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LAKE AND WATERSHED CHARACTERISTICS OF SOME WATER SUPPLY IMPOUNDMENTS IN ILLINOIS

by Shun Dar Lin and Raman K. Raman

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BACKGROUND

Illinois has approximately 2,700 water impoundments with surface areas of 6 acres or more. The origins of these impoundments vary. Some were formed by glaciers. Most were developed by the damming of a stream. About 100 of them serve as raw water supply sources, and a few are used for industrial cooling. They are all used for water-based recreational activities such as swimming, fishing, boating, and water-skiing.

A pressing problem confronting many of the water supply impoundments is the progressively deteriorating quality of the lake waters, which ultimately leads to increased water treatment costs and in some instances even to abandonment of the lake as a water supply source.

Since the impoundments in Illinois inundate rich bottomlands and fertile topsoils, they normally begin their lives with the potential for high biological productivity. This is because mineral nutrients and organic materials are leached from these soils into the overlying waters. Furthermore, runoff from predominantly agricultural watersheds results in high sustained inputs of nutrients into the lake. Consequently, most of the lakes in Illinois show symptoms of eutrophy characterized by hypolimnetic oxygen depletion, high concentrations of phosphorus and nitrogen, and varying degrees of phytoplankton and macrophyte growths. These problems become more and more severe as time progresses. The Illinois State Water Survey has found over the years that impoundents also show symptoms of high eutrophication in their nascency (for example, Lake Evergreen, Johnson Sauk Trail Lake, and Lake Le-Aqua-Na). Most Illinois impoundments are relatively shallow and have low capacity-inflow ratios.

The 1988-1989 drought in Illinois had very severe impacts on the water quality of impoundments in addition to the obvious impact of low to very low water levels in the impoundments. Lack of precipitation and runoff events during summer months resulted in stagnation of the impounded waters, with practically no natural flushing of the lake system occurring. This, combined with weather that was warmer than normal, resulted in more intense thermal stratification accompanied by severe algal blooms, fish kills, and other symptoms of water quality deterioration. The Illinois Department of Conservation (IDOC) received hundreds of calls concerning fish kills in lakes and ponds during the summer of 1988 (Greg Ticachek, IDOC, personal communication).

Because of the eutrophic conditions in the lakes, taste and odor problems are encountered in most water supply systems in Illinois that use impoundments as water supply sources. Algal growths of bloom proportions have been identified as one of the causes of tastes and odors in the finished waters. In addition to color, taste, and odor problems, other problems such as reduced filter runs and increased chemical costs are attributed to planktonic growths in surface water impoundments.

Lake Management Methods

Copper sulfate is routinely employed to control algal blooms in more than 60 of the 100 water supply impoundments in Illinois. However, this chemical is being used without due regard for the chemistry of lake waters, the need for application, and the frequency and proper method of application. For example, copper sulfate application rates in Illinois during 1982 ranged from 5 to 100 pounds per acre with a mean rate of 21.9 lbs/acre. The frequency of application ranged from 1 to 10 applications per year. The research carried out by the Water Survey in Lake Loami (a 10-acre water supply impoundment) indicates that there is no need to use algicides in this lake, yet for many years the lake routinely received more than 400 pounds of copper sulfate (100 pounds per application, four applications per year). It is obvious that the algicide is often misused and misapplied. This is not only economically undesirable but also ecologically damaging.

Most water supply impoundments and treatment systems are owned and operated by municipalities that lack the resources or technical know-how for critically assessing the water quality problems and adopting remedial measures. Many of the practicing civil engineers lack training in limnology and do not consider controlling water treatment problems at the source. This is amply borne out by the Water Survey's experience with the Lake Eureka - City of Eureka supply system.

An integrated and comprehensive approach to assessment and management of the lake watershed and water quality is beneficial. Investigations of the lake watershed should include assessment of soil types, slopes, land uses and land-use practices, soil losses, point and non-point pollution loads, and other relevant characteristics. Because of the limited resources for abating sediment and nutrient loads emanating from the watershed, it is imperative to identify and prioritize critical areas of the watershed for proper management so that the available resources can be allocated judiciously.

