Long-Term Water Quality Database for the Onondaga Lake Ambient Monitoring Program Overview & Discussion of Load Computation Methods

Onondaga Lake Technical Advisory Committee
Workgroup Meeting

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September 16, 2004

Version 1.1 - D R A F T

Longterm Water Quality Database for the
Onondaga Lake Ambient Monitoring Program

prepared for
Department of Water Environment Protection
Onondaga County, New York
by
William W. Walker, Jr., Ph.D.

Access Databases

- Water Quality & Hydrology
- Historical Tributary Loadings
- Lake Buoy Data

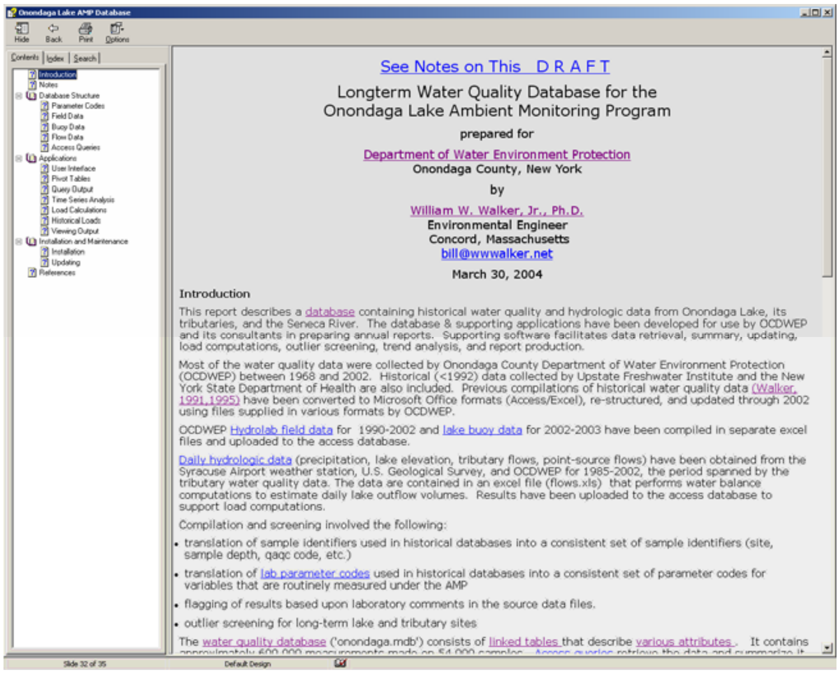
Excel Applications

- Lab Data Query Table Listings
- Time Series Analysis (Outliers & Trends)
- Tributary Load Calculations
- Analysis of Historical Loads
- Pivot Table Analysis - Lab Data
- Pivot Table Analysis - Buoy Data
- Pivot Table Analysis - Field Data
- Output Viewer

Documentation

- Help - Full Version
- Help - Browser Version
- Installation Procedures
- Update Templates
- Current Data Inventory

Start_Here.xls *4/2/2004*


See Notes on This D R A F T
Longterm Water Quality Database for the
Onondaga Lake Ambient Monitoring Program
prepared for
Department of Water Environment Protection
Onondaga County, New York
by
William W. Walker, Jr., Ph.D.
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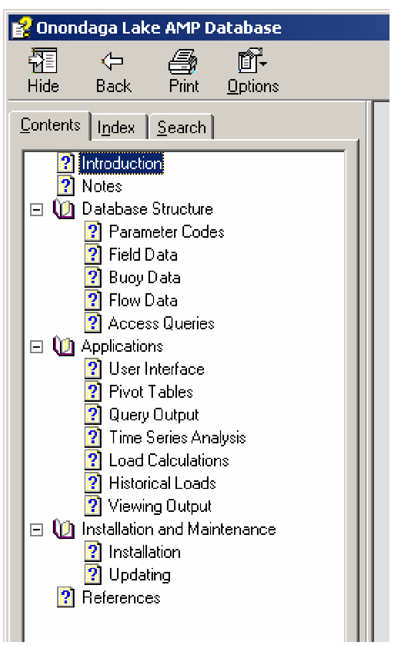
March 30, 2004
Introduction
This report describes a database containing historical water quality and hydrologic data from Onondaga Lake, its tributaries, and the Seneca River. The database & supporting applications have been developed for use by OCDWEP and its consultants in preparing annual reports. Supporting software facilitates data retrieval, summary, updating, load computations, outlier screening, trend analysis, and report production.
Most of the water quality data were collected by Onondaga County Department of Water Environment Protection (OCDWEP) between 1968 and 2002. Historical (<1992) data collected by Upstate Freshwater Institute and the New York State Department of Health are also included. Previous compilations of historical water quality data (Walker, 1991,1995) have been converted to Microsoft Office formats (Access/Excel), re-structured, and updated through 2002 using files supplied in various formats by OCDWEP.
OCDWEP Hydrolab field data for 1990-2002 and lake buoy data for 2002-2003 have been compiled in separate excel files and uploaded to the access database.
Daily hydrologic data (precipitation, lake elevation, tributary flows, point-source flows) have been obtained from the Syracuse Airport weather station, U.S. Geological Survey, and OCDWEP for 1985-2002, the period spanned by the tributary water quality data. The data are contained in an excel file (flows.xls) that performs water balance computations to estimate daily lake outflow volumes. Results have been uploaded to the access database to support load computations.
Compilation and screening involved the following:
• translation of sample identifiers used in historical databases into a consistent set of sample identifiers (site, sample depth, qaqc code, etc.)
• translation of lab parameter codes used in historical databases into a consistent set of parameter codes for variables that are routinely measured under the AMP
• flagging of results based upon laboratory comments in the source data files.
• outlier screening for long-term lake and tributary sites
The water quality database ('onondaga.mdb') consists of linked tables that describe various attributes. It contains
Default Design


Onondaga Lake AMP Database
Hide
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Options
Contents
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Introduction
Notes
Database Structure
Parameter Codes
Field Data
Buoy Data
Flow Data
Access Queries
Applications
User Interface
Pivot Tables
Query Output
Time Series Analysis
Load Calculations
Historical Loads
Viewing Output
Installation and Maintenance
Installation
Updating
References

Database Documentation & Updating Procedures

Onondaga County Department of Water Environment Protection

Updates.xls | **Version 1.1 - DRAFT** | **W. Walker**

Select Sheet:

- Structure
- Dictionary
- Translation of Lab Database
- Samples_Update
- Results_Update
- Source_Index
- Sample_Crosstab
- Results_Crosstab
- -- Access Index Tables--
- Samples
- Parameters
- Lab_parameters
- Qaqc
- Devices
- Indcodes
- Flags
- Labs
- Qualifiers
- Sites
- Sample_types

Retrieve Index Tables — *<--- click at start*

Update References — *<---click when finished entering new records*

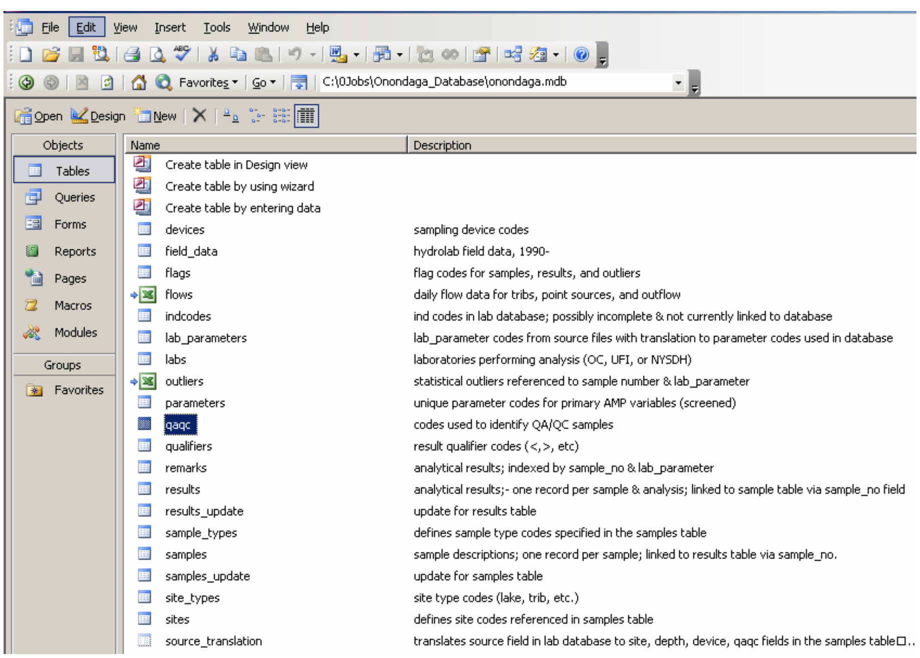
Help

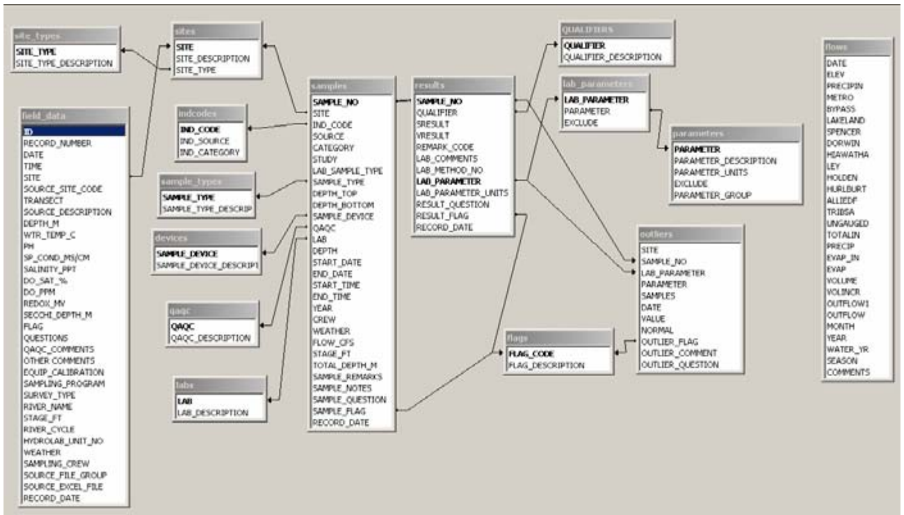
View Sheet

Click Here for General Help on Database

Click Here for Main Database Menu

4/2/2004





Inventory of Database Query: ***master_filtered*** ***do not modify this sheet*** 9/13/2004

Double-click on any cell to see records.

