RAMAKER
& ASSOCIATES, INC.
Consulting Engineers

LAKE MONTELLO LIMITED PHOSPHORUS BUDGET

LAKE MONTELLO PROTECTION & REHABILITATION DISTRICT
MONTELLO, WISCONSIN

May 28, 2004

LPL-780-02

1120 Dallas Street, Sauk City, Wisconsin 53583 ▲ Voice: 608-643-4100 Fax: 608-643-7999
Web: http://www.ramaker.com

LAKE MONTELLO
PHOSPHORUS BUDGET

SITE: Lake Montello
Township of Montello
Marquette County, Wisconsin

PREPARED FOR: Montello Lake Protection and Rehabilitation District
P.O. Box 172
Montello, WI 53949-0172

BOARD OF DIRECTORS (2003): Nick Krmpotich, President
Jim Neeb, Secretary
Patty Fritsche, Treasurer
Jack Elmore, County Representative
Deb Buchholz, City Representative

PREPARED BY: Ramaker & Associates, Inc.
1120 Dallas Street
Sauk City, Wisconsin 53583
Telephone: (608) 643-4100
Fax: (608) 643-7999

RAMAKER PROJECT#: 4430

DATE: May 28, 2004

Ben Christianson, P.H.
Professional Hydrologist

5/28/04
Date

Michael Pinske, P.E.
Project Engineer

5/28/04
Date

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EXECUTIVE SUMMARY

This report is intended to quantify sources of phosphorus loading into Lake Montello. This information is necessary to determine high nutrient-loading areas, and to select the management techniques that are most cost-effective and best designed to address these problem areas.

The majority of Lake Montello's phosphorus is from external loading. The Montello River and other local runoff are estimated to contribute phosphorus loading at the rate of 7,180 kg/yr. Based on this study, the external loading accounts for 84% of all phosphorus loading.

In this study the external phosphorus loading was divided into two categories, loading from the Montello River, and loading from local runoff in what is defined as the "direct tributary area." The direct tributary area is the area within the Montello River Watershed that drains into Lake Montello directly, or drains into the Montello River, downstream of the 11th Road Bridge. Loading from the Montello River accounts for runoff from the majority of Montello River Watershed that drains into the Montello River upstream of the 11th Road Bridge. The Montello River loading accounts for roughly 81% of the external loading. The direct tributary area accounts for the remaining 19% of external loading.

The Canfield-Bachmann Artificial Lake model predicts the Lake Montello in-lake phosphorus concentration should be between of 46 mg/m^3 to 71 mg/m^3. The model predicted the most likely total phosphorus concentration would be 54 mg/m^3. The predicted range was compared to the total phosphorus concentrations measured in historic lake sampling from 1995 to 2002. The historic total phosphorus sampling results fell within this range 16 times out of a total 29 samples, or 55% of the time. The samples that fell outside of the predicted range were below the range 6 times and above the predicted range 7 times. Ideally, the in-lake total phosphorus concentrations would fall within the predicted range 70% of the time.

The in-lake total phosphorus concentrations measured on August 28, 2002 were 61 mg/m3 and 116 mg/m3. The average of the 2 values is 88.5 mg/m3.

The Canfield-Bachmann Artificial Lake model predicts with 70% confidence a phosphorus concentration between of 46 mg/m3 to 71 mg/m3, with the most likely concentration being 54 mg/m3. The average of in-lake phosphorus concentrations listed on the historic sampling summary table is 71 mg/m3. It is reasonable to believe that in-lake phosphorus recycling processes could account for the differences. If the difference between the estimated 54 mg/m3 and the historic average 71 mg/m3 phosphorus were attributed to in-lake processes the in-lake processes would be contributing an additional 1380 kg/yr to the overall loading. In this case the internal recycling would be contributing 16% of the total loading.

In conclusion, the majority of Lake Montello's phosphorus is coming from external loading. Phosphorus concentrations in the lake are largely a reflection of phosphorus loading from the Montello River. Additional runoff loading is enters the lake from the direct tributary area. Internal phosphorus loading accounts for the remainder of the phosphorus loading. This budget estimates that the Montello River accounts for 81% of the external loading. Runoff from the direct tributary accounts for the remaining 19% of external loading. Shallow water depths in conjunction with high nutrient inputs nutrient inputs from the surrounding watershed have resulted in an upper mesotrophic to eutrophic system. The present conditions have resulted in nuisance weed growth. To reduce phosphorus loading to the lake would require land management practice changes over significant percentages of the Montello River watershed. These changes would be beneficial and are encouraged, although it is unlikely that the Lake District could encourage these changes in a manner that they would be implemented and effective in the short term. It is therefore likely that weed control measures such as the ones that have been implemented recently, are the best approach to weed control at this time. The effectiveness of the drawdown that was conducted in the winter of 2002 to 2003 is being evaluated at this time. The Lake District is also experimenting with chemical control measures targeting specific areas of the lake. We recommend that the Lake District explore and encourage land use practices that minimize phosphorus loading from runoff.

We also recognize that the in-lake weed control measures will likely be the most effective in the near term.

This Executive Summary is provided for the reader's convenience and should be considered a part of the appended report. Interpretation of this summary should be considered incomplete without reviewing the entire phosphorus budget and associated appendices.

ACKNOWLEDGMENTS

Ramaker & Associates thanks the following people who contributed to the development of this limited phosphorus budget: Mr. Jim Neeb of the Montello Lake Protection & Rehabilitation District; Mr. John Panuska of the Wisconsin Department of Natural Resources; Mr. Mark Sesing of the Wisconsin Department of Natural Resources; and Mr. James Hebbe of the Marquette County Conservation Department.

SECTION 1
INTRODUCTION

The Montello Lake Protection and Rehabilitation District retained Ramaker & Associates, Inc. to complete a limited phosphorus budget for Montello Lake in Marquette County, Wisconsin.

1.1 BACKGROUND

Montello Lake is an impounded section of the Montello River, located adjacent to the City of Montello and within the Town of Montello in Marquette County, Wisconsin (T15N, R10E, S5-8). The lake is characterized as a drainage lake with one regulated outlet. According to *Wisconsin Lakes*, WDNR Publication FH-800, 2001, the surface area of Lake Montello is 286-acres. It is a small, shallow system that is highly productive as a result of nutrient-enrichment.

A lake management plan was developed in March 2002 in response to concerns raised lake residents regarding the deterioration of Montello Lake's water quality. According to the Montello Lake Protection and Rehabilitation District (the lake district), present lake conditions (namely excessive aquatic plant and algae growth) were interfering with desired lake uses and jeopardizing the long-term health of the lake.

In December 2001, the Lake District granted approval to prepare a phosphorus budget by contracting with the engineering consulting firm of Ramaker & Associates, Inc. An $8,681.83 matching grant, awarded through Wisconsin's Lake Planning Grant Program, was used in conjunction with local revenues to fund the project.

1.2 PURPOSE OF REPORT

The purpose of the phosphorus budget was to evaluate sources of phosphorus loading. The phosphorus loading comparisons should allow the Lake Protection & Rehabilitation District to focus management efforts accordingly.

SECTION 2

ANALYSIS OF EXISTING LAKE & WATERSHED DATA

In order to evaluate the total phosphorus loading, the existing lake and watershed data was evaluated. Lake dimensions and watershed land use information were obtained from the WDNR in digital format. The data is from GEODISC 3.0, a Geographic Information Datasharing CD-ROM produced by the Wisconsin Department of Natural Resources, Bureau of Enterprise Information Technology and Applications, Geographic Services Section (DNR/GEO). This data was last updated on October 22, 1998.

2.1 LAKE AND WATERSHED DATA

Montello Lake is part of a 126.3 square mile watershed. This watershed area was determined by delineating the watershed on topography (quadrangle) maps. For the purposes of developing a land use summary, Ramaker & Associates, Inc. overlaid the watershed onto GIS data provided by the WDNR. By doing this with GIS techniques, the total area of land considered increases slightly because the land information system used by GIS does not correspond perfectly with the watershed boundary. The GIS considers land in square increments (30 meters x 30 meters) that may extend out of the watershed somewhat. This difference is not considered significant. The land use analysis indicates that the watershed contains 83,319 acres (130.2 square miles). The following table summarizes the land use.

Montello River Watershed Land Use/Land Cover		
General Land Use/Cover	**Type**	**Watershed Area (Acres)**
Urban/Developed	High Intensity	239
	Low Intensity	429
Agriculture	Other Agriculture	1354
	Corn	9248
	Other Row Crops	8040
	Forage Crops	8040
	Cranberry Bog	1
Grassland	Grassland	14873
Forest	Jack Pine	507
	Red Pine	507
	Mixed/Other Coniferous	492
	Oak	19114
	Mixed/Other Broad Leafed	2637
	Mixed/Deciduous/Coniferous	6292
Water	Open Water	1555
Wetland	Emergent/Wet Meadow	1555
	Broad Leafed Deciduous	2256
	Broad Leafed Deciduous	3516
	Coniferous	2338
Barren	Barren	143
Shrubland	Shrubland	183
		83,319

Land use within the watershed of Montello Lake is 35% wooded, 32% agricultural, 18% grassland, 12% wetland, 2 % open water, and 1% urban/residential. Approximately 65% of the agricultural land is farmed intensively with row crops such as corn. This type of land use is known to contribute significant quantities of sediment-laden runoff and nutrient loads to receiving water bodies, especially if runoff control measures (known as Best Management Practices or BMPs) are not implemented. Results from a recent watershed inventory study and a watershed land use map have been included in Figure 1 of this report.

Water samples were collected from Montello River upstream from Lake Montello during the 2002 growing season. The samples were collected by Jim Neeb of the Montello Lake Inland Protection & Rehabilitation District. Samples were collected from the Montello River (upstream and downstream from Lake Montello) as well as from Lake Montello itself. Samples were collected at the 11th Road Bridge on the Montello River, approximately 1 mile upstream from Lake Montello, on 12 sampling events from April 4, 2002 to October 8, 2002. The water samples were analyzed for total phosphorus, dissolved reactive phosphorus, and total solids. The concentrations are all reported in micrograms per liter (µg/l) or parts per billion (ppb). These concentrations are also equivalent to milligrams per cubic meter (mg/m^3). A summary of the sample results has been included in Table 1 of this report. Copies of the State Hygiene Lab reports have been included as Appendix C.

Lake samples were collected on August 28, 2002 from two different locations on Lake Montello, and the Montello River below the Lake Montello Dam. The lake samples were collected from the channel adjacent to Jim Neeb's property (Site A) and from the deepest area near the dam (Site B). The sample collected below the dam was collected 200-feet downstream of the Montello dam.

Samples were collected from upstream locations on January 26, 2003. The samples were collected at the Harrisville Bridge on the Montello River (at the outlet of Harris Pond) approximately 6 miles upstream from Lake Montello, the Pioneer Bridge on Westfield Creek approximately 13 miles upstream of Lake Montello, the Lawrence Creek Headwater Bridge, and from the Lawrence Bridge (at the outlet of Lake Lawrence) approximately 15.5 miles upstream of Lake Montello.

The in lake sampling data collected during 2002 is very limited and it is difficult to draw conclusions regarding the relation of phosphorus concentrations in the Montello River upstream of the lake and the in-lake concentrations. The average total phosphorus concentration in the upstream samples collected at the 11th Road Bridge was 60 mg/m^3. The average total phosphorus concentration measured in the in-lake samples on August 28, 2002 was 88.5 mg/m^3. The average suspended solids concentration in the Montello River samples was 12,250 mg/m^3. The average in-lake suspended solids concentration was 5,000 mg/m^3.

The water samples were also analyzed for dissolved reactive phosphorus (DRP). The average DRP concentration in the samples collected from the Montello River was 23 mg/m^3. The average DRP of the two in-lake samples on August 28, 2002 was 23 mg/m^3.

There is historic in-lake data that has been compiled by the USGS and has been included as Table 2 of this report. The sampling summarized in this table was conducted between 1995 and 1998. The samples from 2002 are also included on the table. The average in-lake total phosphorus concentration was 71 mg/m^3.

2.2 LAKE TYPE

Lake Montello is considered to be a drainage lake. A drainage lake is defined by a lake having a prominent inlet and outlet that serve to move water through the system. Montello Lake has one major inlet and outlet, the Montello River, which enters at its northwest corner and exits through a hydroelectric dam at its southeast corner, eventually feeding into the Fox River. There is also one minor, unnamed inlet on the northeast side of the lake. Drainage lakes are referred to as artificial lakes or impoundments when a dam is responsible for at least one-half of their maximum depth, as is the case with Montello Lake.

Montello Lake has a surface area of 0.53 square miles (340 acres), with 6.5 miles of shoreline. The lake is 17 feet at its deepest point, has a mean depth of 5 feet, and contains an average of 1,676 acre-feet of water. It should be noted that the above noted lake acreage was derived from map data obtained from the DNR in electronic form. The lake acreage listed for Lake Montello in the WDNR lake book is 286-acres. The difference in areas may be due to the amount of the inlet that is included as lake surface. The digital DNR data indicating the area as 340-acres was use in this modeling exercise.

Montello Lake is also described as a shallow water body. Shallow lakes tend to be more productive than deep

lakes due to a number of factors. These factors include the large area of bottom sediments relative to the volume of water, more complete wind mixing of the water column, and the large, shallow areas along the lake perimeter that can be colonized by rooted and floating aquatic plants (also known as the littoral zone).

Daily flow rates from the Montello dam were used to calculate an annual mean discharge rate from the Montello dam. Annual mean discharge at the outlet is the volume of water that exits the system over a one-year time period. The annual discharge is necessary to calculate the lake's flushing rate (average length of time water resides in the lake), or hydraulic retention time. Retention time is important in determining the impact of nutrient inputs. For instance, long retention times result in greater nutrient retention in most lakes. Finally, annual discharge is used as an input variable in a number of lake-modeling applications. The annual mean discharge rate was calculated to be 108.0 cubic hectometers/year or 87,600 acre-feet/year. This is equivalent to a daily mean discharge rate of 240 acre-feet/day. Bathymetry calculations based on data provided by the WDNR indicate that volume of Lake Montello is 1,676 acre-feet. The retention time of a lake is equal to the volume of the lake divided by the discharge rate. Based on the above data, the retention time of Lake Montello is 7 days. This retention time calculation assumes that the amount of water exiting the lake by means of evaporation and groundwater is negligible compared to the discharge from the dam.

