests that levels of autochthonous (watershed-derived) organic carbon in Onondaga Lake are low relative to the latter dataset, which was derived primarily from reservoirs. It is possible that higher reservoir TOC levels reflect higher average flushing rates (lower hydraulic residence times) and/or regional factors.

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Observed and predicted organic carbon and nitrogen values are plotted against predicted total phosphorus and time in Figures 12-26 and 12-27, respectively. For consistency with the plot formats used for other response variables, Organic C and N regressions against chlorophyll-a have been re-expressed as functions of predicted total phosphorus concentrations. As observed for the other trophic response variables, the models tend to over-predict organic nutrient concentrations in years prior to 1996, when factors other than phosphorus limited algal growth.

Summer epilimnetic total inorganic nitrogen (TIN) concentrations (Figure 12-28) can be predicted by linking the total nitrogen model (Figures 12-13 & 14) and organic nitrogen (Figure 12-27) models. Results explain 38% of the variance in the TIN levels observed in 1996-2000, with a residual standard error of 22%. Observed ammonia nitrogen levels are also plotted against time in Figure 12-27. With increased nitrification at Metro, ammonia levels in the Lake South epilimnion decreased significantly over the 1996-2000 period. In July-September 2000, mean total inorganic nitrogen levels consisted of 84% nitrate, 7% nitrite, and 9% ammonia. With future reductions in Metro and/or nonpoint ammonia loads, further decreases in Lake nitrite & ammonia levels would be expected. Thus, inorganic nitrogen levels predicted by the model network under future scenarios will primarily reflect nitrate nitrogen.

12.6 MODEL IMPLEMENTATION

The model workbook has been updated to reflect the recalibration and enhancements (Table 12-7). Predictions are driven by lake outflow volume, inflow total phosphorus load, and inflow total nitrogen load, each referenced to a specified hydrologic period of record.

The predicted response of each trophic state indicator to variations in phosphorus load is shown in Figure 12-29. Results are for average 1996-2000 hydrologic conditions (outflow volume = $435 \text{ hm}^3/\text{yr}$). The 80% prediction interval (10^{th} , 50^{th} , 90^{th} percentiles)

is shown for each response variable. These intervals reflect the combined influences of sampling variations (uncertainty in loads and measured responses) and model error.

The following table updates (vs. Ecologic, 2000) projected lake phosphorus concentrations for various management scenarios involving combinations of Metro effluent P levels & nonpoint source load reductions:

		Total P Con	centrations	<u>s (ppb)</u>	
	Assumed Inf	flow Concs.	Predi	icted Lake (Conc.
<u>Scenario</u>	Metro	<u>NonPoint</u>	Mean	<u>10 %</u>	<u>90 %</u>
Existing (1996-2000)	429	78	52	46	60
April 2006	120	78	30	26	34
April 2006 + 20% NPS	120	62	26	22	29
Dec 2012	20	78	22	20	26
Dec 2012 + 20% NPS	20	62	18	16	21
Metro Diversion	0	78	25	21	28
Diversion + 20% NPS	0	62	20	17	23

Lake P levels approach the 20 ppb criterion for management scenarios involving control of Metro load (either by diversion or by achieving the 2012 effluent P level of 20 ppb) and ~20% reduction in nonpoint load. These projections differ only slightly from those derived from the previous calibration of the model (Ecologic, 2000).

12.7 CONCLUSIONS & RECOMMENDATIONS

Conclusions based upon the above analysis are summarized below:

- Primarily as a consequence of Metro improvements, loadings and in-lake concentrations of total phosphorus and total nitrogen in 2000 were the lowest observed in the 1986-2000 period of record.
- 2. Over the last 10 years (1991-2000), decreasing trends in the total lake inflow concentration and/or load are indicated for alkalinity, calcium, ammonia, nitrite,

soluble reactive phosphorus, total Kjeldahl nitrogen, total organic carbon, total inorganic carbon, and total phosphorus, while an increasing trend is indicated for nitrate nitrogen. Significant decreasing trends in lake outflow concentration and/or load are indicated for alkalinity, calcium, 5-Day BOD, ammonia nitrogen, total organic carbon, total inorganic carbon, total nitrogen, and total phosphorus.

- 3. As a consequence of cumulative reductions in phosphorus load, phosphorus limitation has become increasingly important as a factor controlling algal growth in the Lake. Summer epilimnetic soluble reactive phosphorus concentrations averaged <5 ppb in 1996-1998 and <2 ppb in 1999-2000. Chlorophyll-a, transparency, organic nitrogen, and hypolimnetic oxygen depletion rates approached levels that are consistent with predictions of empirical models calibrated to data from other phosphorus-limited lakes. Calibration of the model network to recent years with increased phosphorus limitation improves accuracy and precision for predicting responses to further reductions in phosphorus load.</p>
- 4. Based upon analysis of outlet and epilimnetic time series, samples collected at 12 feet are considered to be more representative of flows leaving the lake, as compared with samples collected at 2 feet previously used to calibrate the annual phosphorus and nitrogen balance models. Calibration to 12-foot samples reduces the standard errors of predicted annual outflow and summer epilimnetic total nitrogen concentrations, but has little influence on the standard errors of predicted phosphorus concentrations.
- 5. When 12-foot outlet samples are used in formulating the lake chloride budget, outflow loads exceeded inflow loads by $16 \pm 3\%$ over the 1996-2000 period. This may reflect inputs from ungauged portions of the watershed, including road salt application to roads and parking lots in urban areas around the lakeshore that are below the tributary monitoring sites or drain directly into the Lake. Ungauged inputs of saline groundwater from the Onondaga Creek watershed documented by

the USGS are also likely to contribute to apparent errors in the chloride and sodium budgets.

- 6. The empirical eutrophication model has been expanded to predict organic carbon, and organic nitrogen as a function of chlorophyll-a, in turn predicted from phosphorus loading. In 1996-2000, levels of allochthonous organic carbon in the Lake epilimnion appear to be lower to average values estimated from other lake and reservoir data sets, while levels of allochthonous organic nitrogen appear to be similar.
- Coupling of the total nitrogen and organic nitrogen models enables prediction of inorganic nitrogen concentrations. Nitrate nitrogen accounted for 84% of the summer epilimnetic inorganic nitrogen concentrations. This percentage is expected to increase with further reductions in Metro ammonia load.

Recommendations for future enhancement of the mass-balance framework and empirical eutrophication model include:

- Resolution of errors in the chloride budget and implications for the lake water budget. This would include quantitative evaluation of road salt inputs and potential groundwater inputs from the Onondaga Creek watershed.
- Resolution of the ~5-fold increase in flows reported for the Crucible Steel discharge in 2000, relative to values reported in 1986-1999. Revision of current and/or historical water and mass balances to reflect any errors identified in these flows.
- Refinements to the estimates of drainage area and land uses above and below the monitoring points on each tributary. This will improve the accuracy and precision of estimated loadings from ungauged portions of the watershed.

- 4. Daily nutrient budgets could be formulate using the same datasets compiled to support annual and seasonal mass balances. This would provide an improved basis for predicting the effects of within-year flow and load variations and time series to support mechanistic modeling of the Lake and Seneca River.
- 5. Other recommendations detailed in the 1999 Lake Monitoring report also stand. These include (a) improvements to the error analysis; (b) software for forecasting lake responses to a given loading scenario under a range of hydrologic conditions; (c) coupling with a simple watershed loading model; (d) prediction of near-shore transparencies; (e) integration of data from other regional lakes for comparison purposes; and (f) evaluation of the effects of nutrient load speciation (organic vs. inorganic) on model performance and trophic response; and (g) consideration of hydraulic exchanges with the Seneca River as an additional input and/or output term in the lake mass balance.
- 6. Addition of volume-days of anoxia as an additional response variable that appears to be correlated with lake phosphorus levels (Figure 6-6).
- 7. Blank samples for total phosphorus averaged 0.008 mg/liter (8 ppb) in the year 2000 lake monitoring program (Chapter 3). This relatively high value could have significant effects on the calibration of the phosphorus mass balance model and on forecasts of future lake conditions relative to the 20 ppb guidance value. Continued refinement of sampling techniques is recommended to identify and eliminate sources of sample contamination.

12.8 REFERENCES

Chapra, S.C., "Comment on an Empirical Method of Estimating the Retention of Phosphorus in Lakes, by W. B. Kirchner & P.J. Dillon", <u>Water Resources Bulletin</u>, Vol. 11, No. 6, pp. 1033-1034, 1975.

Chapra, S.C., "Seneca River Steady-State Model Kinetics", prepared for Quantitative Environmental Analysis, LLC, May 2001.

Ecologic, LLC et al., "Onondaga Lake Monitoring Program, 1999 Annual Report", prepared for Onondaga County, New York, November 2000.

Jones, J.R. & R.W. Bachman, "Prediction of Phosphorus and Chlorophyll Levels in Lakes", Journal of the Water Pollution Control Federation, Vol. 48, No. 9, pp. 2176-2182, 1976.

Vollenweider, R.A., "Possibilities and Limits of Elementary Models Concerning the Budget of Substances in Lakes", <u>Arch. Hydrobiol.</u>, Vol. 66, No. 1, pp. 1-36, April 1969.

Walker, W.W., "Use of Hypolimnetic Oxygen Depletion Rate as a Trophic State Index for Lakes", <u>Water Resources Research</u>, Vol. 15, No. 6, pp. 1463-1470, December 1979.

Walker, W.W., "Significance of Eutrophication in Water Supply Reservoirs", <u>Journal of</u> <u>the American Water Works Association</u>, Vol. 75, No. 1, pp. 38-42, January 1983.

Walker, W.W., "Statistical Bases for Mean Chlorophyll-a Criteria", in "Lake and Reservoir Management - Practical Applications", Proc. 4th Annual Conference, North American Lake Management Society, McAfee, New Jersey, pp. 57-62, October 1984.

Walker, W.W., "Empirical Methods for Predicting Eutrophication in Impoundments -Report 3: Model Refinements", prepared for Office, Chief of Engineers, U.S. Army, Washington, D.C., Technical Report E-81-9, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi, Draft 1983, published March 1985.

Walker, W.W., "Simplified Procedures for Eutrophication Assessment and Prediction",U.S. Army Corps of Engineers, Waterways Experiment Station, Instruction Report W-96-2, September 1996. Walker, W.W., "Onondaga Lake Outlet Time Series, 1991-2000", prepared for Quantitative Environmental Analysis, LLC., August 2001.