Count of VALUE	
YEAR	Total
1985	12570
1986	15331
1987	19377
1988	15788
1989	15402
1990	16269
1991	12602
1992	13359
1993	16459
1994	17811
1995	16835
1996	17983
1997	18015
1998	19989
1999	26331
2000	25098
2001	23331
2002	23559

Count of VALUE		
SITE_TYPE	SITE	Total
LAKE	LKBLANK	4516
	NORTH	18376
	SOUTH	98418
LAKE Total		121310
LAKE_NS	LS_9MILE	460
	LS_BLBRK	190
	LS_HARB	369
	LS_LEY	286
	LS_LKPK	432
	LS_LONGB	36
	LS_MAPLE	484
	LS_MARIN	36
	LS_METRO	286
	LS_WIL	438
LAKE_NS Total		3017
TRIB	ALLIED	4346
	BLOODY	5
	BLOODY_A	3
	BLOODY_B	3
	BLOODY_LIV	64
	BLOODY_LKP	63
	BYPASS	6363
	CKBLANK	8999
	DORWIN	11669
	EFLUME	12915
	HIAWATHA	13244
	KIRKPAT	4001
	LEY_11	575
	LEY_7	608
	LEY_OUT	5
	METBLANK	1408
	METRO	47534
	OC_OUT	2492
	OC_RT20	1849
	OUTLET12	11172
	OUTLET2	14384
	PARK	12878

Count of VALUE	
PARAMETER	Total
ALK	6953
BOD1	19
BOD2	19
BOD5	13561
CA	7264
CBOD5	3022
CH4	621
CHLA	2000
CHLA_L	1985
CHLA_P	2015
CHLT_P	2013
CL	13280
CO2	1163
COND	8354
DO_F	12852
DO_L	5605
DO_W	611
ECOCCI	2056
ECOLI	1673
FCOLI	11146
FE	5721
FSTREP	3016
HARD	2489
K	827
MG	4322
MN	4558
NA	7236
NH3N	15184
NO23N	359
NO2N	9010
NO3N	8892
ORGN	8353
PH_F	7987
PH_L	7556
PHAEO	1495
PHAEO_L	2029
REDOX	22

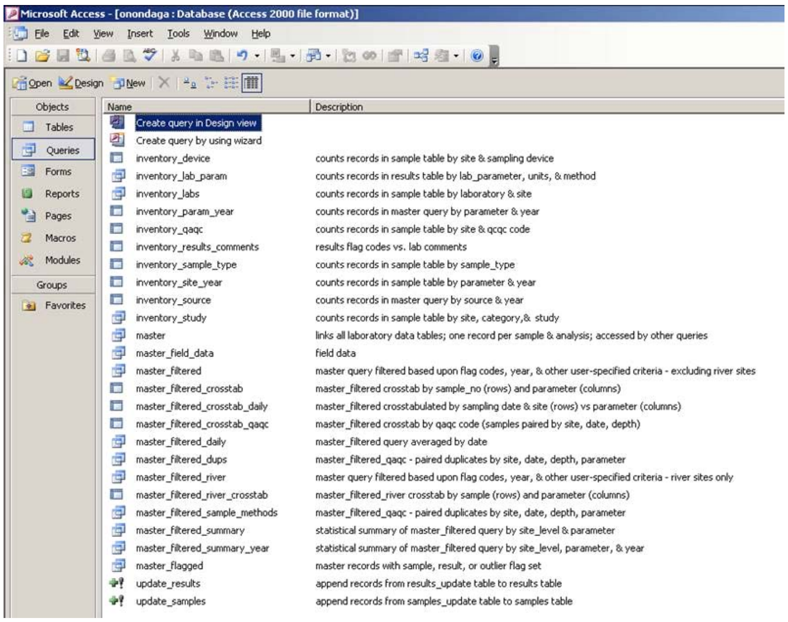
Count of VALUE	
LAB	Total
OC	281837
UFI	44272

Count of VALUE	
SAMPLE_DE\	Total
CARBOY	14
CHURN	2899
DUNKER	2794
DUNKER/CHURN	3524
PAIL	2040
PUMP	2462
(blank)	312376

Count of VALUE	
CATEGORY	Total
Onondaga Creeks	78537
Onondaga Lake	39831
Outlying Creeks	317
Plant-Industry	95
Quality Control	30030
Requested Samp	96
River Monitoring	224
Special Request	174
Storm Event Cree	12810
Storm Event Lake	1097
Treatment Plant	41242
(blank)	121656

Count of VALUE	
STUDY	Total
Onondaga Lake	1080
(blank)	285870
Fall Turnover	1033
Storm Event	14942
Wet Weather	472
By Pass	993
Onondaga Creeks	3378
Quartery Creek Event	814
	11781
Zinc	108
Wet Weathe	94
Dry Study	235
Wet Study	264
Ambient Program	322
Pail	4
Hg Survey	46
Mercury	3
Quarterly Lake Event	1503
Dry Weather	1179
Lake Diurnal	439
Winter Lake	201
Lake Turnover	318
Near Shore	300
Potable Water Study	15
Hypochlorite	11
98111	9
98112	9
98114	11
98115	10
98116	9
98117	9
98118	9
98119	9
981110	12
981111	9
981112	10
981113	9

Access Query Screen



Onondaga Lake Database - Query Output

Onondaga County Department of Water Environment Protection

Queries.xls **Version 1.1** **W. Walker**

Select Sheet:

Check_Lab_Param
Check_Lab_Param_2
Check_Results
Check_Qualifiers
Check_Samples
Check_QAQC
Check_Devices
Check_Labs
Check_Sample_Types
Inventory_samples_overall
Inventory_results_overall
Inventory_results_flagged
Inventory_site_year
Inventory_param_year
Inventory_qaqc
Inventory_study
Inventory_lab_param
Inventory_sample_type
Inventory_device
Inventory_labs
Inventory_field_data
Master_filtered_dups
Master_filtered_methods
Master_flagged
Master_filtered_summary
Master_filtered_summary_year
Parameters
Lab_parameters
Qaqc
Devices
Indcodes
Flags
Labs
Qualifiers
Sites
Sample_Types

View Sheet

press Ctrl-m to return to this page

Run Selected Query

Run All Queries

Help

Click Here for General Help on Database

Click Here for Main Database Menu

3/31/2004

Onondaga Lake AMP Database - Pivot Tables

Onondaga County Department of Water Environment Protection

Pivot_tables.xls **Version 1.1 - D R A F T** **W. Walker**

Select Output Sheet:

- Inventory of Database Query
- CrossTab - Concentrations vs. Site, Date, Depth
- Inventory - Samples vs. Site & Year for a Given Parame
- Inventory by Param & Yr for a Given Site
- Inventory - QAQC vs. Site
- Comparison of Duplicate Samples
- Sampling Method Comparison
- CrossTab - Blank Samples
- Plot of Blank Samples for a Given Parameter
- Chlorophyll-a Samples - Epilimnetic vs. Photic Samples
- Lake Mixed Layer Means By Variable & Year
- Statistical Summary by Site & Depth Interval
- Plot - Daily Time Series
- Plot - Conc vs. Date & Depth Interval
- Plot- Conc vs. Month for Each Year
- Plot- Conc vs. Julian Day for Each Year
- Depth vs. Date Contour Plot
- Plot - Lake Nearshore Stations

View Sheet

Help

Press Ctrl-m to return to Menu

Enter Years: 1985 - 2002

Reconnect to Database

<- run at startup, if years are changed,
if database is modified,
or if data retrieval fails

Query Name: *master_filtered*
Years: 1985 - 2002
Records: 326,109
Sites: 42
Variables 60
Click Here for Details

Click Here for General Help on Database
Click Here for Main Database Menu

3/31/2004

Lake Mixed Layer Means By Variable & Year

SITE	SOUTH
SEASON	SUMMER
DEPTH_INTERVAL	U
QAQC	(All)
SAMPLE_TYPE	(All)

Average of VALUE	YEAR																
PARAMETER	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
ALK	82.611	105.278	119.500	134.222	141.833	159.389	125.667	163.667	169.500	157.929	155.133	153.500	152.667	138.857	106.167	149.000	142.333
BOD5	6.667	3.667	3.333	3.778	2.722	7.222	5.722	2.619	4.429	5.929	5.357	4.833	3.458	3.143	2.708	2.458	2.333
CA	495.111	236.111	177.333	191.222	154.556	164.611	152.444	144.429	152.571	149.143	163.600	143.583	150.333	139.571	133.500	124.467	138.000
CH4							0.000	0.000									
CHLA	33.516	15.466	9.538	16.674	6.821	69.059	34.692	17.796	21.029	32.500	8.043	40.100	16.467	20.727	27.399	24.111	32.207
CHLA_L	35.183	13.039	7.356	6.835	13.253	28.992											
CHLA_P			22.017	21.553	18.486	32.684	39.520										
CHLT_P			29.673	26.799	23.795	37.834	47.859										
CL	1645.951	774.927	628.263	580.376	434.941	459.652	481.853	439.667	507.846	480.071	530.867	437.083	493.917	456.143	513.667	359.417	480.083
CO2	9.944	6.639	4.356	11.056	3.194	5.500	7.167	2.905									
COND	5643.333	2825.000	2566.667	2431.111	2010.556	2094.444	2113.958	1995.714	2135.000	2148.333	2382.300	1978.222	2178.889	1983.857	2224.444	1815.167	2132.556
DO_F	7.006	10.247	8.178	8.252	9.747	7.401	8.207	8.749	5.603	7.491	5.892	7.943	8.022	8.452	9.324	9.286	9.204
DO_W									6.770	7.000	6.360	8.614	9.300				
ECOCCI															6.471	6.923	
ECOLI																12.500	52.692
FCOLI	66.944	98.889	47.222	59.722	31.944	22.500			103.429	26.286	117.429	16.833	272.167	115.286	16.765	22.308	78.846
FE							0.071	0.028	0.103	0.116	0.076	0.054	0.074	0.091	0.127	0.051	0.024
FSTREP	9.444	39.778	14.833	21.167	7.722	15.222								8.750			
HARD							479.000	417.000					478.583	441.786	433.000	406.417	447.500
K												6.575	6.225	5.120	5.353	4.980	5.255
MG							23.800	20.850	23.371	24.107	24.227	23.858	25.058	22.657	24.192	23.225	24.975
MN							0.007	0.001	0.034	0.019	0.032	0.018	0.023	0.007	0.012	0.002	0.007
NA	546.167	288.500	261.667	265.722	195.444	188.500	214.167	192.238	222.714	239.571	291.067	223.167	247.167	204.857	257.667	193.958	242.250
NH3N	1.389	1.050	1.144	2.515	0.923	1.196	0.971	2.113	1.800	1.830	2.637	1.611	1.209	0.782	0.329	0.208	0.193
NO23N							2.119										
NO2N	0.634	0.154	0.151	0.272	0.246	0.245	0.243	0.153	0.372	0.162	0.295	0.275	0.214	0.136	0.129	0.113	0.081
NO3N	1.174	0.938	1.443	1.043	2.303	1.642	2.168	0.913	0.594	1.039	1.034	0.764	1.088	1.833	1.782	1.420	1.678
ORGN	0.917	1.417	1.339	1.589	1.141	0.919			0.873	1.005	0.880	1.104	0.853	0.605	0.855	0.616	0.816
PH_F	6.850	7.483	7.578	7.300	7.961	7.639	7.425	8.054	7.571	7.867	7.701	7.740	7.788	8.004	8.000	7.985	7.917
PH_L	7.488	8.004	7.895	8.146	8.048	7.902	7.889	8.183									
PHAEO	24.324	12.815	5.021	9.671	11.602	9.145	7.689		9.971	3.814	4.557	3.887	4.722	2.739	3.635	1.096	0.261
PHAEO_L	9.315	0.733	28.838	26.745	9.582	6.135											
S		0.000	0.000	0.000	0.000	0.000	1.000										
SECCHI	0.859	0.803	1.887	1.405	1.846	1.223	1.040	1.514	1.722	2.338	1.800	1.083	1.767	1.793	1.439	1.962	2.150
SIO2	0.516	1.118	0.828	0.811	1.700	1.539	1.011	1.900	3.138	3.048	1.500	1.918	1.387	1.720	1.134	1.237	0.967
SO4	189.389	163.389	181.556	175.722	157.279	173.465	233.833	180.833	175.538	158.071	174.067	167.750	183.083	177.357	192.167	156.083	195.417
SRP	0.033	0.023	0.026	0.032	0.011	0.006	0.002	0.014	0.030	0.021	0.017	0.006	0.005	0.002	0.001	0.002	0.002
TCOLI	152.667	796.444	519.389	1244.667	243.500	255.333											
TDP		0.073	0.041	0.043	0.024	0.023	0.019	0.034								0.017	0.011
TDS									1319.429	1397.333	1569.810	1277.111	1291.111	1214.476	1389.111	1124.333	1337.556
TEMP	22.918	20.863	22.677	22.057	22.178	22.021	22.564	20.881	21.355	21.632	22.555	22.416	21.724	22.761	22.834	21.622	22.848
TIC	19.842	26.108	27.008	32.192	37.267	40.100	33.125	43.971	43.067	39.070	37.905	39.089	36.928	37.829	27.128	40.317	34.917
TIP	0.065	0.097	0.078	0.080	0.039	0.044	0.011	0.027	0.076	0.046	0.034	0.021	0.045				
TIP_F	0.047	0.076	0.050	0.062	0.022	0.020	0.012	0.015									
TKN	2.300	2.467	2.483	4.022	1.967	1.841	2.152	3.485	2.673	2.834	3.517	2.731	2.054	1.384	1.185	0.825	1.008
TKN_F	1.833	1.861	2.156	3.156	1.649	1.374			2.524	2.267	3.129	2.193	1.660	1.036	0.734	0.619	0.622
TKN_P	0.489	0.611	0.344	0.878	0.324	0.467			0.294	0.538	0.446	0.635					
TOC	6.567	8.567	6.000	6.667	5.100	5.775	6.042	5.271	4.729	6.381	4.219	5.339	4.589	4.455	4.434	4.510	4.058
TOC_F	5.208	7.492	5.850	6.283	4.625	5.333	4.992	4.879	4.124	5.600	3.743	4.606	4.061	3.964	4.024	4.152	3.530
TP		0.094	0.091	0.104	0.054	0.079	0.064	0.062	0.121	0.089	0.063	0.057	0.049	0.051	0.049	0.043	0.037
TS	3891.000	2138.778	1772.667	1626.222	1354.444	1480.444	1451.111	1323.286	1492.476	1572.667	1684.571	1421.444	1431.667	1323.333	1486.778	1243.111	1440.889
TSS	5.944	10.444	6.056	8.667	7.667	8.500	8.333	4.714	2.429	7.238	3.333	6.111	4.167	3.571	5.500	4.500	3.556
TURB													3.880	2.135	3.575	4.975	
TVS	742.778	530.333	366.667	310.667	303.111	393.222	301.333	237.619	345.048	356.762	306.667	295.667	286.000	264.286	288.889	265.333	298.056
VSS	4.222	7.944	5.000	6.611	5.222	6.444	6.333	3.095	1.619	6.619	2.619	5.111	3.889	3.143	5.222	3.056	3.111