Detailed limnological assessments will include the examination of physical, chemical, and biological characteristics of the water and sediments and the development of hydraulic budgets, nutrient budgets, and bathymetric maps.

The data collected for each lake system will aid in identifying and quantifying the lake and watershed problems and will lead to a well-planned, comprehensive, and integrated lake and watershed management plan. The benefits that can be derived from such an endeavor fall into three categories: those that can be realized soon after the implementation of management strategies, those that can be realized in one to three years, and those benefits that accrue only over a long period of time.

The application of copper sulfate is a measure that has immediate benefits. The effectiveness of copper sulfate, which is the most widely used algicide in Illinois water supply impoundments, is a function of the solubility of the copper ion. This solubility in a particular lake is, in turn, a function of the pH and alkalinity of the lake water. As the pH values increase in summer months as a result of algal blooms, the solubility of copper will decrease, making the algicide application less effective. A chemical analysis of the lake waters can provide the basis for determining the type and amount of algicide needed and the desirable frequency of application of the selected algicide. Proper use and application of an algicide on the basis of sound technical data will not only result in immediate economic benefits but will also be ecologically desirable.

In-lake management techniques such as aeration/destratification, lake bottom sealing, harvesting of nuisance organisms, and dredging can improve lake water quality in a time span of two to three years. Detailed limnological studies can indicate whether these measures would be helpful to a particular lake. These techniques are economically feasible for municipalities, and they should be able to implement them.

Benefits accrue over a long period of time from measures such as erosion control, changes in land-use practices, and adoption of best management practices (BMPs) by the agricultural sector. These measures require the willingness and cooperation of all the landowners in the watershed. Even in a small watershed, quite a few years are required to implement a watershed management plan and to achieve perceptible lake water quality enhancement.

SCOPE OF WORK

The Illinois State Water Survey assisted the Illinois Environmental Protection Agency (IEPA) in gathering lake and watershed information for the 25 water supply impoundments listed below:

Impoundment	*County*	*Impoundment*	*County*
Ashland New Lake	Cass	Mt. Olive New Lake	Macoupin
Ashland Old Lake	Morgan	Mt. Olive Old Lake	. Macoupin
Ashley Reservoir	Washington	Mt. Sterling Lake	Brown
Bunker Hill New Lake	Macoupin	New Berlin Lake	Sangamon
Carthage City Lake	Hancock	Norris City Reservoir	White
Lake Freesen	Macoupin	St. Elmo New City Lake	Fayette
Georgetown Reservoir	Vermilion	Shipman City Lake	Macoupin
Glenn Shoals Lake	Montgomery	Sparta New Reservoir	Randolph
Hillsboro Old Lake	Montgomery	Sparta Old Reservoir	Randolph
Kincaid City Lake	Christian	Vermont City Lake	Fulton
Mauvaise Terre Lake	Morgan	Virginia City Lake	Cass
Morgan Lake	Morgan	West Salem New Reservoir	Edwards
		White Hall Lake	Greene

The Water Survey collected lake assessment data (from existing sources) including data on lake location; morphology; hydrology; ownership/access; lake, watershed, and shoreline impairment; and lake/watershed management currently being practiced.

Water samples were collected 1 foot below the surface and 1 foot above the lake bottom at the deepest point of each lake. These samples were analyzed by the I IEPA for turbidity, total suspended solids, volatile suspended solids, ammonia-N, nitrate-N, Kjeldahl-N, total and dissolved phosphorus, and chemical oxygen demand. In-situ observations for secchi disc readings, and DO and temperature measurements at 2-foot intervals, were also made at the deepest stations. Surface water samples were collected for algal identification and enumeration. All the field monitoring and laboratory analyses were performed by using accepted procedures and methods.

All the lakes were visited once during the period July 3 to August 1, 1989, for in-situ observations and water sample collections. The dates of the visits to these lakes can be found in table 1 along with the temperature and DO profile data.

