

LAKE ASSESSMENT PROGRAM
1986

LAKE VOLNEY
(I.D. #40-0033)

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SUMMARY AND CONCLUSION

Lake Volney was sampled by the Minnesota Pollution Control Agency (MPCA) during the summers of 1985 and 1986 as a part of the Lake Assessment Program (LAP). This pilot program was designed to assist lake associations in the collection of baseline lake water quality data for the purpose of assessing the current trophic status of their lake and to assist in the development of lake management strategies.

Lake Volney exhibited very high phosphorus concentrations in the summer of 1986, averaging 0.160 mg P/l. Relative to a sample of about 1,100 Minnesota Lakes, it would rank at about the 92nd percentile based on this concentration or that about 92% of the lakes exhibit lower values. This high phosphorus concentration produced blooms of algae throughout the summer. However, 1986 average chlorophyll a values were lower than predicted probably due to the effects of the weather (i.e. it was a wet year) and the presence of blue-green algae. Lake Volney would be classified as hypereutrophic based upon these measurements. Lake Volney has much greater in-lake nutrient and chlorophyll (algae) concentrations than the regional average. Phosphorus is reaching the lake at rates 3-10 times what would be generally expected based upon land uses.

Grab samples of selected tributaries to Lake Volney indicated very elevated nutrient levels. These high nutrient levels are likely due to the drainage from feedlot areas, from other agricultural lands in the watershed, including wetland areas now being cultivated, and residential sources such as lawn runoff and septic tanks. The relative magnitudes of water, total phosphorus and total nitrogen quantities reaching Lake Volney were predicted.

Without significant reduction of the nutrient loading to the lake, water quality degradation will continue. It was predicted that if the loading of phosphorus is significantly reduced (e.g. by a factor of 3 to 4), there would be an immediate (within one or two year) improvement in lake water quality. This could be accomplished by controlling runoff from feedlots, agricultural areas, lawns and other urban areas.

CONCLUSIONS

1. The predominant land uses in the watershed were cultivated (72.9%) and pasture (8.9%). The watershed size was relatively small and totaled about 1,906 acres.
2. Based upon this study, Lake Volney appears to be receiving total phosphorus at a rate of about 4.0 kg P/hectare/year (3.57 pounds P/acre/year), or at least 3-10 times what may be reasonably expected based upon regional land uses. Since phosphorus is the most controllable of the aquatic plant nutrients, it is recommended that efforts be aimed at a substantial reduction of this nutrient.
3. Lake Volney is a hypereutrophic lake which is experiencing several symptoms of over-enrichment (e.g. elevated nutrient concentrations, reduced transparencies and blooms of blue-green algae, etc.). Unless substantial watershed phosphorus and nitrogen reduction measures are implemented, continued degradation of the lake will occur. If large nutrient reductions occur by reducing the delivery of P to about 1.0 kg P/hectare/year (about 0.8 pound P/acre/year), water quality will improve.

RECOMMENDATIONS

1. The magnitude of the nutrients reaching Lake Volney should be reduced significantly. For this purpose, a target total phosphorus mass loading of about 1,500 pounds phosphorus from all sources is proposed. This will likely require a reduction of loading from the watershed of about 4,000 pounds P/year or a reduction of about 65%. Of this total, septic tanks probably contribute less than 200 pounds P/year, which may be reduced by routine maintenance and inspection by lakeshore residents.
2. The magnitude of the agricultural phosphorus export appears to be about 3.0 - 5.0 kg P/hectare per year (2.7 - 4.5 pounds P/acre per year). This is significantly higher than literature values of export coefficients for this type of land use. Additional study of the watershed and lake is recommended to refine the estimates presented in this brief study. It is recommended that these values be reduced by implementation of best management practices in the watershed through cooperative efforts with the agricultural community and local authorities such as the Soil and Water Conservation District, Soil Conservation Service, Agricultural Extension Service, LeSueur County, and the MPCA and MDNR. Expertise of these agencies will help further define critical watershed areas.
3. The Volney Lake Association or other interested parties should continue to participate in the Citizen Lake-Monitoring Program (CLMP). Data from this program should provide an excellent basis for assessing long-term and year to year variations in the algal productivity, i.e. trophic status of the lake. Measurements should be taken at two lake sites to allow for good trend assessment.

4. The Lake Volney lake association should continue their lake management efforts. Formation of a lake improvement district or a watershed district should also be considered to help fund lake/watershed improvement measures.
5. Further development in the immediate watershed of the lake should be done in such a manner as to minimize lake water quality impacts. Wetlands must be preserved.

Special Thanks

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INTRODUCTION

Numerous citizen complaints were received during the summer of 1985 by MPCA staff about the perceived degradation of the lake's water quality. In response, MPCA staff presented information at the lake association formation meeting held on April 21, 1986. Due to the lack of lake water quality data, it was proposed that the lake association work with MPCA staff in a pilot cooperative program called the Lake Assessment Program (LAP) to obtain lake water quality data. This program was designed to assist lake associations in the collection of baseline lake water quality data for the purpose of assessing the current trophic status of their lake. The general work plan for LAP includes cooperative lake sampling by MPCA and the association, participation in the Citizen Lake-Monitoring Program (CLMP), examination of land use and drainage patterns in the watershed of the lake and an assessment of the data collected.

What is the value of a recreational lake to its surrounding community? Often times lakes are merely considered places to swim, ski or fish, but in reality, this does not begin to describe the significance of lakes. Lakeshores are valuable real estate areas. Besides producing fish and beautiful scenery, lakes can also provide a good part of the community's economic base.

Put another way, tourism and travel industries in Minnesota generated about \$5.3 billion in 1985. Of this total, over \$11 million was expended in LeSueur County. Dollars directly expended by lake resource users may be expected to also generate additional dollars to the local economies. These indirect revenues are generated as tourist/lakeshore owner dollars are, in turn, spent by

its recipients for their needed goods and services. This is the multiplier effect which may, in effect, generate as much as 2-3 times the original dollar to the county's economy.

It is clear that Minnesotans are sensitive to water pollution, that they largely believe that the appropriate use of their waters is for fish and wildlife habitat, water supply, and recreation, and that they respond to perceived pollution by choosing one of the numerous alternative bodies of water for recreational use (MPCA, 1980). Additionally, reductions in shoreline property values and consequently, public revenues, can be expected with reduced water quality. For Lake Volney, it is not possible to conclude the magnitude of the reduction without further analysis. Reduction in the number of recreationists to the region will reduce the income and employment attributable to tourism expenditures.

In general, Lake Volney's water quality problems are due to nonpoint sources of pollution often termed polluted runoff. This includes nutrient and sediment runoff from agricultural fields, roads, feedlots, leakage from septic tanks, urban sources and various other sources. Of these sources, it has been generally found that the greatest quantities of nutrients and sediments are released (or exported) from urban and agricultural areas. In comparison, forested and wetland areas release relatively small quantities of nutrients and sediments.

The degradation of lakes may be caused by many factors, but most often it is caused by the excessive export of nutrients and sediments from the land or watershed. The nutrient and sediment enrichment of water bodies is referred to as eutrophication. In an undisturbed watershed, eutrophication is a slow

process occurring over a period of many hundreds or thousands of years where nutrients and sediments, generated by the lake's watershed, accumulate producing a gradual filling-in of the lake with silt and organic debris.

The rate of eutrophication is greatly accelerated if abundant nutrient and sediment sources are located in the watershed of the lake. And, when these nutrient sources owe their origins to man's activities, a new term, cultural eutrophication or enrichment is used to describe the potentially rapid enrichment which may take place. Human activities such as wastewater disposal, other waste disposal practices, urbanization and agricultural activities can make even large lakes eutrophic or over-supplied with nutrients in only a few years. Continued levels of excessive nutrients will build up in lake sediments making restoration efforts cost-prohibitive. Early detection and elimination of nutrient sources can result in improved water quality without significant long term adverse affects.

Eutrophic lakes may be characterized by a variety of water quality conditions, dependent upon the rate of nutrient supply or eutrophication. In many instances in Minnesota, eutrophic lakes may support excellent warm water fisheries. However, in advanced stages, the effects of lake eutrophication may cause serious resource degradation. These lakes may have blue-green algal blooms of such severity as to turn the water to "pea-soup," reduce the potential for support of sports fisheries, reduce riparian property values and in severe cases, cause the development of toxic algal blooms capable of killing pets, livestock, waterfowl and other wildlife. Body contact activities in these lakes may be severely reduced due to aesthetically unpleasing conditions of taste and foul odors associated with the algal blooms. Blue-green algal blooms have also

been extensively associated with human respiratory, gastrointestinal and dermal disorders. In general, very eutrophic (hypereutrophic) lakes have a variety of nuisance conditions that detract from the resource's value.

Blue-green algae are also much less desirable in lakes than other types of algae (such as green algae and diatoms) because they are a poor supply of food for microscopic animals or zooplankton. Zooplankton are in turn, an important part of the food chain for the fisheries.

Additionally, blue-green algae tend to become dominant in fertile lakes due to their rapid reproduction and their ability to float near the water surface, sometimes almost excluding the more desirable algae. In the summer months, these algae can dominate the lake and produce massive blooms. As the blooms die-off, they can produce foul odors and reduce the oxygen content of the lake causing fish kills or stress that allows other diseases to cause fish kills. Reduced oxygen content may also produce conditions favoring rough fish species which may have greater tolerance to the lower oxygen content of the waters. These consequences of eutrophication can seriously impair the lake's resource value now and for the generations to come.

Lake resource degradation is not necessarily irreversible. Decreasing the supply of nutrients to lakes has been shown in many instances to produce significant improvements in lake water quality. Among the nutrients necessary for algal growth (and over-growth), phosphorus has been shown to be the key for fresh water algae. Unlike other nutrients, phosphorus is generally not available from natural sources in large quantities. Most importantly, phosphorus is the only essential element that can be made to limit algal growth.

The rate of lake eutrophication is commonly investigated by the calculation of water and phosphorus budgets. These were estimated for Lake Volney. Hydrologic and nutrient budgets provide an accurate appraisal of the sources of cultural eutrophication and therefore provide the basis for determination of sound lake-management options.

This report summarizes relatively limited amounts of data collected during the summers of 1985 and 1986. The hydrologic and phosphorus budgets for Lake Volney were estimated based upon in-lake characteristics and nutrient export coefficients and have been presented with error analyses (degree of certainty) to better define study results for future investigations. Additional study of the watershed and lake will further define problem areas and lake characteristics.

BACKGROUND

Lake Volney is located in Le Sueur County in the Cannon River watershed approximately four miles southeast of Le Center, Minnesota. It is a moderate sized lake with a surface area of about 277 acres placing it above the average for the state.

Lake Volney is comprised of one main basin which has an average depth of about 22.7 feet with a maximum depth of 67 feet. The lake has a total of 14 inlets noted by the lake association and one outlet which drains to Gorman Lake. The largest flows were observed in Ditch #1 (see Figure 1). Lake Volney, like most lakes in the county, was formed from ice blocks deposited in glacial till.