2.3 LAKE DATA ADJUSTMENTS

The operator of the Lake Montello dam, North American Hydro, provided Ramaker & Associates, Inc. with daily power production, spillway gate opening status, and lake stage data for 1993 through 2002. North American Hydro also provided data linking flow volume to power production and lake stage data. Both flow through the hydro-electric generation system, and flow through the spillway were considered in calculating the daily mean discharge rate.

Ramaker used the North American Hydro daily flow data from October 9, 2001 through October 8, 2002 to estimate yearly mean flow and loading rates. The flow records were missing data for 27 days of the one-year time period used in the flow model. The missing data points were substituted with the average of the discharge rates from the day before and the day after the missing dates. The days with missing data were roughly spaced out over the year. The Lake Montello Discharge data is included in Appendix C of this report. Lake stage data for this time period is also included in Appendix B.

The Montello dam has a sluice gate with a top elevation of 783.6 feet, and sill elevation of 777.5 feet. The width of the sluice gate is 3.5 feet. The dam also has 3.5 foot wide, spill slide with a top elevation of 783.4 feet and sill elevations of 778.5 feet and 733.4 feet.

SECTION 3

METHODS OF ESTIMATING TOTAL PHOSPHORUS CONCENTRATIONS

3.1 WISCONSIN LAKE MODELING SUITE (WILMS)

The WiLMS model setup has three modules that account for hydrologic & morphometric factors, non-point source loading, and point source loading. In the Lake Montello phosphorus budget model, we considered the Montello River to be point source loading. The point source loading accounts for runoff from the Montello River Watershed. In this case, we are defining the Montello River watershed as the portion of the watershed area that drains into the Montello River upstream of the 11th Road Bridge. This area excludes the direct tributary area described below.

The direct tributary area was accounted for as non-point source loading. The direct tributary area is defined as the portion of the Montello River watershed that drains into Lake Montello without first draining into the Montello River, upstream of the of the point in the river where samples were collected in 2002 (the 11th Road Bridge). The direct tributary area drains either directly into the lake, into the Montello River downstream of the 11th Road Bridge, or into the smaller tributary that enters the lake east of the Montello River. A map of the direct tributary area has been included as Figure 2.

Hydrologic & Morphometric Module

The inputs for this module are explained below. The input terms and definitions were taken from the Wisconsin Lake Modeling Suite Program Documentation and User's Manual, Panuska, John C., and Kreider, Jeff C., PUBL-WR-363-94, Wisconsin Department of Natural Resources, October 2003.

Tributary Drainage Area – "The tributary drainage area is the area contributing surface water runoff and nutrients to the receiving water."(Panuska and Kreider, 2003) This value is entered automatically by WiLMS and is the total of the land area entered in the non-point source module. In this case the tributary drainage area is equal to the direct tributary area.

Total Unit Runoff – "The total unit runoff is the annual runoff volume from the tributary drainage area divided by the area"(Panuska and Kreider, 2003). The WiLMS model contains unit area runoff values for all counties in Wisconsin. This default value for Marquette County, 9.70 inches, or 0.25 meters, was used in this case.

Annual Runoff Volume – "The annual runoff volume is the total water yield from a tributary drainage area reaching the water body"(Panuska and Kreider, 2003). The WiLMS model multiplies the tributary drainage area by the total unit runoff for this value. The annual runoff volume calculated for Lake Montello was 6940 acre-feet, or 8.6 x 10^6 cubic meters.

Lake Surface Area – The lake area entered for this value was 340 acres, or 1.4 x 10^6 square meters. This is the lake area derived from the GIS data that was provided by the WDNR.

Lake Volume – GIS and bathymetric data was used to estimate the lake volume. The lake volume is estimated to be 1,680 acre-feet, or 2.1 x 10^6 cubic meters.

Lake Mean Depth – "The lake mean depth is automatically calculated by WiLMS as the lake volume divided by the surface area"(Panuska and Kreider, 2003). WiLMS model calculates this automatically based on the lake volume and the lake surface area. The mean depth calculated for Lake Montello is 4.9 feet or 1.5 meters.

Precipitation–Evaporation (net precipitation) - Net Precipitation is net precipitation less net evaporation. The WiLMS model has a default value for net precipitation in Wisconsin. The default value, 3 inches, or

0.10 meters, was used in this case.

Hydraulic Loading – "The hydraulic loading as used in WiLMS represents the total annual water loading to the water body. This includes point and nonpoint sources as well as the net (precipitation-evaporation) to the lake surface" (Panuska and Kreider, 2003). The hydraulic loading is the total annual loading to the lake, combining point source, non-point source, and areal loading. The hydraulic loading calculated by WiLMS for Lake Montello is 84,850 acre-feet per year, or 1 x 10^8 cubic meters per year.

Areal Water Load – "The areal load is the total annual flow volume in cubic meters or acre-feet reaching the water body divided by the surface area of the water body in square meters or acres. The units of areal water loading are typically length per time"(Panuska and Kreider, 2003). The model calculated an areal water load of 250 feet per year, or 76 meters per year, for Lake Montello.

Lake flushing Rate and Water Residence Time – "The lake flushing rate (p) is the hydraulic loading divided by lake volume or the number of lake volumes replaced per year by inflow." 'Its reciprocal value, Tw, is the lake's water residence time, or in other words, the amount of time it takes for the lake's volume to be replaced"(Panuska and Kreider, 2003). The lake flushing rate for Lake Montello was calculated to be 50.6 per year. The water residence time was calculated to be 0.02 years.

Phosphorus Non-Point Source Module

The non-point source loading module estimates phosphorus loading based on land use/land cover type. The model multiplies the various land use areas by phosphorus export coefficients that have been assigned to those land use types. For this modeling exercise, the WiLMS model default export coefficients were used. Ramaker & Associates, Inc. used GIS data to assign land use/land cover types to the direct tributary area. The following table and figure describe the land cover types.

Direct Tributary Land Use/Land Cover		
General Land Use/Cover	**Type**	**Watershed Area (Acres)**
Urban/Developed	High Intensity	79.8
	Low Intensity	232.4
Agricultural	Other Agriculture	147.0
	Herbaceous/Field Crops	2,067.8
Grassland	Grassland	1,422.4
Forest	Coniferous	314.2
	Broad-leaved Deciduous	2,045.8
	Mixed Deciduous/Coniferous	661.0
Open Water	Open Water	505.7
Wetland	Emergent/Wet Meadow	626.7
	Lowland Shrub	220.6
	Forested	586.7
Shrubland	Shrubland	14.9
		Total 8,925.1

The land use/cover types were divided into the WiLMS model, non-point source, default land use categories. The WiLMS land use classifications are slightly different from the GIS data classifications. The land use/cover type categories are included in the WiLMS run print out that is included as Figure 3 of this report. The model output lists the tributary drainage area as 8585 acres. This figure is different than the 8,925-acre direct tributary area listed in the previously table because the model is subtracting out the 340 acres that represent Lake Montello.

The allocations of land use/land cover data could be debated to some degree. However, as will be shown by the WiLMS model, the direct tributary portion of the loading is relatively small compared to the loading from the Montello River. Therefore, small changes in the land use allocations have little to no effect on the modeling results.

The model predicts a non-point source annual loading range between 680 and 3,370 kilograms per year (kg/yr), for the direct tributary area. The predicted, most likely, non-point source annual loading was 1,340 kg/yr. This was 18% of the predicted, most likely, total loading of 7,270 kg/yr. It should be once again noted that the direct tributary area is only 11% of the total Montello River watershed area. Since the land uses for the direct tributary area and the Montello River watershed area are similar, the predicted non-point source most likely loading may be biased high.

Phosphorus Point Source Module

The point source module accounts for point source phosphorus loading and loading from septic systems. Septic systems surrounding Lake Montello were considered in this portion of the model. The number of septic systems was estimated to be 75 systems. This estimate was offered by Jim Neeb of the Montello Lake Protection & Rehabilitation District. For this budget, we made the rough estimate that on average, each septic system is used by 2 people. The model estimates loading by septic systems on a per capita basis. As will be seen in the modeling results, the loading from septic systems is relatively minor compared to other sources. Therefore, we feel that if the estimated number of per capita septic systems use is more or less than the actual number, the percentage of actual loading from septic systems shouldn't be significantly different from the modeling results.

One approach to modeling phosphorus loading from the Montello River watershed would have been to consider the entire Montello River watershed as non-point source loading. Under that approach the entire watershed area, would have been modeled using the non-point source module, not just the direct tributary area. Instead of doing that, the Montello River was considered a point source in this phosphorus budget. This approach is generally considered to be a more accurate method of modeling, because instead of relying on runoff coefficients, the actual phosphorus concentrations in the river are measured. Though this is generally considered to be a more accurate phosphorus loading prediction method, there are also potential flaws in this method. The most obvious potential flaw is that the sampling is not continuous and only provides a snapshot of phosphorus concentrations. If phosphorus concentrations vary greatly with flow volume, the sampling may not accurately portray the phosphorus loading. We feel that this method is still a more accurate than the alternative land use/cover type runoff estimation method.

Phosphorus samples were collected from the Montello River during the 2002 growing season to establish concentrations. Samples were collected from the river at the 11th Street Bridge, in 12 sampling events conducted between April 4, 2002 and October 8, 2002. The average total phosphorus concentration was 60.25 micrograms per liter (µg/l), or milligrams per cubic meter (mg/m^3). The highest and lowest concentrations were 87 mg/m^3 and 31 mg/m^3 respectively. A summary of the water sampling analytical results is included as Table 1 of this report. Analytical reports have been included in Appendix C of this report.

Flow volumes for the river were estimated based on daily dam output levels and gate configurations recorded as part of dam operations. North American Hydro, the operator of the dam, provided Ramaker & Associates, Inc. with a power vs. flow rating table, with 17 power versus flow corresponding ratings. Those ratings were graphed yielding a linear relationship between power and flow. In our calculations it was revealed that the formula for the flow through the dam turbines, in cubic feet per second, was equal to 0.8304 * kilowatt output + 28.

The dam operation logs also recorded flow through a sluice gate. The use of the sluice gate was relatively rare. However, on the days it was used that flow was estimated and added to the flow calculated through the turbine portion of the dam. The flow through the sluice gate was estimated as flow through a large orifice. The formula $Q=3.21*B*(h^{3/2}-H^{3/2})$, where Q = flow (ft/sec), B = gate width (ft), h = the difference in elevations between the headwater and the base of the sluice sill, and H = the difference in elevations of the headwater and the bottom of the sliding sluice gate (the sluice gate pulls up when being opened). The constant 3.21 is $2/3Cd(2g)^{1/2}$ where Cd is the English discharge coefficient (Cd = 0.6), and g is the acceleration of gravity 32.1 ft/second^2.

Using these calculations for flow through the turbine and flow through the sluice gate a list of daily flow rates was compiled for the year period from October 9, 2001 through October 8, 2002. The dam operating logs contained a limited number of data gaps from days on which output data was not recorded. The gaps were filled in by averaging the data from the previous day and the following day. This method of filling in the data is recommend for the FLUX model.

The discharge rate from the Montello dam is not a perfect measure of the in-flow rate of the Montello River coming into the lake. The discharge from the Montello dam is presumably greater than the flow rate of the Montello River entering Lake Montello. This is because the Montello River is not the only source of water entering the lake. There is a small tributary entering the lake to the east of the Montello River. There is also a small tributary that merges with the Montello River downstream of the 11th Road Bridge and upstream of the entrance to lake Montello. There is also some localized run-off and atmospheric water (rain). These sources of loading, referred to as the direct tributary area, were accounted for by modeling the direct tributary area separately. To modeling the point source loading from the Montello River, this water had to be removed from the dam outflow estimates. It was estimated that the direct tributary area is 11% of the total Montello River watershed. Therefore, it was estimated that 89% of the outflow from the dam is attributable to inflow from the Montello River.

There is also presumably water and phosphorus loading from groundwater infiltration. This study did not include analysis of loading from groundwater infiltration. It is unlikely that phosphorus loading from groundwater infiltration is a dominant factor in phosphorus loading compared to external loading from runoff.

Phosphorus loading was modeled using the FLUX program, available through US Army Corps of Engineers. The FLUX model is used for estimating nutrient loading from a tributary. The model uses daily flow rates and nutrient sampling data to estimate the mean or annual loading, which corresponds to the complete flow distribution over the period of interest. The purpose of modeling the loading in this case is to estimate how much phosphorus is entering Lake Montello from the Montello River watershed.

The FLUX model program uses 6 different methods to predict nutrient loading. The methods are listed below.

Method 1 – Direct Mean Loading
Method 2 – Flow-Weighted Concentration (Ratio Estimate)
Method 3 – Modified Ratio Estimate (Bodo and Unny 1983)

Method 4 – Regression, First-Order (Walker 1981)
Method 5 – Regression, Second Order (Walker 1987)
Method 6 – Regression Applied to Individual Daily Flows

The program also predicts uncertainties in the loading estimates. These are reported as CV estimates for each calculation method. The CV equals the standard error of the mean loading divided by the mean loading. CV values less than 0.1 are usually adequate for mass balance modeling. Generally, CV values less than 0.2 are considered adequate in circumstances where flow data is erratic, such as flashy streams.

Tributary sampling was conducted at the Montello River in 2002. Samples were collected from the 11th Road Bridge, in 12 sampling events from April 2002 to October 2002. The 11th Road Bridge is over the Montello River approximately 1 mile upstream of Lake Montello. The tributary sampling establishes the concentrations of nutrients in the river. The 12 samples collected from the river contained total phosphorus concentrations ranging from 31 micrograms per liter (µg/l) measured on April 4, 2002 to the highest concentration, 87 µg/l measured on June 13, 2002. The average of the total phosphorus concentrations measured was 60 µg/l. Dissolved reactive phosphorus concentrations measured in the 11th Road Bridge samples ranged from 9 µg/l to 38 µg/l.