Field Data Pivot Tables

Onondaga County Department of Water Environment Protection

Field_pivot_tables.xls **Version 1.1** **W. Walker**

Select Output Sheet:

Inventory of Database Query
Chart vs. Julian Date & Level
Chart vs. Julian Date & Year
Chart - Vertical Profile
Chart - Temp Contour
Chart - DO Contour

View Sheet

Help

Press Ctrl-m to return to Menu

Reconnect to Database

<- run at startup
if database is modified,
or if data retrieval fails

Query Name: *master_field_data*
Database: *onondaga*

Click Here for General Help on Database
Click Here for Main Database Menu

4/3/2004

Inventory of Field Database Query: master_filtered

Double-click on any cell to see records.

Count of Date	year	
Level	2003	Grand Total
2	24564	24564
6	24564	24564
12	24564	24564
15	24564	24564
Grand Total	98256	98256

Count of Temp	year	
Level	2003	Grand Total
2	22673	22673
6	24556	24556
12	22675	22675
15	24560	24560
Grand Total	94464	94464

Count of SpCond	year	
Level	2003	Grand Total
2	22673	22673
6	24556	24556
12	22675	22675
15	24560	24560
Grand Total	94464	94464

Count of Salinity	year	
Level	2003	Grand Total
2	22673	22673
6	24556	24556
12	22675	22675
15	24560	24560
Grand Total	94464	94464

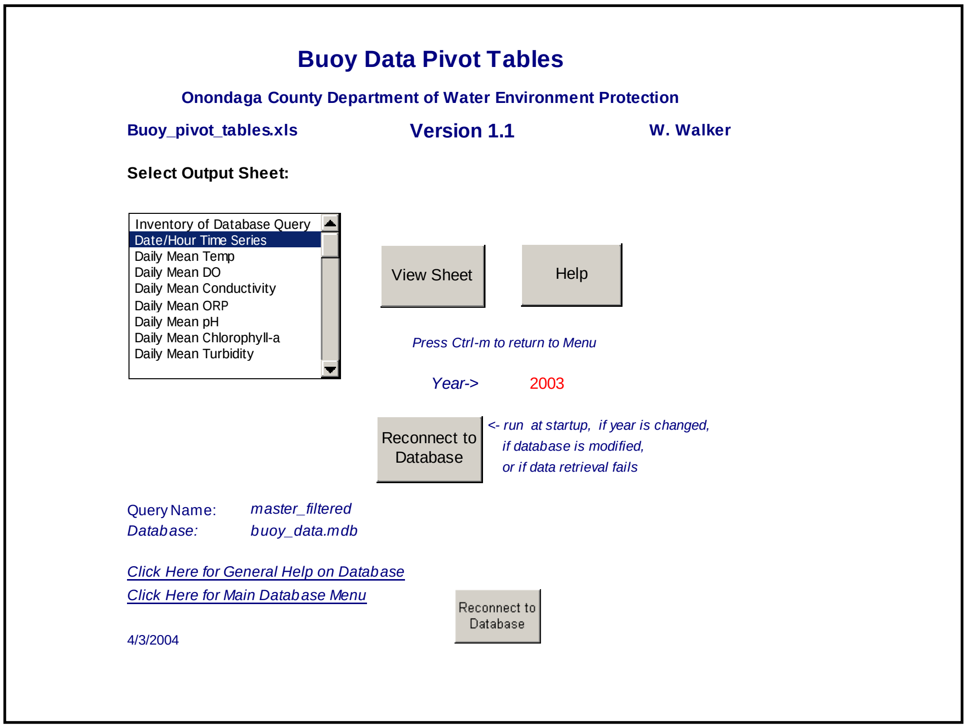
Count of DO%	year	
Level	2003	Grand Total
2	22585	22585
6	24365	24365
12	10583	10583
15	10582	10582
Grand Total	68115	68115

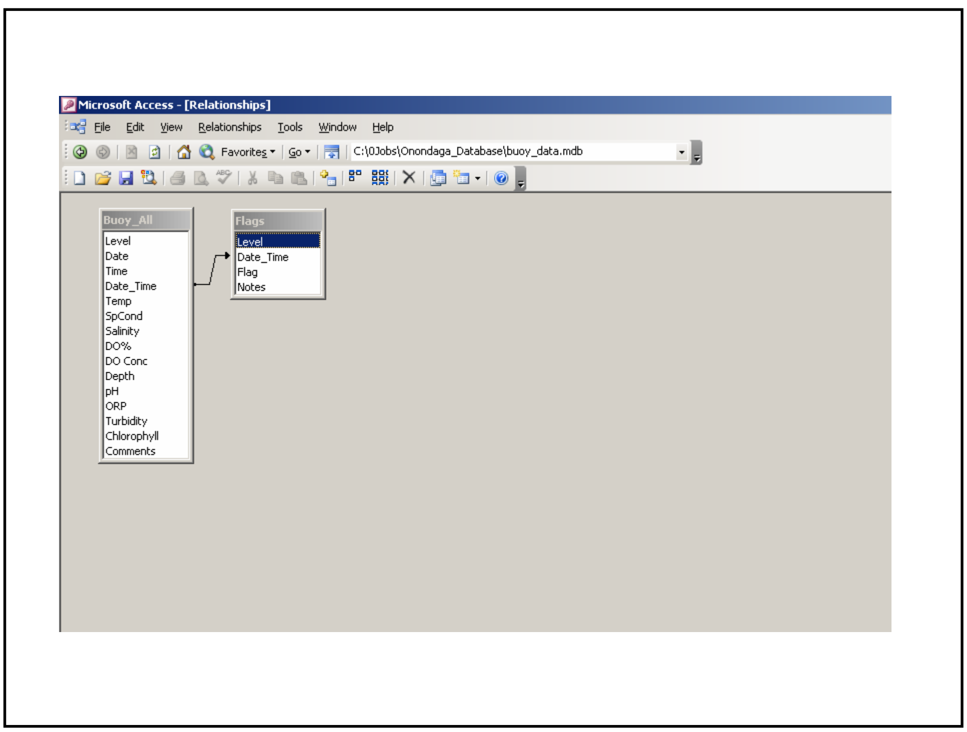
Count of DO Co	year	
Level	2003	Grand Total
2	22585	22585
6	24365	24365
12	10583	10583
15	10582	10582
Grand Total	68115	68115

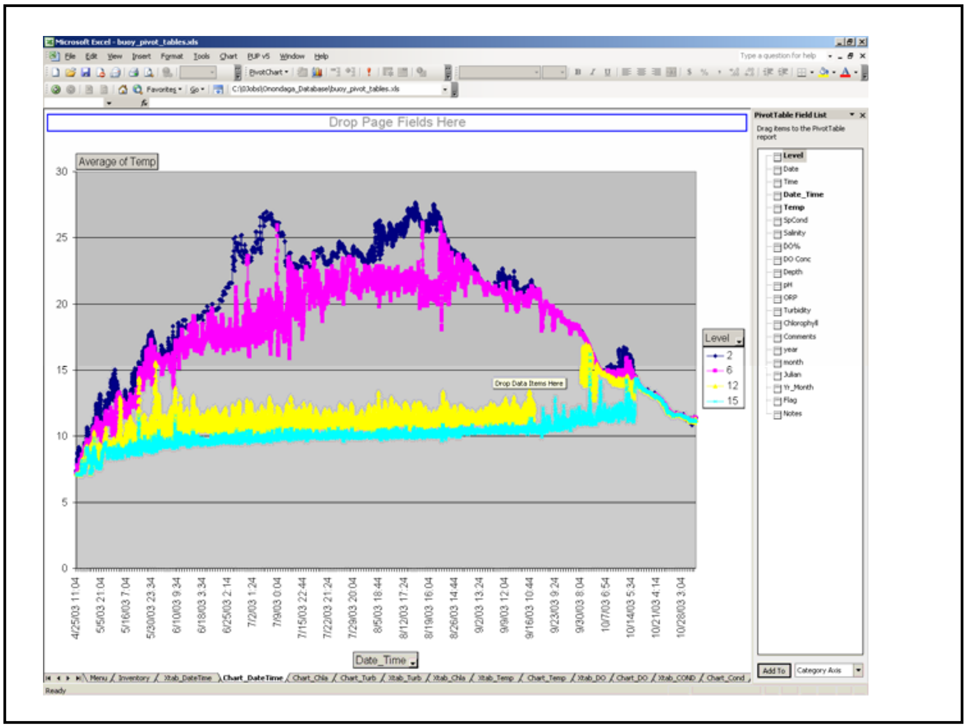
Count of Depth	year	
Level	2003	Grand Total
2	22673	22673
6	24556	24556
12	22675	22675
15	24560	24560
Grand Total	94464	94464