Since land use affects water quality, it can be useful to divide the state into regions where the land use and water resources are similar. For Minnesota, this results in seven regions, referred to as "ecoregions," as defined by soils, land surface forms, natural vegetation, and current land use. Lake Volney is located in the Central Hardwood Forests ecoregion (Figure 1). Its watershed is about 3.0 square miles and land use is dominated by cultivated use (73.9%) plus pasture use (8.9%). The lake represents about 12% of the total watershed area. Regionally, cultivated land use is, on average, about 49.3% of the total.

RESULTS AND DISCUSSION

Water quality data were collected on five occasions from two sites on Lake Volney and from Ditches 1, 2, 12 and the lake outlet (Figure 1) over the summers of 1985 and 1986. Lake samples were obtained on July 31, 1985 and April 24, June 25, July 21, and September 19, 1986. Lake samples were generally collected at two sites (Figure 1). Four series of stream samples were obtained during the summer of 1986. All samples were submitted to the Minnesota Department of Health laboratory for analysis. Total analytical expense was approximately \$1,000 for this investigation.

Lake samples were analyzed for color, pH, suspended solids, turbidity, chloride, conductivity, total Kjeldahl nitrogen, nitrate+nitrite nitrogen, total phosphorus, total alkalinity, and chlorophyll a. Temperature and dissolved oxygen profiles and Secchi disk transparency measurements were also taken. Data from a water quality survey conducted in 1981 were also included for comparison. All data was stored in STORET, the U.S. Environmental Protection Agency's (EPA) national water quality data bank. The following discussion assumes that the

reader is familiar with basic water quality terminology as used in the "Citizens Guide to Lake Protection." For further information and a glossary of terms, please refer to the Citizens Guide to Lake Protection.

IN-LAKE CONDITIONS

A spring sample was obtained in April, 1986 which showed the lake to be nearly isothermal or having the same temperature from the top to the bottom of about 9 degrees Centigrade ($^{\circ}\text{C}$). Concurrently measured dissolved oxygen showed a similar pattern with values about 12 mg/l or parts per million. This pattern is typical of most Minnesota lakes, as the lake was well mixed from top to bottom in the spring. With the progression of the season, temperatures increase and result in different lake conditions.

By June, for example, distinctly different temperature and oxygen profiles were observed at station 101, as the lake thermally stratified. Temperature values at the surface of the lake were about 23°C , while on the bottom of the lake, the temperature was about 13°C . The thermocline, or the lake depth in which the water temperatures decline rapidly, was between 20-26 feet at this time. Similar temperature and dissolved oxygen values were recorded at other summer monitoring times. Station 102, with a depth less than 20 feet, appeared to represent the maximum depth of mixing as temperatures ranged from 26 to 23.9°C on July 21, 1986, from top to bottom.

The temperature and dissolved oxygen profiles indicated that Lake Volney thermally stratifies over the summer with dissolved oxygen concentrations generally greater than 5.0 mg/l to depths of about 15-20 feet. Below this

depth, oxygen concentrations were observed to abruptly decline to near zero concentrations on most summer sampling dates. This is particularly important to fisherman, since oxygen concentrations less than 5.0 mg/l can severely limit the habitat available to fish and other aquatic life during periods of stratification and under ice cover.

Lake total phosphorus (TP) concentrations were very high on all sample dates averaging 160 ug P/l. Relative to a sample of 1,028 Minnesota lakes this phosphorus concentration would place Lake Volney at about the 92nd percentile (Heiskary, 1985.) In other words, its phosphorus concentration was higher than about 92% of the lakes in the sample. Lake Volney would be classified as hypereutrophic or highly productive based upon these TP concentrations.

Total nitrogen (TN) which consists of Total Kjeldahl nitrogen (TKN) plus Nitrate and Nitrite nitrogen ($\text{NO}_2 + \text{NO}_3\text{-N}$) is another essential nutrient for plant growth. TN concentrations were quite high in 1985 and 1986 averaging 2,040 ug N/l (Table 1). Nitrate and nitrite concentrations were extremely high in the April and June sampling dates with values exceeding 1,000 ug N/l. Average in-lake concentrations of $\text{NO}_2 + \text{NO}_3\text{-N}$ may typically be expected to be 30 ug/l or less.

The ratio of TN:TP can provide an indication as to which nutrient is limiting the production of algae in a lake. Ratios of TN:TP < 10 have been used to indicate nitrogen limitation while ratios in excess of 14-17 indicate phosphorus limitation. The average TN:TP ratio for Lake Volney was about 13. This suggests that the amounts of algae in the lake are periodically limited by either phosphorus or nitrogen. Thus, reducing the amount of phosphorus reaching

the lake should (1) generally reduce the amount of algae in the lake and/or (2) shift the predominant species of algae in the lake e.g. a shift from the blue-green algal species to green algal species.

Chlorophyll a concentrations provide an estimate of the amount of algal production or quantities in a lake. In 1985/86, chlorophyll a concentrations averaged about 39 ug/l (micrograms per liter, ug/l, or parts per billion) with a peak measured concentration of 96.4 ug/l on September 19, 1986. Concentrations above 30 ug/l generally suggest bloom or nuisance conditions while concentrations greater than 40 ug/l are suggestive of severe nuisance conditions such as surface scum and odor formation. Peak chlorophyll a concentrations typically are 2 to 3 times the average summer value. Field observations in 1985 and 1986 indicated that the dominant algae species was Aphanizomenon flos-aquae, a blue-green algal species. This algae appears as "grass clippings" in the water. Another blue-green algal species noted in the July 21, 1986 sampling was Microcystis spp. which was observed forming a gelatinous looking surface film on the edges of the lake protected from the wind. These species of algae frequently dominate lakes with high nutrient concentrations.

Secchi disk transparency is generally a function of the amount of algae in the water. Suspended sediments (silt) and color due to dissolved organic matter may also reduce water transparency. In 1986, the average Secchi disk transparency was about 5.4 feet (or 1.6 meters).

One means to evaluate the trophic status of a lake is to interpret the relationship between total phosphorus, chlorophyll a and Secchi disk transparency using Carlson's Trophic Status Index (TSI, Carlson, 1977). This

index was developed from the interrelationships of summer Secchi disk transparency and the concentrations of surface water chlorophyll a and total phosphorus. TSI values are calculated as follows:

$$\text{Total Phosphorus TSI (TSIP)} = 14.42 \ln (\text{TP}) + 4.15$$

$$\text{Chlorophyll } \underline{a} \text{ TSI (TSIC)} = 9.81 \ln (\text{Chl } \underline{a}) + 30.6$$

$$\text{Secchi Disk TSI (TSIS)} = 60 - 14.41 \ln (\text{SD})$$

with TP and chlorophyll a in ug/l and Secchi disk in meters. TSI values range from 0 (ultra-oligotrophic) to 100 (hypereutrophic). In this index, each increase of 10 units represents a doubling of algal biomass. Average TSI values for 1986 are listed in Table 4. These values suggest that Lake Volney would be considered eutrophic to hypereutrophic depending upon the parameter used. The TSIS suggests less eutrophic conditions than the TSIP. This is likely a function of the "artificially high" transparency due to the clumping of the algae Aphanizomenon flos-aquae, which may give greater transparency than may be observed with a different type of algae. In contrast, the TSIP value suggests a hypereutrophic lake or that the lake could assume a much greater productivity than is currently being experienced.

Tributary Water Quality

Grab samples were collected from selected tributaries as a basis for comparing the relative concentrations of nutrients among these sites. Samples were taken from Ditch #1 (on the northeastern corner of the lake), Ditch #2 (agricultural tile drainage from pump), Ditch #12 (which is the stream emptying into the lake by the Dolejs home), and the lake outlet (Outlet). See Appendix C for stream

data. These results reveal very high concentrations of nutrients. Ditch #12, for example, averaged 3,700 ug P/l. Ditch #1 (the newly dug drainage ditch) had concentrations of TP which averaged 922 ug P/l, and Ditch #2 (tile drainage) had an average concentration of about 285 ug P/l. All monitored inlets had very elevated concentrations of nitrogen compounds, particularly $\text{NO}_2 + \text{NO}_3 - \text{N}$ nitrogen with monitored values up to 21,000 ug N/l.

Although no stream flow measurements were taken, the largest water contributors to the lake appeared to be Ditch #1 and Ditch #12. The greatest flows may be expected from Ditch #1, which may contribute about 1/2 of the total inflows to the lake. The areas of the principal subwatersheds were determined in an effort to estimate their water flow volumes. The planimetered subwatershed areas were as follows:

Subwatershed	Estimated Area Acres	% of Watershed Area	Estimated Average acre-feet	% of Total Estimated Annual Flow
Drainage Ditch #1	862 acres	45.2	407.7	52.3
Drainage Ditch #2	67 acres	3.3	38.1	4.9
Drainage Ditch #12	100 acres	5.3	45.4	5.8

The stream water quality results represent only "grab" samples and are of limited value for assessing impact on the water quality of Lake Volney. They do, however, suggest that some current sources of water (e.g. Ditches 1,2, and 12) may be delivering extremely high quantities of nutrients to the lake. While other potential sources of water to the lake may also be contributing excessive nutrient loads, these inlets are probably contributing the majority of the mass loading.

Quantifying Changes Needed for Lake Water Quality Improvements

As stated previously, eutrophication can be defined as the nutrient enrichment of water bodies leading to an excessive production of organic materials by algae and/or aquatic plants and filling-in of a lake basin by silt. Lake water quality degradation is not necessarily irreversible if the amounts of silt and nutrients reaching the lake are reduced. In many instances, it has been shown that reducing the amounts of phosphorus supplied to a lake has resulted in improvement in lake water quality as estimated by water transparency and by chlorophyll a concentrations.

The amount of phosphorus reduction needed for improving lake water quality may be quantified by the use of computer models. Use of these models is necessary due to the complexity of the mathematical and statistical relationships that have evolved from lake research relating factors such as nutrient loading, water flow-through volumes and lake morphometry to in-lake responses such as algal blooms and Secchi disk transparency.

For this study, two computer models were employed to reasonably estimate the quantities of water and phosphorus which go into and out of Lake Volney, over a range of low, average and high annual water year conditions. MPCA staff believe that it is important to characterize watershed and lake conditions over this range, if possible, in order to more realistically convey a range of conditions that will likely be encountered by lake resource users as a result of nonpoint sources (NPS) of pollution.

The first of the models employed was that of Reckhow (1980), which was refined

by Chapra and Reckhow (1986). This model requires relatively little information and therefore it is relatively crude. It requires land-use data along with runoff information to generate probable ranges of phosphorus loading and in-lake phosphorus concentrations. Additionally, the model includes a statistical error analysis to more accurately state the precision of the predictions.