DATA COLLECTED

Although it is preferable to gather limnological data on a periodical basis for one year or at least during the critical spring, summer, and fall months, lack of adequate resources limited the in-situ observations and sample collections for these lakes to only one visit per lake. The DO profiles at the deepest parts of the lakes are given in table 1. The results of chemical analyses and the algal identification and enumeration are included in tables 2 and 3, respectively. With only one data set for each lake, it is impractical to dwell on the limnological characteristics of each lake. However, some very general comments are included which, along with the first-hand knowledge and experience of these impoundment managers, could assist them in their day-to-day operation of the water treatment plants that derive their source water from these lakes.

Thermal Stratification

Deep lakes in the temperate zone (in Illinois, generally those with depths greater than 12 to 15 feet) experience thermal stratification during the period April to September. During thermal stratification, the upper layer (the epilimnion) is isolated from the lower layer of water (the hypolimnion) by a temperature gradient (the thermocline). The most important phase of the thermal regime from the standpoint of eutrophication is the summer stratification period. The hypolimnion, by virtue of its stagnation, traps sediment materials such as decaying plants. In a eutrophic lake, the hypolimnion becomes anaerobic or devoid of oxygen because of the increased content of highly oxidizable material and because of its isolation from the atmosphere. Also, the oxygen demand from organic-rich bottom sediments hastens the oxygen depletion in thermally stratified lakes. This is true for almost all of the lakes in Illinois. In the absence of oxygen, the conditions for chemical reduction become favorable, and more nutrients are released from the bottom sediments to the overlying waters.

The data presented in table 1 indicate that thermal stratification had set in at all the lakes when the observations were made. Since the temporal variations in the DO and temperature profiles were not monitored, it is not possible to identify the onset of thermal stratification, its progression, or the times of peak stratification and subsequent fall turnover. All the lakes showed a temperature gradient. Generally the DO was found to be depleted at depths below 10 feet from the surface. The shallow Morgan Lake had practically no oxygen at depths below 2 feet, even though thermal stratification was not pronounced. Ashland Old Lake had adequate oxygen levels except in the near-bottom waters because it has a motor-speed surface aerator similar to the aerators used in aerated lagoons.

Extreme supersaturation due to algal blooms was in evidence in the lakes of Ashley, Norris City, Sparta, and West Salem. These lakes experienced supersaturation in the range of 210 to in excess of 275 percent on the days observations were made.

Physical and Chemical Characteristics

The physical and chemical data gathered for the lakes are shown in table 2. The nutrient levels in all the lakes were very high, particularly total phosphorus, which was several times higher than the critical phosphorus level of 0.01 mg/L. It is generally considered that phosphorus concentrations greater than 0.01 mg/L tend to result in very high biological productivity in lakes. The secchi disc values for all the lakes except two were less than 60 inches.

Two commonly cited criteria for defining the trophic status of a lake system — total phosphorus and summer secchi disc values — were determined for all the lakes. The other indicator parameters are summer chlorophyll-a and primary productivity. A lake is considered nutrient-rich or eutrophic if the secchi disc transparency is less than 1.5 to 2.0 meters (4.9 to 6.6 feet) and the wintertime total phosphorus is greater man 20 to 30 µg/L. By these measures, all the lakes monitored during this investigation fall under the nutrient-rich or eutrophic category, and many of them could be considered hypereutrophic.

Algal Species

The results of algal identification and enumeration are shown in table 3. Since this field survey was conducted only once during 1989, it is not possible to assess the species succession and the extent of algal blooms that prevailed during the critical summer period. One should keep this fact in mind when trying to interpret the data presented in table 3.

A lake system is considered to experience algal blooms when the algal counts exceed 500/mL. Only 13 of the 23 lakes for which algal assays are reported showed growths of bloom proportion. Among these 13 lakes, blue-green algae, the most troublesome for water treatment systems, were the dominant species in seven lakes. Blue-green algae are known to cause severe taste and odor problems in the finished waters and to cause filter clogging. Mt. Sterling Lake no longer serves as a water supply source. Mt. Olive New Lake is treated with copper sulfate to control algae a few times during the season. Virginia City Lake is used only as a standby source, as wells are the primary source for the village of Virginia. Freesen, Glenn Shoals, Mt. Olive (old), and West Salem Lakes do not receive any algicide treatment to control algae.