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Table 12-7 Model Inputs & Outputs

Model Parameters	<u>Units</u>	Input Value		
Lake Area	km ²	11.7		
P Settling Rate	m/yr	18.92		
Epil P / Outflow P	-	0.513		
Outflow P Error CV	-	0.146		
Lake P Error CV	-	0.088		
Chla/P Slope	-	1.460		
Chla/P Intercept	-	0.078		
Chl-a Error CV	-	0.217		
Chla Temporal CV	-	0.61		
Non-Algal Turbidity	1/m	0.285		
Secchi/Chla Slope	m²/mg	0.018		
Secchi Error CV	-	0.168		
Secchi Temporal CV	-	0.320		
HOD Intercept	-	42.4		
HOD Slope		0.94		
HOD Error CV		0.230		
Spring DO Conc	ppm	12.0		
Hypol. Depth	m	8.340		
Stratified Period	days	183.0		
Total N Setting Rate	m/yr	14.2		
Outflow N CV	-	0.065		
Epil N / Outflow N	-	0.917		
Epil N CV	-	0.047		
Organic N Slope	-	30.4		
Organic N Intercept	dad	113.9		
Organic N CV	-	0.217		
TOC Slope	-	0.102		
TOC Intercept	ppm	2.356		
TOC CV	-	0.041		
Inorgn CV	-	0.12		
C				
<u>Scenario</u>				
<u>Scenario</u> Outflow Volume	hm ³ /yr	435 1	996-2000 Avera	age
<u>Scenario</u> Outflow Volume Inflow P Load	hm ³ /yr kg/yr	435 1 67143 1	996-2000 Avera	age
<u>Scenario</u> Outflow Volume Inflow P Load Inflow N Load	hm ³ /yr kg/yr kg/yr	435 1 67143 1 2112700 1	996-2000 Avera 996-2000 Avera 996-2000 Avera	age age
<u>Scenario</u> Outflow Volume Inflow P Load Inflow N Load	hm ³ /yr kg/yr kg/yr	435 1 67143 1 2112700 1	996-2000 Avera 996-2000 Avera 996-2000 Avera	age age
<u>Scenario</u> Outflow Volume Inflow P Load Inflow N Load <u>Predicted Reponses</u>	hm ³ /yr kg/yr kg/yr <u>Units</u>	435 1 67143 1 2112700 1 <u>Mean</u>	996-2000 Avera 996-2000 Avera 996-2000 Avera Low (10%)	age age age <u>High (90%)</u>
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb	435 1 67143 1 2112700 1 <u>Mean</u> 102	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82	age age age <u>High (90%)</u> 128
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb	435 1 67143 1 2112700 1 <u>Mean</u> 102 52	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46	age age <u>High (90%)</u> 128 60
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb	435 1 67143 1 2112700 1 <u>Mean</u> 102 52	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46	age age <u>High (90%)</u> 128 60
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18	age age <u>High (90%)</u> 128 60 35
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb ppb	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18	age age <u>High (90%)</u> 128 60 35
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb ppb	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78	age age <u>High (90%)</u> 128 60 35 0.98
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb ppb 5 10 20	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33	age age <u>High (90%)</u> 128 60 35 0.98 0.77
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb ppb 5 10 20 30	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12	age age <u>High (90%)</u> 128 60 35 0.98 0.77 0.51
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb ppb 5 10 20 30 30 40	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05	age age <u>High (90%)</u> 128 60 35 0.98 0.77 0.51 0.31
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb ppb ppb 20 20 30 40	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05	age age <u>High (90%)</u> 128 60 35 0.98 0.77 0.51 0.31
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 10 20 30 40 m	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 10 20 30 40 m cies	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies > > > > > Mean Secchi Depth Secchi Interval Frequencies	hm ³ /yr kg/yr kg/yr ppb ppb ppb 20 20 30 40 40 m cies 5 5 1.2	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies > Mean Secchi Depth Secchi Interval Frequencies <	hm ³ /yr kg/yr kg/yr <u>Units</u> ppb ppb ppb 20 30 40 40 m cies 1.2 22	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies > Mean Secchi Depth Secchi Interval Frequence	hm ³ /yr kg/yr kg/yr ppb ppb ppb 20 20 30 40 m cies 1.2 2 2	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies > Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate	hm ³ /yr kg/yr kg/yr ppb ppb ppb 20 20 30 40 40 m cies 1.2 2 2 mg/m ² -day	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies > Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate Days of O2 Supply	hm ³ /yr kg/yr kg/yr ppb ppb ppb 20 20 30 40 m cies 1.2 2 2 mg/m ² -day days	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57	996-2000 Avera 996-2000 Avera 996-2000 Avera 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies > Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate Days of O2 Supply Anoxic Period	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 20 20 30 40 m cies 1.2 2 2 mg/m ² -day days days	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57 126	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81 102	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40 143
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies >> Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate Days of O2 Supply Anoxic Period	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 20 20 30 40 m cies 1.2 2 2 mg/m ² -day days days	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57 126	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81 102	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40 143
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies Algal Bloom Frequencies > > Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate Days of O2 Supply Anoxic Period Outflow N	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 20 20 30 40 m cies 1.2 2 1.2 2 mg/m ² -day days days days	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57 126 3512	996-2000 Avera 996-2000 Avera 996-2000 Avera <u>Low (10%)</u> 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81 102 3179	age age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40 143 3881
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies Algal Bloom Frequencies > > Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate Days of O2 Supply Anoxic Period Outflow N Lake N	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 20 20 30 40 m cies 1.2 2 1.2 2 mg/m ² -day days days days	435 1 67143 1 2112700 1 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57 126 3512 3219	996-2000 Avera 996-2000 Avera 996-2000 Avera 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81 102 3179 2995	Age Age Age Age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40 143 3881 3460
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies >> Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate Days of O2 Supply Anoxic Period Outflow N Lake N	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 10 20 30 40 m ties 1.2 2 mg/m ² -day days days days	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57 126 3512 3219	996-2000 Avera 996-2000 Avera 996-2000 Avera 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81 102 3179 2995	Age Age Age Age High (90%) 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40 143 3881 3460
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies Algal Bloom Frequencies > > Mean Secchi Depth Secchi Interval Frequence < Oxygen Depletion Rate Days of O2 Supply Anoxic Period Outflow N Lake N Organic N	hm ³ /yr kg/yr kg/yr Units ppb ppb ppb 20 20 30 40 m ties 1.2 2 1.2 2 mg/m ² -day days days days ppb ppb	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57 126 3512 3219 8888	996-2000 Avera 996-2000 Avera 996-2000 Avera 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81 102 3179 2995 636	age age Age Age 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40 143 3881 3460 1239
Scenario Outflow Volume Inflow P Load Inflow N Load Predicted Reponses Outflow P Conc Lake P Conc Mean Chlorophyll-a Algal Bloom Frequencies Algal Bloom Frequencies Mean Secchi Depth Secchi Interval Frequence Coxygen Depletion Rate Days of O2 Supply Anoxic Period Outflow N Lake N Organic N Inorganic N	hm ³ /yr kg/yr kg/yr Dhits ppb ppb ppb 20 20 30 40 m 20 30 40 m 20 30 40 m 20 20 30 40 m 20 20 30 40 m 20 20 30 40 m 20 20 30 40 m 20 5 20 5 20 5 20 5 20 5 20 5 20 5 2	435 1 67143 1 2112700 1 <u>Mean</u> 102 52 25 0.92 0.56 0.28 0.14 1.48 0.30 0.87 1754 57 126 3512 3219 888 82331	996-2000 Avera 996-2000 Avera 996-2000 Avera 82 46 18 0.78 0.33 0.12 0.05 1.80 0.13 0.69 1232 81 102 3179 2995 636 1938	age age age <u>High (90%)</u> 128 60 35 0.98 0.77 0.51 0.31 1.19 0.57 0.96 2497 40 143 3881 3460 1239 2804

Figure 12-1



Figure 12-2 Eutrophication Model Network for Onondaga Lake



Figure 12-3 Lake Outflow Time Series





Figure 12-4 Outflow Loads vs. Inflow Loads Water Years 1986-2000

Solid Lines: Y = X

Dashed Lines: Linear Regressions

Symbols = Observed Values +/- 1 Standard Error



Figure 12-5 Lake Inflow Time Series



Total Alkalinity 5-Day Biochemical Oxygen Demand Calcium Concentration (ppm) 7 6 5 4 Concentration (ppm) Concentration (ppm) 2 Chloride Sodium Ammonia Nitrogen Concentration (ppm) Concentration (ppm) Concentration (ppb) Nitrite Nitrogen Nitrate Nitrogen Soluble Reactive Phosphorus Concentration (ppb) Concentration (ppb) Concentration (ppb) Total Inorganic Carbon Total Kjeldahl Nitrogen Total Nitrogen Concentration (ppb) Concentration (ppb) Concentration (ppb) Total Organic Carbon Total Phosphorus Total Suspended Solids Concentration (ppb) Concentration (ppm) Concentration (ppb)

Dotted Lines = Linear Trends

Figure 12-6 Long-Term Trends in Total Inflow & Outflow Concentrations

Squares = Inflow, Circles = Outflow Error Bars = +/- 1 Standard Error

X-Axis = Calendar Year



Figure 12-7 Long-Term Trends in Total Inflow & Outflow Loads



Figure 12-8 Long-Term Trends in NonPoint & Metro Loads

Squares = NonPoint, Circles = Metro+Bypass

Error Bars = +/- 1 Standard Error

Dotted Lines = Linear Trends

X-Axis = Calendar Year







Figure 12-10 Observed & Predicted Time Series - All Variables

Square Symbols = Calibration Period; Observed Means +/- 1 Std Error

Lines = 80% Prediction Intervals



Figure 12-11



Figure 12-12

Figure 12-13 Observed & Predicted Annual Outflow N Concentrations









Figure 12-16 Algal Bloom Frequencies vs. Observed Mean Chlorophyll-a



1**00%** 100% Chla > 10 ppb Chla > 20 ppb 90% 90% 80% 80% 70% 70% Bloom Freq Bloom Freq 60% 60% 50% 50% 40% 40% 30% 30% 20% 20% 10% 10% 0% 0% -20 40 60 80 100 0 0 20 40 60 80 100 Predicted Total P (ppb) **Predicted Total P (ppb)** 100% 100% Chla > 30 ppb Chla > 40 ppb 90% 90% 80% 80% 70% 70% Bloom Freq Bloom Freq 60% 60% 50% 50% 40% **40%** 30% 30% 20% 20% 10% 10% 0% -0% 20 40 60 20 40 60 80 100 0 80 100 0 **Predicted Total P (ppb)** Predicted Total P (ppb)

Figure 12-17 Algal Bloom Frequencies vs. Predicted Total Phosphorus

Figure 12-18 Algal Bloom Frequencies vs. Year





Lake South Epilimnion Samples, 0-3 m, July-September, 1996-2000 **Regression:**

Y =	0.285	+	0.018	Х
$R^2 =$	0.52	SE =	0.25	

Figure 12-19



Figure 12-20





Figure 12-22





Figure 12-24 Observed & Predicted Hypolimnetic Oxygen Depletion Rates

Limited = observed value limited by incomplete spring turnover or partial depletion of oxygen; lower limit of actual value

Figure 12-25 Calibration of Organic Carbon & Organic Nitrogen Models









Figure 12-26 Observed & Predicted Total Organic Carbon Concentrations



Organic N (ppb) 1986-1995 φ 1996-2000 Predicted - 10% - - 90% Predicted Total P (ppb) Organic N (ppb) ∮ þ

Figure 12-27 Observed & Predicted Organic Nitrogen Concentrations

4500 4000 ∮ 3500 ₫ 1986-1995 Inorganic N (ppb) 0 3000 ₫ ₫ 1996-2000 2500 ∮ Predicted 2000 1500 1000 500 0 0 500 1000 1500 2000 2500 3000 3500 Predicted Inorganic N (ppb) 4500 4000 ₫ ₫ 3500 (dd) 3000 2500 2000 1500 ф ₫ ₫ Φ ₫ ł Ŧ 1000 Δ Ŧ $\overline{\mathbf{A}}$ 500 0 1990 1992 1984 1986 1988 1994 1996 1998 2000 2002 Year **o** 1986-1995 1996-2000 — Predicted △ Ammonia N

Figure 12-28 Observed & Predicted Inorganic Nitrogen Concentrations



Reductions in Phosphorus Load

435 hm³/yr 67143 kg/yr 2112700 kg/yr



List of Tables - Chapter 12

- 12-1 10-Year Trends in Load & Concentration
- 12-2 Chloride Balance for 1996-2000
- 12-3 Total Phosphorus Balance for 1996-2000
- 12-4 Total Nitrogen Balance for 1996-2000
- 12-5 Model Calibration Data
- 12-6 Model Equations
- 12-7 Model Inputs & Outputs