Accordingly, the probable range of phosphorus reaching Lake Volney is within a range of 1,015 - 3,432 kg P/year (or 2,238 to 7,568 pounds P/year) and the probable range of water residence times of the lake will be between 5-8 years. In-lake total phosphorus (TP) concentrations over this range of conditions were predicted to be:

TP (High Value)	= 238 ug P/l
TP (Most Likely Value)	= 145 ug P/l
TP (Low Value)	= 70 ug P/l

Therefore, the concentration of in-lake total phosphorus are determined by the rate of phosphorus supplied from the watershed activities as modified by water flushing rates and lake characteristics such as mean depth. Of the watershed activities, discussion has focused upon agricultural and urban activities. Of the "urban" sources, it is important to state the probable amount of phosphorus that is coming into the lake from septic tanks. Of the total amount of phosphorus entering the lake, about 39 - 69 kg P/year (or 86 - 153 pounds P/year) was estimated to be from septic tanks. Septic tank loading was calculated as follows:

1. Total number of annual capita years = 77 capita years/year
2. 77 capitas x 1.0 kg P/year x 0.5* = 36 kg P/year
3. 77 capitas x 1.8 kg P/year x 0.5* = 69 kg P/year

* Soil retention coefficient

Although septic tanks are a relatively small contributor of nutrients to Lake Volney, they are a relatively easily controlled nutrient source with proper installation and maintenance.

A second model, Walker (1986), was employed to estimate the amounts of water, phosphorus and nitrogen that reach Lake Volney on an average water year and to serve as a double check of the results of the Chapra and Reckhow model. This model requires significantly more data/information such as land-use data, stream flow records (if available), tributary sample results, and in-lake data such as TP, chlorophyll a, and Secchi transparency in order to calculate water and nutrient amounts reaching the lake. Lake morphometric and watershed area data is also required for this model.

The results of these calculations are listed in Tables 2 and 3 where it can be seen that for average water years, the lake may receive about 780 acre feet of water per year. At that rate, it would take in excess of seven years to replace the volume of the whole lake of 6,157 acre feet. The amount of water reaching the lake in 1986 was estimated to be about 1,158 acre feet for a water residence time on the order of five years.

Both of these models predicted the 1986 average surface water in-lake TP concentration (160 ug/ P/l) reasonably well with the Walker and Chapra and Reckhow models predicting 178 and 145 ug P/l, respectively. These models appear to adequately predict current conditions in Lake Volney. The range of characteristics from Lake Volney are consistent with values used to develop these models (i.e., Lake Volney's characteristics are within the data base) and therefore we have not over-extended the models. It is therefore reasonable to

use these models to predict in-lake conditions resulting from 1) no corrective actions taking place in the watershed, and 2) reduction of mass loading to the lake from the watershed.

Lake Volney receives nutrients at rates much greater than expected based upon land use in the watershed. Watersheds with comparable land-uses may be expected to generally contribute 0.10 to 1.50 kg P/ha/year (0.1 - 1.3 pounds P/acre/year) (Omernik, 1977). Based upon this study, Lake Volney appears to be receiving TP at a rate of about 4.2 kg P/ha/year (3.8 pounds/acre/year), or at least 3-10 times what may be reasonably expected based upon land-use. Since phosphorus is the most controllable of the aquatic plant nutrients, it is recommended that efforts be aimed at reduction of this nutrient. For this reason, the response of the lake to reductions of phosphorus mass loading have been estimated.

Future Lake Water Quality

Lake Volney has several physical characteristics which may prove to be quite beneficial if the phosphorus quantities exported from the watershed are reduced. For one, the lake basin is relatively deep which will tend to "trap" the massive amounts of historical phosphorus loading. The phosphorus retention value was estimated to be about 0.90 or that about 90% of the incoming phosphorus will be retained in the lake basin. One of the implications of this is that the lake will tend to respond quickly to reductions in nutrient loadings. If the amount of phosphorus is reduced by a factor of about 4, to a value more closely approximating 1500 pounds P/year, then the lake was predicted to have an average in-lake TP of about 70 to 90 ug P/l. These values do not seem unrealistic, given that the regional average in-lake TP was about 50 ug P/l

(Heiskary et. al., 1986). Reduction of the in-lake TP levels will likely have immediate impacts upon the types of algae found in the lake as well, encouraging the green algal species to grow rather than the blue-green species. It is also probable that the severity of chlorophyll a observed in the lake will also decrease with reduced in phosphorus loading. This decrease may not be as dramatic as suggested by the relative drop in the phosphorus, however. It is important to note that the severity of the algal blooms, or peak chlorophyll a, will decrease with the reduction in the phosphorus loading (for example, nuisance algal blooms may occur less than 30% of the summertime rather than 60% of the summertime).

The extent of lake eutrophication may also be evaluated by examination of the Secchi disk transparency - total phosphorus relationship (Figure 3) developed from approximately 70 Minnesota lakes sampled in 1985-1986. As may be observed, Lake Volney has an average in-lake TP of about 160 ug P/l, while the regional average is about 50 ug P/l. Based upon this relationship, the average in-lake TP shall have to be significantly reduced to result in a perceptible increase in average summer transparency. Without reduction of the in-lake TP, it is also possible that average summer transparencies less than 2 feet may be encountered.

Therefore, if nutrient loadings are not reduced, it is probable that increased nuisance conditions may be encountered by lake users. These nuisance conditions may include: "blooms" of blue- green algae which may form surface scums and odors; high levels of nutrients; depletion of dissolved oxygen; increased rough fish populations and reduced water transparencies. The severity of these nuisance conditions will also likely increase with time if corrective actions are not undertaken.

The analyses conducted in this investigation have revealed that there is significant lake water quality degradation occurring in Lake Volney and that effective actions are required. Help in planning and implementing water quality protection/restoration is available from many different government agencies. The most important first source of assistance will probably be through your local officials and agencies, such as your soil and water conservation district or the county planning and zoning offices. You can also get additional help from the Minnesota Department of Natural Resources, the Soil and Water Conservation Board, the MPCA and other state agencies. A working partnership among local concerned citizens, local government units with environmental authority in your area, and state agencies that can provide technical assistance will give a broad base of knowledge and experience to use in the development of the management plan for Lake Volney.

Lastly, it may be necessary to consider pursuing a higher level of organization to fund lake management actions. There are several local governmental unit alternatives that can help with lake and watershed management, including lake improvement districts. In addition, cities and counties may play a very important role either directly by taking the responsibility for this work, or indirectly by sponsoring or assisting in the establishment of a special-purpose local governing unit.

TABLE 1. AVERAGE SUMMER WATER QUALITY AND TROPHIC STATUS INDICATORS.

Water Quality Characteristics : Average Summer Epilmnetic Values

Parameter	1985/1986 Mean	Range of Values
Secchi disk (feet)	5.4 <i>1.6 m</i>	1.5 - 12.1
Chlorophyll <u>a</u> (ug/l)	39.3	6.4 - 96.4
Total phosphorus (ug/l)	160	54 - 262
Total Kjeldahl Nitrogen (ug/l)	1,560	1,160 - 2,190
Nitrite+Nitrate Nitrogen (ug/l)	480	< 10 - 1,200
Alkalinity (mg/l)	0.134	--
Color (Pt-Co Units)	20	--
Chloride (mg/l)	18.6	--

Carlson's Trophic Status Indicators

Total Phosphorus TSI = 77.3
 Chlorophyll a TSI = 66.6
 Secchi disk TSI = 53.0

TABLE 2. MODELING SUMMARY

Morphometric Characteristics

Lake Volume	6156.7 acre feet	
Lake Surface Area	277 acres	112 ha
Mean Depth	22.7 feet	6.9m

$$W_{NET} = 112 \text{ acres} = 660 \text{ ha}$$

Probable Range of Water Loading Rates (0.8-1.5 m/year)

Probable Range of Outflow Rates 1.0 - 1.75 cfs

Probable Range of Water Residence Times 5 - 8 years

Probable Range of Current Phosphorus Mass Loading

1,015 - 3,432 kg P* per year 2,238 - 7,568 pounds P/year

Probable Range of Current Areal Phosphorus Loading

0.9 - 3.1 grams P/m²-year

Probable Range of Predicted In-Lake Phosphorus Concentrations

Chapra and Reckhow (1986)

P(high) = 238 ug P/l

P(most likely) = 145 ug P/l

P(low) = 70 ug P/l

Walker (1986)

P(most likely) = 178 ug P/l

Observed Average In-lake Phosphorus Concentration = 160 ug P/l.

* Probable range of septic tank loadings 39-69 kg P/year (86-153 #P/year)

TABLE 3. Summary of Estimated Water Income-Outgo to Lake Volney.

	Drainage Area		Mean Flow Volumes	
	(KM ²) ¹	Acres	(HM ³) ²	Acre-Feet
Ditch #1	3.39	862	0.503	407.7
Ditch #2	0.32	64	0.047	38.1
Ditch #12	0.38	100	0.056	45.4
Remainder	2.40	600	0.356	295.9
PRECIPITATION	1.12	277	1.12	907.9
EXTERNAL INFLOW			0.962	779.8
OUTFLOW			0.300	243.2
STORAGE INCREASE			0.662	536.7

¹ KM₂ = Square Kilometers, rounded
² Cubic Hectometers or 1,000,000 m³.

TABLE 4. Estimated Total Phosphorus and Nitrogen Budgets for an Average Year Using Walker (1986) Model.

	Mass TP kg P	% of Total	Mass TN kg N	% of Total
Ditch #1	1422.3	52.1	5215.9	47.4
Ditch #2	112.5	4.1	400.2	3.6
Ditch #3	142.5	5.2	507.8	4.6
Remainder	1017.5	37.3	3770.6	34.3
Precipitation	33.6	1.2	1103.2	10.0
Total Inflow	2728.4	100	10997.7	100
Total Outflow	49.8	1.8	444.3	4.0
Net Retention	2556.3	93.7	9463.1	86.0

Estimated Average In-Lake Total Phosphorus = 178 ug P/l
 Observed Average In-Lake Total Phosphorus = 160 ug P/l
 Estimated TN:TP Ratio = 8.98
 Observed TN:TP Ratio = 12.75

TABLE 5. LAKE VOLNEY: MORPHOMETRIC, WATERSHED AND FISHERY CHARACTERISTICS.

MDNR I.D. #40-0033

STORET #40-0033 Watershed: Cannon River

Area¹: 277 acresVolumes¹: 6156.7 acre-feet

Mean Hydraulic Retention Time: Estimated 8.5 years

Mean Depth: 22.7 feet

Maximum Depth: 67 feet

Littoral Area: 46%

Fisheries Management: Warm-water Gamefish

Public Access: 1

Inlets/outlets: 12 culvert inlets
1 channel inlet
1 outlet

Watershed Area (total): 1,906 acres (750.4 ha)

Watershed Area to Lake Area: 6.9:1 ratio

Land Use Summary, Lake Volney Watershed versus
Regional Average Values by Percents.