As stated previously, nearly two-thirds of the 100 water supply impoundments in Illinois are treated routinely with copper sulfate to control taste and odor problems. The experience of one of the authors is that most of the taste and odor problems in water treatment systems with impoundments as raw water sources are caused not by algae but by the withdrawal of hypolimnetic waters with high concentrations of iron, manganese, hydrogen sulfide, and other products of anaerobic decomposition. The Water Survey's Miscellaneous Publication 111, *Using Copper Sulfate to Control Algae in Water Supply Impoundments*, can be a valuable resource for water treatment plant personnel. This publication deals with algae in aquatic ecosystems, algal types and effects, checking for excessive algal growth, optimal copper sulfate dosages, increasing copper sulfate solubility, changes caused by copper sulfate applications, alternative methods of lake management to avoid taste and odor problems, and guidelines for algal control.

Other Characteristics

Morphological data, watershed data, and other pertinent data for the lakes included in this investigation are contained in table 4.

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Special thanks are due each and every one of the individuals associated with the lakes investigated by the authors, who were very courteous, shared their information and knowledge about the lakes and their watersheds, and made the data collection effort easier. Without their fullest cooperation, this task could not have been accomplished in a timely and orderly fashion. The authors owe a debt of gratitude to each one of them.

Table 1. Dissolved Oxygen and Temperature Data
for Some Water Supply Impoundments

	Ashland, new 7/21/89		Ashland, old 7/21/89		Ashley 7/6/89		Bunker Hill 7/31/89		Carthage 7/3/89	
Depth	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp
0	4.6	23.7	5.0	24.4	13.8	27.5	9.7	29.3	10.8	28.0
2	4.8	23.6	4.9	24.4	16.2	28.5	9.7	29.3	10.8	28.0
4	4.8	23.6	5.0	24.4	5.1	22.7	9.8	29.3	10.8	28.0
6	4.7	23.5	5.0	24.4	2.3	23.0	9.8	29.0	0.6	26.5
8	4.7	23.5	4.9	24.4	0.7	21.5	9.8	28.3	0.4	25.3
10	4.7	23.5	4.6	24.4	0.5	19.5	9.2	27.5	0.4	22.5
12	4.7	23.5	4.8	24.3	0.5	16.5	6.7	25.5	0.4	20.7
14	4.5	23.4	4.5	24.3	0.5	14.5	4.9	23.2	0.4	18.5
16	0.3	21.3	4.3	24.2	0.5	14.5	2.4	21.0	0.4	15.4
18	0.2	19.2	0.3	23.7			1.8	17.3	0.4	14.5
20	0.2	17.3	0.1	21.4			0.4	14.4	0.4	13.9
22	0.2	15.9					0.3	12.3	0.4	13.4
24							0.3	10.7		
26							0.2	9.9		
28							0.2	9.5		
30							0.2	9.5		

	Freesen 7/31/89		Georgetown 7/5/89		Glenn Shoals 7/24/89		Hillsboro 7/24/89		Kincaid 8/1/89	
Depth	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp
0	11.1	29.5	8.0	25.7	9.1	26.5	10.3	27.3	9.5	27.8
2	11.0	29.2	5.7	23.7	9.1	26.6	9.7	27.1	9.5	27.8
4	11.5	28.8	3.5	22.6	8.2	25.7	10.1	26.9	.9.0	27.7
6	10.9	28.5	2.4	22.3	6.3	25.3	8.8	26.5	8.5	27.6
8	4.6	26.5	2.0	22.3	6.3	25.3	4.6	25.5	1.0	26.5
10	0.6	24.3	0.9	21.7	6.1	25.1	2.4	25.0	0.3	23.9
12	0.4	21.5			5.2	25.0	1.1	24.5	0.3	23.3
14	0.3	19.5			3.9	24.6	0.3	23.3		
16	0.3	18.5			2.3	24.4	0.3	20.3		
18					1.1	24.0	0.3	17.5		
20					0.3	23.6				
22					0.1	22.0				
24					0.1	19.7				
26					0.1	19.3				
28					0.1	19.5				
30										

Note: Depth in feet; DO = dissolved oxygen in mg/L;
Temp = temperature, degrees Celsius.