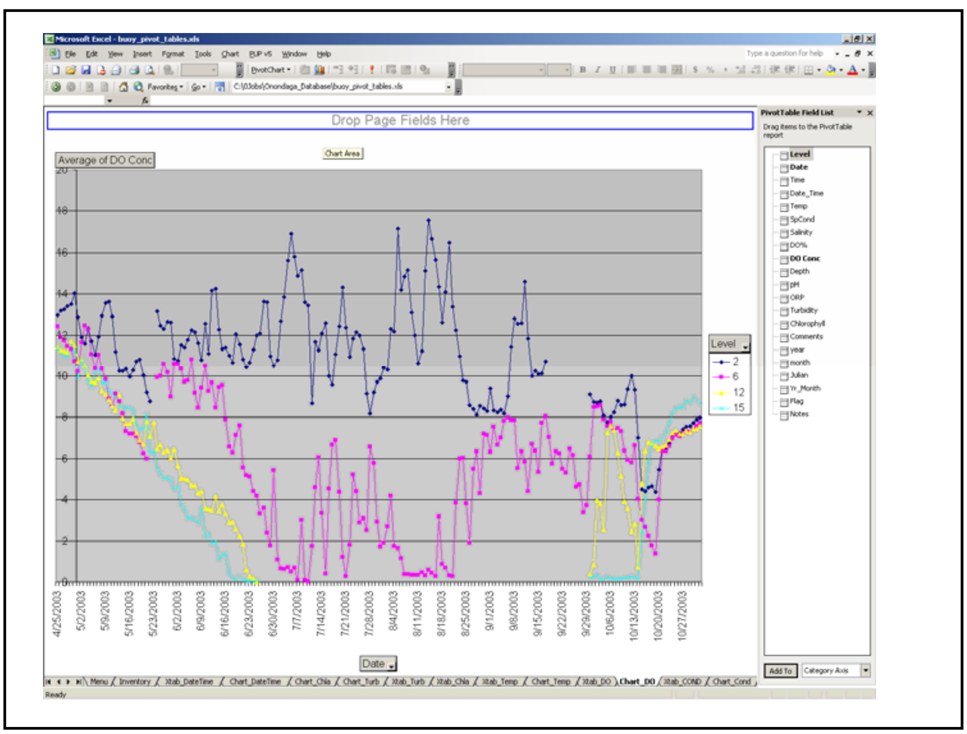
Count of pH	year	
Level	2003	Grand Total
2	22673	22673
6	24556	24556
12	22675	22675
15	24560	24560
Grand Total	94464	94464

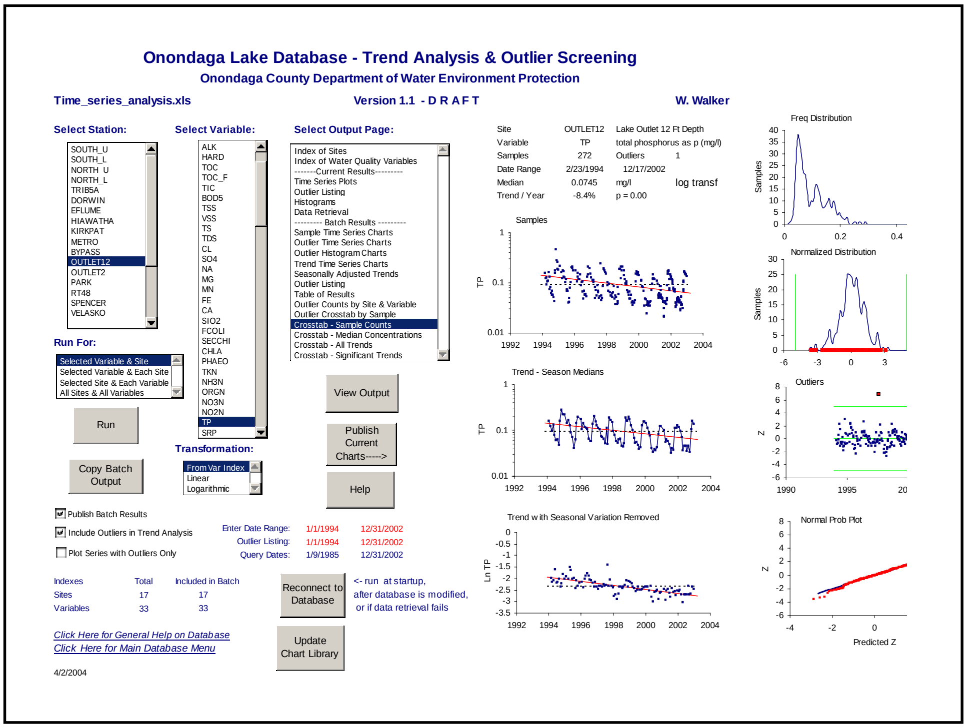
Count of ORP	year	
Level	2003	Grand Total
2	22673	22673
6	24556	24556
12	22675	22675
15	24560	24560
Grand Total	94464	94464

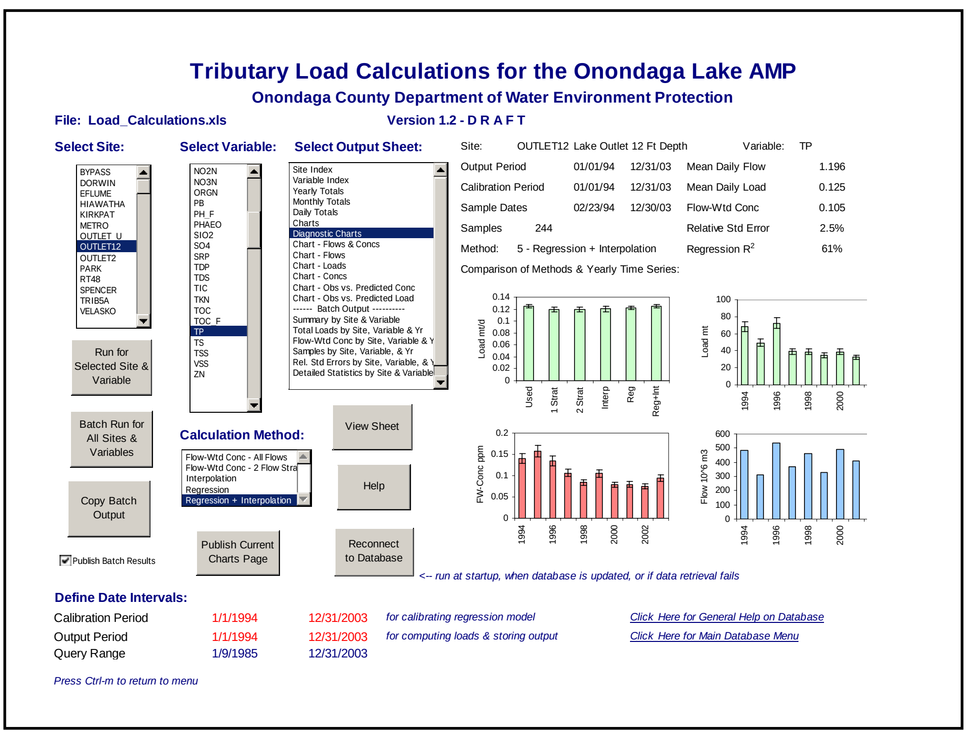

Buoy Data Pivot Tables
Onondaga County Department of Water Environment Protection
Buoy_pivot_tables.xls
Version 1.1
W. Walker
Select Output Sheet:
Inventory of Database Query
Date/Hour Time Series
Daily Mean Temp
Daily Mean DO
Daily Mean Conductivity
Daily Mean ORP
Daily Mean pH
Daily Mean Chlorophyll-a
Daily Mean Turbidity
View Sheet
Help
Press Ctrl-m to return to Menu
Year-> 2003
Reconnect to Database
<- run at startup, if year is changed,
if database is modified,
or if data retrieval fails
Query Name: master_filtered
Database: buoy_data.mdb
Click Here for General Help on Database
Click Here for Main Database Menu
Reconnect to Database
4/3/2004


Microsoft Access - [Relationships]
File Edit View Relationships Tools Window Help
Favorites Go
C:\0Jobs\Onondaga_Database\buoy_data.mdb
Buoy_All
Level
Date
Time
Date_Time
Temp
SpCond
Salinity
DO%
DO Conc
Depth
pH
ORP
Turbidity
Chlorophyll
Comments
Flags
Level
Date_Time
Flag
Notes


Drop Page Fields Here
Average of Temp
Level
2
6
12
15
Drop Data Items Here
Date_Time
PivotTable Field List

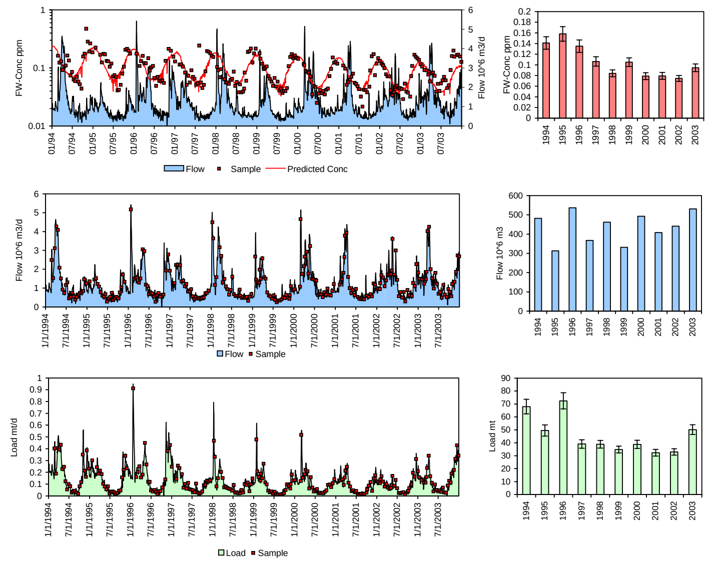

Drop Page Fields Here
Average of DO Conc
Chart Area
Level
2
6
12
15
Date
PivotTable Field List


Onondaga Lake Database - Trend Analysis & Outlier Screening
Onondaga County Department of Water Environment Protection
Time_series_analysis.xls
Version 1.1 - D R A F T
W. Walker
Select Station:
Select Variable:
Select Output Page:
Run For:
Selected Variable & Site
Selected Variable & Each Site
Selected Site & Each Variable
All Sites & All Variables
Run
Copy Batch Output
Transformation:
From Var Index
Linear
Logarithmic
View Output
Publish Current Charts----->
Help
Publish Batch Results
Include Outliers in Trend Analysis
Plot Series with Outliers Only
Enter Date Range: 1/1/1994 12/31/2002
Outlier Listing: 1/1/1994 12/31/2002
Query Dates: 1/9/1985 12/31/2002
Reconnect to Database
<- run at startup, after database is modified, or if data retrieval fails
Update Chart Library
Click Here for General Help on Database
Click Here for Main Database Menu
4/2/2004
Site OUTLET12 Lake Outlet 12 Ft Depth
Variable TP total phosphorus as p (mg/l)
Samples 272 Outliers 1
Date Range 2/23/1994 12/17/2002
Median 0.0745 mg/l log transf
Trend / Year -8.4% p = 0.00
Samples
Trend - Season Medians
Trend with Seasonal Variation Removed
Freq Distribution
Normalized Distribution
Outliers
Normal Prob Plot
Predicted Z

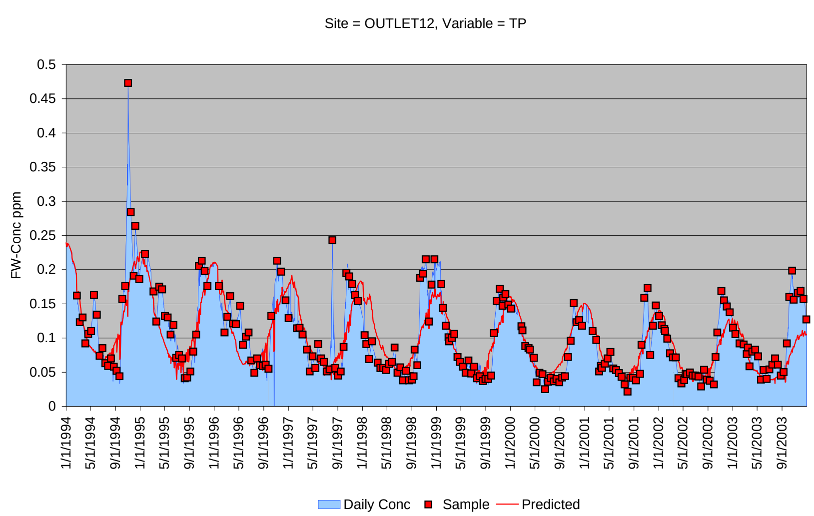

Tributary Load Calculations for the Onondaga Lake AMP
Onondaga County Department of Water Environment Protection
File: Load_Calculations.xls
Version 1.2 - D R A F T
Select Site:
Select Variable:
Select Output Sheet:
Site: OUTLET12 Lake Outlet 12 Ft Depth Variable: TP
Output Period 01/01/94 12/31/03 Mean Daily Flow 1.196
Calibration Period 01/01/94 12/31/03 Mean Daily Load 0.125
Sample Dates 02/23/94 12/30/03 Flow-Wtd Conc 0.105
Samples 244 Relative Std Error 2.5%
Method: 5 - Regression + Interpolation Regression R2 61%
Comparison of Methods & Yearly Time Series:
Run for Selected Site & Variable
Batch Run for All Sites & Variables
Copy Batch Output
Publish Batch Results
Calculation Method:
Flow-Wtd Conc - All Flows
Flow-Wtd Conc - 2 Flow Strata
Interpolation
Regression
Regression + Interpolation
View Sheet
Help
Publish Current Charts Page
Reconnect to Database
<-- run at startup, when database is updated, or if data retrieval fails
Define Date Intervals:
Calibration Period 1/1/1994 12/31/2003 for calibrating regression model
Output Period 1/1/1994 12/31/2003 for computing loads & storing output
Query Range 1/9/1985 12/31/2003
Click Here for General Help on Database
Click Here for Main Database Menu
Press Ctrl-m to return to menu