	<u>Lake Volney</u>	<u>Regional Average</u>
Forested	0	15.9
Water	11.9	8.1*
Wetland	4.0	
Urban	0	5.3**
Residential	1.4	
Pasture	8.9	21.4
Cultivated	73.9	49.3

* Water and Wetland

** Urban and Residential

Shoreland Zoning: Recreational Development

Development (Homes)	<u>Seasonal</u>	<u>Permanent</u>	<u>Total</u>
1967	7	7	14
1982	30	20	50
1986 ³	29	16	45

2.8 persons/home⁴

- 1 - Planimetered from MDNR morphometric map dated 1-11-69.
- 2 - From Land Management Information Center, 1987.
- 3 - Number of homes counted by lake association.
- 4 - State Demographer

FIGURE 1. Lake Volney and Tributaries

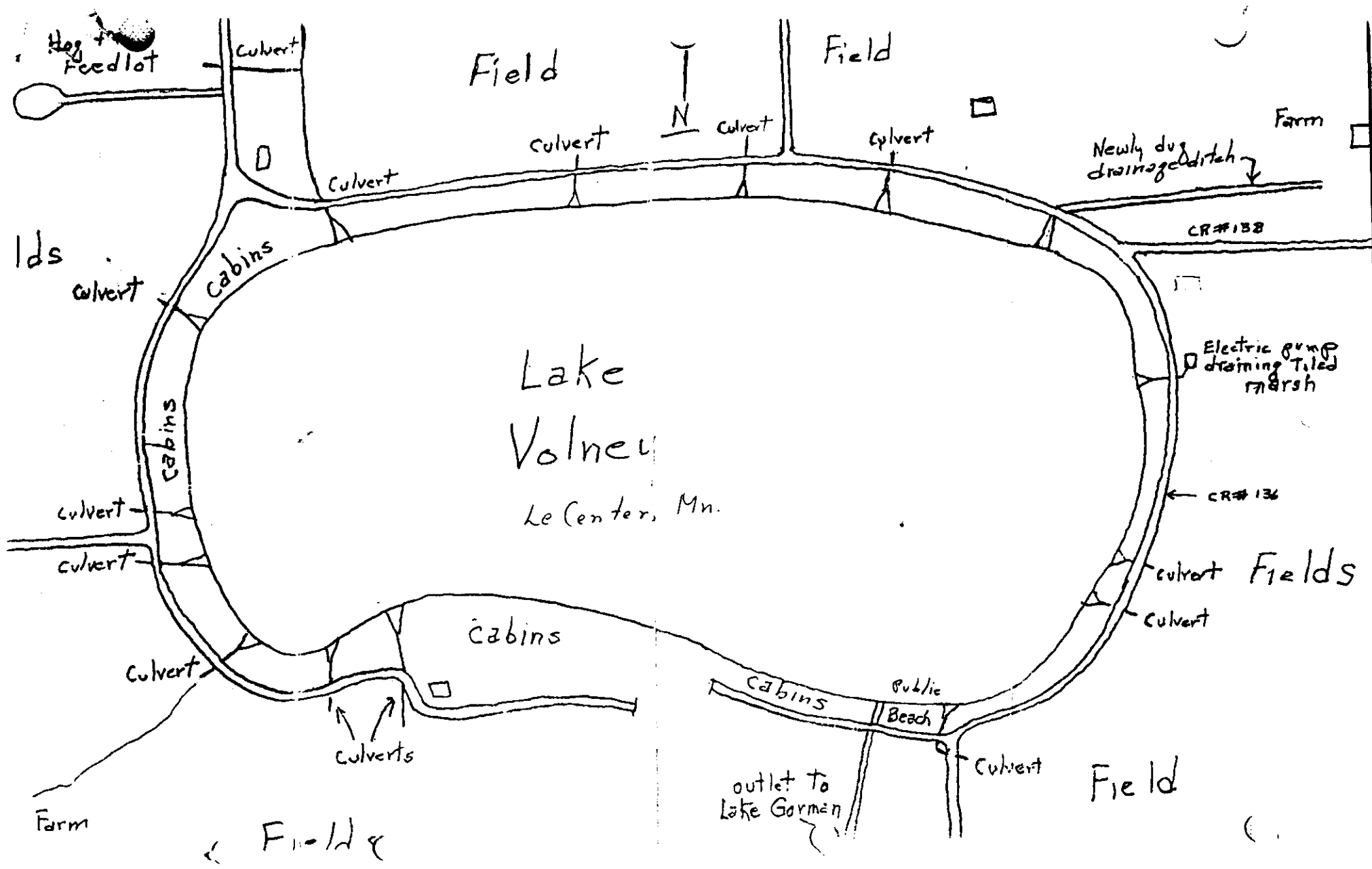
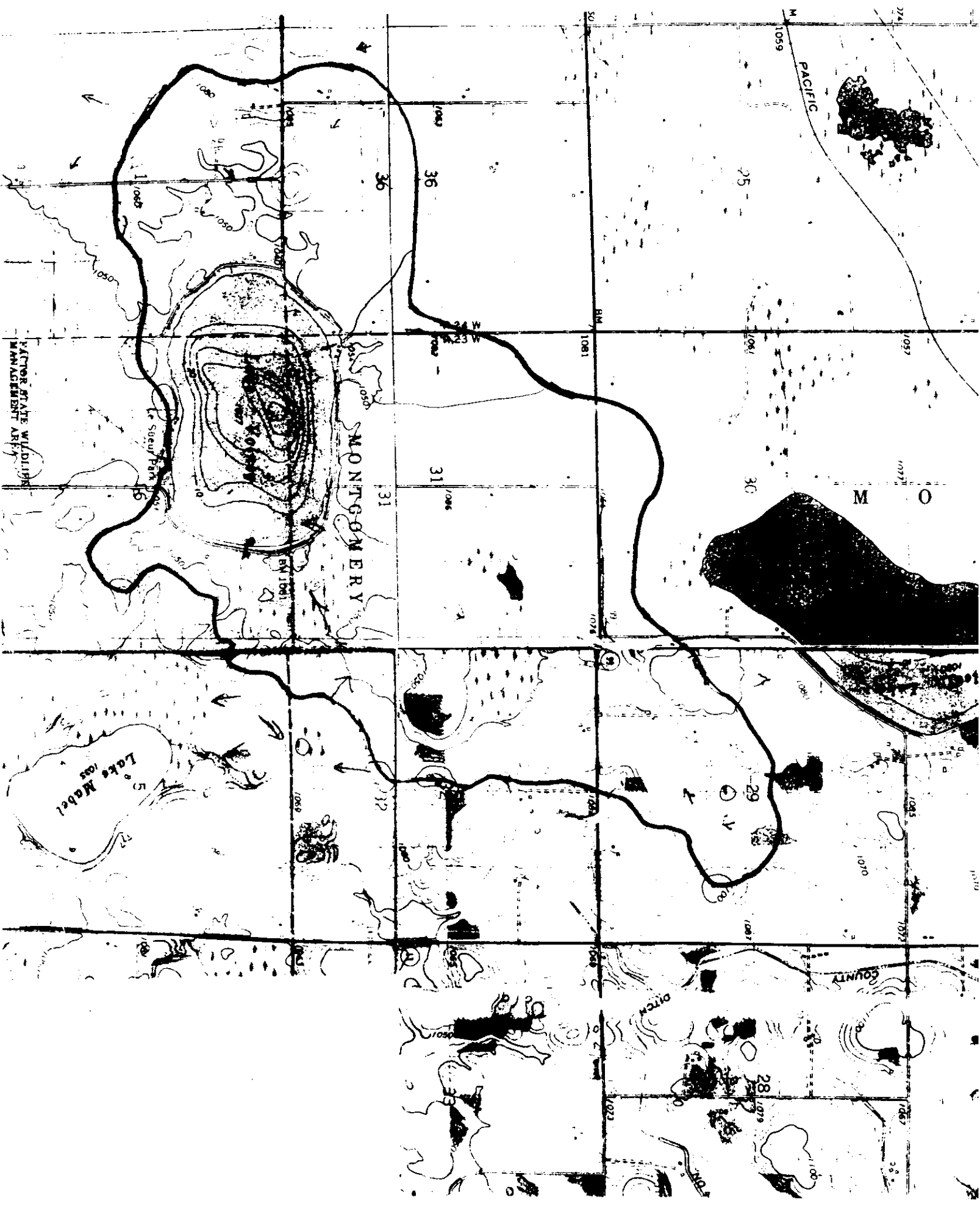


FIGURE 2. Lake Volney Watershed



FACITOR STATE WILDLIFE
MANAGEMENT AREA

Le Sueur Park

MONTGOMERY

PACIFIC

COUNTY

36

36

35

31

30

29

28

BM 1081

BM 1078

BM 1084

BM 1088

BM 1072

M 1059

M O

1085

1070

1072

1083

1087

1082

1086

1089

1057

1077

1081

1084

1088

1092

1096

1100

1104

1108

1112

1116

1120

1124

1128

1132

1136

1140

1144

1148

1152

1156

1160

1164

1168

1172

1176

1180

1184

1188

1192

1196

1200

1204

1208

1212

1216

1220

1224

1228

1232

1236

1240

1244

1248

1252

1256

1260

1264

1268

1272

1276

1280

1284

1288

1292

1296

1300

1304

1308

1312

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1324

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1332

1336

1340

1344

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1352

1356

1360

1364

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1396

1400

1404

1408

1412

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1420

1424

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1432

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1440

1444

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1484

1488

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1496

1500

1504

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1520

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1544

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1552

1556

1560

1564

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1584

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1592

1596

1600

1604

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1660

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1920

1924

1928

1932

1936

1940

1944

1948

1952

1956

1960

1964

1968

1972

1976

1980

1984

1988

1992

1996

2000

2004

2008

2012

2016

2020

2024

2028

2032

2036

2040

2044

2048

2052

2056

2060

2064

2068

2072

2076

2080

2084

2088

2092

2096

2100

2104

2108

2112

2116

2120

2124

2128

2132

2136

2140

2144

2148

2152

2156

2160

2164

2168

2172

2176

2180

2184

2188

2192

2196

2200

2204

FIGURE 3. Average Summer Secchi Disk Transparency versus
Average Summer Total Phosphorus

Secchi (ft)