The daily flow data used in modeling the load from the Montello River was derived from the discharge measured at the Montello dam. Based on the daily discharge values from October 9, 2001 to October 8, 2002 the annual mean flow was 96.05 cubic hectometers per year (HM3/YR). This converts to 96,050,000 cubic meters or 77,870 acre-ft/yr.

The six methods for estimating phosphorus loading (FLUX) predicted total phosphorus loading ranging from 5,780 kg/yr to 6,500 kg/yr. The CV values for the six prediction methods ranged from 0.084 to 0.114. A summary of the FLUX model results has been included as Table 5 of this report. The four methods with the lowest CV values were methods 2, 4, 5 and 6. The high and low loading rates predicted by these four methods were 5,840 kg/yr and 5,755 kg/yr. The average FLUX predicted by these four methods is 5,803 kg/yr. The average CV of the lowest four CV values is 0.086. Multiplying the average CV by the average loading gives a standard deviation of 497.6 kg/yr. Adding the standard deviation to the average loading gives a high loading value of 6300.6 kg/yr. Subtracting the standard deviation from the average gives a low loading value of 5305.3 kg/yr. This average loading/FLUX figure was used in the phosphorus budgeting models outlined in following sections of this report.

In a separate modeling study, we modeled the phosphorus loading using only point source loading. In this exercise, we assumed that the direct tributary runoff phosphorus concentrations would resemble those measured in the Montello River. Using this method, we did not adjust the daily outflows downward. Using this method to predict external loading, the average of the four regressions with the lowest CV values, was 6,520 kg/year. The CV values were the same as those calculated for the first method. The standard deviation was 559 kg/year, yielded a predicted high loading value of 7079 mg/year and a low value of 5961 mg/yr.

3.3 WILMS, CANFIELD-BACHMAN PHOSPHORUS PREDICTION

The Wisconsin Lake Model Suite (WILMS) predicts the spring overturn (SPO) and growing season mean (GSM) in-lake total phosphorus concentrations and estimates the annual nutrient loading. The modeling suite uses 13 phosphorus prediction regressions, which gives the user several options to best fit the lake data. The model inputs include the following: drainage area, total unit runoff, lake surface area, lake volume, precipitation minus evaporation, external phosphorus inputs and the annual in-lake phosphorus concentration.

The observed spring overturn total phosphorus concentration that was input to the model was 50 mg/m^3. This value was the average of total phosphorus concentrations measured on April 27, 1995 and April 7, 1998.

Sampling was not conducted in the spring of 2002 to establish spring overturn phosphorus concentrations in 2002.

The Canfield-Bachman, Artificial Lake, regression appears to be an appropriate method for Lake Montello. The model predicts a concentration range for in-lake total phosphorus. Using the 2002 sampling data, the model predicted an in-lake phosphorus range of 46 mg/m^3 to 71 mg/m^3. Based on the model we expect the lake to be lake to be within the high and the low 70 percent of the time. The model also predicts the most likely total phosphorus concentration to be 54 mg/m^3. The results from the WILMS model are listed in Figure 3. The WiLMS model printout that considers the Montello River as a point source, and the direct tributary as non-point source contribution, is titled Scenario 1 in Figure 3.

The WiLMS predicted phosphorus concentrations were slightly lower using the second prediction method, which accounts for all external loading using the point source module. In this method, the direct tributary area was not input into the non-point source portion of the model. Instead the phosphorus concentrations measured in the Montello River were assigned to runoff from the direct tributary area. The total outflow from the damn was assumed to represent all runoff entering the lake. This method predicted an in-lake phosphorus range between 45 mg/m^3 and 54 mg/m^3 (Canfield – Bachmann Artificial Lake Method). The predicted most likely concentration was 49 mg/m^3. The WiLMS model printout that considers the entire Montello River Watershed as a point source contribution is titled Scenario 2.

3.5 IN-LAKE TOTAL PHOSPHORUS DATA

Phosphorus samples were collected from Lake Montello on August 28, 2002. Samples were collected from 2 locations (Site A and Site B) in that sampling event. These samples allow for the comparison of in-lake phosphorus concentrations to concentrations in the Montello River upstream of Lake Montello. The in-lake samples had total phosphorus concentrations of 61 mg/m^3 at Site A, and 116 mg/m^3 at site B. The average of these two samples is 88.5 mg/m^3. Site B was located in the deepest part of the lake near the damn. Site A is located in the lake near the Jim Neeb residence. The total phosphorus concentrations measured in Lake Montello and the Montello River indicate eutrophic status.

Trophic Classification of Wisconsin Lakes Based on Total Phosphorus, Chlorophyll a, and Secchi Depth Values.

(Adapted from Lillie and Mason, 1983.)

Trophic Level	Trophic State Index	Total Phosphorus (mg/l)	Chlorophyll *a* (ug/l)	Secchi Depth (meters)
Eutrophic				
----------	----------50----------	--------0.017----------	----------7.4----------	----------2.0----------
Mesotrophic				
----------	----------40----------	--------0.005----------	----------2.0----------	----------4.0----------
Oligotrophic				

SECTION 4
RESULTS

4.1 PHOSPHORUS INPUTS FROM SEPTIC SYSTEMS

The model estimated that 0.1% of the total phosphorus loading comes from septic systems. This percentage is very low. It is based on an assumed population of 150 individuals on septic systems, on land surrounding the lake. The population number is a rough estimate. Based on the other sources of loading, it is unlikely that loading from septic systems is significant.

4.2 PHOSPHORUS NON-POINT SOURCE LOADING - DIRECT TRIBUTARY AREA

The WiLMS Model estimated the total phosphorus loading from the direct tributary would be in the range of 690 kg/yr to 3,500 kg/yr. The model calculated that the most likely loading from the direct tributary area would be 1,380 kg/yr. This is 19% of the predicted total external loading.

4.3 PHOSPHORUS INPUTS FROM THE MONTELLO RIVER

The phosphorus loading from the Montello River is listed in the modeling results under "Point Source Data". The loading in this section of the model was actually calculated in the FLUX model. The FLUX model predicted phosphorus loading of 5,800 kg/yr. The FLUX model also calculated an error mean coefficient of variation (CV value) for the loading. The CV value, multiplied by the loading estimate, yielded a standard deviation of 500 kg/yr. The standard deviation added and subtracted by the mean value yielded a predicted loading range between 6,300 kg/yr and 5,300 kg/yr. The estimated mean loading for the Montello River accounts for 81% of the estimated total external loading.

4.4 PHOSPHORUS INPUTS FROM INTERNAL RECYCLING

The WiLMS model includes an internal load estimator module. This module contains four internal loading estimation methods, a mass budget method, a growing season method, an in-situ phosphorus, and phosphorus release method. The latter three methods required more extensive data that was not collected as part of this study. The first method, the mass budget method, seemed appropriate for this phosphorus budget study. "The mass budget approach implicitly considers internal loading because the mass of phosphorus in the outflow is greater than that of the inflow in lakes with internal loading. A typical phosphorus mass balance can be written as follows: Outflow Pmass = External Load Pmass + Internal Load Pmass – Sedimentation"(Panuska and Kreider, 2003). The model assumes that the outflow phosphorus concentration is the same as the annual water column phosphorus concentration, which is entered by the user. The value entered for the annual water column phosphorus concentration, was 71 mg/m^3, which is the average of phosphorus concentrations listed on the historic water quality summary table. The model estimated that the internal loading was 1,380 kg/yr. The estimated loading from external sources was 7,290 kg/yr. The internal loading makes up 16% of the total predicted loading (8,670 kg/yr).

4.5 WILMS PHOSPHORUS LOADING CHANGE PREDICTIONS

The WiLMS model was used to predict total phosphorus changes based on hypothetical changes in phosphorus loading. For comparison purposes, the point source loading percentages and the non-point (direct tributary area) loading percentages were varied while the resultant changes in the predicted, in-lake total phosphorus, concentrations were noted. It was determined that percentage changes in the loading from the Montello River made the biggest difference in predicted in-lake total phosphorus concentrations. This

would be expected because the Montello River contributes more phosphorus loading than the direct tributary area. Graphs illustrating the change in phosphorus loading versus the changes in predicted in-lake phosphorus concentrations have been included in Figure 4 of this report.

SECTION 5
CONCLUSION

In conclusion, the majority of Lake Montello's phosphorus is coming from external loading. Phosphorus concentrations in the lake are largely a reflection of phosphorus loading from the Montello River. Additional runoff loading is enters the lake from the direct tributary area. Internal phosphorus loading accounts for the remainder of the phosphorus loading. This budget estimates that the Montello River accounts for 81% of the external loading. Runoff from the direct tributary accounts for the remaining 19% of external loading.

The Canfield-Bachmann Artificial Lake model predicts with 70% confidence a phosphorus concentration between of 46 mg/m3 to 71 mg/m3, with the most likely concentration being 54 mg/m3. The average of in-lake phosphorus concentrations listed on the historic sampling summary table is 71 mg/m3. It is reasonable to believe that in-lake phosphorus recycling processes could account for the differences. If the difference between the estimated 54 mg/m3 and the historic average 71 mg/m3 phosphorus were attributed to in-lake processes the in-lake processes would be contributing an additional 1380 kg/yr to the overall loading. In this case the internal recycling would be contributing 16% of the total loading.

Phosphorus sampling conducted in the years 1995, 1996, 1997, 1998 and 2002 reveals a range of measured in-lake phosphorus concentrations from 21 mg/m3 to 400 mg/m3. The average concentration was 71 mg/m3. The highest concentrations may be contributed to short-term increased sediment re-suspension and not reflective of normal conditions. The concentrations measured on August 28, 2002 were 61 mg/m3 and 116 mg/m3. The average of the 2 values is 88.5 mg/m3.

Based on the sampling we feel that the model accurately predicts phosphorus loading from external sources. The external loading combined with some in-lake phosphorus concentrations observed in the historic sampling.

Shallow water depths in conjunction with high nutrient inputs nutrient inputs from the surrounding watershed have resulted in an upper mesotrophic to eutrophic system. The present conditions have resulted in nuisance weed growth. To reduce phosphorus loading to the lake would require land management practice changes over significant percentages of the Montello River watershed. These changes would be beneficial and are encouraged, although it is unlikely that the lake district could encourage these changes in a manner that they would be implemented and effective in the short term. It is therefore likely that weed control measures such as the ones that have been implemented recently, are the best approach to weed control at this time. The effectiveness of the drawdown that was conducted in the winter of 2002 to 2003 is being evaluated at this time. The lake district is also experimenting with chemical control measures targeting specific areas of the lake. We recommend that the lake district explore and encourage land use practices that minimize phosphorus loading from runoff. We also recognize that the in-lake weed control measures will likely be the most effective in the near term.

SECTION 6
REFERENCES

Ramaker & Associates, Inc., Montello Lake Management Plan, (March 2002).

U.S. Department of Agriculture, Marquette County Soil Survey, (1975).

Lillie, Richard A., and Mason, John W., Limnological Characteristics of Wisconsin Lakes, Technical Bulletin No. 138, Department of Natural Resources, (1983).

Panuska, John C., and Kreider, Jeff C., Wisconsin Lake Modeling Suite, PUBL-WR-363-94, Wisconsin Department of Natural Resources, (October 2003).

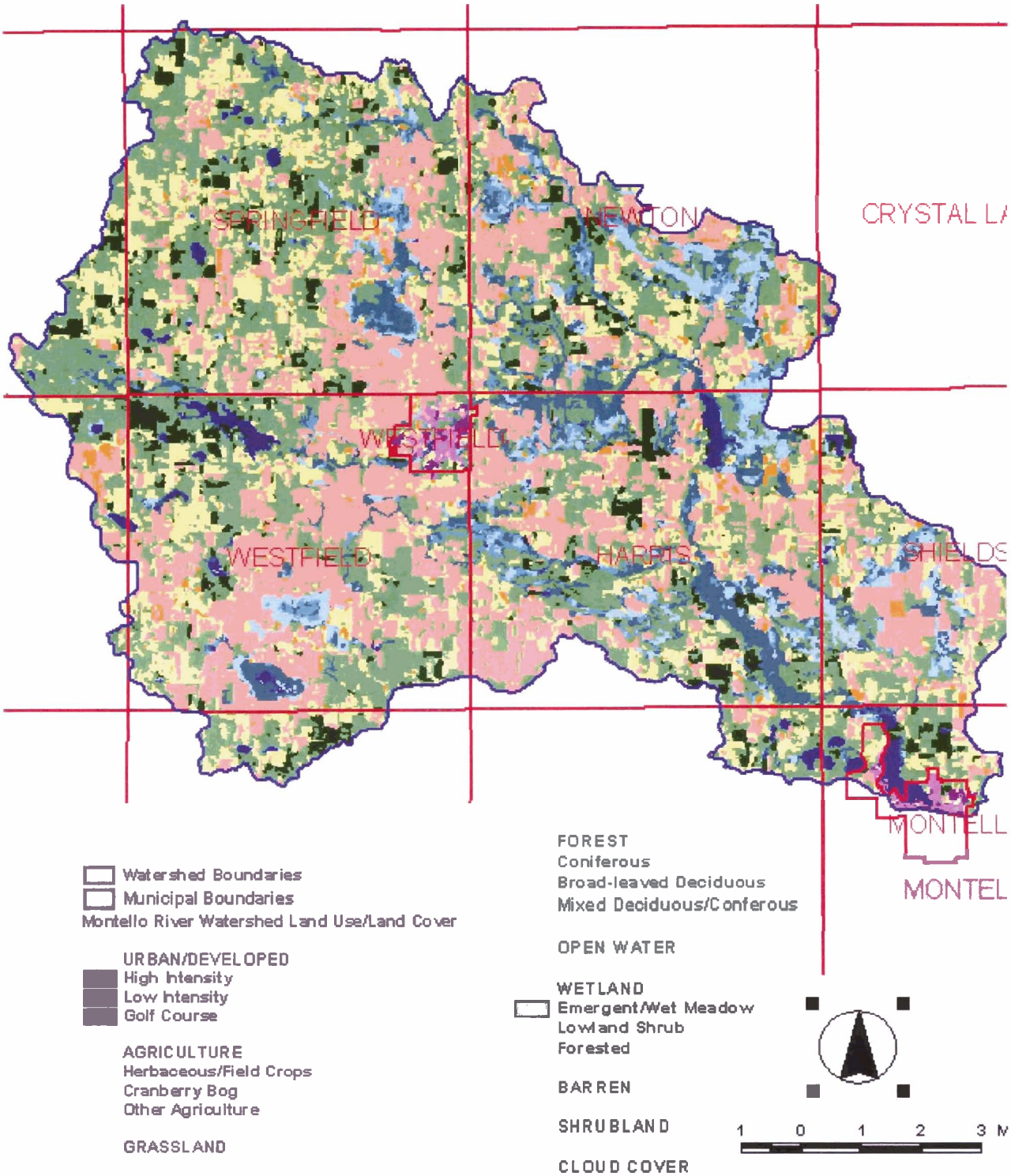
Walker, William W., Simplified Procedures for Eutrophication Assessment and Prediction: User Manual, Instruction Report W-96-2, US Army corps of Engineers, (September 1996 - Updated April 1999).