Table 12-1: 10-Year Trends in Load & Concentration

Load Trends (% /	yr)						Period:	1991	to	2000	I	Period: Y	ear			
<u>Term</u> Metro	<u>ALK</u>	<u>BOD5</u> -5%	<u>CA</u>	<u>CL</u>	<u>FCOLI</u>	<u>NA</u> 4%	<u>NH3N</u> -8%	<u>NO2N</u>	<u>NO3N</u> 18%	<u>ORTHOP_</u> -14%	<u>TIC</u>	<u>TKN</u> -7%	<u>TN</u> -4%	<u>TOC</u> -7%	<u>TP</u> -8%	<u>tss</u>
Bypass Allied Crucible	-30%	-29%	-27%	-27%	-46%	-24%	-40%	-35%	-29%	36%	-29%	-40%	-38%	-30%	-20%	
Harbor/Hiawatha														-13%		
Ley/Park												-7%	-6%			
Ninemile/Rt48			-5%	-5%		-6%								-12%		
Harbor/Velasko						19%			25%							
Onondaga/Dorwin						1070			2070							
Total Gauged			-3%				-8%		7%	-13%		-7%	-4%	-10%	-8%	
NonPoint Gauged			-4%											-10%		
Ungauged			-4%											-10%		
Total NonPoint			-4%		450/		260/	250/				250/	240/	-10%		
Total Municipal	-3%				-40%	3%	-30%	-33%	17%	-16%	-3%	-35%	-51%	-9%	-10%	
Total External	070		-3%			070	-8%		7%	-13%	070	-7%	-4%	-10%	-8%	
							- / -						.,.		- / -	
Total Inflow			-3%				-8%		6%	-13%		-7%	-4%	-10%	-8%	
Total Outflow		-4%					-8%					-6%		-9%		
Retention		=0/							34%	32%		-9%	-6%	-12%	-10%	
Outlet2		-5%					-7%					-7%		-9%		-9%
Outlet 12		-4%					-8%					-6% 7%		-9%		
South Epil		-4%	-3%				-8%					-7%	-4%	-370		
		(
Concentration Tre	enas (%	/yr)														
<u>Term</u>	<u>ALK</u>	BOD5	CA	<u>CL</u>	FCOLI	NA	NH3N	NO2N	NO3N	ORTHOP_	TIC	TKN	<u>TN</u>	TOC	<u>TP</u>	TSS
Metro	-2%	-5%				4%	-8%		18%	-14%	-2%	-7%	-4%	-7%	-8%	
Bypass	-2%	-5%							14%	-13%					-5%	
Allied	-3%	10/	00/		-31%	2%	-13%	-9%	50/	0.497	-3%	-13%	-10%	-4%	100/	
Crucible		-4%	3%	E0/		3%		-9%	-5%	24%			-5%	-7%	12%	
Lev/Park		5%		5%		4 70								-1170		
Ninemile/Rt48	-1%	5%				-3%										
Onond./Kirkpatrick	-2%	7%									-1%	2%			-4%	
Harbor/Velasko					-33%		-13%	-56%	7%	-26%						
Onondaga/Dorwin	-2%	5%						9%	3%		-2%		4%			-9%
Total Gauged	-1%		-2%						8%	-12%	-1%	-5%		-8%	-6%	
NonPoint Gauged	-1%													-9%		
Total NonPoint	-1%													-9%		
Total Industrial	-1%	-4%			-38%		-21%	-20%	-6%	7%	-2%	-19%	-15%	-9 % -6%		
Total Municipal	-2%	170			0070	4%	-8%	2070	18%	-16%	-2%	-7%	-4%	-9%	-9%	
Total External	-1%		-2%				2.0		8%	-12%	-1%	-5%		-8%	-6%	
T ()) (~~		C C C C C C C C C C											6	<u> </u>	
Lotal Inflow	-2%		-2%				<u> </u>		8%	-12%	-1%	-5%		-8%	-6%	
i otal Outriow	-2%		-1%				-6%		3%		-1%	-4%		-1%		
Outlet2	-2%	-4%	-2%				-5%		3%		-1%	-5%	-3%	-7%		-7%

Variable:	Chloride			Ave	erage for	Years:	1996	thru	2000	S	Season: `	Year
							Percen	t of Total In	flow	Drain.		Export
	Flow	Load	Std Error	Conc	RSE	Samp.	Flow	Load	Error	Area	Runoff	mtons/
<u>Term</u>	<u>10^6 m3</u>	mtons	mtons	ppm	<u>%</u>	per yr	<u>%</u>	<u>%</u>	<u>%</u>	<u>km2</u>	<u>cm</u>	<u>km2</u>
Metro Effluent	91.07	31605	2138	347	7%	26	21%	20%	34%			
Metro Bypass	1.90	883	194	464	22%	6	0%	1%	0%			
East Flume	0.36	167	7	459	4%	27	0%	0%	0%			
Crucible	1.15	454	18	394	4%	27	0%	0%	0%			
Harbor Brook	8.43	2071	98	246	5%	29	2%	1%	0%	29.3	28.8	70.7
Ley Creek	34.10	10272	564	301	5%	28	8%	6%	2%	77.5	44.0	132.5
Ninemile Creek	129.70	56559	1760	436	3%	27	29%	35%	23%	298.1	43.5	189.7
Onondaga Creek	146.17	52623	2157	360	4%	29	33%	33%	35%	285.1	51.3	184.6
Nonpoint Gauged	318.40	121525	2842	382	2%	112	72%	75%	60%	690.0	46.1	176.1
Nonpoint Ungauged	17.09	6522	893	382	14%	0	4%	4%	6%	37.0	46.1	176.1
NonPoint Total	335.49	128047	2979	382	2%	112	76%	79%	66%	727.0	46.1	176.1
Industrial	1.52	621	19	409	3%	54	0%	0%	0%			
Municipal	92.98	32488	2146	349	7%	32	21%	20%	34%			
Total External	429.99	161156	3672	375	2%	198	97%	100%	100%	727.0	59.1	221.7
Precipitation	12.49	12	1	1	9%	0	3%	0%	0%	11.7	106.8	1.1
Total Inflow	442.48	161168	3672	364	2%	198	100%	100%	100%	738.7	59.9	218.2
Evaporation	8.86						2%			11.7	75.7	
Outflow	433.62	187716	3007	433	2%		98%	116%	67%	738.7	58.7	254.1
Retention	0.00	-26548	4746		18%		0%	-16%				
Alternative Estimates of La	ke Output											
Outlet 12 Feet	433.62	187716	3007	433	2%	24	98%	116%	67%	738.7	58.7	254.1
Outlet 2 Feet	433.62	158049	3667	364	2%	25	98%	98%	100%	738.7	58.7	213.9
Lake Epil	433.62	183268	2191	423	1%	20	98%	114%	36%	738.7	58.7	248.1
Upstream/Downstream Co	ntrast- Harbor	Brook										
Upstream - Velasko	6.51	1418	55	218	4%	23	1%	1%	0%	25.9	25.1	54.7
Downstream - Hiawatha	8.43	2071	98	246	5%	29	2%	1%	0%	29.3	28.8	70.7
Local Inflow	1.92	654	112	341	17%		0%	0%	0%	3.4	56.9	194.0
Upstream/Downstream Co	ntrast - Onond	aga Creek										
Upstream - Dorwin	114.19	13488	441	118	3%	29	26%	8%	1%	229.4	49.8	58.8
Downstream - Kirkpatrick	146.17	52623	2157	360	4%	29	33%	33%	35%	285.1	51.3	184.6
Local Inflow	31.98	39135	2202	1224	6%		7%	24%	36%	55.7	57.4	702.2
Lake Overflow Rate Lake Residence Time	37.06 r 0.29 y	n/yr rears	Calib. Settling Calib. Retenti	Rate on Coef.	-5.2 m/ -16%	/yr l	RSE % = Re Error % = Pe	lative Std. E ercent of Vari	rror of Load iance in Tot	& Inflow Co al Inflow Lo	onc. Estimat ad Estimate	tes

Table 12-2: Chloride Balance for 1996-2000

Variable:	Total Phosphorus		Ave	Average for Years:			thru	2000	S	Season: `	Year	
							Percen	t of Total In	flow	Drain.		Export
	Flow	Load	Std Error	Conc	RSE	Samp.	Flow	Load	Error	Area	Runoff	kg /
Term	<u>10^6 m3</u>	kg	kg	ppb	%	per yr	%	%	<u>%</u>	<u>km2</u>	<u>cm</u>	<u>km2</u>
Metro Effluent	91.07	36359	404	399	1%	365	21%	55%	5%			
Metro Bypass	1.90	2688	92	1411	3%	39	0%	4%	0%			
East Flume	0.36	78	6	215	7%	27	0%	0%	0%			
Crucible	1.15	123	4	106	4%	27	0%	0%	0%			
Harbor Brook	8.43	699	174	83	25%	29	2%	1%	1%	29.3	28.8	23.9
Ley Creek	34.10	4178	651	123	16%	27	8%	6%	14%	77.5	44.0	53.9
Ninemile Creek	129.70	7906	965	61	12%	27	29%	12%	31%	298.1	43.5	26.5
Onondaga Creek	146.17	12076	1180	83	10%	28	33%	18%	46%	285.1	51.3	42.4
Nonpoint Gauged	318.40	24860	1667	78	7%	111	72%	38%	93%	690.0	46.1	36.0
Nonpoint Ungauged	17.09	1334	211	78	16%	0	4%	2%	1%	37.0	46.1	36.0
NonPoint Total	335.49	26194	1680	78	6%	111	76%	40%	94%	727.0	46.1	36.0
Industrial	1.52	201	7	133	4%	54	0%	0%	0%			
Municipal	92.98	39047	415	420	1%	404	21%	59%	6%			
Total External	429.99	65442	1731	152	3%	569	97%	99%	100%	727.0	59.1	90.0
Precipitation	12.49	375	34	30	9%	0	3%	1%	0%	11.7	106.8	32.0
Total Inflow	442.48	65817	1731	149	3%	569	100%	100%	100%	738.7	59.9	89.1
Evaporation	8.86						2%			11.7	75.7	
Outflow	433.62	43023	1662	99	4%		98%	65%	92%	738.7	58.7	58.2
Retention	0.00	22794	2400		11%		0%	35%				
Alternative Estimates of La	ke Output											
Outlet 12 Feet	433.62	43023	1662	99	4%	24	98%	65%	92%	738.7	58.7	58.2
Outlet 2 Feet	433.62	38797	1552	89	4%	25	98%	59%	80%	738.7	58.7	52.5
Lake Epil	433.62	40229	1805	93	4%	21	98%	61%	109%	738.7	58.7	54.5
Upstream/Downstream Co	ntrast- Harbor I	Brook										
Upstream - Velasko	6.51	279	54	43	19%	23	1%	0%	0%	25.9	25.1	10.7
Downstream - Hiawatha	8.43	699	174	83	25%	29	2%	1%	1%	29.3	28.8	23.9
Local Inflow	1.92	421	182	219	43%		0%	1%	1%	3.4	56.9	124.9
Upstream/Downstream Co	ntrast - Ononda	aga Creek										
Upstream - Dorwin	114.19	7383	800	65	11%	29	26%	11%	21%	229.4	49.8	32.2
Downstream - Kirkpatrick	146.17	12076	1180	83	10%	28	33%	18%	46%	285.1	51.3	42.4
Local Inflow	31.98	4692	1426	147	30%		7%	7%	68%	55.7	57.4	84.2
Lake Overflow Rate Lake Residence Time	37.06 n 0.29 y	n/yr ears	Calib. Settling Calib. Retenti	Rate on Coef.	19.6 m 35%	/yr I	RSE % = Re Error % = Pe	lative Std. E ercent of Var	rror of Load iance in Tot	& Inflow Co al Inflow Lo	onc. Estimat ad Estimate	tes