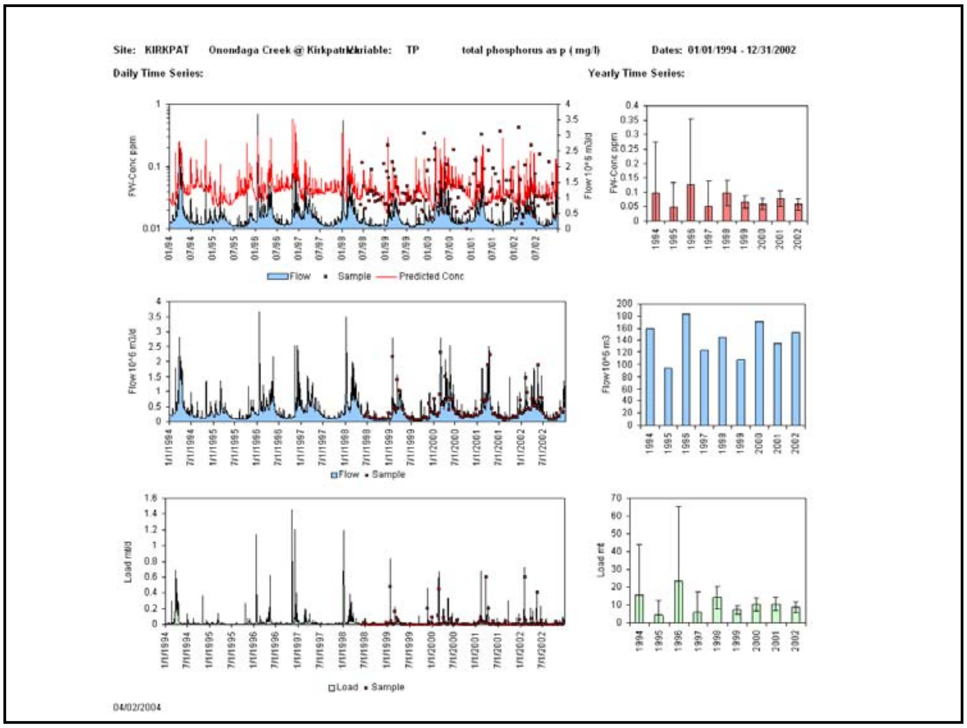
Site: OUTLET12 Lake Outlet 12 Ft Depth **Variable:** TP total phosphorus as p (mg/l) **Dates:** 01/01/1994 - 12/31/2003

Daily Time Series: **Yearly Time Series:**



09/15/2004





Analysis of Longterm Tributary Loading Database

Onondaga County Department of Water Environment Protection

Historical_Load_Analysis.xls **Version 1.0 - DRAFT** **W. Walker**

Select Sheet:

- Number of Sampled Dates by Site, Variable, & Year
- Number of Daily Records by Site & Year
- Mean Daily Flows by Site & Year
- Long-Term or Yearly Averages
- Flow-Wtd Concentrations by Variable, Site, & Year
- Mean Daily Loads by Site, Variable, & Year
- Daily Time Series for a Given Site, Variable & Year
- Month x Year Crosstab
- Monthly Time Series for a Given Site, Variable, & Year
- Yearly Time Series for a Given Site & Variable
- Lake Inflow Volumes, Loads, & Concentrations by Year
- Lake Outflow Volumes, Loads, & Concs by Variable & Year
- Daily Time Series Chart
- Monthly Time Series Chart
- Yearly Time Series Chart

View Sheet Help

Enter 'Ctrl-m' to return to menu

Click Here for General Help on Database

Click Here for Main Database Menu

3/31/2004

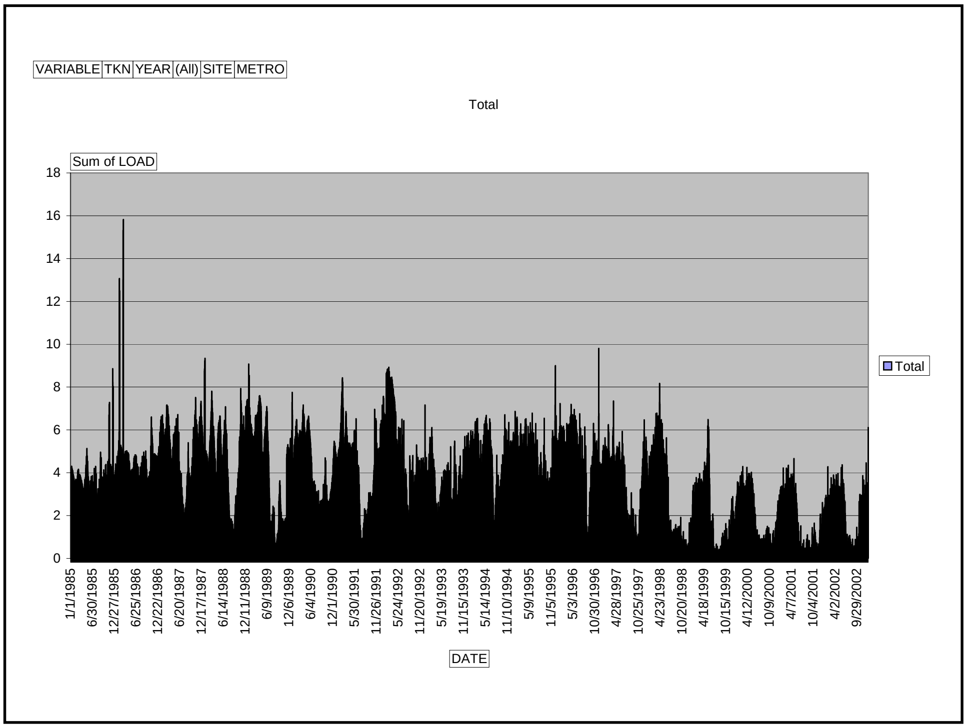
Contents of Current Database:

Years:	**1985 - 2002**
Sites:	**14**
Variables:	**21**
Records:	**1,932,756**

Years to be Analyzed: **1985** **thru** **2002**

Reconnect with Database

<- click at startup, if year range is change
after database is modified,
or if data retrieval fails



Lake Inflow Volumes, Loads, & Concentrations by Year **Variable: CA** D R A F T

Grand Total = total of gauged tributaries & point sources that discharge directly into lake

Total Flows

VARIABLE	CA
SEASON	(All)

Sum of FLOW	YEAR																	
SITE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HIAWATHA	7.6223	10.062	7.1287	5.9008	7.7467	13.296	9.2295	10.432	11.92	10.315	5.5636	10.752	6.5342	9.2361	6.6106	9.0257	8.8867	9.0735
KIRKPAT	120.88	169.88	107.92	103.99	160.88	213.95	128.14	173.05	173.84	159.49	93.533	184	122.93	145.12	107.91	170.85	135.54	153.01
PARK	29.801	45.196	26.695	31.811	34.632	55.32	32.671	44.02	57.3	33.378	27.219	44.113	28.581	34.667	25.772	38.49	37.025	37.157
RT48	121.06	154.96	109.85	84.67	142.97	227.38	136.29	164.62	163.88	148.05	81.497	168.41	98.328	143.25	87.652	150.05	113.89	124.97
METRO	100.19	105.02	95.324	97.073	101.12	107.62	93.306	94.083	79.869	95.999	85.062	96.047	88.245	96.36	83.106	91.615	86.858	88.822
BYPASS	0.3694	0.9604	1.1192	1.2938	0.5717	2.5438	0.7595	4.6993	21.163	3.5349	2.3655	3.0193	0.4801	2.1363	2.3178	1.5689	1.5125	3.4054
EFLUME	60.993	11.559	5.423	3.87	3.8028	3.8028	2.9223	1.6639	0.2627	0.2627	0.2325	0.6387	0.1546	0.2104	0.2305	0.5865	0.4182	0.4569
TRIB5A	3.4482	3.4202	3.4045	3.5894	3.5551	3.5551	3.7193	3.1628	2.9882	2.9882	2.8568	3.0494	3.0422	2.878	2.6486	3.2994	2.5364	2.7596
Grand Total	444.37	501.05	356.86	332.2	455.28	627.47	407.04	495.73	511.22	454.02	298.33	510.04	348.3	433.85	316.24	465.49	386.66	419.65

Total Loads

VARIABLE	CA
SEASON	(All)

Sum of LOAD	YEAR																	
SITE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HIAWATHA	1697.9	2092.6	1727.4	1411.7	1529.6	2479.9	1784.7	2047.1	2127.7	1949.6	1230.6	1923	1569.5	1849.7	1442.4	1826.6	1805.6	1739.1
KIRKPAT	12573	16258	11628	11740	15824	18783	13356	16702	15191	14830	10810	16468	13031	13839	11694	16652	14293	16078
PARK	3004	4404	2759.2	3477.2	3376.8	5361.6	3271.1	4124.3	5140.5	3317.4	2858.6	3985.7	3127.6	3415.9	2636.8	3854.8	3719.1	3776.8
RT48	61347	58245	48149	35351	38267	55242	41341	42253	40184	35405	25680	37001	26960	30502	23270	30683	26473	27364
METRO	122253	29390	13377	10960	11048	13768	11848	12870	8331.8	10528	9414.6	11117	11044	10440	9298.4	10696	8562.9	10528
BYPASS	41.557	121.81	126.27	140.6	68.938	276.56	86.996	518.29	2619.8	468.63	273.73	413.74	46.595	234.22	267.05	135.63	105.54	254.15
EFLUME	38084	5354.7	820.44	503.42	467.37	473.64	352.7	244.73	37.578	38.018	36.017	79.758	24.583	28.086	24.771	65.272	40.793	45.905
TRIB5A	347.74	402.78	333.05	358.74	376.92	411.92	363.69	355.68	412.51	349.32	275.03	304.16	390.79	362.69	357.04	470.84	326.85	357.19
Grand Total	239349	116268	78920	63943	70958	96798	72404	79115	74046	66886	50579	71292	56194	60672	48991	64384	55327	60143

Flow-Weighted-Mean Concentrations

VARIABLE	CA
SEASON	(All)