Table 1. Continued

Depth	Mauvaise Terre 7/13/89 DO	Mauvaise Terre 7/13/89 Temp	Morgan 7/13/89 DO	Morgan 7/13/89 Temp	Mt. Olive, new 8/1/89 DO	Mt. Olive, new 8/1/89 Temp	Mt. Olive, old 8/1/89 DO	Mt. Olive, old 8/1/89 Temp	Mt. Sterling 7/3/89 DO	Mt. Sterling 7/3/89 Temp
0	4.6	29.7	4.2	23.0	9.6	27.2	13.5	27.0	12.6	28.7
2	2.7	29.5	2.6	22.1	9.7	27.2	14.0	27.1	12.2	28.5
4	2.1	29.3	1.1	21.3	4.0	27.1	14.0	27.1	12.1	27.7
6	1.7	29.2			0.4	23.5	4.7	25.9	0.8	25.5
8	1.5	29.2			0.3	21.4	0.6	23.8	0.6	22.0
10					0.3	18.7	0.4	20.7	0.4	18.7
12					0.2	15.5	0.3	16.5	0.4	16.5
14					0.2	14.3	0.3	12.9	0.4	15.0
16							0.2	10.5	0.4	13.5
18							0.2	9.4	0.4	12.5
20							0.2	8.5	0.4	11.5
22							0.2	8.1	0.4	11.5
24							0.2	7.9		
26							0.2	7.8		
28							0.2	7.7		
30							0.2	7.6		

Depth	New Berlin 7/21/89 DO	New Berlin 7/21/89 Temp	Norris City 7/6/89 DO	Norris City 7/6/89 Temp	St. Elmo 7/5/89 DO	St. Elmo 7/5/89 Temp	Shipman 7/31/89 DO	Shipman 7/31/89 Temp	Sparta, new 7/6/89 DO	Sparta, new 7/6/89 Temp
0	8.1	24.6	18.8	26.9	7.2	30.5	8.2	29.5	>20	30.5
2	8.1	24.6	18.2	25.7	7.0	30.1	8.1	29.4	>20	30.0
4	8.1	24.5	17.1	25.5	6.7	27.5	8.0	28.9	>20	27.8
6	8.2	24.1	16.5	24.5	3.6	25.7	0.6	25.1	1.2	24.5
8	7.9	24.0	8.2	23.7	1.5	24.9	0.4	19.5	0.3	22.5
10	7.9	24.0	1.8	23.5	0.3	24.7	0.3	17.3	0.3	17.9
12	7.8	23.8	0.4	23.5	0.3	19.5	0.3	14.4	0.3	17.5
14	7.7	23.8	0.4	24.3	0.3	16.5	0.3	13.0	0.3	18.1
16	7.5	23.7	0.3	23.3	0.3	13.7	0.3	12.4		
18	1.0	20.2	0.3	21.1	0.3	12.3	0.3	11.5		
20	0.3	16.3	0.3	23.3	0.3	11.7	0.3	11.5		
22	0.3	14.2								
24										
26										
28										
30										

Note: Depth in feet; DO = dissolved oxygen in mg/L; Temp = temperature, degrees Celsius.