Wisconsin Lakes, PUB-FH-800 2001, Bureau of Fisheries and Habitat Management, Wisconsin Department of Natural Resources, (2001).

FIGURE 1

MONTELLO RIVER WATERSHED LAND USE MAP AND LAND USE STUDY RESULTS

Montello River Watershed Land Uses



Montello River Watershed Land Use

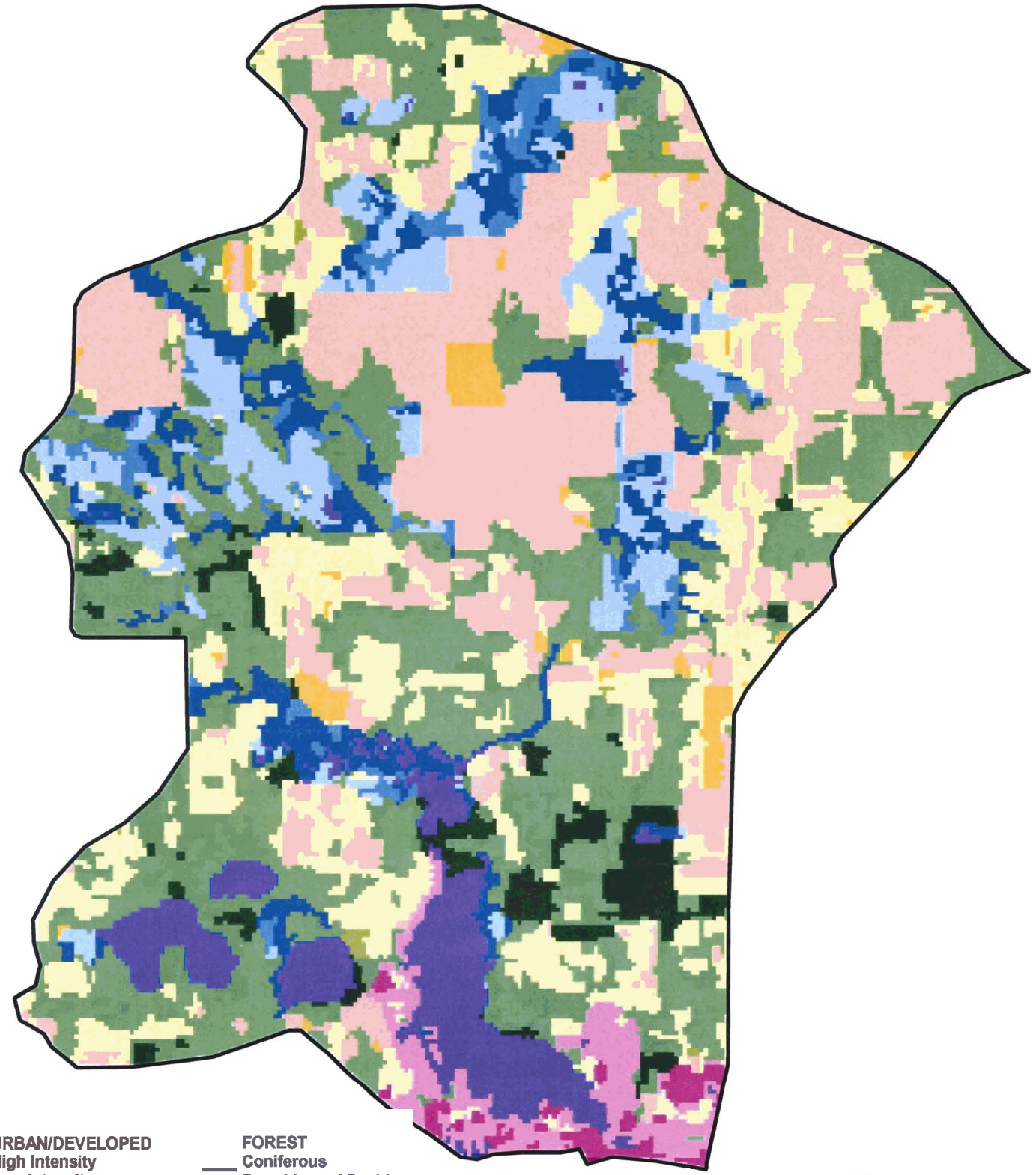
VALUE			Area Square Meters	Area in Acres
101	Urban/Developed	High Intensity	965,700	238.6
104		Low Intensity	1,737,000	429.2
110	Agriculture	Other Agriculture	5,481,000	1,354.4
113		Corn	37,425,600	9,248.0
118		Other Row Crops	32,537,700	8,040.2
124		Forage Crops	32,537,700	8,040.2
148		Cranberry Bog	4,500	1.1
150	Grassland	Grassland	60,189,300	14,873.0
162	Forest	ck Pine	2,050,200	506.6
163		Red Pine	2,050,200	506.6
173		Mixed/Other Coniferous	1,990,800	491.9
177			77,352,300	19,114.1
187		Mixed/Other Broad Leafed Decidious	10,673,100	2,637.4
190		Mixed/Decidious/Coniferous	25,463,700	6,292.2
200	Water	Open Water	6,292,800	1,555.0
211	Wetlar	Emergent/Wet Meadow	6,292,800	1,555.0
218		Broad Leafed Decidious	9,130,500	2,256.2
223		Broad Leafed Decidious	14,229,000	3,516.0
229		Coniferous	9,459,900	2,337.6
240		Barren	577,800	142.8
250		Shrubland	741,600	183.3
			337,183,200	83,319.5

Meters to Acres Conversion
0.000247104

FIGURE 2

DIRECT TRIBUTARY AREA WATERSHED LAND USE MAP AND LAND USE STUDY RESULTS

Lake Montello Direct Tributary Area Land Uses



URBAN/DEVELOPED
High Intensity
Low Intensity
Golf Course

AGRICULTURE
Herbaceous/Field Crops
Cranberry Bog
Other Agriculture

GRASSLAND

FOREST
Coniferous
Broad-leaved Deciduous
Mixed Deciduous/Conferous

OPEN WATER

WETLAND
Emergent/Wet Meadow
Lowland Shrub
Forested

BARREN

SHRUBLAND

CLOUD COVER

N

0.25 0 0.25 0.5 Miles

Direct Tributary Land Use/Land Cover		
General Land Use/Cover	**Type**	**Watershed Area (Acres)**
Urban/Developed	High Intensity	79.8
	Low Intensity	232.4
Agricultural	Other Agriculture	147.0
	Herbaceous/Field Crops	2,067.8
Grassland	Grassland	1,422.4
Forest	Coniferous	314.2
	Broad-leaved Deciduous	2,045.8
	Mixed Deciduous/Coniferous	661.0
Open Water	Open Water	505.7
Wetland	Emergent/Wet Meadow	626.7
	Lowland Shrub	220.6
	Forested	586.7
Shrubland	Shrubland	14.9
		8,925.1

FIGURE 3

WILMS MODEL OUTPUTS

Date: 5/26/2004 Scenario: 1

Lake Id: Lake Montello Modified Discharge
Watershed Id: Montello River

Hydrologic and Morphometric Data

Tributary Drainage Area: 8585.1 acre
Total Unit Runoff: 9.70 in.
Annual Runoff Volume: 6939.6 acre-ft
Lake Surface Area <As>: 340.0 acre
Lake Volume <V>: 1676.2 acre-ft
Lake Mean Depth <z>: 4.9 ft
Precipitation - Evaporation: 3.0 in.
Hydraulic Loading: 84853.1 acre-ft/year
Areal Water Load <qs>: 249.6 ft/year
Lake Flushing Rate <p>: 50.62 1/year
Water Residence Time: 0.02 year
Observed spring overturn total phosphorus (SPO): 50.0 mg/m^3
Observed growing season mean phosphorus (GSM): 88.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	---- Loading (kg/ha-year) ----				----- Loading (kg/year) ----		
Row Crop AG	2067.8	0.50	1.00	3.00	11.6	418	837	2511
Mixed AG	147.0	0.30	0.80	1.40	0.7	18	48	83
Pasture/Grass	1422.4	0.10	0.30	0.50	2.4	58	173	288
HD Urban (1/8 Ac)	79.8	1.00	1.50	2.00	0.7	32	48	65
MD Urban (1/4 Ac)	232.4	0.30	0.50	0.80	0.7	28	47	75
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	1434.0	0.10	0.10	0.10	0.8	58	58	58
Forest	3036.0	0.05	0.09	0.18	1.5	61	111	221
Other Lakes	165.7	0.10	0.30	1.00	0.3	7	20	67
Lake Surface	340.0	0.10	0.30	1.00	0.6	14	41	138

POINT SOURCE DATA

Point Sources	Water Load	Low	Most Likely	High	Loading %
	(m^3/year)	(kg/year)	(kg/year)	(kg/year)	
User Defined 1	0.0	0.0	0.0	0.0	0.0
User Defined 2	0.0	0.0	0.0	0.0	0.0
User Defined 3	0.0	0.0	0.0	0.0	

0.0				
User Defined 4	0.0	0.0	0.0	0.0
0.0				
Montello River	9.6E+007	5305.3	5803.0	6300.6
80.7				
User Defined 6	0.0	0.0	0.0	0.0
0.0				

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	150.0				
% Phosphorous Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.90	7.50	24.00	0.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	13228.6	15857.9	21671.0	100.0
Total Loading (kg)	6000.5	7193.1	9829.9	100.0
Areal Loading (lb/ac-year)	38.91	46.64	63.74	
Areal Loading (mg/m^2-year)	4361.03	5227.81	7144.19	
Total PS Loading (lb)	11696.1	12793.3	13890.3	
Total PS Loading (kg)	5305.3	5803.0	6300.6	
Total NPS Loading (lb)	1500.3	2957.1	7424.5	
Total NPS Loading (kg)	680.5	1341.3	3367.7	

Phosphorus Prediction and Uncertainty Analysis Module

Date: 5/26/2004 Scenario: 1
Observed spring overturn total phosphorus (SPO): 50.0 mg/m^3
Observed growing season mean phosphorus (GSM): 88.5 mg/m^3
Back calculation for SPO total phosphorus: 0.0 mg/m^3
Back calculation GSM phosphorus: 0.0 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted P (mg/m^3)	% Dif. -Observed
Walker, 1987 Reservoir	49	59	80	-30	-34
Canfield-Bachmann, 1981 Natural Lake	51	61	81	-28	-32
Canfield-Bachmann, 1981 Artificial Lake	46	54	71	-35	-40
Rechow, 1979 General	42	51	69	-38	-43
Rechow, 1977 Anoxic	51	61	83	-28	-32
Rechow, 1977 water load<50m/year	N/A	N/A	N/A		

N/A N/A				
Rechow, 1977 water load>50m/year	48	57	79	
-32 -36				
Walker, 1977 General	50	60	82	
10 20				
Vollenweider, 1982 Combined OECD	38	45	58	
-24 -35				
Dillon-Rigler-Kirchner	41	50	68	
0 0				
Vollenweider, 1982 Shallow Lake/Res.	32	38	49	
-31 -45				
Larsen-Mercier, 1976	50	60	82	
10 20				
Nurnberg, 1984 Oxic	48	58	79	
-31 -35				

Lake Phosphorus Model Parameter	**Back Calculation**	**Model Type**	**Confidence Lower Bound**	**Confidence Upper Bound**	**Fit? (kg/year)**
Walker, 1987 Reservoir			41	84	Tw
0		GSM			
Canfield-Bachmann, 1981 Natural Lake			19	176	FIT
1		GSM			
Canfield-Bachmann, 1981 Artificial Lake			17	156	FIT
1		GSM			
Rechow, 1979 General			34	75	FIT
0		GSM			
Rechow, 1977 Anoxic			44	85	FIT
0		GSM			
Rechow, 1977 water load<50m/year			N/A	N/A	N/A
N/A N/A					
Rechow, 1977 water load>50m/year			51	70	FIT
0		GSM			
Walker, 1977 General			35	98	FIT
0		SPO			
Vollenweider, 1982 Combined OECD			25	76	FIT
0		ANN			
Dillon-Rigler-Kirchner			36	70	P L
0		SPO			
Vollenweider, 1982 Shallow Lake/Res.			22	63	FIT
0		ANN			
Larsen-Mercier, 1976			45	82	P Pin p
0		SPO			
Nurnberg, 1984 Oxic			36	91	L
0		ANN			

Date: 5/26/2004 Scenario: 2

Lake Id: Lake Montello Total Discharge

Watershed Id: Montello River

Hydrologic and Morphometric Data

Tributary Drainage Area: 0.0 acre

Total Unit Runoff: 9.70 in.