Table 12-3: Total Phosphorus Balance for 1996-2000

Variable:	Total Nite	rogen		Ave	erage for `	Years:	1996	thru	2999	5	Season: \	(ear
							Percen	t of Total In	flow	Drain.		Export
	Flow	Load	Std Error	Conc	RSE	Samp.	Flow	Load	Error	Area	Runoff	kg/
<u>Term</u>	<u>10^6 m3</u>	kg	<u>kg</u>	ppb	<u>%</u>	per yr	<u>%</u>	<u>%</u>	<u>%</u>	<u>km2</u>	<u>cm</u>	km2
Metro Effluent	91.07	1428326	25746	15683	2%	29	21%	69%	52%			
Metro Bypass	1.90	28960	17070	15207	59%	6	0%	1%	23%			
East Flume	0.36	2765	93	7597	3%	27	0%	0%	0%			
Crucible	1.15	2585	155	2244	6%	27	0%	0%	0%			
Harbor Brook	8.43	17202	428	2042	2%	27	2%	1%	0%	29.3	28.8	587.3
Ley Creek	34.10	60237	5460	1767	9%	25	8%	3%	2%	77.5	44.0	777.2
Ninemile Creek	129.70	240150	12726	1852	5%	27	29%	12%	13%	298.1	43.5	805.6
Onondaga Creek	146.17	235147	10298	1609	4%	27	33%	11%	8%	285.1	51.3	824.7
Nonpoint Gauged	318.40	552736	17263	1736	3%	105	72%	27%	23%	690.0	46.1	801.0
Nonpoint Ungauged	17.09	29664	4204	1736	14%	0	4%	1%	1%	37.0	46.1	801.0
NonPoint Total	335.49	582400	17767	1736	3%	105	76%	28%	25%	727.0	46.1	801.0
Industrial	1.52	5351	181	3529	3%	54	0%	0%	0%			
Municipal	92.98	1457286	30891	15673	2%	35	21%	70%	75%			
Total External	429.99	2045037	35636	4756	2%	193	97%	99%	100%	727.0	59.1	2812.8
Precipitation	12.49	23731	2136	1900	9%	0	3%	1%	0%	11.7	106.8	2028.3
Total Inflow	442.48	2068768	35700	4675	2%	193	100%	100%	100%	738.7	59.9	2800.4
Evaporation	8.86						2%			11.7	75.7	
Outflow	433.62	1492653	27433	3442	2%		98%	72%	59%	738.7	58.7	2020.5
Retention	0.00	576115	45023		8%		0%	28%				
Alternative Estimates of La	ake Output											
Outlet 12 Feet	433.62	1492653	27433	3442	2%	24	98%	72%	59%	738.7	58.7	2020.5
Outlet 2 Feet	433.62	1323137	28945	3051	2%	25	98%	64%	66%	738.7	58.7	1791.1
Lake Epil	433.62	1519526	22491	3504	1%	21	98%	73%	40%	738.7	58.7	2056.9
Upstream/Downstream Co	ntrast- Harbor	Brook										
Upstream - Velasko	6.51	13018	300	2000	2%	23	1%	1%	0%	25.9	25.1	502.2
Downstream - Hiawatha	8.43	17202	428	2042	2%	27	2%	1%	0%	29.3	28.8	587.3
Local Inflow	1.92	4185	523	2181	12%		0%	0%	0%	3.4	56.9	1241.8
Upstream/Downstream Co	ntrast - Onono	daga Creek										
Upstream - Dorwin	114.19	181336	8707	1588	5%	26	26%	9%	6%	229.4	49.8	790.5
Downstream - Kirkpatrick	146.17	235147	10298	1609	4%	27	33%	11%	8%	285.1	51.3	824.7
Local Inflow	31.98	53812	13486	1683	25%		7%	3%	14%	55.7	57.4	965.6
Lake Overflow Rate	37.06	m/yr	Calib. Settling	g Rate	14.3 m/y	yr I	RSE % = Re	lative Std. E	rror of Load	& Inflow Co	onc. Estimat	es
Lake Residence Time	0.29	years	Calib. Retent	ion Coef.	28%	l	Error % = Pe	rcent of Var	iance in Tot	al Inflow Lo	ad Estimate	
Lake Residence Time	0.32	years	Calib. Retent	ion Coef.	41%	I	Error % = Pe	rcent of Var	iance in Tot	al Inflow Lo	ad Estimate	