Table 1. Concluded

	Sparta, old 7/6/89		Vermont 7/18/89		Virginia 7/18/89		West Salem 7/5/89		White Hall 7/31/89	
Depth	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp
0	17.6	31.5	7.4	26.1	9.6	25.9	20.0	29.0	8.6	27.6
2	>20	30.5	7.4	26.1	9.8	26.0	20.0	28.5	8.6	27.6
4	18.2	28.5	6.7	25.9	9.6	25.7	13.0	26.0	8.7	27.5
6	16.0	237.5	6.0	25.7	8.8	25.5	0.7	23.0	8.5	27.5
8	8.7	26.5	6.4	25.7	3.6	25.0	0.3	22.0	3.8	26.0
10	4.9	24.8			1.1	24.4	0.3	18.3	0.7	24.7
12	1.0	23.5			0.4	22.4	0.3	16.8	0.3	22.8
14	0.3	19.5			0.4	20.3	0.3	17.5	0.2	20.0
16	0.3	17.5							0.2	18.0
18	0.3	17.5							0.2	15.8
20									0.2	14.9
22									0.2	14.5
24										
26										
28										
30										

Note: Depth in feet; DO = dissolved oxygen in mg/L; Temp = temperature, degrees Celsius.

Table 2. Water Quality Characteristics of Some Water Supply Impoundments

Lake	Sample location	Date of sampling	Turbidity	Secchi	TSS	VSS	Ammonia-N	Nitrate-N	Kjeldahl-N	Total phosphorus	Dissolved phosphorus	COD
Ashland, new	Surface	7/21/89	1.1	192	1	1	0.42	4.40	1.00	0.103	0.060	12
	Near bottom		14.0		159	36	6.40	0.10	9.50	2.100	1.875	36
Ashland, old	Surface	7/21	4.3	22	8	6	0.57	3.80	2.30	0.068	0.049	27
	Near bottom		7.6		26	8	1.30	3.10	2.80	0.118	0.084	23
Ashley Reservoir	Surface	7/6	36.0	12	14	8	0.10	0.10	1.00	0.106	0.081	28
	Near bottom		120.0		82	16	2.30	0.10	2.70	0.826	0.305	31
Bunker Hill	Surface	7/31	2.3	72	12	5	0.10	0.10	0.70	0.041	0.006	19
	Near bottom		11.0		3	2	0.10	0.10	0.70	0.040	0.040	19
Carthage	Surface	7/3	2.7	39	9	4	0.10	0.10	0.40	0.042	0.038	19
	Near bottom		1.1		6	2	2.20	0.10	2.10	0.644	0.552	18
Freesen	Surface	7/31	4.7	24	8	5	0.10	0.10	1.00	0.044	0.026	28
	Near bottom		35.0		62	15	1.60	0.10	2.40	0.285	0.272	24
Georgetown Reservoir	Surface	7/5	1.4	24	21	5	0.10	9.70	0.30	0.065	0.056	11
	Near bottom		11.0		45	7	0.19	9.70	0.50	0.076	0.055	11
Glenn Shoals	Surface	7/24	5.3	25	11	5	0.10	0.10	1.00	0.053	0.025	21
	Near bottom		13.0		29	7	0.83	0.10	1.90	0.152	0.124	23
Hillsboro	Surface	7/24		24								
	Near bottom											
Kincaid	Surface	8/1	6.3	18	52	15	1.10	0.10	2.00	0.121	0.079	24
	Near bottom		10.0		14	7	0.10	0.10	0.60	0.470	0.142	23
MauvaiseTerre	Surface	7/13	5.6	9	40	12	0.75	0.22	2.50	0.172	0.144	27
	Near bottom		5.5		49	13	0.70	0.22	3.10	0.201	0.190	26
Morgan	Near bottom											

Note: Turbidity in NTU; Secchi values in inches; TSS = total suspended solids; VSS = volatile suspended solid's; COD = chemical oxygen demand; all others in mg/L.