Annual Runoff Volume: 6939.6 acre-ft

Lake Surface Area <As>: 340.0 acre

Lake Volume <V>: 1676.2 acre-ft
Lake Mean Depth <z>: 4.9 ft
Precipitation - Evaporation: 3.0 in.
Hydraulic Loading: 84853.1 acre-ft/year
Areal Water Load <qs>: 249.6 ft/year
Lake Flushing Rate <p>: 50.62 1/year
Water Residence Time: 0.02 year
Observed spring overturn total phosphorus (SPO): 50.0 mg/m^3
Observed growing season mean phosphorus (GSM): 88.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|	
Row Crop AG	0.0	0.50	1.00	3.00	0.0	0	0	0
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	0.0	0.10	0.10	0.10	0.0	0	0	0
Forest	0.0	0.05	0.09	0.18	0.0	0	0	0
Lake Surface	340.0	0.10	0.30	1.00	0.6	14	41	138

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
STP	0.0	20.0	40.0	55.0	0.6
Tomahawk	0.0	15.0	20.0	35.0	0.3
Rhinelander	0.0	20.0	25.0	30.0	0.4
Madison	0.0	0.0	0.0	0.0	0.0
Montello River	1.1E+008	5961.0	6520.0	7079.0	98.0
User Defined 6	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %

Septic Tank Output (kg/capita-year)		0.30	0.50
0.80			
# capita-years	75.0		
% Phosphorous Retained by Soil		98.0	90.0
80.0			
Septic Tank Loading (kg/year)		0.45	3.75
12.00	0.1		

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	13294.2	14660.7	16200.7	100.0
Total Loading (kg)	6030.2	6650.0	7348.6	100.0
Areal Loading (lb/ac-year)	39.10	43.12	47.65	
Areal Loading (mg/m^2-year)	4382.64	4833.11	5340.82	
Total PS Loading (lb)	13262.9	14561.4	15870.9	
Total PS Loading (kg)	6016.0	6605.0	7199.0	
Total NPS Loading (lb)	0.0	0.0	0.0	
Total NPS Loading (kg)	0.0	0.0	0.0	

Phosphorus Prediction and Uncertainty Analysis Module

Date: 5/26/2004 Scenario: 2
Observed spring overturn total phosphorus (SPO): 50.0 mg/m^3
Observed growing season mean phosphorus (GSM): 88.5 mg/m^3
Back calculation for SPO total phosphorus: 0.0 mg/m^3
Back calculation GSM phosphorus: 0.0 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted P (mg/m^3)	% Dif. -Observed
Walker, 1987 Reservoir	49	54	59	-35	-40
Canfield-Bachmann, 1981 Natural Lake	50	55	60	-34	-38
Canfield-Bachmann, 1981 Artificial Lake	45	49	54	-40	-45
Rechow, 1979 General	41	46	50	-43	-49
Rechow, 1977 Anoxic	49	54	60	-35	-40
Rechow, 1977 water load<50m/year	N/A	N/A	N/A	N/A	N/A
Rechow, 1977 water load>50m/year	47	51	57	-38	-43
Walker, 1977 General	49	54	60	4	8
Vollenweider, 1982 Combined OECD	38	41	44	-28	-40
Dillon-Rigler-Kirchner	41	45	49	-5	-10
Vollenweider, 1982 Shallow Lake/Res.	31	34	37	-35	-51

Larsen-Mercier, 1976		49	54	60
4	8			
Nurnberg, 1984 Oxic		47	52	57
-37	-42			

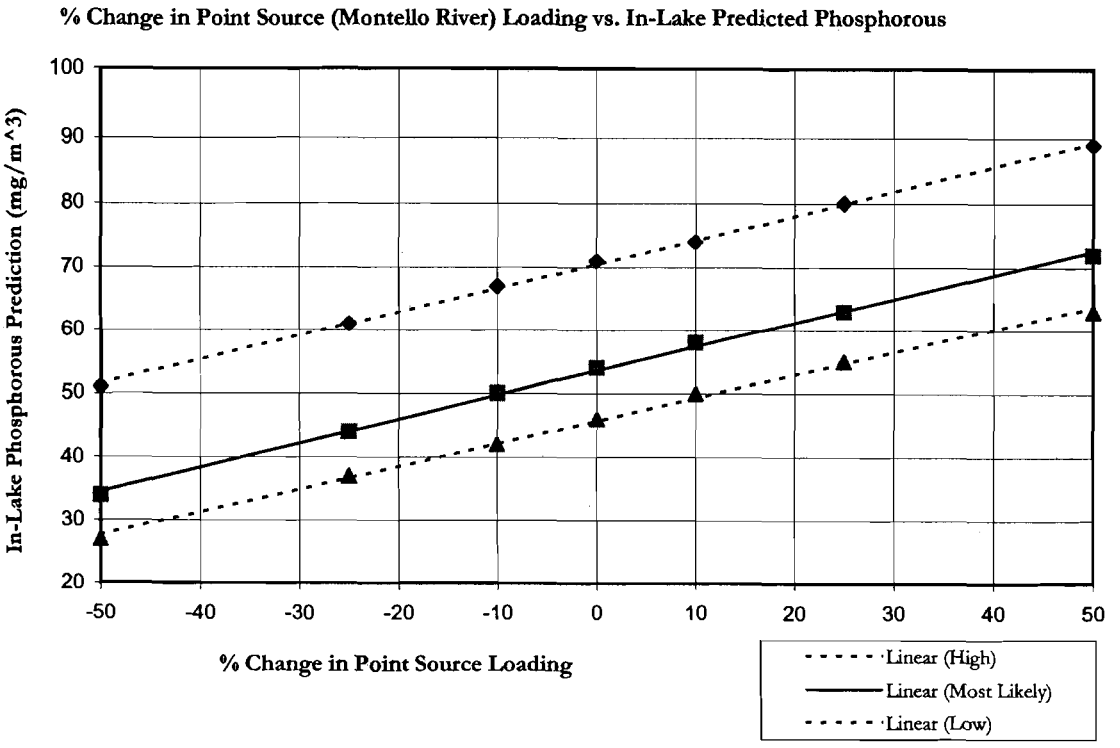
Lake Phosphorus Model Parameter	**Back Model**	**Confidence** Lower Bound	**Confidence** Upper Bound	Fit?
Calculation	Type			
(kg/year)				
Walker, 1987	Reservoir	39	74	Tw
0	GSM			
Canfield-Bachmann, 1981	Natural Lake	17	158	FIT
1	GSM			
Canfield-Bachmann, 1981	Artificial Lake	15	141	FIT
1	GSM			
Rechow, 1979	General	31	65	FIT
0	GSM			
Rechow, 1977	Anoxic	40	72	FIT
0	GSM			
Rechow, 1977	water load<50m/year	N/A	N/A	N/A
N/A	N/A			
Rechow, 1977	water load>50m/year	48	55	FIT
0	GSM			
Walker, 1977	General	32	86	FIT
0	SPO			
Vollenweider, 1982	Combined OECD	23	69	FIT
0	ANN			
Dillon-Rigler-Kirchner		33	61	P L
0	SPO			
Vollenweider, 1982	Shallow Lake/Res.	20	56	FIT
0	ANN			
Larsen-Mercier, 1976		41	70	P Pin p
0	SPO			
Nurnberg, 1984	Oxic	33	79	L
0	ANN			

FIGURE 4

PHOSPHORUS LOADING RESPONSE GRAPHS

Lake Montello
Canfield-Bachman Artificial Lake Prediction

Figure 4



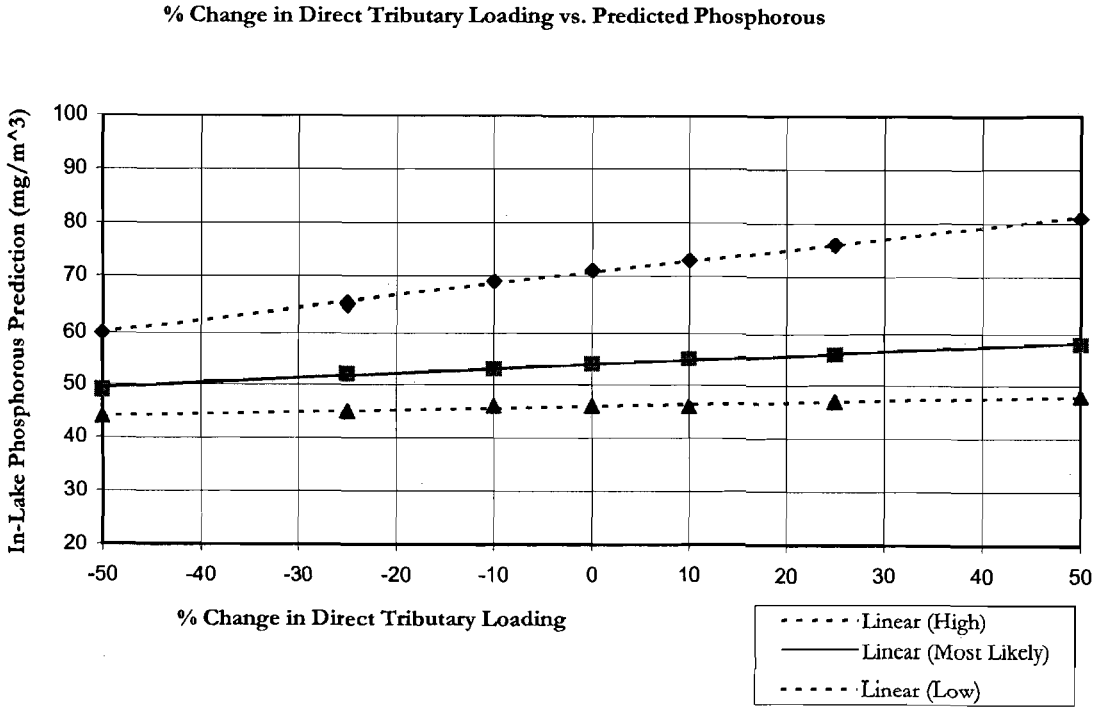


TABLE 1

2002 LAKE SAMPLING ANALYTICAL SUMMARY

2002 Phosphorous Sampling Analytical Summary

Sample Location	Sample Date	Total Phosphorus µg/l	Suspended Solids µg/l	Dissolved Reactive Phosphorus µg/l
Montello River 11th Rd Bridge	04/04/02	31	7000	9
Montello River 11th Rd Bridge	04/17/02	68	16000	13
Montello River 11th Rd Bridge	05/15/02	46	7000	13
Montello River 11th Rd Bridge	05/30/02	49	12000	11
Montello River 11th Rd Bridge	06/13/02	87	21000	34
Montello River 11th Rd Bridge	07/02/02	86	15000	38
Montello River 11th Rd Bridge	07/18/02	58	12000	26
Montello River 11th Rd Bridge	08/01/02	68	12000	31
Montello River 11th Rd Bridge	08/07/02	73	7000	31
Montello River 11th Rd Bridge	08/15/02	63	9000	29
Montello River 11th Rd Bridge	09/18/02	43	3000	22
Montello River 11th Rd Bridge	10/08/02	51	26000	18
Montello River Harrisville Bridge	01/26/03	21	2000	8
Lawrence Bridge	01/26/03	14	3000	4
Lawrence Creek Headwaters Bridge	01/26/03	26	3000	20
Westfield Creek Pioneer Bridge	01/26/03	35	3000	19
Site A Montello Lake - Neeb House	08/28/02	61	3000	32
Site B Montello Lake - Dam	08/28/02	116	7000	14
Site C 200 Feet Downstream from Dam	08/28/02	47	3000	11

TABLE 2

HISTORIC WATER QUALITY SAMPLING SUMMARY

Lake Montello
Historic Water Quality Sampling Summary

April/May

Date	Secchi Depth (m)	Sample Depth (ft)	Chla (ug/L)	Dissolved Oxygen	TP (mg/L)
04/27/95	1.8	1.5	8.71	**	0.034
04/27/95	1.8	11	8.71	**	0.036
05/02/96	1.6	1.5	12.00	12.90	0.052
05/02/96	1.6	13	**	13.00	0.050
04/07/98	1.2	**	4.95	**	0.065
04/07/98	1.2	**	4.95	**	0.066
Average	1.53		7.86		0.051

June

Date	Secchi Depth (m)	Sample Depth (ft)	Chla (ug/L)	Dissolved Oxygen	TP (mg/L)
06/14/95	1.4	1.5	28.8	13.5	0.064
06/14/95	1.4	13	**	0.8	0.400
06/06/96	2.1	1.5	5.07	9.3	0.061
06/06/96	2.1	13	**	1.9	0.085
06/08/98	**	**	3.24	**	0.024
06/08/98	**	**	**	**	0.056
Average	1.75		12.37		0.115

July

Date	Secchi Depth (m)	Sample Depth (ft)	Chla (ug/L)	Dissolved Oxygen	TP (mg/L)
07/10/95	4.1	1.5	**	**	0.052
07/10/95	4.1	13	**	**	0.091
07/20/95	3.2	**	**	**	**
07/22/96	2.4	1.5	6.05	10.4	0.048
07/22/96	2.4	7.5	**	9.1	0.048
07/22/98	2.0	**	2.07	**	0.089
07/22/98	2.0	**	**	**	0.095
Average	2.9		4.06		0.071

August

Date	Secchi Depth (m)	Sample Depth (ft)	Chla (ug/L)	Dissolved Oxygen	TP (mg/L)
08/10/95	2.5	1.5	7.38	**	0.054
08/10/95	2.5	10	**	**	0.070
08/22/96	2.6	1.5	5.30	8.10	0.036
08/22/96	2.6	10.5	**	2.80	0.069
08/27/97	2.7	**	6.02	**	0.021
08/27/97	2.7	**	**	**	0.040
08/21/98	3.3	**	3.92	**	0.047
08/21/98	3.3	**	**	**	0.058
08/21/98	3.3	**	3.92	**	0.076
08/28/02	**	1.5	**	**	0.061
08/28/02	**	1.5	**	**	0.116
Average	2.8		5.31		0.059