Table 12-4: Total Nitrogen Balance for 1996-2000

Table 12-5 **Model Calibration Data**

	s Balance										July-Sept	
14/-1	Net	Metro+	Total	05	Outflow	05	Inflow P	05	Outflow	05	0-3 m	05
Vvater	Inflow hm2	Bypass	Load	SE	Load	SE	P Conc	SE	P Conc	SE	P Conc	SE
1986	483.5	121740	174968	8330	74508	2796	361.9	17.2	154.1	5.8	146.0	11.3
1987	440.5	104222	145808	5619	96439	6653	331.0	12.8	218.9	15.1	118.2	62
1988	341.8	89279	116002	3906	76868	5375	339.4	11.4	224.9	15.7	120.5	14.7
1989	426.7	74729	120874	6817	58577	4370	283.3	16.0	137.3	10.2	80.9	11.8
1990	602.3	73460	139838	8048	99223	11908	232.2	13.4	164.7	19.8	95.5	23.0
1991	536.7	61088	103589	9702	53830	4198	193.0	18.1	100.3	7.8	64.7	6.5
1992	476.1	55830	86216	4939	49383	4603	181.1	10.4	103.7	9.7	61.7	15.4
1993	563.7	112279	156070	7536	102672	6627	276.8	13.4	182.1	11.8	109.0	13.1
1994	478.2	61232	81034	6850	62614	6293	169.5	14.3	130.9	13.2	79.1	12.6
1995	296.7	47372	70431	5456	50507	5110	237.4	18.4	170.2	17.2	65.0	9.0
1996	474.2	52661	89570	4898	63094	5088	188.9	10.3	133.1	10.7	60.9	3.8
1997	444.9	40422	61/25	1922	48247	4750	138.7	4.3	108.4	10.7	52.8	5.9
1996	400.Z 312.5	34174	51366	2204	33627	3503	164.4	7.5	107.6	11.2	53.9	4.2
2000	477.9	32953	62386	3606	39538	3950	130.5	7.5	82.7	8.3	43.8	4.6
Nitrogen Ba	alance										July-Sept	
	Net	Metro+	Total		Outflow		Inflow P		Outflow		0-3 m	
Water	Inflow	Bypass	Load	SE	Load	SE	P Conc	SE	N Conc	SE	N Conc	SE
Year 1096	<u>nm3</u>	1700557	2740662	<u>KQ</u>	2001250	<u>kg</u>	ppb	<u>ppb</u>	<u>ppb</u>	ppb 155	2704	<u>ppb</u>
1986	483.5	1070212	2791109	01727	2001359	74980	5008	142	4139	155	3704	295
1907	3/1.8	2058300	2631510	80553	1737374	68650	7608	200	5082	201	5507	204
1989	426.7	2111344	2793577	78436	2095994	80087	6546	184	4912	188	4083	253
1990	602.3	1725019	2614438	91045	2032496	41581	4340	151	3374	69	3806	234
1991	536.7	1777828	2598964	83851	1742457	64203	4843	156	3247	120	4100	226
1992	476.1	1873839	2568401	68474	1854635	62849	5395	144	3896	132	4552	395
1993	563.7	2011697	2762308	69379	1907806	58847	4900	123	3384	104	3581	138
1994	478.2	1818246	2448586	85229	1883996	49810	5121	178	3940	104	4234	483
1995	296.7	1800917	2146274	73875	1344905	43370	7233	249	4533	146	4851	325
1996	474.2	1924330	2634024	/3836	1966103	68425	5555	156	4146	144	3829	210
1997	444.9	1762833	23//383	48233	1581144	43669	5343	108	3554	98	3373	128
1990	312.5	1219387	1613254	54959	1024155	21900	5162	176	3286	70	3208	180
2000	477.9	1077170	1755075	67796	1443324	82450	3672	142	3020	173	2373	99
Chlorophyll	-a			July - Septer	mber, Lake	South Statio	n, 0 to 3 m	eters				
Water	Sample	Mean	Std Dev	SE	Freq > 10	Freq > 20	Freq > 30	Freq > 40	Freq > 60			
Year	Dates	ppb	<u>ppb</u>	<u>bpb</u>		-	-		-			
1986	6	20.5	26.2	10.7	0.667	0.333	0.167	0.167	0.167			
1907	0	9.7	5.3	2.2	0.500	0.000	0.000	0.000	0.000			
1980	6	73	6.4	26	0.033	0.000	0.000	0.000	0.000			
1990	6	47.2	29.4	12.0	1.000	1.000	0.500	0.500	0.167			
1991	13	39.4	27.0	7.5	0.923	0.692	0.538	0.462	0.154			
1992	14	19.3	9.6	2.6	0.857	0.429	0.143	0.000	0.000			
1993	7	21.0	17.8	6.7	0.857	0.429	0.143	0.143	0.000			
1994	7	31.1	39.3	14.9	0.429	0.429	0.429	0.429	0.143			
1995	7	8.0	4.4	1.6	0.571	0.000	0.000	0.000	0.000			
1996	6	40.1	22.4	9.1	1.000	1.000	0.667	0.167	0.167			
1997		10 5			11667	0.167	0.167	0.167	0.000			
4000	6	16.5	12.7	5.2	0.007	0 400	0.000	0.000	0.000			
1998	6 10 14	16.5 19.1 27.5	12.7 9.2 16.2	5.2 2.9	0.900	0.400	0.200	0.000	0.000			
1998 1999 2000	6 10 14 13	16.5 19.1 27.5 24.2	12.7 9.2 16.2 15.3	5.2 2.9 4.3 4.2	0.900 1.000 0.846	0.400 0.500 0.615	0.200 0.357 0.231	0.000 0.143 0.154	0.000 0.071 0.000			
1998 1999 2000	6 10 14 13	16.5 19.1 27.5 24.2	12.7 9.2 16.2 15.3	5.2 2.9 4.3 4.2	0.900 1.000 0.846	0.400 0.500 0.615	0.200 0.357 0.231	0.000 0.143 0.154	0.000 0.071 0.000			
1998 1999 2000 Secchi Dep	6 10 14 13 th	16.5 19.1 27.5 24.2	12.7 9.2 16.2 15.3	5.2 2.9 4.3 4.2 July - Septe	0.900 1.000 0.846 mber, Lake	0.400 0.500 0.615 South Statio	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy	0.000 0.071 0.000 gen Depleti	on Rate		
1998 1999 2000 Secchi Dep Water	6 10 14 13 th Sample	16.5 19.1 27.5 24.2 Mean	12.7 9.2 16.2 15.3 Std Dev	5.2 2.9 4.3 4.2 July - Septe SE	0.900 1.000 0.846 mber, Lake Freq < 1.2	0.400 0.500 0.615 South Statio Freq < 2.0	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 met	0.000 0.071 0.000 gen Depleti	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u>	6 10 14 13 th Sample <u>Dates</u>	16.5 19.1 27.5 24.2 Mean <u>m</u>	12.7 9.2 16.2 15.3 Std Dev <u>m</u>	5.2 2.9 4.3 4.2 July - Septer SE <u>m</u>	0.900 1.000 0.846 mber, Lake Freq < 1.2	0.400 0.500 0.615 South Statio Freq < 2.0	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day	0.000 0.071 0.000 gen Depleti	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986	6 10 14 13 th Sample <u>Dates</u> 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151	5.2 2.9 4.3 4.2 July - Septe SE <u>m</u> 0.061	0.900 1.000 0.846 Freq < 1.2 <u>-</u> 1.000	0.400 0.500 0.615 South Statio Freq < 2.0	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyg below 6 met <u>mg/m²-day</u> 1111	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1982	6 10 14 13 th Sample <u>Dates</u> 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731	5.2 2.9 4.3 4.2 July - Septer SE 0.061 0.299 0.200	0.900 1.000 0.846 mber, Lake Freq < 1.2 <u>-</u> 1.000 0.000	0.400 0.500 0.615 South Statio Freq < 2.0 <u>-</u> 1.000 0.667	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyg below 6 met mg/m ² -day 1111 1425	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989	6 10 14 13 th Sample <u>Dates</u> 6 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.250	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217	5.2 2.9 4.3 4.2 July - Septe SE <u>m</u> 0.061 0.299 0.093	0.000 0.900 1.000 0.846 mber, Lake Freq < 1.2 <u>-</u> 1.000 0.000 0.500	0.400 0.500 0.615 South Statio Freq < 2.0 <u>-</u> 1.000 0.667 1.000	0.200 0.357 0.231	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1623 1027	0.000 0.071 0.000 gen Depleti ters *	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990	6 10 14 13 th Sample <u>Dates</u> 6 6 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512	5.2 2.9 4.3 4.2 July - Septer SE <u>m</u> 0.061 0.299 0.093 0.089 0.209	0.000 0.900 1.000 0.846 mber, Lake Freq < 1.2 <u>-</u> 1.000 0.000 0.500 0.167 0.500	0.400 0.500 0.615 South Statio Freq < 2.0 <u>-</u> 1.000 0.667 1.000 1.000	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyr below 6 met <u>ma/m²-day</u> 1111 1425 1623 1927 1687	0.000 0.071 0.000 gen Depleti ters *	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991	6 10 14 13 th Sample <u>Dates</u> 6 6 6 6 6 5	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288	5.2 2.9 4.3 4.2 July - Septe SE <u>m</u> 0.061 0.299 0.093 0.089 0.209 0.129	0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.167 0.500 0.800	0.400 0.500 0.615 South Statio Freq < 2.0 	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyg below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992	6 10 14 13 Sample <u>Dates</u> 6 6 6 6 6 6 5 7	16.5 19.1 27.5 24.2 Mean 0.667 1.833 1.100 1.350 1.317 1.040 1.514	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157	5.2 2.9 4.3 4.2 July - Septe SE <u>m</u> 0.061 0.299 0.093 0.089 0.209 0.129 0.059	0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.167 0.500 0.800 0.000	0.400 0.500 0.615 South Statio Freq < 2.0 <u>-</u> 1.000 0.667 1.000 1.000 1.000 1.000	0.200 0.357 0.231	0.000 0.143 0.154 Hypol. Oxyg below 6 met ma/m ² -day 1111 1425 1623 1927 1687 1889 1974	0.000 0.071 0.000 gen Depleti ters * *	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993	6 10 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 5 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.228 0.217 0.512 0.288 0.157 0.857	5.2 2.9 4.3 4.2 July - Septe SE <u>m</u> 0.061 0.299 0.093 0.089 0.209 0.129 0.059 0.324	0.900 1.000 0.846 mber, Lake Freq < 1.2 <u>-</u> 1.000 0.000 0.500 0.167 0.500 0.800 0.800 0.800 0.800 0.800 0.800	0.400 0.500 0.615 South Statio Freq < 2.0 	0.200 0.357 0.231	0.000 0.143 0.154 Hypol. Oxy below 6 met <u>mq/m²-day</u> 1111 1425 1623 1927 1687 1889 1974 1278	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994	6 10 14 3 Sample <u>Dates</u> 6 6 6 6 6 6 5 7 7 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514 1.814 2.243	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.217 0.512 0.288 0.157 0.857 0.857	5.2 2.9 4.3 4.2 July - Septe SE 0.061 0.299 0.093 0.089 0.209 0.129 0.052 0.324 0.324	0.900 0.900 0.846 mber, Lake Freq < 1.2 <u>-</u> 1.000 0.500 0.500 0.800 0.0167 0.500 0.800 0.433 0.286	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 1.000 1.000 0.714 0.286	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyr below 6 met 1425 1623 1927 1687 1889 1974 1278 904	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995	6 10 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 5 7 7 7 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.317 1.040 1.514 1.514 1.514 1.243 1.767	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.218 0.217 0.512 0.288 0.157 0.857 0.971 0.258	5.2 2.9 4.3 4.2 July - Septer SE <u>m</u> 0.061 0.299 0.093 0.009 0.129 0.059 0.324 0.327	0.900 0.900 0.846 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.600 0.800 0.000 0.800 0.000 0.286 0.000 0.286 0.000 0.000 0.500 0.900 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.50000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 1.000 0.714 0.286 0.677	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyg belov 6 met mg/m ² -day 11111 1425 1623 1927 1687 1889 1974 1278 8904 2358	0.000 0.071 0.000 gen Depleti ters • • •	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996	6 10 14 13 Sample <u>Dates</u> 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.857 0.971 0.258 0.223	5.2 2.9 4.3 4.2 July - Septe SE 0.061 0.299 0.093 0.209 0.209 0.324 0.367 0.105 0.119 0.105	0.900 0.900 0.846 mber, Lake Freq < 1.2 <u>-</u> 1.000 0.500 0.500 0.600 0.800 0.000 0.143 0.286 0.000 0.500	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 0.714 0.286 0.667 1.000	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² day 1111 1425 1623 1927 1687 1887 1887 1887 1887 1887 1887 188	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1996	6 10 14 13 Sample <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 6 6 6 6 7 7 7 7 7 7 7 7 6 6 6 6 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.218 0.217 0.512 0.288 0.157 0.857 0.857 0.857 0.971 0.258 0.293 0.301	5.2 2.9 4.3 4.2 July - Septe <u>m</u> 0.061 0.299 0.093 0.089 0.209 0.129 0.059 0.324 0.367 0.105 0.119 0.123	0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.6500 0.800 0.000 0.143 0.286 0.000 0.500 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.667	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² day 1111 1425 1623 1927 1687 1889 1974 1278 904 2258 81714 1116	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1994 1995 1994 1995 1996 1997 1998	6 100 14 13 Sample Dates 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.317 1.040 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.793	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.971 0.258 0.293 0.301 0.688 0.529	5.2 2.99 4.3 4.2 July - Septe 0.061 0.299 0.029 0.029 0.029 0.029 0.029 0.059 0.326 0.119 0.123 0.1200 0.1200 0.1200 0.1200 0.120000000000	0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.600 0.600 0.800 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000 0.00000 0.0000000 0.00000 0.0000000	0.400 0.500 0.615 South Statio Freq < 2.0 0.667 1.000 1.000 1.000 1.000 1.000 0.671 0.667 1.000 0.671 0.067	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 met <u>mg/m²-day</u> 1111 1425 1623 1927 1687 1889 1974 1278 904 2358 1714 1116 1519 2077	0.000 0.071 0.000 gen Depleti eers	on Rate		
1998 1999 2000 Secchi Dep Water 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 6 6 6 6 7 13 13	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.3510 1.3510 1.3514 1.814 2.243 1.767 1.083 1.767 1.793 1.300	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.228 0.157 0.857 0.971 0.258 0.293 0.301 0.688 0.529 0.690	5.2 2.99 4.3 4.2 July - Septe 5 0.061 0.299 0.099 0.209 0.129 0.059 0.324 0.365 0.119 0.123 0.260 0.147 0.147	0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.800 0.000 0.433 0.286 0.000 0.500 0.000 0.500 0.350 0.000	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.671 0.923 0.615	0.200 0.357 0.231	0.000 0.143 0.154 Hypol. Oxyy below 6 met <u>ma/m²-day</u> 1111 1425 1623 1927 1687 1889 1974 1278 904 2358 1714 1116 1519 2077 2013	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7 13 13	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.300 1.962	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.228 0.287 0.971 0.258 0.293 0.301 0.688 0.529 0.690	5.2 2.9 4.3 4.2 July - Septe SE 0.061 0.299 0.029 0.129 0.059 0.324 0.367 0.105 0.324 0.367 0.105 0.119 0.1260 0.147 0.191	0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.800 0.800 0.000 0.800 0.000 0.800 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 - 1.000 0.667 1.000 1.000 0.714 0.286 0.667 1.000 0.667 1.000 0.667 0.667 0.571 0.923 0.615	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 mei <u>mg/m²-day</u> 1111 1425 1623 1927 1687 1889 1974 1278 904 2358 1714 1116 1519 2077 2013	0.000 0.071 0.000 gen Depleti erers	on Rate		