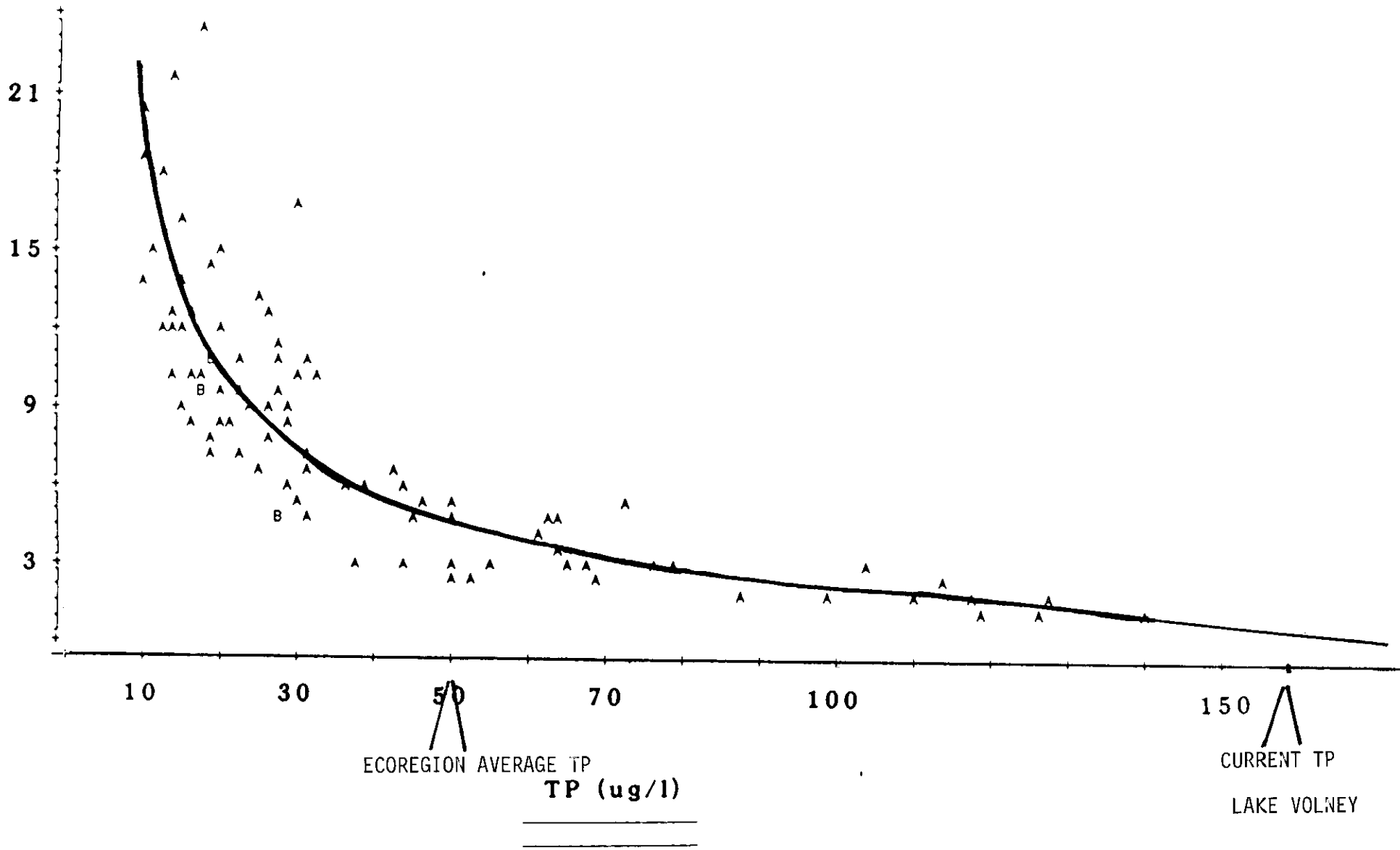










FIGURE 4. Morphometric Map of Lake Volney

LEGEND

- GRAVEL ROAD 
- UNIMPROVED ROAD 
- COUNTY ROAD 
- STATE WILDLIFE MANAGEMENT AREA 
- INTERMITTENT STREAM 
- DITCH 
- MARSH AREA 
- WOODED AREA 

- PLANIMETERED AREA : 283 ACRES
- LITTORAL AREA : 129 ACRES
- LENGTH OF SHORELINE : 2.5 MILES

BM NO. 1: YELLOW "X" AT TOP OF SOUTH END OF 90" CULVERT 125' EAST OF BOAT LANDING AT NORTHEAST CORNER OF LAKE

WS ELEV = 74 FEET BELOW BM.
(75' BELOW ON 6-20-80)

BM NO. 2: YELLOW "X" AT HIGH POINT OF 3'x5' GRANITE BOULDER, 3' FROM WATER'S EDGE 125' 20" EAST OF PUBLIC ACCESS AT SOUTHEAST CORNER OF LAKE

WS ELEV 32 FEET BELOW BM

OUTLINE DRAWN FROM 1964 BUREAU OF ENGINEERING PHOTO NO. WF-SEE-176

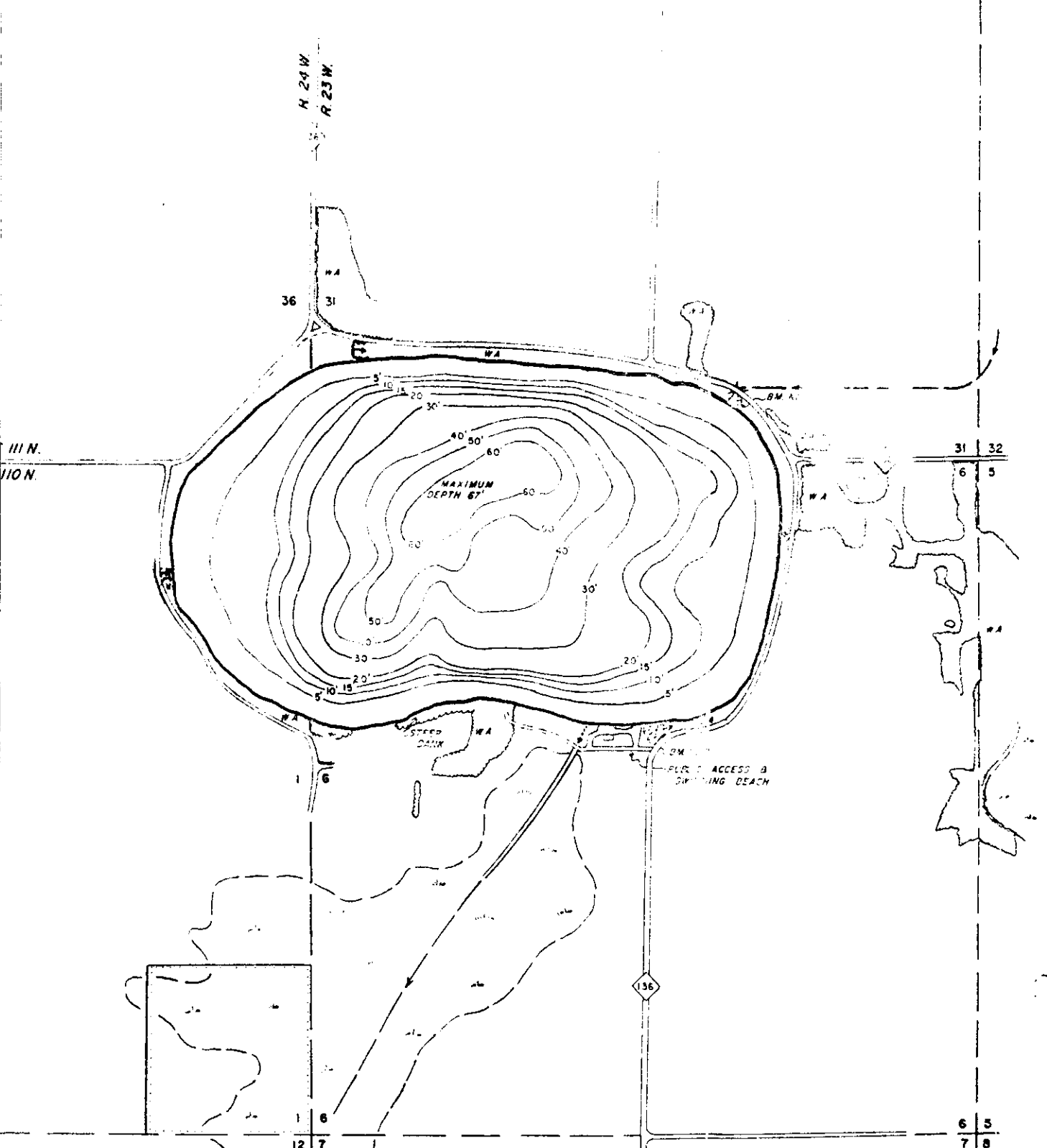


STATE OF MINNESOTA
DEPARTMENT OF CONSERVATION

DIVISION OF GAME AND FISH
TECHNICAL SERVICES SECTION

VOLNEY LAKE

(40-



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LAKE VOLNEY WATER CHEMISTRY (LAKEID=40-0033)

UNITS

DATE	SITE	D	DM	TP	RTP	TKN	N2N3	PH	TSS	TURB	CL	COND	ALK	SD	CHLA	COLOR
810909	101	0	0	0.085		1.70	0.18						130	1.0000	73.00	30
810909		3	1													
850731	101	0	0	0.112		1.67	0.01	9.03	2.8	3.0	20	350	120	1.4000	47.40	25
850731	101	3	1													
850731	102	0	0	0.122		1.71	0.01	9.05	4.8	3.0	20	330	120	1.3000	26.00	20
850814	201	0												1.6764		
850815	201	0												1.5240		
860424	101	0	0	0.222		1.69	1.20	8.53	3.8	1.5	18	380	140	1.4000	41.00	20
860617	201	0												3.6576		
860624	201	0												1.3716		
860625	101	0	0	0.131		1.21	1.00	8.28	3.2	2.8	20	370	150	1.2500	37.50	20
860625	102	0	0	0.137		1.16	1.20	8.30	4.6	3.0	17	380	150	1.2000	6.41	20
860625	103	0	0	0.160		1.29			6.2	4.0	17	370	150	0.7500		20
860703	201	0												1.5240		
860709	201	0												1.9812		
860715	201	0												1.5240		
860721	101	0	0	0.054		1.23	0.01	9.5	5	3.0	21	310	110	1.5000	30.4	15
860721	102	0	0					9.7						1.4000	29.8	
860722	201	0												1.8288		
860731	201	0												0.6096		
860806	201	0												0.4572		
860812	201	0												2.5908		
860818	201	0												1.8288		
860825	201	0												0.9144		
860903	201	0												1.9812		
860912	201	0												0.9144		
860919	101	0	0	0.262		2.19	0.19		50	5.2	16	330	140	1.5000	96.4	30
860919	102	0	0	0.241		1.92	0.20							2.0000	38.8	

mg/l unless noted
 D=depth feet
 DM=depth meters
 PH=SU
 TURB=NTU
 COND=umhos/cm
 SD=Secchi disk meters
 CHLA=ug/l
 COLOR=PT-Co

RETRIEVAL FOR B.WILSON

40-0033
 44 22 00.0 093 38 30.0 3
 LAKE: VOLNEY 4 MI SE OF LE CENTER
 27079 MINNESOTA LE SUEUR
 AREA: 114.5 HECTARE M 070639
 MEAN DEPTH: - M MAX DEPTH: 20.4 M
 21MINNL 820213 07040002 HQ
 0000 FEET DEPTH