TABLE 3

DAILY FLOW VOLUME FLUX INPUT

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
10/09/01	136	121
10/10/01	161	143
10/11/01	107	95
10/12/01	128	114
10/13/01	153	136
10/14/01	87	77
10/15/01	82	73
10/16/01	107	95
10/17/01	116	103
10/18/01	141	125
10/19/01	111	99
10/20/01	145	129
10/21/01	78	69
10/22/01	57	51
10/23/01	103	92
10/24/01	153	136
10/25/01	120	107
10/26/01	161	143
10/27/01	174	155
10/28/01	82	73
10/29/01	120	107
10/30/01	133	118
10/31/01	145	129
11/01/01	149	133
11/02/01	120	107
11/03/01	136	121
11/04/01	70	62
11/05/01	78	69
11/06/01	78	69
11/07/01	141	125
11/08/01	111	99
11/09/01	87	77
11/10/01	91	81
11/11/01	70	62
11/12/01	57	51
11/13/01	111	99
11/14/01	157	140
11/15/01	165	147
11/16/01	160	142
11/17/01	121	108
11/18/01	82	73
11/19/01	120	107
11/20/01	153	136
11/21/01	161	143
11/22/01	78	69
11/23/01	153	136
11/24/01	137	122

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
11/25/01	120	107
11/26/01	165	147
11/27/01	153	136
11/28/01	165	147
11/29/01	168	150
11/30/01	170	151
12/01/01	170	151
12/02/01	161	143
12/03/01	95	85
12/04/01	99	88
12/05/01	120	107
12/06/01	161	143
12/07/01	170	151
12/08/01	170	151
12/09/01	170	151
12/10/01	141	125
12/11/01	82	73
12/12/01	161	143
12/13/01	165	147
12/14/01	165	147
12/15/01	170	151
12/16/01	99	88
12/17/01	87	77
12/18/01	95	85
12/19/01	120	107
12/20/01	161	143
12/21/01	120	107
12/22/01	103	92
12/23/01	111	99
12/24/01	124	110
12/25/01	120	107
12/26/01	120	107
12/27/01	107	95
12/28/01	161	143
12/29/01	161	143
12/30/01	103	92
12/31/01	45	40
01/01/02	47	42
01/02/02	49	44
01/03/02	86	77
01/04/02	120	107
01/05/02	136	121
01/06/02	91	81
01/07/02	69	61
01/08/02	136	121
01/09/02	120	107
01/10/02	103	92

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
01/11/02	136	121
01/12/02	111	99
01/13/02	82	73
01/14/02	91	81
01/15/02	161	143
01/16/02	87	77
01/17/02	87	77
01/18/02	78	69
01/19/02	74	66
01/20/02	99	88
01/21/02	95	85
01/22/02	99	88
01/23/02	157	140
01/24/02	134	119
01/25/02	111	99
01/26/02	99	88
01/27/02	82	73
01/28/02	103	92
01/29/02	153	136
01/30/02	161	143
01/31/02	103	92
02/01/02	157	140
02/02/02	99	88
02/03/02	95	85
02/04/02	53	47
02/05/02	120	107
02/06/02	99	88
02/07/02	78	69
02/08/02	66	59
02/09/02	145	129
02/10/02	91	81
02/11/02	87	77
02/12/02	91	81
02/13/02	106	94
02/14/02	120	107
02/15/02	87	77
02/16/02	128	114
02/17/02	110	98
02/18/02	91	81
02/19/02	165	147
02/20/02	170	151
02/21/02	277	247
02/22/02	306	272
02/23/02	153	136
02/24/02	161	143
02/25/02	161	143
02/26/02	161	143

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
02/27/02	161	143
02/28/02	145	129
03/01/02	157	140
03/02/02	110	98
03/03/02	62	55
03/04/02	25	22
03/05/02	74	66
03/06/02	149	133
03/07/02	74	66
03/08/02	82	73
03/09/02	120	107
03/10/02	141	125
03/11/02	161	143
03/12/02	161	143
03/13/02	161	143
03/14/02	153	136
03/15/02	174	155
03/16/02	111	99
03/17/02	161	143
03/18/02	149	133
03/19/02	165	147
03/20/02	165	147
03/21/02	161	143
03/22/02	163	145
03/23/02	161	143
03/24/02	150	134
03/25/02	116	103
03/26/02	128	114
03/27/02	161	143
03/28/02	111	99
03/29/02	95	85
03/30/02	165	147
03/31/02	159	142
04/01/02	153	136
04/02/02	161	143
04/03/02	165	147
04/04/02	157	140
04/05/02	161	143
04/06/02	157	140
04/07/02	145	129
04/08/02	165	147
04/09/02	165	147
04/10/02	153	136
04/11/02	153	136
04/12/02	74	66
04/13/02	165	147
04/14/02	153	136

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
04/15/02	149	133
04/16/02	170	151
04/17/02	161	143
04/18/02	165	147
04/19/02	165	147
04/20/02	165	147
04/21/02	165	147
04/22/02	161	143
04/23/02	165	147
04/24/02	157	140
04/25/02	153	136
04/26/02	157	140
04/27/02	157	140
04/28/02	161	143
04/29/02	161	143
04/30/02	157	140
05/01/02	153	136
05/02/02	153	136
05/03/02	161	143
05/04/02	153	136
05/05/02	107	95
05/06/02	161	143
05/07/02	157	140
05/08/02	155	138
05/09/02	161	143
05/10/02	136	121
05/11/02	111	99
05/12/02	116	103
05/13/02	153	136
05/14/02	165	147
05/15/02	165	147
05/16/02	165	147
05/17/02	165	147
05/18/02	120	107
05/19/02	116	103
05/20/02	124	110
05/21/02	157	140
05/22/02	111	99
05/23/02	128	114
05/24/02	153	136
05/25/02	99	88
05/26/02	161	143
05/27/02	124	110
05/28/02	163	145
05/29/02	161	143
05/30/02	161	143
05/31/02	95	85

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
06/01/02	161	143
06/02/02	95	85
06/03/02	161	143
06/04/02	161	143
06/05/02	157	140
06/06/02	111	99
06/07/02	165	147
06/08/02	165	147
06/09/02	157	140
06/10/02	74	66
06/11/02	141	125
06/12/02	157	140
06/13/02	161	143
06/14/02	116	103
06/15/02	157	140
06/16/02	111	99
06/17/02	128	114
06/18/02	74	66
06/19/02	120	107
06/20/02	153	136
06/21/02	128	114
06/22/02	153	136
06/23/02	153	136
06/24/02	165	147
06/25/02	165	147
06/26/02	161	143
06/27/02	165	147
06/28/02	141	125
06/29/02	136	121
06/30/02	157	140
07/01/02	82	73
07/02/02	128	114
07/03/02	153	136
07/04/02	78	69
07/05/02	62	55
07/06/02	132	117
07/07/02	103	92
07/08/02	74	66
07/09/02	161	143
07/10/02	157	140
07/11/02	78	69
07/12/02	74	66
07/13/02	78	69
07/14/02	13	12
07/15/02	13	12
07/16/02	120	107
07/17/02	145	129

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
07/18/02	132	117
07/19/02	149	133
07/20/02	124	110
07/21/02	103	92
07/22/02	49	44
07/23/02	91	81
07/24/02	132	117
07/25/02	87	77
07/26/02	87	77
07/27/02	87	77
07/28/02	82	73
07/29/02	78	69
07/30/02	70	62
07/31/02	49	44
08/01/02	149	133
08/02/02	82	73
08/03/02	82	73
08/04/02	111	99
08/05/02	74	66
08/06/02	111	99
08/07/02	145	129
08/08/02	120	107
08/09/02	13	12
08/10/02	74	66
08/11/02	82	73
08/12/02	111	99
08/13/02	99	88
08/14/02	78	69
08/15/02	87	77
08/16/02	74	66
08/17/02	95	85
08/18/02	153	136
08/19/02	178	158
08/20/02	91	81
08/21/02	57	51
08/22/02	74	66
08/23/02	111	99
08/24/02	111	99
08/25/02	95	85
08/26/02	97	86
08/27/02	99	88
08/28/02	111	99
08/29/02	111	99
08/30/02	111	99
08/31/02	124	110
09/01/02	91	81
09/02/02	66	59

Daily Flow Volume FLUX Input

Daily flows at Montello Dam, CFS

Date	Flow	Adjusted
09/03/02	13	12
09/04/02	91	81
09/05/02	70	62
09/06/02	111	99
09/07/02	78	69
09/08/02	82	73
09/09/02	70	62
09/10/02	57	51
09/11/02	78	69
09/12/02	82	73
09/13/02	87	77
09/14/02	91	81
09/15/02	91	81
09/16/02	91	81
09/17/02	91	81
09/18/02	82	73
09/19/02	91	81
09/20/02	87	77
09/21/02	91	81
09/22/02	83	74
09/23/02	74	66
09/24/02	78	69
09/25/02	87	77
09/26/02	91	81
09/27/02	84	75
09/28/02	78	69
09/29/02	88	78
09/30/02	82	73
10/01/02	38	34
10/02/02	58	52
10/03/02	78	69
10/04/02	91	81
10/05/02	91	81
10/06/02	91	81
10/07/02	70	62
10/08/02	87	77

TABLE 4

SAMPLING FLUX INPUT

Sample FLUX Input

11th Road Bridge Samples, flows in CFS

Date	Flow	Adjusted	TP	TSS	DRP
04/04/02	157	140	31	7000	9
04/17/02	161	143	68	16000	13
05/15/02	165	147	46	7000	13
05/30/02	161	143	49	12000	11
06/13/02	161	143	87	21000	34
07/02/02	128	114	86	15000	38
07/18/02	132	117	58	12000	26
08/01/02	149	133	68	12000	31
08/07/02	145	129	73	7000	31
08/15/02	87	77	63	9000	29
09/18/02	82	73	43	3000	22
10/08/02	87	77	51	26000	18

TABLE 5

FLUX LOADING ESTIMATION

FLUX Output Loading Summary

FLUX Output - Lake Montello Loading

Method	Mass (kg)	FLUX (kg/yr)	FLUX Variance	Concentration	CV
1	6499.6	6504.1	5.4560E+05	67.67	0.114
2	5836.1	5840.1	2.7000E+05	60.76	0.089
3	5837.5	5841.5	2.7450E+05	60.77	0.090
4	5751.1	5755.1	2.3220E+05	59.87	0.084
5	5773.0	5777.0	2.4230E+05	60.10	0.085
6	5835.6	5839.6	2.4830E+05	60.75	0.085

average of 4 methods with lowest CV value (methods 2,4,5,6)

	5799.0	5803.0	2.4820E+05	60.4	0.086

Standard Deviation

	497.3	497.6
High	6296.2	6300.6
Low	5301.7	5305.3

Flow Duration 365 days

Mean Flow Rate 96.25 HM3/YR 9.62E+07 m^3

Lake Area 340 acres

Lake Volume 1676 acre/feet

Observed Spring Turnover Total Phosphorus 50 mg/m^3

Observed Growing Season Mean Phosphorus 88.5 mg/m^3

APPENDIX A

PRECIPITATION DATA

Wisconsin State Climatology Rainfall Data
Midwestern Regional Climate Center
STATION: MONTELLO, WI (Station ID: 475581)

Precipitation Observation

Year	Mo	Dy	(in)
JANUARY			
2002	1	14	0.08
2002	1	15	0.25
2002	1	17	0.1
2002	1	31	0.1
			0.53
MARCH			
2002	3	2	0.21
2002	3	3	0.24
2002	3	6	0.03
2002	3	8	0.22
2002	3	9	0.22
2002	3	10	0.08
2002	3	15	0.08
2002	3	18	0.13
2002	3	20	0.68
2002	3	21	0.04
2002	3	29	0.17
			2.1
MAY			
2002	5	2	0.44
2002	5	6	0.04
2002	5	9	0.48
2002	5	12	0.41
2002	5	13	0.04
2002	5	25	0.16
2002	5	26	0.63
2002	5	29	0.06
			2.26

Year	Mo	Dy	(in)
FEBRUARY			
2002	2	1	0.39
2002	2	10	0.09
2002	2	19	0.48
2002	2	20	0.42
2002	2	21	0.93
2002	2	27	0.02
			2.33
APRIL			
2002	4	2	0.25
2002	4	3	0.15
2002	4	7	0.08
2002	4	8	0.22
2002	4	9	0.48
2002	4	12	0.22
2002	4	15	0.03
2002	4	17	0.02
2002	4	18	0.16
2002	4	19	0.45
2002	4	21	0.04
2002	4	22	0.39
2002	4	24	0.72
2002	4	28	0.82
2002	4	30	0.03
			4.06
JUNE			
2002	6	3	1.8
2002	6	4	0.42
2002	6	5	0.15
2002	6	11	0.3
2002	6	14	0.18
2002	6	15	0.03
2002	6	17	0.1
2002	6	20	0.06
2002	6	21	0.65
2002	6	22	0.66
2002	6	23	0.24
2002	6	26	0.77
2002	6	27	0.07
			5.43

JULY

2002	7	9	0.4
2002	7	19	0.09
2002	7	21	0.03
2002	7	22	0.77
2002	7	26	0.04
2002	7	29	1.23
2002	7	31	0.02
			2.58

AUGUST

2002	8	4	0.55
2002	8	12	0.02
2002	8	13	0.15
2002	8	17	0.43
2002	8	19	0.07
2002	8	22	0.85
2002	8	23	0.03
			2.1

SEPTEMBER

2002	9	2	0.47
2002	9	3	0.47
2002	9	11	0.13
2002	9	15	0.32
2002	9	19	2.3
2002	9	20	0.08
2002	9	21	0.23
2002	9	27	0.04
2002	9	29	0.37
			4.41

OCTOBER

2002	10	1	0.02
2002	10	2	0.44
2002	10	3	0.25
2002	10	4	0.36
2002	10	5	0.88
2002	10	6	0.13
2002	10	7	0.08
2002	10	8	0.07
2002	10	9	0.05
2002	10	10	0.11
2002	10	11	0.17
2002	10	13	0.06
2002	10	18	0.19
2002	10	21	0.15
2002	10	22	0.14
2002	10	24	0.12
2002	10	25	0.2
2002	10	26	0.16
			3.58

NOVEMBER

2002	11	5	0.03
2002	11	6	0.09
2002	11	11	0.06
2002	11	19	0.11
			0.29

DECEMBER

2002	12	2	0.06
2002	12	18	0.35
2002	12	19	0.15
2002	12	20	0.05
			0.61

TOTALS

January	February	March	April	May	June	July	August	September	October
0.53	2.33	2.1	4.06	2.26	5.43	2.58	2.1	4.41	3.58