Sum of CONC	YEAR																	
SITE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
HIAWATHA	222.76	207.96	242.31	239.24	197.46	186.52	193.38	196.24	178.51	189.01	221.18	178.85	240.2	200.27	218.2	202.38	203.18	191.67
KIRKPAT	104.02	95.704	107.75	112.9	98.361	87.793	104.23	96.515	87.387	92.985	115.58	89.499	106	95.363	108.37	97.464	105.46	105.08
PARK	100.8	97.442	103.36	109.31	97.504	96.919	100.12	93.691	89.712	99.389	105.03	90.351	109.43	98.534	102.31	100.15	100.45	101.64
RT48	506.73	375.88	438.32	417.51	267.65	242.95	303.34	256.67	245.2	239.14	315.1	219.7	274.19	212.93	265.48	204.48	232.46	218.97
METRO	1220.2	279.86	140.33	112.9	109.25	127.94	126.98	136.79	104.32	109.67	110.68	115.74	125.16	108.35	111.89	116.75	98.586	118.53
BYPASS	112.5	126.83	112.82	108.67	120.58	108.72	114.55	110.29	123.79	132.57	115.72	137.03	97.047	109.64	115.21	86.447	69.779	74.631
EFLUME	624.4	463.27	151.29	130.08	122.9	124.55	120.69	147.08	143.02	144.7	154.91	124.87	159.02	133.49	107.48	111.29	97.539	100.48
TRIB5A	100.85	117.77	97.825	99.944	106.02	115.87	97.785	112.46	138.05	116.9	96.273	99.742	128.45	126.02	134.8	142.7	128.86	129.44
Grand Total	538.62	232.05	221.15	192.49	155.86	154.27	177.88	159.59	144.84	147.32	169.54	139.78	161.34	139.84	154.91	138.31	143.09	143.32

View Output from Time Series & Load Calculations

Onondaga County Department of Water Environment Protection

View_Output.xls **Version 1.1** **W. Walker**

Select Chart:

- Load Calculations
- Time Series
- Samples - All Sites
- Samples - All Variables
- Trends - All Sites
- Trends - All Variables
- Seasonally Adjusted Trends - All Sites
- Seasonally Adjusted Trends - All Variables
- Outliers - All Sites
- Outliers - All Variables
- Histograms - All Sites
- Histograms - All Variables

View Output

Help

Select Site:

- SOUTH_U - Lake South
- SOUTH_L - Lake South
- NORTH_U - Lake North
- NORTH_L - Lake North
- TRIB5A - Crucible Steel / Trib 5A
- DORWIN - Onondaga Ck @ Dorwin
- EFLUME - Allied Chemical Discharge
- HIAWATHA - Harbor Brook @ Hiawatha
- KIRKPAT - Onondaga Creek @ Kirkpatrick
- METRO - Metro STP Effluent
- BYPASS - Metro STP Bypass
- OUTLET12 - Lake Outlet 12 Ft Depth
- OUTLET2 - Lake Outlet 2 Ft Depth
- OUTLET_U - Lake Outlet Load/ South UL
- PARK - Ley Creek @ Park
- RT48 - Ninemile Creek @ RT48
- SPENCER - Onondaga Ck @ Spencer
- VELASKO - Harbor Brook @ Velasko

Select Variable:

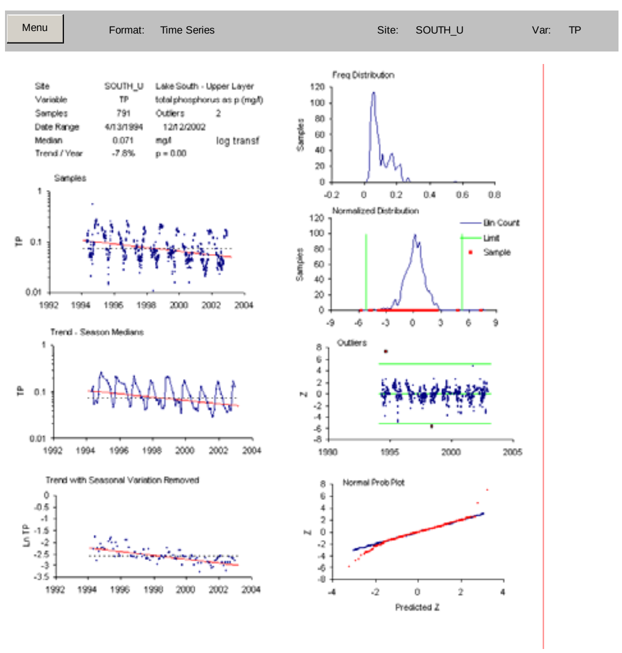
- TEMP - water temperature (deg C)
- DO_F - dissolved oxygen - meter (field) (mg/l)
- PH_F - pH measured in field (-log [h])
- COND - conductivity (field) (umHos/cm)
- ALK - alkalinity to pH 4.5 (mg/l)
- HARD - hardness (mg/l)
- TOC - total organic carbon (mg/l)
- TOC_F - filtered total organic carbon (mg/l)
- TIC - total inorganic carbon (mg/l)
- BOD5 - 5-day biochemical oxygen demand (mg/l)
- TSS - total suspended solids (mg/l)
- VSS - volatile suspended solids (mg/l)
- TS - total solids (mg/l)
- TDS - total dissolved solids (180 C) (mg/l)
- CL - chloride (mg/l)
- SO4 - sulfate (mg/l)
- NA - sodium (mg/l)
- MG - magnesium (mg/l)
- MN - manganese (mg/l)
- FE - total iron (mg/l)
- CA - calcium (mg/l)
- SIO2 - silicon dioxide (mg/l)
- FCOLI - fecal coliform (MF method) (#/100 ml)
- SECCHI - secchi depth (meters)
- CHLA - chlorophyll-a (ug/l)
- PHAEO - phaeophytin pigments (ug/l)
- TKN - total kjeldahl nitrogen (mg/l)
- NH3N - ammonia nitrogen as n (mg/l)
- ORGN - organic nitrogen as n (mg/l)
- NO3N - nitrate nitrogen as n (mg/l)
- NO2N - nitrite nitrogen as n (mg/l)
- TP - total phosphorus as p (mg/l)
- SRP - soluble reactive p (mg/l)

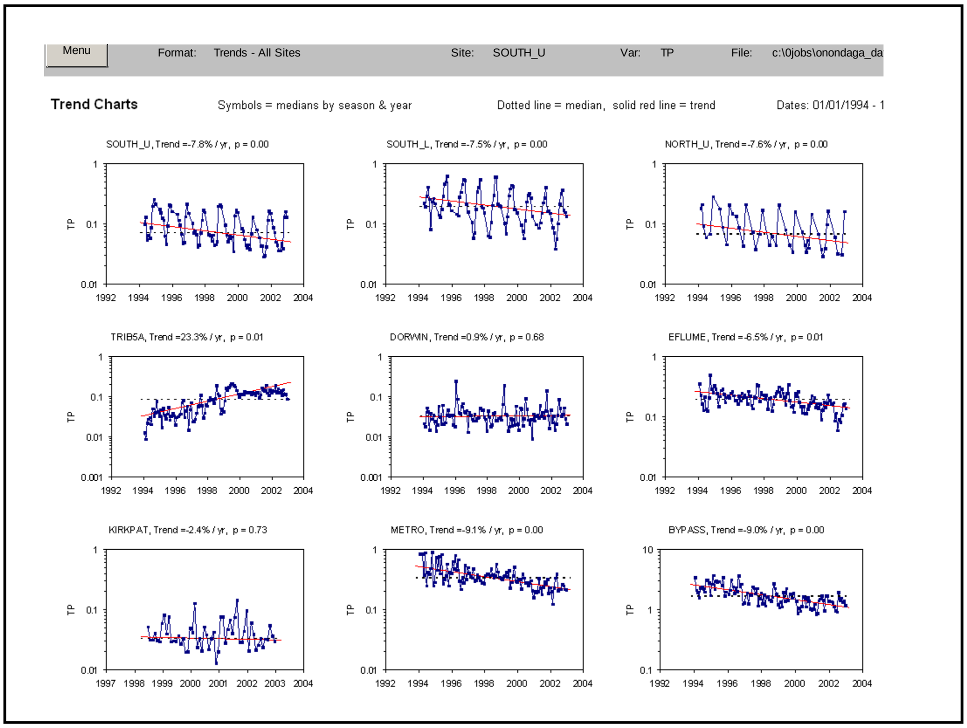
View Files in Database Subdirectory--> web/demo

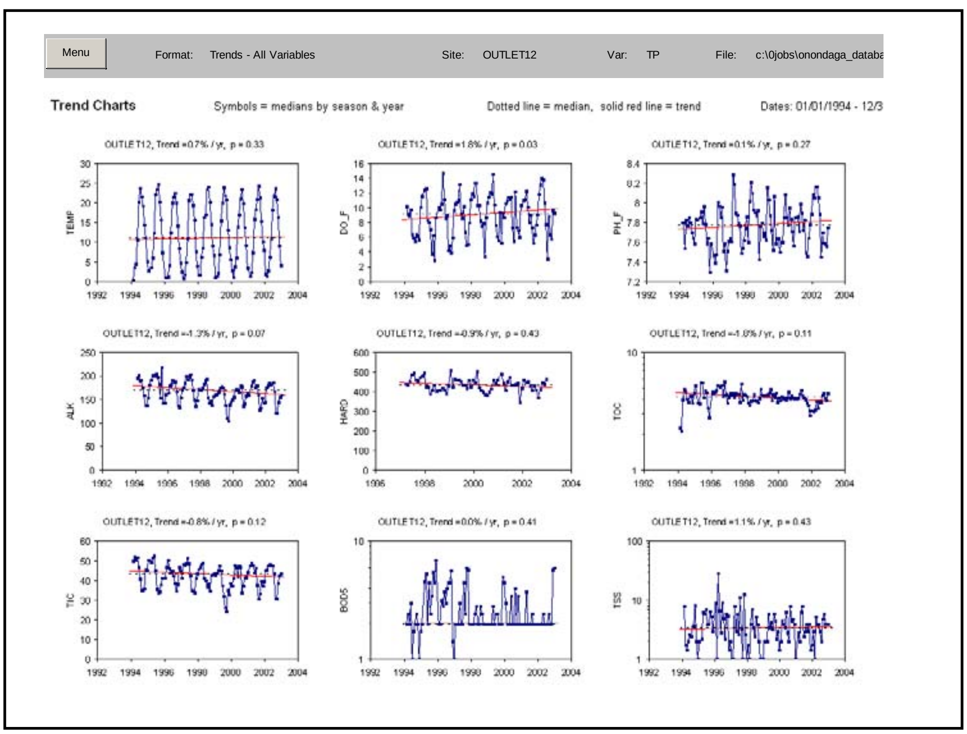
Click Here for General Help on Database

Click Here for Main Database Menu

9/13/2004




Menu
Format: Trends - All Sites
Site: SOUTH_U
Var: TP
File: c:\0jobs\onondaga_da
Trend Charts
Symbols = medians by season & year
Dotted line = median, solid red line = trend
Dates: 01/01/1994 - 1
SOUTH_U, Trend =-7.8% / yr, p = 0.00
SOUTH_L, Trend =-7.5% / yr, p = 0.00
NORTH_U, Trend =-7.6% / yr, p = 0.00
TRIB5A, Trend =23.3% / yr, p = 0.01
DORWIN, Trend =0.9% / yr, p = 0.68
EFLUME, Trend =-6.5% / yr, p = 0.01
KIRKPAT, Trend =-2.4% / yr, p = 0.73
METRO, Trend =-9.1% / yr, p = 0.00
BYPASS, Trend =-9.0% / yr, p = 0.00
TP


Menu
Format: Trends - All Variables
Site: OUTLET12
Var: TP
File: c:\0jobs\onondaga_databa
Trend Charts
Symbols = medians by season & year
Dotted line = median, solid red line = trend
Dates: 01/01/1994 - 12/3
OUTLET12, Trend =0.7% / yr, p = 0.33
OUTLET12, Trend =1.8% / yr, p = 0.03
OUTLET12, Trend =0.1% / yr, p = 0.27
OUTLET12, Trend =-1.3% / yr, p = 0.07
OUTLET12, Trend =-0.9% / yr, p = 0.43
OUTLET12, Trend =-1.0% / yr, p = 0.11
OUTLET12, Trend =-0.8% / yr, p = 0.12
OUTLET12, Trend =0.0% / yr, p = 0.41
OUTLET12, Trend =1.1% / yr, p = 0.43
TEMP
DO_F
PH_F
ALK
HARD
TOC
TIC
BOD5
TSS

Microsoft Excel Help

Tributary Load Calculations

File: Load_Calculations.xls

Features

Computes daily loads for selected sites, variables, & date intervals (1985-present).
Concentration and flow data are retrieved from the access database.
Output is summarized on an average, yearly, and monthly basis within the workbook.
Produces a daily output file that can be appended to the historical loading database and subsequently analyzed.
See general instructions for installation and the user interface.