1998 1999 2000 Secchi Dep Water Year 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 6 6 6 6 6 7 7 7 7 13 13	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.093 1.300 1.962	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.218 0.217 0.512 0.288 0.217 0.512 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe	5.2 2.9 4.3 4.2 July - Septe SE 0.061 0.299 0.029 0.209 0.209 0.324 0.367 0.105 0.119 0.123 0.260 0.147 0.191 mber, Lake	0.900 0.946 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.600 0.800 0.000 0.413 0.286 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 met <u>mg/m²-day</u> 1111 1425 1623 1927 1687 1889 1974 1278 904 22588 1714 1116 1519 2077 2013	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water 1987 1988 1989 1990 1991 1992 1993 1994 1995 1997 1998 1999 2000 Nutrients	6 100 14 13 Sample Dates 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 6 6 6 6 7 13 3 13	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.351 1.307 1.514 1.814 1.814 1.767 1.083 1.767 1.793 1.300 1.962	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.971 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe	5.2 2.9 4.3 4.2 July - Septe 0.093 0.299 0.029 0.029 0.324 0.324 0.367 0.105 0.119 0.123 0.260 0.147 0.191 mber, Lake nic N	0.900 0.946 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.500 0.600 0.413 0.286 0.000 0.246 0.000 0.246 0.385 0.000 0.286 0.000 0.500	0.400 0.500 0.615 South Statio Freq < 2.0 - 1.000 0.667 1.000 1.000 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.671 0.023 0.615 on, 0 to 3 me mina N	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyr below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1278 904 2358 1714 1116 1519 2077 2013	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1994 1995 1994 1997 1998 1997 1998 1999 2000 Nutrients	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 6 6 6 6 7 13 13 13	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.793 1.300 1.962 SE SE	12.7 9.2 16.2 15.3 Std Dev 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.857 0.857 0.857 0.857 0.857 0.857 0.859 0.690 0.690 0.690 0.690 0.690 0.690 0.690 0.690 0.690 0.690	5.2 2.99 4.3 4.2 July - Septe 0.093 0.089 0.299 0.059 0.324 0.327 0.105 0.119 0.123 0.260 0.119 0.123 0.260 0.147 0.191 0.125 0.147 0.195 0.147 0.195 0.147 0.195 0.147 0.195 0.147 0.195 0.147 0.195 0.155 0.115 0.155 0.555 0.155 0.555 0.155 0.555 0.155 0.5550	0.900 0.900 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.000 0.143 0.286 0.000 0.286 0.385 0.000 0.500 0.000 0.500 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000 0.00000 0.0000000 0.00000 0.0000000	0.400 0.500 0.615 South Statio Freq < 2.0 0.667 1.000 1.000 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.671 0.923 0.615 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.71 0.925 5.75 0.925	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyg below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1389 1974 1388 1974 1388 1974 1358 2077 2013 2077 2013 2077 2013 2077 2013	0.000 0.071 0.000 gen Depleti eers	on Rate		
1998 1999 2000 Secchi Dep Water Year 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water Year 1986	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 6 6 6 6 6 7 7 7 7 7 8 8 9 7 7 7 7 6 6 6 6 9 7 7 7 7 7 8 8 9 9 7 7 9 9 9 9 9 9 9 9	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.083 1.767 1.902 1	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.228 0.217 0.512 0.288 0.157 0.971 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Organ</u> Mean <u>pb</u>	5.2 2.99 4.3 4.2 July - Septe 5 0.061 0.299 0.029 0.299 0.299 0.299 0.229 0.324 0.367 0.1059 0.324 0.367 0.1059 0.324 0.367 0.119 0.129 0.129 0.324 0.367 0.119 0.119 0.191 0.191 0.191 0.260 0.147 0.191 0.260 0.147 0.191 0.260 0.191 0.260 0.191 0.260 0.260 0.2700 0.2700 0.2700 0.270000000000	0.900 0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.000 0.167 0.500 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000 0.0000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.667 1.000 0.667 0.667 0.571 0.923 0.615 0.615 0.515 0.515 0.525 0.515 0.525 0.515 0.525 0.515 0.525 0.515 0.525 0.515 0.525 0.55	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1278 904 1278 904 1278 904 1278 904 1278 904 2358 1714 1116 1519 2077 2013 22 SE SE <u>SE</u> <u>SE</u> <u>SE</u>	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water Year 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water Year 1986 1987	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 6 6 7 7 7 6 0 6 7 7 7 6 0 7 8 9 7 7 6 9 37 8 937 6 27	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.350 1.351 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.083 1.767 1.903 1.300 1.962 Carbon SEE DPM 0.67 0.14	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.517 0.527 0.857 0.971 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Oraal</u> Mean <u>peb</u> 1467	5.2 2.9 4.3 4.2 July - Septer 0.061 0.299 0.033 0.089 0.209 0.129 0.059 0.324 0.367 0.119 0.123 0.260 0.147 0.191 mber, Lake <u>ppb</u> 222 102	0.900 0.946 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.500 0.600 0.635 0.000 0.000 0.043 0.286 0.000 0.000 0.286 0.000 0.286 0.000 0.550 0.000 0.550 0.000 0.550 0.000 0.550 0.000 0.550 0.000 0.550 0.000 0.550 0.000 0.167 0.500 0.000 0.500 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 1.000 1.000 0.714 0.286 0.667 0.571 1.000 0.667 0.571 1.000 0.615 o.615 o.615 o.615 SE 0.51 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.923 0.615 0.511 0.511 0.923 0.615 0.511 0.511 0.923 0.615 0.511 0.511 0.923 0.615 0.511 0.511 0.923 0.615 0.511 0	0.200 0.357 0.231 n	0.000 0.143 0.154 Hypol. Oxyg below 6 met mg/m ² -day 1111 1425 1683 1927 1687 1889 1974 1276 904 2358 1714 1116 1257 2013 2013 2013 2013 2013 2015 2	0.000 0.071 0.000 gen Depleti ers	on Rate		
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1998 1999 2000 Secchi Dep Water 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1997 1998 1999 2000 Nutrients Water Year 1986 1987 1988 1987	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 6 6 6 6 6 6 7 13 13 13 13 Total Org Mean <u>ppm</u> 9.37 6.27 7.05 5.27	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.350 1.317 1.040 1.514 2.243 1.767 1.083 1.767 1.793 1.300 1.962 Carbon SE <u>DPM</u> 0.67 0.14 0.67 0.14	12.7 9.2 16.2 15.3 Std Dev 0.151 0.228 0.217 0.512 0.288 0.157 0.857 0.971 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Oraau</u> Mean <u>pcb</u> 1467 1383 1642	5.2 2.99 4.3 4.2 July - Septe 0.093 0.089 0.209 0.129 0.059 0.324 0.365 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.123 0.260 0.119 0.125	0.900 0.900 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.000 0.167 0.500 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000 0.0000	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 1.000 1.000 1.000 0.667 1.000 0.714 0.286 0.677 1.000 0.667 1.000 0.667 0.571 0.923 0.615 0.615 SE <u>Deb</u> 117 191 210 121	0.200 0.357 0.231 n Mean <u>DPb</u> 44.0 42.9 34.8 17.6	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1278 904 1278 904 1278 904 2358 1714 1116 1519 2077 2013 2013	0.000 0.071 0.000 gen Depleti - - -	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water <u>Year</u> 1986 1987 1986 1987 1988 1989	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.083 1.767 1.902 1	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.217 0.512 0.288 0.157 0.971 0.258 0.293 0.301 0.689 0.690 July - Septe <u>Organ</u> Mean <u>ppb</u> 1383 1642 1158 1043	5.2 2.9 4.3 4.2 July - Septer 0.061 0.299 0.029 0.029 0.029 0.029 0.029 0.029 0.129 0.059 0.324 0.367 0.105 0.119 0.123 0.367 0.105 0.119 0.123 0.367 0.119 0.240 0.1410	0.900 0.946 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.600 0.600 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.0000000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.615 0.571 0.923 0.615 son, 0 to 3 me nial N SE <u>ppb</u> 117 191 210 121 69	0.200 0.357 0.231 n n <u>ppb</u> 44.0 44.0 34.8 17.6 12.4	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² day 1111 1425 1623 1927 1687 1889 1944 1278 904 1278 904 1278 904 1278 904 1278 904 1278 904 2358 1714 1116 1519 2077 2013 <u>SE</u> <u>SE</u> <u>Pob</u> 2.6 4.0 8.7 4.5 4.5 4.8	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water <u>Year</u> 1986 1987 1988 1989 1980 1981	6 100 14 13 Sample Dates 6 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.793 1.300 1.962 <u>Carbon</u> <u>SE</u> <u>ppm</u> 0.67 0.14 0.47 0.18 1.23 0.64	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.871 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Organ</u> Mean <u>pob</u> 1467 1383 1642 1158 1642	5.2 2.99 4.3 4.2 July - Septe 0.093 0.089 0.209 0.029 0.029 0.029 0.029 0.324 0.324 0.367 0.105 0.110 0.143 0.260 0.147 0.191 mber, Lake nic N SE <u>pbb</u> 2222 103 243 171 246	0.900 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.650 0.650 0.650 0.650 0.650 0.000 0.167 0.500 0.000 0.167 0.500 0.000 0.286 0.000 0.286 0.000 0.286 0.000 0.500 0.500 0.500 0.500 0.000 0.500 0.500 0.500 0.000 0.167 0.500 0.000 0.167 0.500 0.000 0.1100 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.1100 0.000 0.100 0.000 0.000 0.000 0.000 0.100 0.000 0.000 0.100 0.000 0.000 0.000 0.100 0.000 0.000 0.100 0.100 0.000 0.100 0.000 0.100 0.000 0.100 0.100 0.000 0.100 0.000 0.100 0.000 0.100 0.000 0.000 0.100 0.000 0.000 0.000 0.000 0.000 0.100 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 - 1.000 0.667 1.000 1.000 1.000 1.000 1.000 0.0714 0.286 0.667 1.000 0.671 1.000 0.667 0.571 0.923 0.615 set <u>pobe</u> 117 191 210 285 285 285 295 295 295 205 205 205 205 205 205 205 20	0.200 0.357 0.231 n Mean <u>pob</u> 44.0 42.9 34.8 17.6 12.4 1.7	0.000 0.143 0.154 Hypol. Oxy below 6 mei mg/m ² -day 1111 1425 1683 1927 1683 1889 1974 1278 904 2358 1714 1116 1278 904 2358 1714 1116 2077 2013 2013 2077 2013 207 2013 207 2013 207 2013 207 2013 207 2013 207 2013 207 2013 207 2013 207 2015 207 207 207 207 207 207 207 207	0.000 0.071 0.000 gen Depleti lers • •	on Rate		
1998 1999 2000 Secchi Dep Water 1986 1987 1988 1989 1990 1991 1992 1994 1995 1994 1995 1994 1997 1998 1997 1998 1999 2000 Nutrients Water <u>Year</u> 1986 1987 1986 1987 1988 1989 1989 1989 1990	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.793 1.300 1.962 <u>Carbon</u> 0.67 0.14 0.68 <u>Nem</u> 0.67 0.14 0.18 1.23 0.64 0.11	12.7 9.2 16.2 15.3 Std Dev 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.857 0.857 0.871 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Organ</u> Mean <u>pbb</u> 1467 1383 1642 1158 1043 877 1372	5.2 2.99 4.3 4.2 July - Septe 0.093 0.089 0.299 0.059 0.324 0.324 0.327 0.105 0.119 0.123 0.260 0.1470	0.900 0.900 0.846 mber, Lake Freq -1.2 1.000 0.500 0.500 0.600 0.000 0.167 0.500 0.000 0.167 0.500 0.000 1.0000 1.0000 1.000 1.000	0.400 0.500 0.615 South Static Freq < 2.0 1.000 1.000 1.000 1.000 0.667 1.000 1.000 0.714 0.286 0.667 1.000 0.671 0.923 0.615 on, 0 to 3 me nia N SE <u>Deb</u> 117 191 210 1210	0.200 0.357 0.231 n Mean <u>ppb</u> 44.0 42.9 34.8 17.6 12.4 1.7 1.4.0	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1278 904 2358 1714 1278 904 2358 1714 1116 1519 2077 2013 2013 2013 2013 2015 2.6 4.0 8.7 4.5 4.8 0.4 6.3	0.000 0.071 0.000 gen Depleti	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water <u>Year</u> 1986 1987 1988 1987 1988 1987 1988 1987 1988 1989 1990 1991 1992 1993	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 6 6 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.3510 1.317 1.040 1.3510 1.300 1.3510 1.300 1.300 1.300 1.3612 1.300 1.400 0.14 0	12.7 9.2 16.2 15.3 Std Dev 0.151 0.228 0.217 0.512 0.288 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Oraau</u> Mean <u>pob</u> 1467 1383 1642 1158 1043 877 1372 922	5.2 2.99 4.3 4.2 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	0.900 0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.600 0.800 0.000 0.800 0.000 0.413 0.286 0.000 0.000 0.286 0.385 0.000 0.286 0.000 0.1100 1.1000 1.100 1.10	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 1.000 1.000 1.000 0.667 1.000 0.714 0.286 0.667 1.000 0.667 0.571 0.923 0.615 SE <u>Pobb</u> 191 210 121 191 221 211 232 213	0.200 0.357 0.231 n n Mean <u>ppb</u> 4400 42.9 34.8 17.6 12.4 1.7 14.0 21.1	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1278 904 1278 904 1278 904 1278 904 1278 904 1278 2077 2013 2077 2014 2077 2014 2077 2014 2077 2014 2077 2014 2077 2014 2077 2014 2014 2014 2014 2014 