November	December
0.29	0.61

Annual Rainfall 30.28

APPENDIX B

LAKE MONTELLO DISCHARGE DATA

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
9/1/2001	5.113	150	153	Closed	0	0	153
9/2/2001	5.07	55	74	Closed	0	0	74
9/3/2001	5.093	35	57	Closed	0	0	57
9/4/2001	5.117	87	101	Closed	0	0	101
9/5/2001	5.107	125	132	Closed	0	0	132
9/6/2001	5.08	115	124	Closed	0	0	124
9/7/2001	5.093	130	136	Closed	0	0	136
9/8/2001	5.362	160	161	Open	.75	151	312
9/9/2001	5.068	80	95	Closed	0	0	95
9/10/2001	5.16	165	165	Closed	0	0	165
9/11/2001	5.123	150	153	Closed	0	0	153
9/12/2001	5.129	150	153	Closed	0	0	153
9/13/2001	5.117	160	161	Closed	0	0	161
9/14/2001	5.126	120	128	Closed	0	0	128
9/15/2001	5.116	80	95	Closed	0	0	95
9/16/2001	5.107	100	111	Closed	0	0	111
9/17/2001	5.056	160	161	Closed	0	0	161
9/18/2001	5.072	155	157	Closed	0	0	157
9/19/2001	5.074	150	153	Closed	0	0	153
9/20/2001	5.103	100	111	Closed	0	0	111
9/21/2001	5.099	110	120	Closed	0	0	120
9/22/2001	5.117	110	120	Closed	0	0	120
9/23/2001	5.109	140	145	Closed	0	0	145
9/24/2001	5.074	120	128	Closed	0	0	128
9/25/2001	5.103	130	136	Closed	0	0	136
9/26/2001	5.097	155	157	Closed	0	0	157
9/27/2001	5.101	140	145	Closed	0	0	145
9/28/2001	5.095	135	141	Closed	0	0	141
9/29/2001	5.093	110	120	Closed	0	0	120
9/30/2001	5.085	105	116	Closed	0	0	116
10/1/2001	5.103	72	88	Closed	0	0	88
10/2/2001	5.08	125	132	Closed	0	0	132
10/3/2001	5.078	75	91	Closed	0	0	91
10/4/2001	5.101	130	136	Closed	0	0	136
10/5/2001	5.096	50	70	Closed	0	0	70
10/6/2001	5.086	65	82	Closed	0	0	82
10/7/2001	5.021	18	43	Closed	0	0	43
10/8/2001	5.064	10	25	Closed	0	0	25
10/9/2001	5.097	130	136	Closed	0	0	136

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
10/10/2001	5.105	160	161	Closed	0	0	161
10/11/2001	5.126	95	107	Closed	0	0	107
10/12/2001	5.146	120	128	Closed	0	0	128
10/13/2001	5.14	150	153	Closed	0	0	153
10/14/2001	5.099	70	87	Closed	0	0	87
10/15/2001	5.097	65	82	Closed	0	0	82
10/16/2001	5.113	95	107	Closed	0	0	107
10/17/2001	5.08	105	116	Closed	0	0	116
10/18/2001	5.101	135	141	Closed	0	0	141
10/19/2001	5.085	100	111	Closed	0	0	111
10/20/2001	5.093	140	145	Closed	0	0	145
10/21/2001	5.097	60	78	Closed	0	0	78
10/22/2001	5.097	35	57	Closed	0	0	57
10/23/2001	5.099	90	103	Closed	0	0	103
10/24/2001	5.103	150	153	Closed	0	0	153
10/25/2001	5.103	110	120	Closed	0	0	120
10/26/2001	5.016	160	161	Closed	0	0	161
10/27/2001	5.197	175	174	Closed	0	0	174
10/28/2001	5.083	65	82	Closed	0	0	82
10/29/2001	5.103	110	120	Closed	0	0	120
10/31/2001	5.099	140	145	Closed	0	0	145
11/1/2001	5.095	145	149	Closed	0	0	149
11/2/2001	5.097	110	120	Closed	0	0	120
11/3/2001	5.081	130	136	Closed	0	0	136
11/4/2001	5.076	50	70	Closed	0	0	70
11/5/2001	5.097	60	78	Closed	0	0	78
11/6/2001	5.096	60	78	Closed	0	0	78
11/7/2001	5.091	135	141	Closed	0	0	141
11/8/2001	5.098	100	111	Closed	0	0	111
11/9/2001	5.111	70	87	Closed	0	0	87
11/10/2001	5.098	75	91	Closed	0	0	91
11/11/2001	5.109	50	70	Closed	0	0	70
11/12/2001	5.101	35	57	Closed	0	0	57
11/13/2001	5.098	100	111	Closed	0	0	111
11/14/2001	5.099	155	157	Closed	0	0	157
11/15/2001	5.099	165	165	Closed	0	0	165
11/16/2001	5.105	158	160	Closed	0	0	160
11/18/2001	5.107	65	82	Closed	0	0	82
11/19/2001	5.101	110	120	Closed	0	0	120

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
11/20/2001	5.099	150	153	Closed	0	0	153
11/21/2001	5.099	160	161	Closed	0	0	161
11/22/2001	5.103	60	78	Closed	0	0	78
11/23/2001	5.097	150	153	Closed	0	0	153
11/25/2001	5.101	110	120	Closed	0	0	120
11/26/2001	5.097	165	165	Closed	0	0	165
11/27/2001	5.119	150	153	Closed	0	0	153
11/28/2001	5.209	165	165	Closed	0	0	165
11/29/2001	5.216	168	168	Closed	0	0	168
11/30/2001	5.368	170	170	Closed	0	0	170
12/1/2001	5.39	170	170	Closed	0	0	170
12/2/2001	5.213	160	161	Closed	0	0	161
12/3/2001	2.097	80	95	Closed	0	0	95
12/4/2001	5.103	85	99	Closed	0	0	99
12/5/2001	5.103	110	120	Closed	0	0	120
12/6/2001	5.246	160	161	Closed	0	0	161
12/7/2001	5.371	170	170	Closed	0	0	170
12/8/2001	5.418	170	170	Closed	0	0	170
12/9/2001	5.186	170	170	Closed	0	0	170
12/10/2001	5.081	135	141	Closed	0	0	141
12/11/2001	5.08	65	82	Closed	0	0	82
12/12/2001	5.186	160	161	Closed	0	0	161
12/13/2001	5.179	165	165	Closed	0	0	165
12/14/2001	5.193	165	165	Closed	0	0	165
12/15/2001	5.218	170	170	Closed	0	0	170
12/16/2001	5.099	85	99	Closed	0	0	99
12/17/2001	5.095	70	87	Closed	0	0	87
12/18/2001	5.103	80	95	Closed	0	0	95
12/19/2001	5.101	110	120	Closed	0	0	120
12/20/2001	5.095	160	161	Closed	0	0	161
12/21/2001	5.103	110	120	Closed	0	0	120
12/22/2001	5.097	90	103	Closed	0	0	103
12/23/2001	5.103	100	111	Closed	0	0	111
12/24/2001	5.095	115	124	Closed	0	0	124
12/25/2001	5.1	110	120	Closed	0	0	120
12/26/2001	5	110	120	Closed	0	0	120
12/27/2001	4.95	95	107	Closed	0	0	107
12/28/2001	5.3	160	161	Closed	0	0	161
12/29/2001	5.15	160	161	Closed	0	0	161

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
12/31/2001	4.7	20	45	Closed	0	0	45
1/2/2002	4.960	25	49	Closed	0	0	49
1/3/2002	5.100	25	49	Closed	0	0	49
1/3/2002	5.100	168	168	Closed	0	0	168
1/4/2002	4.902	110	120	Closed	0	0	120
1/5/2002	4.898	130	136	Closed	0	0	136
1/6/2002	4.901	75	91	Closed	0	0	91
1/7/2002	4.892	49	69	Closed	0	0	69
1/8/2002	4.931	130	136	Closed	0	0	136
1/10/2002	4.907	90	103	Closed	0	0	103
1/11/2002	4.900	130	136	Closed	0	0	136
1/12/2002	4.903	100	111	Closed	0	0	111
1/13/2002	4.898	65	82	Closed	0	0	82
1/14/2002	4.901	75	91	Closed	0	0	91
1/15/2002	4.894	160	161	Closed	0	0	161
1/16/2002	4.898	70	87	Closed	0	0	87
1/17/2002	4.888	70	87	Closed	0	0	87
1/18/2002	4.874	60	78	Closed	0	0	78
1/19/2002	4.876	55	74	Closed	0	0	74
1/20/2002	4.896	85	99	Closed	0	0	99
1/21/2002	4.892	80	95	Closed	0	0	95
1/22/2002	4.884	85	99	Closed	0	0	99
1/23/2002	4.902	155	157	Closed	0	0	157
1/25/2002	4.900	100	111	Closed	0	0	111
1/26/2002	4.900	85	99	Closed	0	0	99
1/27/2002	4.900	65	82	Closed	0	0	82
1/28/2002	4.909	90	103	Closed	0	0	103
1/29/2002	4.894	150	153	Closed	0	0	153
1/30/2002	4.904	160	161	Closed	0	0	161
1/31/2002	4.898	90	103	Closed	0	0	103
2/1/2002	4.900	155	157	Closed	0	0	157
2/2/2002	4.894	85	99	Closed	0	0	99
2/3/2002	4.890	80	95	Closed	0	0	95
2/4/2002	4.915	30	53	Closed	0	0	53
2/5/2002	4.903	110	120	Closed	0	0	120
2/7/2002	4.898	60	78	Closed	0	0	78
2/8/2002	4.876	45	66	Closed	0	0	66
2/9/2002	4.888	140	145	Closed	0	0	145
2/10/2002	4.876	75	91	Closed	0	0	91

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
2/11/2002	4.900	70	87	Closed	0	0	87
2/12/2002	4.872	75	91	Closed	0	0	91
2/14/2002	4.903	110	120	Closed	0	0	120
2/15/2002	4.893	70	87	Closed	0	0	87
2/16/2002	4.898	120	128	Closed	0	0	128
2/18/2002	4.917	75	91	Closed	0	0	91
2/19/2002	4.964	165	165	Closed	0	0	165
2/20/2002	5.242	170	170	Closed	0	0	170
2/21/2002	5.426	170	170	Closed	0	0	170
2/21/2002	5.377	160	161	Open	0.75	151	313
2/22/2002	5.250	155	157	Open	0.75	149	306
2/23/2002	4.988	150	153	Closed	0	0	153
2/24/2002	4.976	160	161	Closed	0	0	161
2/25/2002	4.847	160	161	Closed	0	0	161
2/26/2002	5.029	160	161	Closed	0	0	161
2/27/2002	4.987	160	161	Closed	0	0	161
2/28/2002	5.089	140	145	Closed	0	0	145
3/1/2002	4.906	155	157	Closed	0	0	157
3/3/2002	4.882	40	62	Closed	0	0	62
3/4/2002	4.878	10	25	Closed	0	0	25
3/5/2002	4.897	55	74	Closed	0	0	74
3/6/2002	4.902	145	149	Closed	0	0	149
3/7/2002	4.902	55	74	Closed	0	0	74
3/8/2002	4.904	65	82	Closed	0	0	82
3/9/2002	5.101	110	120	Closed	0	0	120
3/11/2002	4.907	160	161	Closed	0	0	161
3/12/2002	4.915	160	161	Closed	0	0	161
3/13/2002	4.935	160	161	Closed	0	0	161
3/14/2002	5.250	150	153	Closed	0	0	153
3/15/2002	5.915	175	174	Closed	0	0	174
3/16/2002	5.242	100	111	1 gate	0	0	111
3/17/2002	4.907	160	161	Closed	0	0	161
3/18/2002	4.892	145	149	Closed	0	0	149
3/19/2002	5.134	165	165	Closed	0	0	165
3/20/2002	5.140	165	165	1/2 gate	0	0	165
3/21/2002	5.081	160	161	Closed	0	0	161
3/22/2002	5.070	162	163	6"	0	0	163
3/23/2002	5.046	160	161	20"	0	0	161
3/24/2002	4.919	146	150	Closed	0	0	150

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
3/25/2002	4.898	105	116	8"	0	0	116
3/26/2002	4.921	120	128	Closed	0	0	128
3/27/2002	4.894	160	161	Closed	0	0	161
3/28/2002	4.898	100	111	Closed	0	0	111
3/29/2002	4.896	80	95	Closed	0	0	95
3/30/2002	4.925	165	165	Closed	0	0	165
4/1/2002	4.904	150	153	Closed	0	0	153
4/2/2002	4.978	160	161	Closed	0	0	161
4/3/2002	5.044	165	165	Closed	0	0	165
4/4/2002	5.019	155	157	Closed	0	0	157
4/5/2002	4.929	160	161	Closed	0	0	161
4/6/2002	4.935	155	157	Closed	0	0	157
4/7/2002	4.898	140	145	Closed	0	0	145
4/8/2002	5.111	165	165	Closed	0	0	
4/9/2002	5.238	165	165	Closed	0	0	165
4/10/2002	5.002	150	153	?	0	0	153
4/11/2002	5.357	150	153	11 gate	0	0	153
4/12/2002	5.074	55	74	Closed	0	0	74
4/13/2002	5.202	165	165	1 gate	0	0	165
4/14/2002	5.158	150	153	Closed	0	0	153
4/15/2002	5.095	145	149	Closed	0	0	149
4/16/2002	5.298	170	170	Closed	0	0	170
4/17/2002	5.246	160	161	1/2 gate	0	0	161
4/18/2002	5.287	165	165	Closed	0	0	165
4/19/2002	5.500	165	165	Open	0	0	165
4/20/2002	5.000	165	165	Open	0	0	165
4/21/2002	5.700	165	165	Open	0	0	165
4/22/2002	5.119	160	161	Closed	0	0	161
4/23/2002	5.439	165	165	1/2	0	0	165
4/24/2002	5.222	155	157	1/2 gate	0	0	157
4/25/2002	5.250	150	153	1/2	0	0	153
4/26/2002	5.222	155	157	1/2	0	0	157
4/27/2002	5.050	155	157	1/4	0	0	157
4/28/2002	5.211	160	161	1/4	0	0	161
4/29/2002	5.312	160	161	1/2	0	0	161
4/30/2002	5.396	155	157	1 1/2	0	0	157
5/1/2002	5.117	150	153	1 gate	0	0	153
5/2/2002	5.278	150	153	Closed	0	0	153
5/3/2002		160	161	1 gate	0	0	161