/TYPA/AMBNT/LAKE

INDEX
 MILES

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (FT)	00029 FIELD IDENT NUMBER	00098 VSAMPLOC DEPTH METERS	00300 DO MG/L	00301 DO SATUR PERCENT	00010 WATER TEMP CENT	00011 WATER TEMP FAHN
81/09/09	1300	WATER	0	101	.00	9.8		21.0	
81/09/09	1300	WATER	3		1.00	9.8		21.0	
81/09/09	1300	WATER	6		2.00	9.8		21.0	
81/09/09	1300	WATER	9		3.00	9.6		20.5	
81/09/09	1300	WATER	13		4.00	9.5		20.5	
81/09/09	1300	WATER	16		5.00	9.4		20.5	
81/09/09	1300	WATER	19		6.00	8.6		20.5	
81/09/09	1300	WATER	22		7.00	8.5		20.5	
81/09/09	1300	WATER	26		8.00	8.0		20.0	
81/09/09	1300	WATER	32		10.00	.3		19.5	
81/09/09	1300	WATER	39		12.00	.0		15.5	
81/09/09	1300	WATER	45		14.00	.0		14.0	
81/09/09	1300	WATER	52		16.00	.0		13.5	
85/07/31	1215	WATER	0	101	.00	6.8		22.5	
85/07/31	1215	WATER	3.28	101	1.00	6.8		22.5	
85/07/31	1215	WATER	6.56	101	2.00	6.8		22.5	
85/07/31	1215	WATER	9.84	101	3.00	6.7		22.5	
85/07/31	1215	WATER	13.12	101	4.00	6.6		22.5	
85/07/31	1215	WATER	16.4	101	5.00	6.6		22.5	
85/07/31	1215	WATER	19.68	101	6.00	6.6		22.5	
85/07/31	1215	WATER	22.96	101	7.00	6.4		22.5	
85/07/31	1215	WATER	26.24	101	8.00	.2		22.0	
85/07/31	1215	WATER	29.52	101	9.00	.05		19.0	
85/07/31	1215	WATER	32.8	101	10.00	.05		17.0	
85/07/31	1215	WATER	36.08	101	11.00	.05		16.0	
85/07/31	1215	WATER	39.36	101	12.00	.0		15.0	
85/07/31	1215	WATER	42.64	101	13.00	.0		14.0	
85/07/31	1215	WATER	45.92	101	14.00	.0		13.5	
85/07/31	1215	WATER	49.2	101	15.00	.0		13.0	
85/07/31	1215	WATER	52.48	101	16.00	.0		12.5	
85/07/31	1215	WATER	55.76	101	17.00	.0		12.5	
85/07/31	1215	WATER	59.04	101	18.00	.0		12.0	
85/07/31	1255	WATER	0	102	.00				
85/08/14	1200	WATER	0	201					
85/08/15	1230	WATER	0	201					
86/04/24	1530	WATER	0	101	.00	12.7		9.5	
86/04/24	1530	WATER	3.28	101	1.00	12.8		9.4	
86/04/24	1530	WATER	6.56	101	2.00	12.8		9.4	
86/04/24	1530	WATER	9.84	101	3.00	12.7		9.4	
86/04/24	1530	WATER	13.12	101	4.00	12.7		9.3	
86/04/24	1530	WATER	16.4	101	5.00	12.7		9.3	
86/04/24	1530	WATER	19.68	101	6.00	12.7		9.3	

STORET RETRIEVAL DATE 87/01/16
 RETRIEVAL FOR B.WILSON

PGM=RET

PAGE: 2

40-0033
 44 22 00.0 093 38 30.0 3
 LAKE: VOLNEY 4 MI SE OF LE CENTER
 27079 MINNESOTA LE SUEUR
 AREA: 114.5 HECTARE M 070639
 MEAN DEPTH: - M MAX DEPTH: 20.4 M
 21MINNL 820213 07040002 HQ
 0000 FEET DEPTH

/TYPA/AMBNT/LAKE

INDEX
 MILES

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (FT)	00029 FIELD IDENT NUMBER	00098 VSAMPLOC DEPTH METERS	00300 DO MG/L	00301 DO SATUR PERCENT	00010 WATER TEMP CENT	00011 WATER TEMP FAHN
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86/04/24	1530	WATER	26.24	101	8.00	12.7		9.3	
86/04/24	1530	WATER	29.52	101	9.00	12.7		9.3	
86/04/24	1530	WATER	32.8	101	10.00	12.4		9.1	
86/04/24	1530	WATER	39.36	101	12.00	12.1		9.0	
86/04/24	1530	WATER	45.92	101	14.00	12.1		9.0	
86/04/24	1530	WATER	55.76	101	17.00				
86/06/17	1330	WATER	0	201					
86/06/24	1415	WATER	0	201					
86/06/25	1200	WATER	0	101	.00	10.2		23.2	
86/06/25	1200	WATER	3.28	101	1.00	10.3		23.2	
86/06/25	1200	WATER	6.56	101	2.00	10.4		23.2	
86/06/25	1200	WATER	9.84	101	3.00	10.4		23.1	
86/06/25	1200	WATER	13.12	101	4.00	10.4		23.1	
86/06/25	1200	WATER	16.4	101	5.00	10.3		23.1	
86/06/25	1200	WATER	19.68	101	6.00	6.3		21.3	
86/06/25	1200	WATER	22.96	101	7.00	2.0		18.7	
86/06/25	1200	WATER	26.24	101	8.00	.5		16.1	
86/06/25	1200	WATER	29.52	101	9.00	.4		14.6	
86/06/25	1200	WATER	32.8	101	10.00	.4		13.7	
86/06/25	1200	WATER	39.36	101	12.00	.3		13.1	
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86/06/25	1230	WATER	9.84	102	3.00	8.3		22.9	
86/06/25	1230	WATER	13.12	102	4.00	8.2		22.8	
86/06/25	1230	WATER	16.4	102	5.00	6.3		22.0	
86/06/25	1230	WATER	19.68	102	6.00	5.0		20.9	
86/06/25	1230	WATER	22.96	102	7.00	1.5		18.1	
86/06/25	1230	WATER	26.24	102	8.00	.6		15.8	
86/06/25	1300	WATER	0	103	.00				
86/07/03	1400	WATER	0	201					
86/07/09	1430	WATER	0	201					
86/07/15	1530	WATER	0	201					
86/07/21	1110	WATER	0	101	.00	9.9		25.9	
86/07/21	1110	WATER	3.28	101	1.00	10.0		25.9	
86/07/21	1110	WATER	6.56	101	2.00	10.0		25.9	
86/07/21	1110	WATER	9.84	101	3.00	9.2		25.8	
86/07/21	1110	WATER	13.12	101	4.00	6.7		25.0	

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86/07/21	1110	WATER	16.4	101	5.00	4.5		23.8	
86/07/21	1110	WATER	19.68	101	6.00	2.8		22.4	
86/07/21	1110	WATER	22.96	101	7.00	.5		20.6	
86/07/21	1110	WATER	26.24	101	8.00	.4		17.0	
86/07/21	1110	WATER	29.52	101	9.00	.4		14.6	
86/07/21	1110	WATER	32.8	101	10.00	.4		13.9	
86/07/21	1110	WATER	36.08	101	11.00	.4		13.4	
86/07/21	1110	WATER	39.36	101	12.00	.3		13.2	
86/07/21	1110	WATER	42.64	101	13.00	.3		13.0	
86/07/21	1110	WATER	45.92	101	14.00	.3		12.8	
86/07/21	1110	WATER	47.56	101	14.50	.3		12.8	
86/07/21	1110	WATER	49.2	101	15.00				
86/07/21	1200	WATER	0	102	.00	10.0		26.0	
86/07/21	1200	WATER	3.28	102	1.00	10.1		26.0	
86/07/21	1200	WATER	6.56	102	2.00	9.4		25.8	
86/07/21	1200	WATER	9.84	102	3.00	9.1		25.7	
86/07/21	1200	WATER	13.12	102	4.00	7.6		25.2	
86/07/21	1200	WATER	16.4	102	5.00	3.1		23.9	
86/07/22	1400	WATER	0	201					
86/07/31	1430	WATER	0	201					
86/08/06	1500	WATER	0	201					
86/08/12	1500	WATER	0	201					
86/08/18	1500	WATER	0	201					
86/08/25	1500	WATER	0	201					
86/09/03	1500	WATER	0	201					
86/09/12	1500	WATER	0	201					
86/09/19	1100	WATER	0	101	.00	7.8		16.2	
86/09/19	1100	WATER	3.28	101	1.00	7.2		16.2	
86/09/19	1100	WATER	6.56	101	2.00	7.1		16.1	
86/09/19	1100	WATER	9.84	101	3.00	6.9		16.1	
86/09/19	1100	WATER	13.12	101	4.00	6.8		16.1	
86/09/19	1100	WATER	16.4	101	5.00	6.9		16.1	
86/09/19	1100	WATER	19.68	101	6.00	6.8		16.1	
86/09/19	1100	WATER	22.96	101	7.00	6.6		16.1	
86/09/19	1100	WATER	26.24	101	8.00	6.5		16.0	
86/09/19	1100	WATER	32.8	101	10.00	6.3		16.0	
86/09/19	1100	WATER	36.08	101	11.00	4.6		15.9	
86/09/19	1100	WATER	39.36	101	12.00	2.9		15.9	
86/09/19	1100	WATER	42.64	101	13.00	2.6		15.8	
86/09/19	1100	WATER	45.92	101	14.00	2.4		15.7	
86/09/19	1100	WATER	49.2	101	15.00	1.4		15.6	
86/09/19	1100	WATER	52.48	101	16.00	.5		15.4	

STORET RETRIEVAL DATE 87/01/16
RETRIEVAL FOR B.WILSON

PGM=RET

PAGE: 4

40-0033
44 22 00.0 093 38 30.0 3
LAKE: VOLNEY 4 MI SE OF LE CENTER
27079 MINNESOTA LE SUEUR
AREA: 114.5 HECTARE M 070639
MEAN DEPTH: - M MAX DEPTH: 20.4 M
21MINNL 820213 07040002 HQ
0000 FEET DEPTH

/TYPA/AMBNT/LAKE

INDEX
MILES

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (FT)	00029 FIELD IDENT NUMBER	00098 VSAMPLOC DEPTH METERS	00300 DO MG/L	00301 DO SATUR PERCENT	00010 WATER TEMP CENT	00011 WATER TEMP FAHN
86/09/19	1115	WATER	0	102	.00				

MS205

VLN-T3
44 22 18.0 093 38 42.0 2
DI TO LAKE VOLNEY IN T111N/R23W/S31/SWQ/SWQ/NWQ
27079 MINNESOTA LE SUEUR
MAJ BASIN: UPPER MISS 070606
MIN BASIN: LOWER PORTION UPPER MISS
21MINN 870110 07040002017
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