Computation Methods

Select default method on the menu:

1. Flow-wtd-mean conc, 1 flow stratum
2. Flow-wtd-mean conc, 2 flow strata (~AUTOFLUX method)
3. Interpolation (concentration vs. date)
4. Multiple regression vs. flow, season, & date
5. Method 4 with residual interpolation (recommended)

Each method uses only those samples collected on dates with positive flow.
Methods 3 -5 require at least 20 samples, otherwise Method 2 is used.
Method 2, in turn, requires at least 2 samples per flow stratum, otherwise Method 1 used.
Mean loads computed using each method are displayed on the menu sheet.
Time series results are provided only for the selected method.

Regression Algorithm

Adapted from: Walker & Havens, 2003 See Equations.

Steps:

Regression Algorithm

Adapted from: Walker & Havens, 2003   See Equations.

Steps:

1 Retrieve Daily Flows for Desired Period and Site from Access Database
2 Retrieve Concentrations for Desired Period, Site, & Parameter from Database
3 Average Sample Concentrations by Day
4 Pair Mean Daily Flow with Mean Daily Sample Concentrations
5 Calibrate Regression Model Relating Concentration to Flow, Season, & Trend
6 Apply Regression Model to Each Sampled Date
7 Compute Residual for Each Sampled Date = Ln (Observed / Predicted Conc)
8 Compute Residual for Each Day by Interpolating between Sampling Events
9 Apply Regression Model to Each Day in Period
10 Combine Predicted Concentrations & Interpolated Residuals on Each Day
11 Multiply Concentration by Mean Daily Flow to Compute Mean Daily Load
12 Store Daily Results in a Text File for Later Uploading to the Historical Loading Database
13 Summarize Results on Monthly, & Yearly Time Intervals
14 Compute Standard Error of Mean Load Estimate for Each Year and the Entire P

Development and Application of a Phosphorus Balance Model for Lake Istokpoga, Florida

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South Florida Water Management District
3301 Gun Club Rd.
West Palm Beach, Florida 33416
E-mail: khavens@sfwmd.gov

No.	Equation
1	$\text{Ln}(C_S) = F(\text{Flow, Season, Trend}) + \text{Error}$
2	$F = A_0 + B_0 + B_1 X + B_2 X^2 + B_3 X^3 + B_4 \text{Sin}(\theta) + B_5 \text{Cos}(\theta) + B_6 (T)$
4	$A_0 = SE^2 / 2$
3	$R_S = \ln(C_S / F)$
4	$R_T = \text{Interpolate}(R_S)$
5	$C_T = \text{Exp}[\, F(\text{Flow, Season, Trend}) + R_T \,]$
6	$L_T = Q_T\ C_T$
7	$CV_L = \{\Sigma\,[Q(C_S - F)]^2 / (N_S - 7)\}^{1/2} / \{\Sigma\ Q\ C_S / N_S\}$
8	$RSE_L = CV_L / N_S^{1/2}$

Symbol	Description
C_S	mean daily concentration for sample date S
$B_0 - B_6$	regression coefficients
X	maximum (Q, Q_{MIN} / 2), allows for inclusion of 0 flows in regression
Q	mean daily flow on sample date (million m^3 / day)
Q_{MIN}	minimum daily flow, excluding days with no flow
θ	season index = $2\Pi\ J / 365$
J	julian day = day of year
T	excel date sequence number (days from Jan 1, 1900)
A_0	adjustment for transformation of log regression back to linear scale
SE	regression standard error of estimate
R_S	regression residual for sample date S
R_T	residual for day T, interpolated between adjacent sample dates (R_S)
C_T	predicted mean concentration for day T
L_T	predicted mean load for day T
S_L	standard error of mean load for entire period
Σ	sum over all sample dates
N_S	number of sample dates
CV_L	residual load coefficient of variation
RSE_L	relative standard error of average load estimate

Flux and Sources of Nutrients in the Mississippi–Atchafalaya River Basin

Topic 3 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico

Donald A. Goolsby, William A. Battaglin, Gregory B. Lawrence, Richard S. Artz, Brent T. Aulenbach, Richard P. Hooper, Dennis R. Keeney, and Gary J. Stensland

May 1999

4.1.1 Model Structure

Consistent with many past studies (e.g., Cohn et al. 1992), a seven-parameter model was fit of the form

$$\ln[\phi] = \beta_0 + \beta_1 \ln[Q/\overline{Q}] + \beta_2 (\ln[Q/\overline{Q}])^2 + \beta_3[T - \overline{T}]$$

$$+ \beta_4[T - \overline{T}]^2 + \beta_5 \sin[2\pi T] + \beta_6 \cos[2\pi T] + \varepsilon \qquad (1)$$

where:

ln[]	is the natural logarithm of the argument in brackets
Φ	is the flux of the solute ($C \bullet Q$)
C	is the solute concentration
Q	is the daily average discharge
$\overline{Q}$	is a centering term (a constant) to ensure that the linear and quadratic flow terms are independent
T	is time, expressed in decimal years and
$\overline{T}$	is a centering term (a constant) to ensure that the linear and quadratic time terms are independent
ε	is the error term
$\beta_0 \ldots \beta_6$	are the fitted parameters in the multiple regression model

APPENDIX 4: MASS-BALANCE MODELING - 2001

DEVELOPMENT OF DAILY LOAD ESTIMATES

Under the existing mass-balance framework (Figure 1), the AUTOFLUX program is used develop annual and seasonal (May-September) load estimates for each year, tributary, and water quality constituent. Load estimates on a shorter time scale would be needed to evaluate seasonal factors discussed above and to support development of a mechanistic water quality model of the Lake. This section evaluates the potential for upgrading the framework to provide daily load estimates for each source using the same flow and concentration data that are used in the current framework.

Simulation of lake dynamics would not necessary require accurate estimation of variations in loads on a day-to-day basis. Lake response to daily load variations are dampened by the relatively large volume of water stored in the Lake. Estimation of loads on a daily basis is convenient, however, given the availability of daily flow data. Load time series for other period (weekly, monthly, seasonal, annual) can be readily computed from the daily series.

Figure 8 suggests that the correlation between TP concentration and flow varies with season in Onondaga Creek. At a given flow, concentrations tend to be much higher in the summer and early fall (June – October), as compared with the rest of the year. Similar patterns may be present in other creeks. The relatively high AUTOFLUX loading estimate for 2001 (Figure 7) may reflect the assumption that the concentration distributions under spring high flows and the September storm are similar. If the alternative algorithm is used to estimate creek loads in 2001, the total nonpoint load decreases from 38,000 ± 6,000 kg to 25,000 kg and the total lake load decreases from 62,000 ± 6,000 kg to 49,000 kg.

Refinement of the mass balance framework to generate daily load estimates would serve lake modeling needs and appears to be feasible using recent monitoring data than include periodic, high-flow, and storm-event sampling. Because the regression/interpolation algorithm accounts for factors that are not considered in the existing AUTOFLUX algorithm, it is possible that the refined framework would improve the accuracy and precision of annual load estimates, as well. Further refinement of the regression/interpolation algorithm, including application to data for other constituents and development of methods for estimating precision, is recommended.

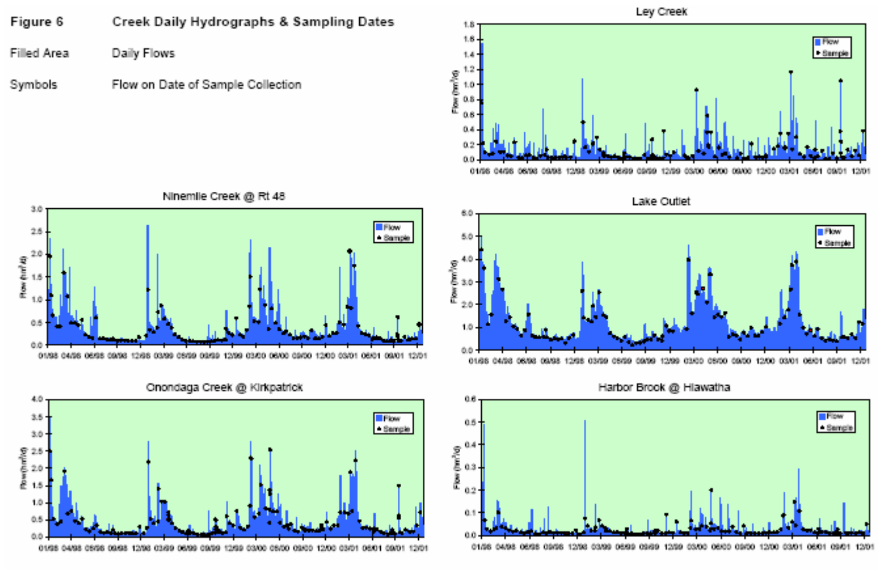


Figure 6
Creek Daily Hydrographs & Sampling Dates
Filled Area
Daily Flows
Symbols
Flow on Date of Sample Collection
Ley Creek
Ninemile Creek @ Rt 48
Lake Outlet
Onondaga Creek @ Kirkpatrick
Harbor Brook @ Hiawatha

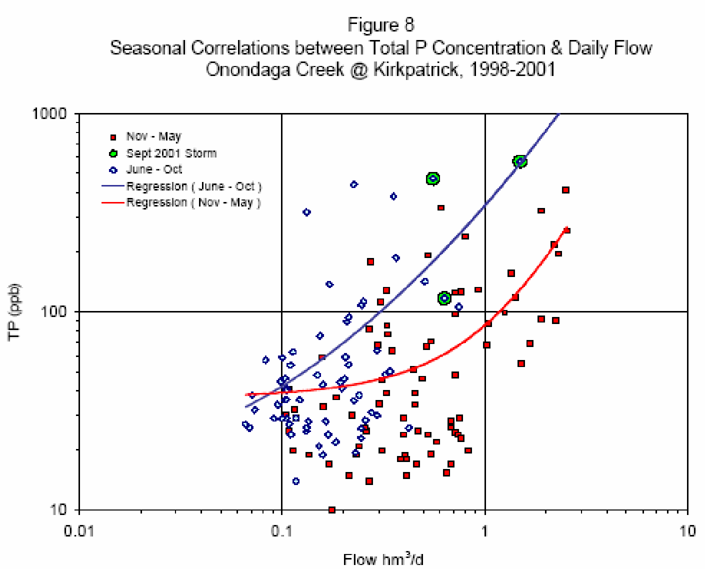
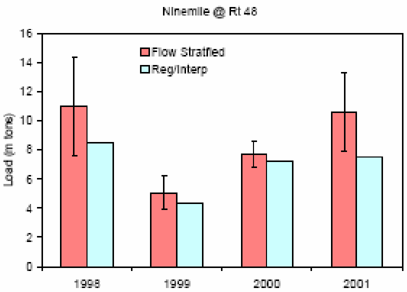
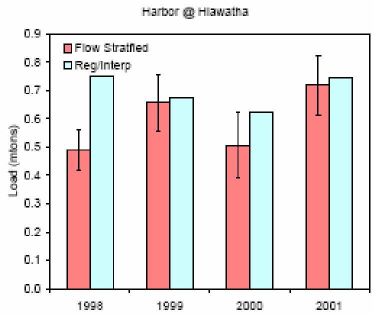