2014 2014 2014	0.000 0.071 0.000 gen Depleti ers • •	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1999 2000 Nutrients Water <u>Year</u> 1986 1989 1999 2000 Nutrients Water <u>Year</u> 1988 1988 1988 1988 1989 1990 1991 1992 1993	6 100 14 13 Sample <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 6 6 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.350 1.317 1.040 1.350 1.317 1.040 1.350 1.350 1.317 1.040 1.350 1.317 1.040 1.514 1.64 0.67 0.14 0.67 0.18 1.22 0.67 0.18 0.67 0.63 0.67 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.64 0.63 0.53 0.53 0.53 0.54 0.55	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.217 0.512 0.288 0.297 0.857 0.971 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Oraal</u> Mean <u>peb</u> 1363 1642 1158 1043 1642 1158 1043 1642 1383 1642 1387 1372 922 1305	5.2 2.99 4.3 4.2 July - Septer 0.061 0.299 0.033 0.089 0.209 0.129 0.032 0.324 0.367 0.105 0.119 0.123 0.367 0.119 0.123 0.260 0.147 0.191 mber, Lake <u>pbb</u> 222 103 243 171 246 6 122 103	0.900 0.946 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.500 0.600 0.600 0.000 0.000 0.000 0.000 0.000 0.000 0.286 0.000 0.000 0.286 0.000 0.500 0.000 0.500 0.000 0.500 0.000 0.1100 1100 1100 11728 0.000 0.1102 0.000 0.1100 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.1102 0.000 0.000 0.1102 0.000 0.1102 0.000 0.000 0.1102 0.000 0.000 0.1102 0.000 0.000 0.1102 0.000 0.000 0.1102 0.000 0.000 0.000 0.000 0.000 0.000 0.1102 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000 0.0000 0.0000 0.00000000	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.714 0.286 0.667 1.000 0.615 o.615 o.615 o.615 0.571 0.923 0.615 0.571 0.923 0.615 0.571 1.010 0.571 0.923 0.615 0.571 1.000 0.571 0.923 0.615 0.571 1.000 0.571 0.923 0.615 0.571 1.000 0.571 0.923 0.615 0.571 1.000 0.571 0.923 0.615 0.571 1.000 0.571 0.923 0.615 0.571 0.923 0.571 0.923 0.571 0.923 0.571 0.923 0.571 0.923 0.571 0.923 0.571 0.923 0.571 0.714 0.923 0.571 0.923 0.571 0.923 0.571 0.571 0.923 0.571 0.923 0.571 0.714 0.923 0.571 0.714 0.923 0.571 0.571 0.923 0.571 0.714 0.923 0.571 0.757 1.000 0.571 0.571 0.757 1.000 0.571 0.714 0.572 0.571 0.714 0.572 0.771 0.77	0.200 0.357 0.231 n n <u>ppb</u> 44.0 44.0 44.0 44.0 44.0 11.4 1.7 14.0 21.1 1.7	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 904 1974 1687 1889 904 1974 1974 2015 889 1974 1974 2015 889 904 1276 889 1974 2015 889 2017 2013 88 86 2077 2013 88 86 2077 2013 88 87 207 207 2013 88 87 207 207 2013 88 87 206 207 207 2013 87 207 207 207 207 207 207 207 20	0.000 0.071 0.000 gen Depleti - - -	on Rate		
1998 1999 2000 Secchi Dep Water <u>Year</u> 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water <u>Year</u> 1986 1987 1988 1989 1980 Nutrients 1988	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 6 6 6 6 6 6 6 6 6 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.083 1.767 1.793 1.300 1.962 <u>Carbon</u> 0.67 0.14 0.47 0.18 1.23 0.64 0.44 0.41 0.20 0.33 0.64 0.44 0.44 0.44 0.45 0.44 0.45 0.44 0.45 0.44 0.45 0.45 0.44 0.45	12.7 9.2 16.2 15.3 Std Dev 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.857 0.971 0.258 0.293 0.301 0.688 0.529 0.690 July - Septer 0.690 July - Septer 1467 1383 1642 1158 1043 877 1372 922 1305 947	5.2 2.99 4.3 4.2 July - Septe 0.003 0.089 0.299 0.029 0.029 0.029 0.029 0.059 0.324 0.105 0.119 0.123 0.260 0.147 0.191 mber, Lake <u>pbb</u> 2222 103 243 171 246 122 158 113 519 203 203	0.900 0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.600 0.167 0.500 0.800 0.000 0.167 0.500 0.800 0.000 0.413 0.286 0.000 0.286 0.000 0.500 1100 1100 1100 1100 1100 1213	0.400 0.500 0.615 South Statio Freq < 2.0 - 1.000 0.667 1.000 1.000 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.671 1.000 0.671 0.923 0.615 SE <u>pbb</u> 117 191 210 212 332 213 178 84 347 247 247 247 247 247 247 247 2	0.200 0.357 0.231 n n <u>PDb</u> 44.0 44.0 44.0 44.0 34.8 17.6 12.4 1.7 14.0 21.1 19.6 (15.7) 7 0.2	0.000 0.143 0.154 Hypol. Oxy below 6 mei mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1278 904 2358 1714 1116 1278 904 2358 1714 1116 2077 2013 32 SE SE <u>PDb</u> 2.6 4.0 8.7 4.5 4.8 0.4 5.4 8.6 7.5 16.3 16.3 16.3 16.3 16.3 16.3 17.4 16.3 16.3 17.4 16.3 17.4 16.3 17.4 16.3 17.4 16.3 17.4 17.5 16.3 17.4 17.5 16.3 17.4 17.5 16.3 17.4 17.5 16.3 17.4 17.5 16.3 17.4 17.5 16.3 17.4 17.5 16.5 17.4 17.5 16.5 17.4 17.5 16.5 17.4 17.5 16.5 17.4 17.5 16.5 17.4 17.5 16.5 16.5 17.5 16.5 17.5 16.5 17.5 16.5 17.5 16.5 17.5 16.5 17.5	0.000 0.071 0.000 gen Depleti lers	on Rate		
1998 1999 2000 Secchi Dep Water Year 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1998 1999 2000 Nutrients Water Year 1986 1987 1988 1989 1990 1991 1992 1988 1989 1990 1991 1992 1993 1990 1991 1992 1993 1994 1995 1996 1997	6 100 14 13 th Sample Dates 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7 7 7 6 6 6 6 6 6 6 7 13 13 13 13 Total Org Mean P <u>PT</u> 9.377 6.27 7,05 5.277 7,663 6.27 7,055 5.277 7,655 6.27 7,055 7,77 7,77	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.3510 1.3510 1.317 1.040 1.514 1.814 2.243 1.767 1.793 1.300 1.962 <u>Carbon</u> <u>SE</u> <u>ppm</u> 0.67 0.14 0.47 0.18 1.23 0.64 0.14 0.14 0.41 0.20 0.33 0.36 0.44 0.14 0.44 0.14	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.857 0.857 0.857 0.871 0.258 0.293 0.301 0.688 0.529 0.301 0.688 0.529 0.690 July - Septe <u>Ortaal</u> Mean <u>pbb</u> 1467 1383 1642 1158 1043 877 1372 922 1305 946 (1237 87	5.2 2.99 4.3 4.2 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	0.900 0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.000 0.167 0.500 0.000 1108 2342 7783 907 9411 2113 1709 1709 1709 1709 1709 1709 1709 1704	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 0.714 0.286 0.677 1.000 0.677 1.000 0.667 0.571 0.923 0.615 0.615 0.615 0.571 0.923 0.615 0.571 0.714 0.923 0.615 0.571 0.714 0.923 0.615 0.571 0.714 0.714 0.923 0.615 0.571 0.714 0.714 0.714 0.714 0.724 0.714 0.724 0.714 0.714 0.723 0.615 0.714 0.714 0.714 0.714 0.714 0.723 0.615 0.714 0.71	0.200 0.357 0.231 n Mean <u>Dpb</u> 44.0 42.9 34.8 17.6 12.4 1.7 14.0 21.1 1.9 6 (15.7 4.9 2.5 1.7 14.0 21.1	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1623 1927 1687 1889 1974 1278 904 2358 1714 1116 1519 2077 2013 2013 2013 2013 2013 2013 2014 4.6 3.6 8.6 7.5 10.6 6 3.12 2 1	0.000 0.071 0.000 gen Depleti - - -	on Rate		
1998 1999 2000 Secchi Dep Water Year 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1999 2000 Nutrients Water Year 1986 1987 1988 1989 1990 1991 1992 1993 1994 1993 1994 1993 1994 1993 1994 1995 1996 1997 1998 1996 1997 1998	6 100 14 13 th <u>Dates</u> 6 6 6 6 6 6 6 6 6 7 7 7 7 7 6 6 6 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.3510 1.3510 1.3510 1.3510 1.3510 1.3510 1.3510 1.3500 1.3510 1.300 1.3510 1.300 0.47 0.14 0.47 0.14 0.47 0.14 0.47 0.14 0.44 0.14 0.44	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.517 0.577 0.857 0.857 0.971 0.258 0.293 0.301 0.688 0.293 0.301 0.689 0.529 0.690 July - Septe <u>Ortaal</u> Mean <u>ppb</u> 1467 1383 1642 1158 1043 1642 1158 1043 1642 1158 1043 1642 1158 1043 1642 1158 1043 1642 1158 1043 1642 1158 1642 1642 1642 1642 1642 1642 1642 1642	5.2 2.99 4.3 4.2 July - Septe m 0.061 0.299 0.029 0.029 0.209 0.209 0.209 0.129 0.059 0.209 0.324 0.367 0.105 0.119 0.123 0.367 0.105 0.142 0.367 0.119 0.123 0.260 0.147 0.191 mber, Lake nic N SE 202 103 243 171 246 65 120	0.900 0.900 1.000 0.846 mber, Lake Freq < 1.2 1.000 0.000 0.500 0.600 0.600 0.000 0.1100 1100 1102 1728 2577 1554 1204 692 0.000 0.000 0.000 0.000 0.000 0.1100 0.000 0.11000 0.1100 0.11000 0.11000 0.11000 0.	0.400 0.500 0.615 South Statio Freq < 2.0 1.000 0.667 1.000 1.000 1.000 0.714 0.286 0.667 1.000 0.714 0.286 0.667 1.000 0.615 0.571 0.923 0.615 0.571 0.923 0.615 5 5 <u>ppb</u> 117 191 191 191 191 210 121 69 285 332 213 314 267 162 178 314 267 162 182 182 182 182 182 182 182 18	0.200 0.357 0.231 n n <u>ppb</u> 44.0 42.9 34.8 17.6 12.4 1.7 14.0 21.1 19.6 15.7 4.9 5.0 2 0	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² /day 1111 1425 1623 1927 1889 904 1278 904 1278 904 1278 904 1278 904 1278 904 1278 904 1278 904 1278 904 1278 904 1278 904 1278 904 1519 2077 2013 82 SE <u>pob</u> 2.66 4.00 8.77 4.5 4.8 0.4 6.3 8.63 1.2 2.1 0.63 1.2 2.1 0.63 1.2 2.1 0.63 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2	0.000 0.071 0.000 gen Depleti ters	on Rate		
1998 1999 2000 Secchi Dep Water Year 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water Year 1986 1987 1988 1989 1999 2000 Nutrients Water Year 1986 1987 1988 1989 1999 2000 Nutrients 1988 1989 1999 2000 Nutrients 1988 1989 1999 2000 Nutrients 1988 1989 1999 1991 1992 1993 1994 1992 1993 1994 1995 1995 1996 1997 1998 1999 1997 1998 1999 1997 1998 1999 1997 1998 1997 1998 1999 1997 1998 1999 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1999 1997 1998 1999 1997 1998 1997 1998 1997 1998 1999 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1997 1998 1999 1997 1998 1997 1998 1999 1997 1998 1999 1997 1998 1999 1999 1999 1999 1999 1999 1999 1999 1999 1999 1999 1999 1999 1999 1999 1998 1998 1999 1997 1998 1998 1998 1998 1998 1998 1999 1998 1999 1998 1997 1998 1997 1998 1997 19	6 100 14 13 Sample Dates 6 6 6 6 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.317 1.040 1.514 1.814 2.243 1.767 1.793 1.300 1.962 <u>Carbon</u> SE <u>ppm</u> 0.67 0.14 0.47 0.18 1.23 0.64 0.11 0.23 0.64 0.11 0.23 0.64 0.14 0.14 0.12 0.33 0.64 0.14 0.14 0.12 0.33 0.64 0.14 0.14 0.15 0.14 0.15 0.14 0.15 0.14 0.15 0.14 0.15 0.1	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.857 0.971 0.258 0.293 0.301 0.688 0.529 0.690 July - Septe <u>Organ</u> Mean <u>ppb</u> 1467 1383 1642 1158 1043 8777 1372 922 21305 946 1237 867 649 1018	5.2 2.99 4.3 4.2 5.2 5.2 5.2 5.2 5.2 5.2 5.2 5.2 5.2 5	0.900 0.946 mber, Lake Freq < 1.2 1.000 0.500 0.500 0.500 0.600 0.600 0.413 0.286 0.000 0.043 0.286 0.000 0.043 0.500 0.000 0.413 0.286 0.000 0.000 0.000 0.286 0.000 0.000 0.286 0.000 0.500 0.000 0.500 0.000 0.000 0.500 0.000 0.1100 1100 1100 1102 1728 2577 1554 1204 1204 2202 2272 2577 1554 1204 2202 2202 2277 1554 1204 1204 2202 2202 2202 2277 1554 1204 1204 2202 2202 2277 1554 1204 1	0.400 0.500 0.615 South Statio Freq < 2.0 - 1.000 0.667 1.000 1.000 1.000 1.000 1.000 0.714 0.286 0.667 0.571 1.000 0.667 0.571 1.000 0.615 0.571 1.000 0.615 0.571 1.000 0.615 0.571 1.000 0.615 0.571 1.000 0.513 1.000 0.615 0.571 1.000 0.571 1.000 0.571 1.000 0.615 0.571 1.000 0.571 1.017 1.017 0.571 1.017 1.017 1.017 1.020 0.571 1.017 1	0.200 0.357 0.231 n n <u>pob</u> 44.0 42.9 34.8 17.6 12.4 1.7 14.0 21.1 19.6 15.7 4.9 5.0 2.0 1.1	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² -day 1111 1425 1683 1927 1683 1889 1974 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2358 1714 1278 904 2077 2013 2013 2013 2015 108 1097 2013 2015 108 1097 2013 2015 108 1097 2013 2015 108 1097 2013 2015 108 1097 2015 1087 2015 1087 2015 1088 1094 1076 1076 1077 2013 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 2015 1087 1087 1088 1094 1076 1097 2015 1087 1087 1097 2015 1087 1087 1087 1097 2015 1087 1087 1087 1097 2015 1087 1087 1097 2015 1087 1097 2015 1087 1097 1097 2015 1087 1097 1097 2015 1087 1097 1097 2015 1087 1097 100	0.000 0.071 0.000 gen Depleti ers • •	on Rate		
1998 1999 2000 Secchi Dep Water 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 Nutrients Water <u>Year</u> 1986 1987 1988 1989 1990 Nutrients 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998	6 100 14 13 bates 6 6 6 6 6 6 6 6 6 6 7 7 7 7 7 6 6 6 6	16.5 19.1 27.5 24.2 Mean <u>m</u> 0.667 1.833 1.100 1.350 1.350 1.350 1.514 1.814 2.243 1.767 1.083 1.767 1.793 1.300 1.962 Carbon 0.67 0.14 0.47 0.18 1.23 0.64 0.11 0.20 0.33 0.36 0.44 0.11 0.20 0.33 0.36	12.7 9.2 16.2 15.3 Std Dev <u>m</u> 0.151 0.731 0.228 0.217 0.512 0.288 0.157 0.857 0.857 0.971 0.258 0.293 0.301 0.688 0.529 0.690 0.690 0.690 0.690 0.690 1467 1383 1642 1158 1043 877 1372 922 1305 946 1237 867 649 1018 8673	5.2 2.99 4.3 4.2 July - Septe 0.093 0.089 0.299 0.059 0.324 0.324 0.324 0.324 0.105 0.119 0.123 0.260 0.147 0.105 0.119 0.222 103 243 171 246 1222 103 243 171 246 122 158 113 519 203 86 65 120	0.900 0.900 1.000 0.846 mber, Lake Freq <1.2 1.000 0.500 0.500 0.670 0.500 0.000 0.167 0.500 0.000 0.000 0.163 0.286 0.000 0.286 0.385 0.000 0.500 1.100	0.400 0.500 0.615 South Static Freq < 2.0 1.000 0.667 1.000 1.000 1.000 0.667 1.000 0.677 1.000 0.714 0.286 0.667 1.000 0.677 1.000 0.667 1.002 0.615 1.07 1.01 1.01 1.01 1.01 1.01 1.01 1.01 1.01 1.01 1.01 1.01 1.021 1.	0.200 0.357 0.231 n n Mean <u>ppb</u> 44.0 42.9 34.8 17.6 12.4 1.7 14.0 2.1.1 19.6 0.15.7 4.9 5.0 2.0 1.1 1.4	0.000 0.143 0.154 Hypol. Oxy below 6 met mg/m ² day 1111 1425 1623 1927 1687 1889 904 2358 1714 1116 1278 904 2358 1714 1116 2077 2013 32 <u>PE</u> <u>PE</u> <u>PE</u> 2.6 4.0 8.7 4.5 4.8 0.4 5.4 8.6 7.5 1.6 0.6 1.2 2.11 1.5 1.2 1.2 1.2 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0.000 0.071 0.000 gen Depleti	on Rate		