OFF

INITIAL DATE INITIAL TIME MEDIUM			86/06/25 1325 WATER	86/06/28 0840 WATER	86/07/05 1845 WATER	86/07/05 2015 WATER	86/07/11 1145 WATER	86/07/15 1250 WATER	86/09/19 WATER
00008 LAB IDENT. NUMBER			123191	123355	123356	123357	123358	123359	123795
00076 TURB TRBIDMTR HACH FTU			41.0						46.0
00080 COLOR PT-CO UNITS			140						70
00095 CNDUCTVY AT 25C MICROMHO			410						
00116 INTNSVE SURVEY IDENT			862701	862701	862701	862701	862701	862701	
00136 SAMPLE TEMP AT LAB DEGC				6.00000	6.00000	6.00000	6.00000	6.00000	
00403 LAB PH SU			7.8						
00410 T ALK CACO3 MG/L			120						
00500 RESIDUE TOTAL MG/L			400						
00530 RESIDUE TOT NFLT MG/L			71						50
00605 ORG N N MG/L									2.320
00610 NH3+NH4- N TOTAL MG/L			.450						.210
00625 TOT KJEL N MG/L			2.840	1.890	5.060	4.800	2.640	21.200	2.530
00630 NO2&NO3 N-TOTAL MG/L			11.00						5.50
00665 PHOS-TOT MG/L P			1.170	1.730	4.540	3.820	5.080	8.820	.738
00940 CHLORIDE TOTAL MG/L			20						16
70507 PHOS-T ORTHO MG/L P			1.060						
74041 WQF SAMPLE UPDATED			870116	870116	870116	870116	870116	870116	870116

STORET RETRIEVAL DATE 87/01/14

DESCRIPTIVE PARAGRAPH

PAGE: 11

MS205 VLN-T3
44 22 18.0 093 38 42.0 2
DI TO LAKE VOLNEY IN T111N/R23W/S31/SWQ/SWQ/NWQ
27079 MINNESOTA LE SUEUR
MAJ BASIN: UPPER MISS 070606
MIN BASIN: LOWER PORTION UPPER MISS
21MINN 870110 07040002017
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

OFF

DESCRIPTION

DITCH TO THE NORTHWEST SIDE OF LAKE VOLNEY OFF OF LESUEUR COUNTY ROAD
136 IN THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER OF THE SOUTHWEST
QUARTER OF SECTION 31. THE SITE IS 5 MILES SOUTHEAST OF LECENTER,
MINNESOTA;
LOWER PORTION UPPER MISS BASIN T111N/R23W/S31 LESUEUR COUNTY
WATER QUALITY SAMPLES WERE COLLECTED BY THE MINNESOTA POLLUTION CONTROL
AGENCY FOR A SURVEY AT LAKE VOLNEY. THE SITE IS ON A CULVERT DRAINING
A HOG AND CATTLE FEEDLOT INTO LAKE VOLNEY.

VLN-T2
 44 22 04.0 093 37 53.0 2
 DI TO E LAKE VOLNEY ON CR136 5 MI SE OF LECENTER
 27079 MINNESOTA LE SUEUR
 MAJ BASIN: UPPER MISS 070606
 MIN BASIN: LOWER PORTION UPPER MISS
 21MINN 870110 07040002017
 0000 FEET DEPTH

/TYPA/AMBNT/STREAM

OFF

INITIAL DATE	INITIAL TIME	MEDIUM	IDENT.	NUMBER	86/06/25	86/09/19
00008	LAB				123192	123794
00076	TURB	TRBIDMTR	HACH	FTU	10.0	
00080	COLOR	PT-CO		UNITS	120	
00095	CNDUCTVY	AT 25C		MICROMHO	780	
00116	INTNSVE	SURVEY		IDENT	862701	
00403	LAB	PH		SU	7.4	
00410	T ALK	CACO3		MG/L	210	
00500	RESIDUE	TOTAL		MG/L	650	
00530	RESIDUE	TOT NFLT		MG/L	6	
00605	ORG N	N		MG/L		2.540
00610	NH3+NH4-	N TOTAL		MG/L	.110	.560
00625	TOT KJEL	N		MG/L	2.880	3.100
00630	NO2&NO3	N-TOTAL		MG/L	21.00	7.40
00665	PHOS-TOT			MG/L P	.191	.378
00940	CHLORIDE	TOTAL		MG/L	23	
70507	PHOS-T	ORTHO		MG/L P	.136	
74041	WQF	SAMPLE		UPDATED	870116	870116

MS203
 44 22 04.0 093 37 53.0 2
 DI TO E LAKE VOLNEY ON CR136 5 MI SE OF LECENTER
 27079 MINNESOTA LE SUEUR
 MAJ BASIN: UPPER MISS 070606
 MIN BASIN: LOWER PORTION UPPER MISS
 21MINN 870110 07040002017
 0000 FEET DEPTH

/TYPA/AMBNT/STREAM

OFF

DESCRIPTION

DRAINAGE DITCH TO EAST SIDE OF LAKE VOLNEY AT THE FIRST CULVERT SOUTH OF
 LESUEUR COUNTY ROAD 138 ON COUNTY ROAD 136. THE SITE IS 5 MILES
 SOUTHEAST OF LECENTER, MINNESOTA;
 LOWER PORTION UPPER MISSISSIPPI BASIN T110N/R23W/S6 LESUEUR COUNTY
 WATER QUALITY SAMPLES WERE COLLECTED BY THE MINNESOTA POLLUTION CONTROL
 AGENCY FOR A SUVEY AT LAKE VOLNEY. THE SITE IS ON A DRAINAGE DITCH
 THAT DRAINS INTO LAKE VOLNEY.

MS202 VLN-T1
 44 22 16.0 093 37 59.0 2
 DI TO LAKE VOLNEY AT CR-138 5 MI SE OF LECENTER
 27079 MINNESOTA LE SUEUR
 MAJ BASIN: UPPER MISS 070606
 MIN BASIN: LOWER PORTION UPPER MISS
 21MINN 870110 07040002017
 0000 FEET DEPTH

/TYPA/AMBNT/STREAM

OFF

INITIAL DATE	INITIAL TIME	MEDIUM	IDENT.	NUMBER	86/06/25	86/07/15	86/09/19
00008	LAB		TRBIDMTR	HACH FTU	123190	123360	123793
00076	TURB		PT-CO	UNITS	7.0		
00080	COLOR		AT 25C	MICROMHO	120		
00095	CNDUCTVY		SURVEY	IDENT	460	862701	
00116	INTNSVE		TEMP AT	LAB DEGC	862701	6.00000	
00136	SAMPLE		PH	SU	7.2		
00403	LAB		CACO3	MG/L	200		
00410	T ALK		TOTAL	MG/L	400		
00500	RESIDUE		TOT NFLT	MG/L	30		
00530	RESIDUE		N	MG/L			1.670
00605	ORG N		N TOTAL	MG/L	.100		1.190
00610	NH3+NH4-		N	MG/L	1.590	3.150	2.860
00625	TOT KJEL		N-TOTAL	MG/L	3.00		2.80
00630	NO2&NO3		MG/L P		.499	1.550	.717
00665	PHOS-TOT		TOTAL	MG/L	13		
00940	CHLORIDE		ORTHO	MG/L P	.448		
70507	PHOS-T		SAMPLE	UPDATED	870116	870116	870116
74041	WQF						

MS202 VLN-T1
 44 22 16.0 093 37 59.0 2
 DI TO LAKE VOLNEY AT CR-138 5 MI SE OF LECENTER
 27079 MINNESOTA LE SUEUR
 MAJ BASIN: UPPER MISS 070606
 MIN BASIN: LOWER PORTION UPPER MISS
 21MINN 870110 07040002017
 0000 FEET DEPTH

/TYPA/AMBNT/STREAM

OFF

DESCRIPTION

DRAINAGE DITCH TO NORTHEAST SIDE OF LAKE VOLNEY AT LESUEUR COUNTY ROAD 138- ON THE SOUTH SIDE, IN THE SOUTHEAST QUARTER OF SECTION 31 (T111N, R23W). THE SITE IS 5 MILES SOUTHEAST OF LECENTER, MINNESOTA;
 LOWER PORTION UPPER MISSISSIPPI BASIN T111N/R23W/S31 LESUEUR COUNTY
 WATER QUALITY SAMPLES WERE COLLECTED BY THE MINNESOTA POLLUTION CONTROL AGENCY FOR A SUVEY AT LAKE VOLNEY. THE SITE IS ON A DRAINAGE DITCH THAT DRAINS INTO LAKE VOLNEY.

STORET RETRIEVAL DATE 87/01/21
VLN. TRIB

PGM=RET

PAGE: 7

MS204 VLN-OUTLET
44 21 51.0 093 38 16.0 2
LAKE VOLNEY OUTLET NR ACCESS 5 MI SE OF LECENTER
27079 MINNESOTA LE SUEUR
MAJ BASIN: UPPER MISS 070606
MIN BASIN: LOWER PORTION UPPER MISS
21MINN 870110 07040002017 OFF
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (FT)	00008 LAB IDENT. NUMBER	00136 SAMPLE TEMP AT LAB DEGC	00403 LAB PH SU	00500 RESIDUE TOTAL MG/L	00530 RESIDUE TOT NFLT MG/L	00076 TURB TRBIDMTR HACH FTU	00940 CHLORIDE TOTAL MG/L	00095 CONDUCTVY AT 25C MICROMHO	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L
86/09/19	1220	WATER		123796								1.88	.26

STORET RETRIEVAL DATE 07/01/14

DESCRIPTIVE PARAGRAPH

PAGE: 12

MS204 VLN-OUTLET
44 21 51.0 093 38 16.0 2
LAKE VOLNEY OUTLET NR ACCESS 5 MI SE OF LECENTER
27079 MINNESOTA LE SUEUR
MAJ BASIN: UPPER MISS 070606
MIN BASIN: LOWER PORTION UPPER MISS
21MINN 870110 07040002017 OFF
0000 FEET DEPTH

/TYPA/AMBNT/STREAM

DESCRIPTION

LAKE VOLNEY OUTLET NEAR THE BOAT ACCESS ON THE SOUTH END OF LAKE VOLNEY.
THE SITE IS 5 MILES SE OF LECENTER, MINNESOTA;
LOWER PORTION UPPER MISS BASIN T110N/R23W/S6 LESUEUR COUNTY
WATER QUALITY SAMPLES WERE COLLECTED BY THE MINNESOTA POLLUTION CONTROL
AGENCY FOR A SURVEY AT LAKE VOLNEY. THE SITE IS ON THE OUTLET OF LAKE
VOLNEY.

PHYSICAL CHARACTERISTICS FOR LAKE: VOLNEY

Lake type: PANFISH LAKE

Dominant forest/soil type: DECID/LOAM

Size of lake: 268 Acres Shorelength: 2.4 Miles.

Maximum depth: 70.0 Median depth: 15.0

Secchi disk reading (water clarity): 4.1 feet.