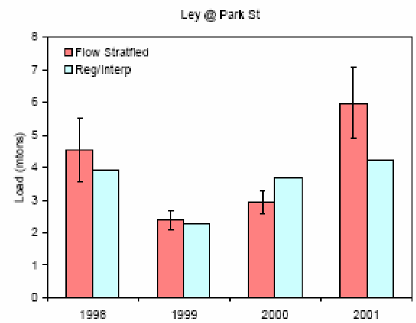
Figure 8
Seasonal Correlations between Total P Concentration & Daily Flow
Onondaga Creek @ Kirkpatrick, 1998-2001
Nov - May
Sept 2001 Storm
June - Oct
Regression (June - Oct)
Regression (Nov - May)
TP (ppb)
1000
100
10
0.01
0.1
1
10
Flow hm³/d

Figure 7
Yearly Total P Loads Estimated Using Two Methods

Units	Metric Tons per Year
Flow Stratified	AUTOFLUX with 2 Flow Strata Mean +/- 1 Standard Error
Reg/Interp	Regression & Interpolation Algorithm Sum of Daily Loads







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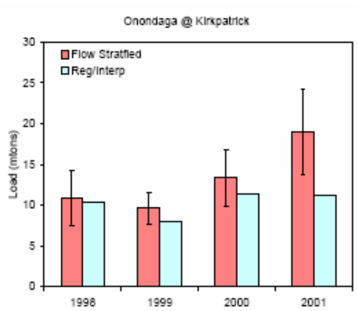
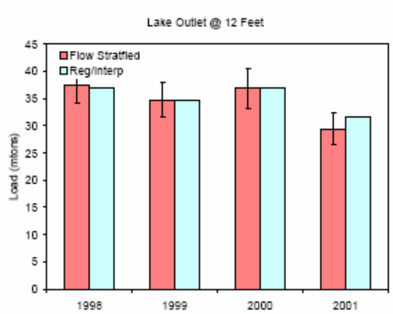
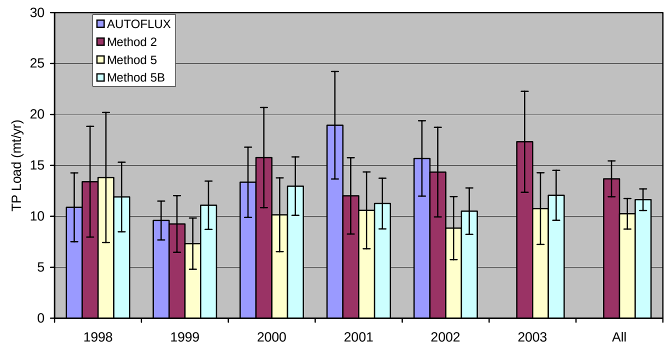


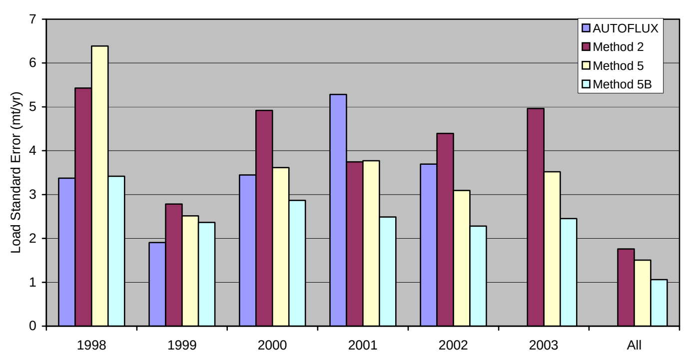


Comparison of Yearly TP Load Estimates **Onondoaga Creek @ Kirkpatrick**



AUTOFLUX	AUTOFLUX, 2 Flow Strata, Computed Separately in Each Year (in yearly AMP reports <=2002)
Method 2	2 Flow Strata, flow-weighted mean concentrations in each high and low flow stratum, pooled across years
Method 5	Regression with Residual Interpolation
Method 5B	Modified Regression (with Flow Derivative Term) and Residual Interpolation

Precision of Yearly TP Load Estimates **Onondoaga Creek @ Kirkpatrick**



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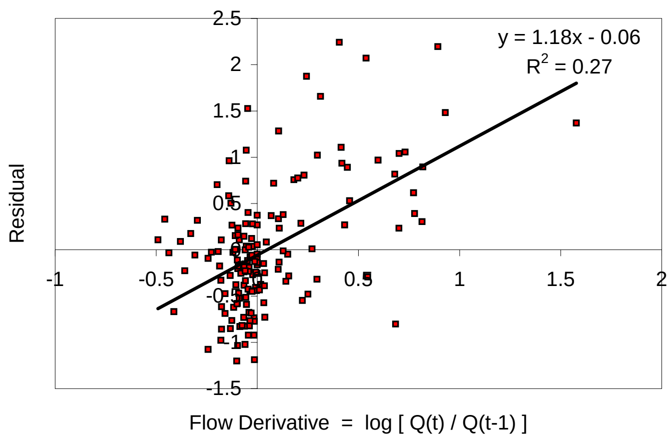
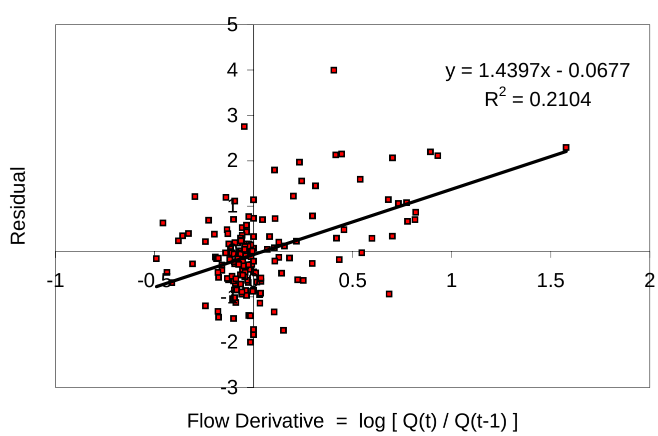
Method 5B	Modified Regression (with Flow Derivative Term) and Residual Interpolation

Regression Residuals vs. Flow Derivative
Onondaga Creek @ Kirkpatrick, 1998-2003 TP



Residual = ln (Observed / Predicted Sample Concentration)

Regression Residuals vs. Flow Derivative
Onondaga Creek @ Kirkpatrick, 1998-2003 TSS



Residual = ln (Observed / Predicted Sample Concentration)

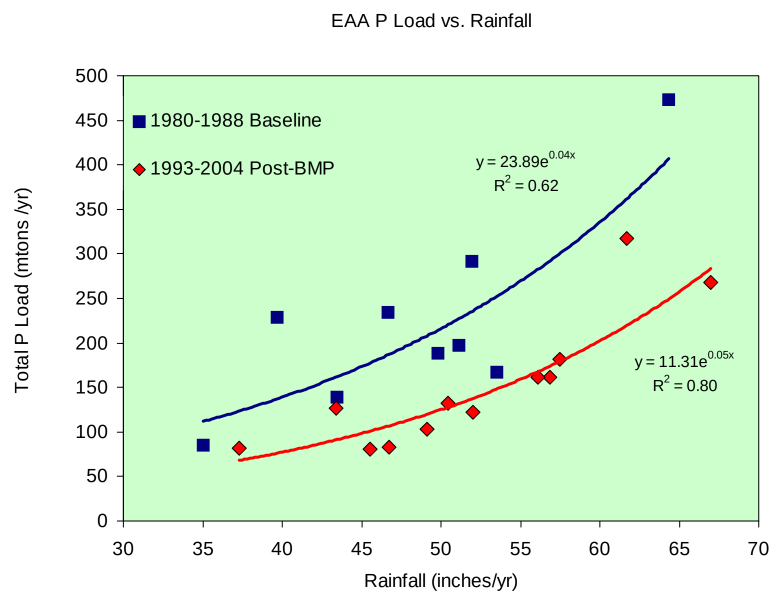


Table 3: Total Phosphorus Balance for 1998-2002

Variable: Total Phosphorus **Average for Years:** 1998 thru 2002 **Season:** Year

Term	Flow 10^6 m3	Load kg	Std Error kg	Conc ppb	RSE %	Percent of Total Inflow: Sampl per yr	Flow %	Load %	Error %	Drain. Area km2	Runoff cm	Export kg / km2
Metro Effluent	89.35	28745	281	322	1%	365	21%	47%	2%			
Metro Bypass	2.19	2568	77	1174	3%	40	1%	4%	0%			
East Flume	0.50	95	6	191	6%	28	0%	0%	0%			
Crucible	2.82	373	10	132	3%	28	1%	1%	0%			
Harbor Brook	8.56	704	118	82	17%	30	2%	1%	0%	29.3	29.2	24.0
Ley Creek	34.40	3965	330	115	8%	30	8%	6%	3%	77.5	44.4	51.2
Ninemile Creek	124.13	9149	963	74	11%	29	29%	15%	24%	298.1	41.6	30.7
Onondaga Creek	142.49	13688	1655	96	12%	31	33%	22%	70%	285.1	50.0	48.0
Nonpoint Gauged	309.58	27506	1947	89	7%	120	72%	45%	96%	690.0	44.9	39.9
Nonpoint Ungauged	16.61	1476	229	89	15%	0	4%	2%	1%	37.0	44.9	39.9
NonPoint Total	326.19	28982	1960	89	7%	120	76%	47%	98%	727.0	44.9	39.9
Industrial	3.32	467	12	141	2%	55	1%	1%	0%			
Municipal	91.54	31313	291	342	1%	405	21%	51%	2%			
Total External	421.05	60762	1982	144	3%	581	98%	99%	100%	727.0	57.9	83.6
Precipitation	10.65	320	29	30	9%	0	2%	1%	0%	11.7	91.0	27.3
Total Inflow	431.70	61081	1982	141	3%	581	100%	100%	100%	738.7	58.4	82.7
Evaporation	8.86						2%			11.7	75.7	
Outflow	422.84	34216	1483	81	4%		98%	56%	56%	738.7	57.2	46.3
Retention	0.00	26865	2475		9%		0%	44%				
Alternative Estimates of Lake Output												
Outlet 12 Feet	422.84	34216	1483	81	4%	26	98%	56%	56%	738.7	57.2	46.3
Outlet 2 Feet	422.84	32232	1313	76	4%	26	98%	53%	44%	738.7	57.2	43.6
Lake Epil	422.84	31890	1368	75	4%	22	98%	52%	48%	738.7	57.2	43.2
Upstream/Downstream Contrast- Harbor Brook												
Upstream - Velasko	8.03	365	57	45	16%	28	2%	1%	0%	25.9	31.0	14.1
Downstream - Hiawatha	8.56	704	118	82	17%	30	2%	1%	0%	29.3	29.2	24.0
Local Inflow	0.53	339	131	643	39%		0%	1%	0%	3.4	15.6	100.5
Upstream/Downstream Contrast - Onondaga Creek												
Upstream - Dorwin	109.29	7925	768	73	10%	31	25%	13%	15%	229.4	47.6	34.5
Downstream - Kirkpatrick	142.49	13688	1655	96	12%	31	33%	22%	70%	285.1	50.0	48.0
Local Inflow	33.20	5763	1824	174	32%		8%	9%	85%	55.7	59.6	103.4

Lake Overflow Rate 36.14 m/yr Calib. Settling Rate 28.4 m/yr RSE % = Relative Std. Error of Load & Inflow Conc. Estimates
Lake Residence Time 0.30 years Calib. Retention Coef. 44% Error % = Percent of Variance in Total Inflow Load Estimate

Potential Refinements to Load Computations

- Include Flow Derivative Term in Regression
- Include Quadratic Trend Term in Regression
- Refine Log-Normal Bias Correction Factor
- Algorithm for Processing of Storm Event Samples
- Trend Analysis with Rainfall Adjustment
- Integrate with Lake Mass Balance Framework
- Verify Database Update Process