SE = Standard Error of Mean
* Lower limit of actual HOD because of incomplete spring turnover or loss of oxygen during calculation interval

Table 12-6 **Model Equations**

Predicted Trophic Response Variables:

- Water Year Flow-Wtd-Mean Outflow Total P (ppb) Po =
- P = Mean Total P (ppb) * No = Water Year Flow-Wtd-Mean Outflow Total N (ppb)
- N =
- Mean Total N (ppb) * В = Mean Chlorophyll-a (ppb) *
- Mean Secchi Depth (m) * S =
- HOD =
- Hypolimnetic Oxygen Depletion Rate (mg/m²-day) TOC =
- Total Organic Carbon (ppm) * TON = Total Organic Nitrogen (ppb) *
- TIN Total Inorganic Nitrogen (ppb) *
- * July-September, 0-3 meters, Lake South Station

Lake Outflow Total P:

Reference: Vollenweider (1969), Chapra (1975), Sas (1989)

- $P_O = W_P / (Q_O + U_P A)$
- W_P = Inflow P Load (kg/yr)
- Outflow = External Inflow + Precip ET (hm³/yr) Q_O =
- 11.7 km² A = Lake Surface Area = P Settling Rate = 18.9 m/yr U_P = Calibrated to 1995-1999

Period	1996-2000	1986-1995
Residual CV	0.15	0.24
R ²	0.51	0.45

Lake South Epilimnetic Total P:

alker (1	978), Sas (1989)	
0.51	Calibrated to 1	996-2000
	1996-2000 198	6-1995
	0.09	0.13
	0.44	0.89
	alker (19 0.51	alker (1978), Sas (1989) 0.51 Calibrated to 1 1996-2000 198 0.09 0.44

Lake Outflow Total N:

$N_0 = W_N /$	(Q ₀ + U _N A)	
W _N = I	nflow N Load (kg/yr)	
U _N = 1	V Settling Rate =	14.2 m/yr
Calibrated to	1995-1999	
Period	1996-2000 1986	6-1995
Residual CV	0.07	0.07
R ²	0.70	0.84

Lake South Epilimnetic Total N: NI

$IN = F_N INO$			
F _N =	0.92	Calibrated to 1	996-200
Period		1996-2000 198	6-1995
Residual CV		0.05	0.13
R ²		0.92	0.56

Lake South Chlorophyll-a:

Reference: Jones & Bachman (1976) $B = k P^{1.46}$ k = 0.078 DataSet J& B 1996-2000 Residual CV - 0.22 R^2 0.90 0.64

Algal Bloom Frequencies:

Reference:	Walker (1984)
F_X =	1 - Normal [(ln(X) - ln(B) - 0.5 S _B ²) / S _B]
S _B =	$[\ln (1 + C_B^2)]^{1/2}$
X =	Bloom Criterion (10, 20, 30 or 40 ppb)
$F_X =$	Frequency of Chl-a > X
Normal	Cumulative Normal Frequency Distribution
S _B =	Standard Deviation of In (Chl-a)
C _B =	Within-Year Temporal CV = 0.61
	Calibrated to 1996-2000 Data

Lake South Secchi Depth:

Reference	e: Walker (19	985,1996)
S =	exp (Ss2)	/(a+bB)
Calibrate	d to Sample	Dates, 1996-1999
a =	0.285419	1/m
b =	0.018	m²/mg
Period		1996-2000

Residual CV	0.17
R ²	0.53

Secchi Interval Frequencies:

Reference: Walker (1984)

0.31

- Y = Secchi Criterion (1.2 or 2 m)
- F_Y = Frequency of Secchi < Y
- S_S = Standard Deviation of In (Secchi) C_S = Within-Year Temporal CV of Secol
- C_S = Within-Year Temporal CV of Secchi Depth

Hypolimnetic Oxygen Depletion Rate:

Reference: Walker (1979) $Log HOD = -0.58 + 0.0204 I + 4.55 log Z -2.04 (Log Z)^{2}$ I = Phosphorus Trophic Index = -15.6 + 46.1 log P Z = Mean Depth = 10.90 mHOD = 42.3 P^{0.94} not not recalibrated DataSet Walker(1979) 1996-2000 Residual CV 0.23 0.25 R^2 0.91 0.00

Days of Oxygen Supply in Hypolimnion: Deferen

Reference	: walker (1979)		
T _{DO} = 10	000 DO _S Z _H / HOD		
$T_{ANOXIC} =$	T _{STRAT} - T _{DO}		
T _{DO} =	Oxygen Supply at Spring Turnove	er (days)	
$T_{ANOXIC} =$	Duration of Anoxic Period (days)		
DO _S =	Oxygen at Spring Turnover =	12	ppm
Z _H =	Mean Hypolimnetic Depth =	8.34	meters
T _{STRAT} =	for 6-meter Thermocline Depth Duration of Stratified Period =	183	days
	April 15 - October 15		

Lake South Total Organic Carbon:

Reference: Walker (1983)		
TOC =	a + b B	
a =	2.36	
b =	0.10	
		1996-2000
Residual CV		0.04
R ²		0.90

Lake South Total Organic Nitrogen:

-		-
Reference: V	Valker (1	985; 1996)
TON = a +	bВ	
a =	113.9	
b =	30.4	
		1996-2000
Residual CV		0.22
R ²		0.38

Lake South Total Inorganic Nitrogen: TIN - N - TON

	1996-2000
Residual CV	0.12
R ²	0.50