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
5/4/2002	5.212	150	153	1 gate	0	0	153
5/5/2002	4.900	95	107	Closed	0	0	107
5/6/2002	5.099	160	161	Closed	0	0	161
5/7/2002	5.091	155	157	Closed	0	0	157
5/8/2002	5.087	153	155	Closed	0	0	155
5/9/2002	5.205	160	161	Closed	0	0	161
5/10/2002	5.306	?		1/2 gate	0	0	0
5/11/2002	5.062	100	111	Closed	0	0	111
5/12/2002	5.089	105	116	Closed	0	0	116
5/13/2002	5.123	150	153	Closed	0	0	153
5/14/2002	5.297	165	165	Closed	0	0	165
5/15/2002	5.324	165	165	1/2	0	0	165
5/16/2002	4.849	Auto		1/2	0	0	0
5/17/2003	5.146	165	165	Closed	0	0	165
5/18/2002	5.111	110	120	Closed	0	0	120
5/19/2002	5.297	105	116	Closed	0	0	116
5/20/2002	5.207	115	124	Closed	0	0	124
5/21/2002	5.074	155	157	Closed	0	0	157
5/22/2002	5.101	100	111	Closed	0	0	111
5/23/2002	5.093	120	128	Closed	0	0	128
5/24/2002	5.103	150	153	Closed	0	0	153
5/25/2002	5.093	85	99	Closed	0	0	99
5/26/2002	5.102	160	161	Closed	0	0	161
5/27/2002	5.101	115	124	Closed	0	0	124
5/28/2002	5.115	162	163	Closed	0	0	163
5/29/2002	5.097	160	161	Closed	0	0	161
5/30/2002	5.099	160	161	Closed	0	0	161
5/31/2002	5.089	80	95	Closed	0	0	95
6/1/2002	5.085	160	161	Closed	0	0	161
6/2/2002	5.099	80	95	Closed	0	0	95
6/3/2002	5.105	160	161	Closed	0	0	161
6/4/2002	5.390	160	161	1/3	0	0	161
6/5/2002	5.353	155	157	2/3	0	0	157
6/6/2002	5.205	100	111	2/3	0	0	111
6/7/2002	5.248	165	165	Closed	0	0	165
6/8/2002	5.323	165	165	1/3	0	0	165
6/9/2002	5.160	155	157	12"	0	0	157
6/10/2002	5.080	55	74	Closed	0	0	74
6/11/2002	5.098	135	141	Closed	0	0	141

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
6/12/2002	5.097	155	157	Closed	0	0	157
6/13/2002	5.097	160	161	Closed	0	0	161
6/14/2002	5.107	105	116	Closed	0	0	116
6/15/2002	5.103	155	157	Closed	0	0	157
6/16/2002	5.101	100	111	Closed	0	0	111
6/17/2002	5.107	120	128	Closed	0	0	128
6/18/2002	5.091	55	74	Closed	0	0	74
6/19/2002	5.113	110	120	Closed	0	0	120
6/20/2002	5.101	150	153	Closed	0	0	153
6/21/2002	5.081	120	128	Closed	0	0	128
6/22/2002	5.130	150	153	Closed	0	0	153
6/23/2002	5.103	150	153	Closed	0	0	153
6/24/2002	5.259	165	165	Closed	0	0	165
6/25/2002	5.306	165	165	?	0	0	165
6/26/2002	5.136	160	161	Closed	0	0	161
6/27/2002	5.107	165	165	Closed	0	0	165
6/28/2002	5.091	136	141	Closed	0	0	141
6/29/2002	5.097	130	136	Closed	0	0	136
6/30/2002	5.064	155	157	Closed	0	0	157
7/1/2002	5.081	65	82	Closed	0	0	82
7/2/2002	5.074	120	128	Closed	0	0	128
7/3/2002	5.119	150	153	Closed	0	0	153
7/4/2002	5.097	60	78	Closed	0	0	78
7/5/2002	5.066	40	62	Closed	0	0	62
7/6/2002	5.101	125	132	Closed	0	0	132
7/8/2002	5.101	55	74	Closed	0	0	74
7/9/2002	5.103	160	161	Closed	0	0	161
7/10/2002	5.093	155	157	Closed	0	0	157
7/11/2002	5.079	60	78	Closed	0	0	78
7/12/2002	5.081	55	74	Closed	0	0	74
7/13/2002	5.084	60	78	Closed	0	0	78
7/14/2002	5.087	5	13	Closed	0	0	13
7/15/2002	5.078	5	13	Closed	0	0	13
7/16/2002	5.099	110	120	Closed	0	0	120
7/17/2002	5.074	140	145	Closed	0	0	145
7/18/2002	5.107	125	132	Closed	0	0	132
7/19/2002	5.101	145	149	Closed	0	0	149
7/20/2002	5.076	115	124	Closed	0	0	124
7/21/2002	5.064	90	103	Closed	0	0	103

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
7/22/2002	5.062	25	49	Closed	0	0	49
7/23/2002	5.081	75	91	Closed	0	0	91
7/24/2002	5.080	125	132	Closed	0	0	132
7/25/2002	5.066	70	87	Closed	0	0	87
7/26/2002	5.000	70	87	Closed	0	0	87
7/27/2002	5.101	70	87	Closed	0	0	87
7/28/2002	5.103	65	82	Closed	0	0	82
7/29/2002	5.134	60	78	Closed	0	0	78
7/30/2002	5.089	50	70	Closed	0	0	70
7/31/2002	5.123	25	49	Closed	0	0	49
8/1/2002	4.903	145	149	Closed	0	0	149
8/2/2002	5.085	65	82	Closed	0	0	82
8/3/2002	5.072	65	82	Closed	0	0	82
8/4/2002	5.073	100	111	Closed	0	0	111
8/5/2002	5.080	55	74	Closed	0	0	74
8/6/2002	5.099	100	111	Closed	0	0	111
8/7/2002	5.080	140	145	Closed	0	0	145
8/8/2002	5.080	110	120	Closed	0	0	120
8/9/2002	5.078	5	13	Closed	0	0	13
8/10/2002	5.074	55	74	Closed	0	0	74
8/11/2002	5.062	65	82	Closed	0	0	82
8/12/2002	5.070	100	111	Closed	0	0	111
8/13/2002	5.080	85	99	Closed	0	0	99
8/14/2002	5.070	60	78	Closed	0	0	78
8/15/2002	5.070	70	87	Closed	0	0	87
8/16/2002	5.066	55	74	Closed	0	0	74
8/16/2002	5.061	55	74	Closed	0	0	74
8/17/2002	5.158	80	95	Closed	0	0	95
8/18/2002	5.133	150	153	Closed	0	0	153
8/19/2002	5.068	180	178	Closed	0	0	178
8/20/2002	5.076	75	91	Closed	0	0	91
8/21/2002	5.117	35	57	Closed	0	0	57
8/22/2002	5.105	55	74	Closed	0	0	74
8/23/2002	5.099	100	111	Closed	0	0	111
8/24/2002	5.101	100	111	Closed	0	0	111
8/25/2002	5.058	80	95	Closed	0	0	95
8/26/2002	5.101	?		?	0	0	0
8/27/2002	5.097	85	99	Closed	0	0	99
8/28/2002	5.265	0	0	4'	0	0	0

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
8/28/2002	5.140	0	0	3 1/2'	0	0	0
8/29/2002	5.078	0	0	3'	0	0	0
8/30/2002	5.048	0	0	24"	0	0	0
8/31/2002	5.101	115	124	Closed	0	0	124
9/1/2002	5.101	75	91	Closed	0	0	91
9/2/2002	5.089	45	66	Closed	0	0	66
9/3/2002	4.917	5	13	Closed	0	0	13
9/4/2002	4.800	75	91	24"	0	0	91
9/5/2002	4.500	50	70	?	0	0	70
9/6/2002	4.000	100	111	Closed	0	0	111
9/7/2002	3.950	60	78	Closed	0	0	78
9/8/2002	3.900	65	82	Closed	0	0	82
9/10/2002	4.000	35	57	Closed	0	0	57
9/11/2002	3.700	60	78	24"	0	0	78
9/12/2002	3.300	65	82	Closed	0	0	82
9/14/2002	3.200	75	91	Closed	0	0	91
9/15/2002	3.050	?		24"	0	0	0
9/17/2002	2.700	75	91	Closed	0	0	91
9/18/2002	2.700	65	82	Closed	0	0	82
9/19/2002	2.700	75	91	Full	0	0	91
9/20/2002	2.650	70	87	Full	0	0	87
9/21/2002	2.300	75	91	Full	0	0	91
9/23/2002	2.600	55	74	Closed	0	0	74
9/24/2002	1.900	60	78	Closed	0	0	78
9/25/2002	1.900	70	87	12"	0	0	87
9/26/2002	1.700	75	91	Full	0	0	91
9/27/2002	1.500	?		Full	0	0	0
9/28/2002	1.200	60	78	?	0	0	78
9/29/2002	1.100	72	88	Closed	0	0	88
9/30/2002	?	65	82	Closed	0		
10/1/2002	?	15	38	Closed	0		
10/3/2002	1.680	60	78	? Full	0	0	78
10/4/2002	1.500	75	91	Full	0	0	91
10/5/2002	1.600	75	91	Full	0	0	91
10/6/2002	1.700	75	91	Full	0	0	91
10/7/2002	0.800	50	70	Closed	0	0	70
10/8/2002	1.100	70	87	Closed	0	0	87
10/9/2002	1.200	75	91	6"	0	0	91
10/10/2002	0.875	75	91	?	0	0	91

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
10/12/2002	1.050	75	91	1/2	0	0	91
10/13/2002	1.000	45	66	Closed	0	0	66
10/15/2002	1.050	75	91	Closed	0	0	91
10/16/2002	?	65	82	?	0		82
10/17/2002	1.350	80	95	6"	0	0	95
10/18/2002	1.200	80	95	Full	0	0	95
10/19/2002	1.150	75	91	6"	0	0	91
10/22/2002	1.200	65	82	Closed	0	0	82
10/23/2002	1.500	25	49	Full	0	0	49
10/24/2002	1.500	80	95	Full	0	0	95
10/25/2002	1.600	35	57	Full	0	0	57
10/26/2002	1.800	25	49	2 Full	0	0	49
10/27/2002	1.400	50	70	1 Full	0	0	70
10/28/2002	1.000	255	240	1 Full	0	0	240
10/29/2002	1.000	?		Closed	0	0	0
10/30/2002	1.150	75	91	Closed	0	0	91
10/31/2002	1.500	60	78	Full	0	0	78
11/1/2002	1.375	75	91	?	0	0	91
11/2/2002	1.350	75	91	Full	0	0	91
11/3/2002	?	50	70	Closed	0		70
11/5/2002	1.500	0	0	2 Full	0	0	0
11/6/2002	1.800	0	0	4 gates Full	0	0	0
11/7/2002	1.700	0	0	3 Full	0	0	0
11/8/2002	1.550	0	0	4 Full	0	0	0
11/9/2002	1.600	0	0	4 gates	0	0	0
11/10/2002	1.400	0	0	4 gates	0	0	0
11/11/2002	1.200	0	0	4 gates	0	0	0
11/12/2002	1.550	0	0	4 gates	0	0	0
11/13/2002	1.450	100	111	Closed	0	0	111
11/14/2002	1.100	85	99	Closed	0	0	99
11/15/2002	1.000	75	91	Closed	0	0	91
11/16/2002	0.800	70	87	Closed	0	0	87
11/17/2002	1.000	40	62	Closed	0	0	62
11/19/2002	1.400	100	111	Closed	0	0	111
11/21/2002	1.150	35	57	Closed	0	0	57
11/22/2002	1.200	75	91	Closed	0	0	91
11/23/2002	1.300	75	91	Closed	0	0	91
11/24/2002	1.150	50	70	Closed	0	0	70
11/25/2002	1.350	50	70	Closed	0	0	70

MONTELLO LAKE OUTLET - DISCHARGE FROM DAM 2002

Date	Head Water (feet)	KW Output	Flow 1 (cfs)	Spillway Gate Open or Closed	Percent of Sluice Gate Open	Flow 2 (cfs)	Total Flow (cfs)
11/26/2002	1.250	75	91	Closed	0	0	91
11/27/2002	1.350	100	111	Closed	0	0	111
11/29/2002	0.900	?		Closed	0	0	0
11/30/2002	0.900	?		Closed	0	0	0
12/2/2002	1.000	550	485	Closed	0	0	485
12/5/2002	1.000	50	70	Closed	0	0	70
12/6/2002	1.000	50	70	Closed	0	0	70
12/7/2002	1.350	75	91	Closed	0	0	91
12/8/2002	0.850	?		Closed	0	0	0
12/9/2002	0.925	25	49	Closed	0	0	49
12/10/2002	1.000	50	70	Closed	0	0	70
12/11/2002	1.050	25	49	Closed	0	0	49
12/13/2002	1.000	?		Closed	0	0	0
12/14/2002	0.900	25	49	Closed	0	0	49
12/15/2002	1.200	55	74	Closed	0	0	74
12/17/2002	1.050	75	91	Closed	0	0	91
12/18/2002	1.000	85	99	Closed	0	0	99
12/20/2002	1.000	75	91	Closed	0	0	91
12/21/2002	1.050	100	111	Closed	0	0	111
12/22/2002	1.000	50	70	Closed	0	0	70
12/23/2002	0.900	30	53	Closed	0	0	53
12/24/2002	1.100	55	74	Closed	0	0	74
12/25/2002	1.200	100	111	Closed	0	0	111
12/28/2002	1.250	100	111	Closed	0	0	111
12/29/2002	0.950	50	70	Closed	0	0	70
12/31/2002	1.100	100	111	Closed	0	0	111