Lake contour map number: C1914 (available at cost from Documents Division)
(phone: 612-297-3000)

Enter the report or MENU: FIS

DNR SECTION OF FISHERIES INFORMATION FOR LAKE VOLNEY

WATER CHEMISTRY SURVEY DATE: 5/22/1981

Water color: NA

Secchi disk: NA

Cause of water color: NA

% Littoral: 45

LAKE DESCRIPTION

Surface water area: 243
Management class: WARM-WATER GAMEFISH
Ecological type: ROUGHFISH-GAMEFISH

Accessibility: County owned public access on SE corner of lake.
Private landing on NE corner.

Area fisheries supervisor: DIRK PETERSON
P.O. BOX 86 WATERVILLE

(507) 362-8558
56096

*** PUSH RETURN FOR CATCH DATA ***

NET CATCH DATA

GILL NETS

No. of sets: 4

Gill net survey date: 5/22/1981

species	# fish	# per set	total pounds	pounds per set
Walleye	23	5.8	38.00	9.50
Northern Pike	26	6.5	110.93	27.73
Black Crappie	39	9.8	6.97	1.74
Yellow Perch	630	157.5	93.50	23.38
F.W. Drum (Sheepshead)	31	7.8	5.43	1.36
Black Bullhead	14	3.5	7.66	1.92
Carp	25	6.3	61.00	15.25

TRAP NETS

No. of sets: 4

Trap survey date: 5/22/1981

species	# fish	# per set	total pounds	pounds per set
---------	--------	-----------	--------------	----------------

TRAP NETS

No. of sets: 4

Trap survey date: 5/22/1981

species	# fish	# per set	total pounds	pounds per set
Black Crappie	50	12.5	11.56	2.89
Yellow Perch	1	0.3	0.06	0.02
Shiner Minnow	5	1.3	0.30	0.08
F.W. Drum (Sheepshead)	1	0.3	0.20	0.05
Black Bullhead	2	0.5	0.43	0.11

*** PUSH RETURN FOR STOCKING DATA ***

FISH STOCKING DATA

year	species	size	# released
71	Northern Pike	ADULT	38
71	Northern Pike	YEARLING	347
71	Northern Pike	FINGERLING	6600
71	Crappie	ADULT	27
73	Walleye	ADULT	62
73	Walleye	YEARLING	1263
74	Northern Pike	ADULT	85
74	Northern Pike	YEARLING	2
74	Northern Pike	FINGERLING	1000
74	Walleye	FINGERLING	2730
74	Crappie	ADULT	1280
74	Sunfish	YEARLING	5120
74	Bluegill Sunfish	YEARLING	2400
75	Northern Pike	FINGERLING	1585
75	Crappie	ADULT	9285
75	Walleye	FINGERLING	1116
76	Northern Pike	ADULT	507

More (Y/N): Y

year	species	size	# released
76	Crappie	ADULT	3412
76	White Bass	ADULT	500
76	Walleye	YEARLING	2400
76	Walleye	ADULT	18
77	Northern Pike	YEARLING	59
77	Northern Pike	ADULT	534
78	Northern Pike	YEARLING	21
79	Walleye	FINGERLING	5016
79	Northern Pike	YEARLING	115
79	Crappie	ADULT	500
79	Bluegill Sunfish	ADULT	12
80	Northern Pike	YEARLING	530
80	Crappie	ADULT	67
80	Walleye	FINGERLING	2100
81	Walleye	YEARLING	1908
82	Walleye	FINGERLING	7394
83	Walleye	YEARLING	4255
84	Walleye	ADULT	1112

Enter the report or MENU: MENU

SWIM-LAKE SUMMARY DATA FILE

Lake name: VOLNEY DNR Division of Waters lake number 40- 33
 Primary county: LE SUEUR Secondary county: LE SUEUR
 Lake VOLNEY is in 1 county
 Location: Township 110,111 Range 2 ,24
 Watershed CANNON RIVER

ENTER REPORT

- PHY for physical characteristics
- DEV for development characteristics
- FIS for the fish report
- PER for permit characteristics
- ALL for all four reports

- B to go back one menu (lake choice)
- C to go back two menus (county choice)
- Q to leave this data base

Enter the report or MENU: ALL

PHYSICAL CHARACTERISTICS FOR LAKE: VOLNEY

Lake type: PANFISH LAKE
 Dominant forest/soil type: DECID/LOAM
 Size of lake: 268 Acres Shorelength: 2.4 Miles.
 Maximum depth: 70.0 Median depth: 15.0
 Secchi disk reading (water clarity): 4.1 feet.
 Lake contour map number: C1914 (available at cost from Documents Division
 (phone: 612-297-3000))

DEVELOPMENT CHARACTERISTICS FOR LAKE: VOLNEY

Shoreland zoning classification: RECREATIONAL DEVELOPMENT
 Public accesses in 1983: 1

Development	Seasonal Homes	Permanent Homes	Total Homes
1967	7	7	14
1982	30	20	50

*** PUSH RETURN TO CONTINUE ***

DNR SECTION OF FISHERIES INFORMATION FOR LAKE VOLNEY

WATER CHEMISTRY SURVEY DATE: 5/22/1981

Water color: NA Secchi disk: NA
 Cause of water color: NA % Littoral: 46

LAKE DESCRIPTION

Surface water area: 283

LAKE DESCRIPTIONS

Surface water area: 283
 Management class: WARM-WATER GAMEFISH
 Ecological type: ROUGHFISH-GAMEFISH

Accessibility: County owned public access on SE corner of lake.
 Private landing on NE corner.

Area fisheries supervisor: DIRK PETERSON (507) 362-8558
 P.O. BOX 86 WATERVILLE 56096

*** PUSH RETURN FOR CATCH DATA ***

NET CATCH DATAGILL NETS

No. of sets: 4 Gill net survey date: 5/22/1981

species	# fish	# per set	total pounds	pounds per set
Walleye	23	5.8	38.00	9.50
Northern Pike	26	6.5	110.93	27.73
Black Crappie	39	9.8	6.97	1.74
Yellow Perch	630	157.5	93.50	23.38
F.W. Drum (Sheepshead)	31	7.8	5.43	1.36
Black Bullhead	14	3.5	7.68	1.92
Carp	25	6.3	61.00	15.25

TRAP NETS

No. of sets: 4 Trap survey date: 5/22/1981

species	# fish	# per set	total pounds	pounds per set
Black Crappie	50	12.5	10.51	2.63
Yellow Perch	1	0.3	0.35	0.09
Shiner Minnow	5	1.3	0.30	0.08
F.W. Drum (Sheepshead)	1	0.3	0.20	0.05
Black Bullhead	2	0.5	0.43	0.11

*** PUSH RETURN FOR STOCKING DATA ***

FISH STOCKING DATA

year	species	size	# released
71	Northern Pike	ADULT	38
71	Northern Pike	YEARLING	347
71	Northern Pike	FINGERLING	6600
71	Crappie	ADULT	27
73	Walleye	ADULT	62
73	Walleye	YEARLING	1263
74	Northern Pike	ADULT	85
74	Northern Pike	YEARLING	2
74	Northern Pike	FINGERLING	1000
74	Walleye	FINGERLING	2730
74	Crappie	ADULT	1280
74	Sunfish	YEARLING	5120
74	Bluegill Sunfish	YEARLING	2400
75	Northern Pike	FINGERLING	1585
75	Crappie	ADULT	3285
75	Walleye	FINGERLING	1116
76	Northern Pike	ADULT	507

More (Y/N): N

USER: WILSON LAKE: VOLNEY
LOCATION: LECENTER MINNESOTA
LAKE VOLNEY LAF

CURRENT DATE/TIME: 8701131450

PREDICTION UNCERTAINTY RESULTS

1. positive model error = 2.652232E-02 mg/l
2. negative model error = .019752 mg/l
3. positive loading error = 2.980884E-02 mg/l
4. negative loading error = 1.717035E-02 mg/l
5. total positive uncertainty = 3.989988E-02 mg/l
6. total negative uncertainty = 2.617178E-02 mg/l

CONFIDENCE LIMITS RESULTS

PROB1 5.251432E-02 mg/l <= P <= .1152824 mg/l] >= .5075408

LAKE VOLNEY WATER CHEMISTRY (LAKEID=40-0033)

DATE	SITE	D	DM	TP	RTP	TKN	N2N3	PH	TSS	TURB	CL	COND	ALK	SD	CHLA	COLOR	
810909	101	0	0	0.085	1.70	0.18	.	.	.	.	.	130	1.0000	73.00	30	.	
810909	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
850731	101	0	0	0.112	1.67	0.01	9.03	2.8	3.0	20	350	120	1.4000	47.40	25	.	
850731	101	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
850731	102	0	0	0.122	1.71	0.01	9.05	4.8	3.0	20	330	120	1.3000	26.00	20	.	
850814	201	0	.	.	.	.	.	.	.	.	.	.	1.6764	.	.	.	.
850815	201	0	.	.	.	.	.	.	.	.	.	.	1.5240	.	.	.	.
860424	101	0	0	0.222	1.69	1.20	8.53	3.8	1.5	18	380	140	1.4000	41.00	20	.	
860617	201	0	.	.	.	.	.	.	.	.	.	.	3.6576	.	.	.	.
860624	201	0	.	.	.	.	.	.	.	.	.	.	1.3716	.	.	.	.
860625	101	0	0	0.131	1.21	1.00	8.28	3.2	2.8	20	370	150	1.2500	37.50	20	.	
860625	102	0	0	0.137	1.16	1.20	8.30	4.6	3.0	17	380	150	1.2000	6.41	20	.	
860625	103	0	0	0.160	1.29	.	.	6.2	4.0	17	370	150	0.7500	.	20	.	
860703	201	0	.	.	.	.	.	.	.	.	.	.	1.5240	.	.	.	.
860709	201	0	.	.	.	.	.	.	.	.	.	.	1.9812	.	.	.	.
860715	201	0	.	.	.	.	.	.	.	.	.	.	1.5240	.	.	.	.
860721	101	0	0	0.054	1.23	0.01	9.5	5	3.0	21	310	110	1.5000	30.4	15	.	
860721	102	0	0	.	.	.	9.7	.	.	.	.	.	1.4000	29.8	.	.	.
860722	201	0	.	.	.	.	.	.	.	.	.	.	1.8288	.	.	.	.
860731	201	0	.	.	.	.	.	.	.	.	.	.	0.6096	.	.	.	.
860806	201	0	.	.	.	.	.	.	.	.	.	.	0.4572	.	.	.	.
860812	201	0	.	.	.	.	.	.	.	.	.	.	2.5908	.	.	.	.
860818	201	0	.	.	.	.	.	.	.	.	.	.	1.8288	.	.	.	.
860825	201	0	.	.	.	.	.	.	.	.	.	.	0.9144	.	.	.	.
860903	201	0	.	.	.	.	.	.	.	.	.	.	1.9812	.	.	.	.
860912	201	0	.	.	.	.	.	.	.	.	.	.	0.9144	.	.	.	.
860919	101	0	0	0.262	2.19	0.19	.	50	5.2	16	330	140	1.5000	96.4	30	.	
860919	102	0	0	0.241	1.92	0.20	.	.	.	.	.	.	2.0000	38.8	.	.	.