Table 2. Concluded

Lake	Sample location	Date of sampling	Turbidity	Secchi	TSS	VSS	Ammonia-N	Nitrate-N	Kjeldahl-N	Total phosphorus	Dissolved phosphorus	COD
Mt. Olive, new	Surface	8/1/89	11.0	18	16	13	0.10	0.10	0.80	0.217	0.094	55
	Near bottom		18.0		31	16	6.60	0.10	7.40	2.768	2.696	49
Mt. Olive, old	Surface	8/1	7.0	17	9	6	0.18	0.10	2.80	0.231	0.089	46
	Near bottom		7.5		10	7	4.50	0.10	5.90	1.545	1.380	29
Mt. Sterling	Surface	7/3	5.7	18	8	5	0.20	-	1.50	0.077	0.051	40
	Nearbottom		11.0		19	9	3.10	0.10	2.50	0.540	0.528	28
New Berlin	Surface	7/21		60								
	Near bottom											
Norris City Reservoir	Surface	7/6	2.0	28	10	6	0.10	0.10	1.50	0.058	0.048	21
	Nearbottom		4.6		55	13	0.38	0.10	0.90	0.025	0.018	18
St. Elmo	Surface	7/5	2.5	44	5	4	0.52	0.10	1.20	0.053	0.042	24
	Nearbottom		14.0		26	10	2.50	0.04	3.20	1.600	0.421	25
Shipman	Surface	7/31	2.0	34	4	3	0.10	0.10	1.00	0.834	0.808	26
	Nearbottom		49.0		16	6	10.00	0.10	9.60	3.540	3.310	56
Sparta, new	Surface	7/6		22								
	Near bottom											
Sparta, old	Surface	7/6	0.2	30	5	4	0.10	0.10	0.30	0.148	0.117	18
	Nearbottom		12.0		9	7	3.90	0.10	3.20	2.000	1.500	32
Vermont	Surface	7/18	14.0	18	11	4	0.10	0.10	1.30	0.128	0.092	27
	Nearbottom		14.0		24	7	0.21	0.10	0.70	0.113	0.099	24
Virginia	Surface	7/18	2.5	39	4	4	0.10	0.10	0.60	0.071	0.044	16
	Nearbottom		7.7		9	7	0.10	0.10	0.80	0.090	0.043	21
West Salem	Surface	7/5	7.8	24	12	8	0.10	0.10	0.80	0.016	0.001	31
	Nearbottom		3.4		69	16	1.80	0.10	1.80	0.272	0.272	30
White Hall	Surface	7/31	5.2	32	22	12	0.10)	0.10	0.70	0.029	0.020	18
	Nearbottom		43.0		15	5	1.70	0.10	2.70	0.214	0.116	21

Note: Turbidity in NTU; Secchi values in inches; TSS = total suspended solids; VSS = volatile suspended solids; COD = chemical oxygen demand; all others in mg/L.

Table 3. Observed Algal Species in Some Illinois Water Supply Impoundments

Algae	Significance	Ashland (new)	Ashland (old)	Ashley	Bunker Hill	Carthage
Blue-Green Algae						
Anabaena flos-aquae	F					
A. spiroides						
Anacystis cyanea	T					21
A. thermalis						
A.sp.						
Aphanizomenonflos-aquae	T			390		
Lyngbya digneti	P					
Oscillatoria sp.						
Green Algae						
Actinastrum hatzschii	S					
Ankistrodesmus falcatus	S					
Chlorosarcina consociata	S					
Coelastrum microporum	S		510	1700		8
Crucigenia rectangularis				190	21	
C. tetrapedia						
Micractinium pusillum	S					
Oocystis borgei	S		180	160	32	34
Pediastrum duplex	S	11	260	42		
P. simplex						
Scenedesmus carinatus						
S. dimorphus	S					32
Diatoms						
Cyclotella meneghiniana	F					
C. ocellata						
Diatoma vulgare	T,F					
Melosira granulata	F		1740			
Flagellates						
Ceratium hirundinella	T		42		6	38
Euglena gracilis	S,P					
E. oxyuris	P					
E. viridis	P					
Glenodinium sp.	T					
Phacus pleuronectes	S					
Platydorina caudatum						
Trachelomonas crebea	F	15		105	15	8
Total count		26	2730	2590	74	140
Date of sample collection (1989)		7/21	7/21	7/6	7/31	7/3

Note: Density in counts per milliliter
F = Filter clogging
P = Pollution tolerant
S = Free floating
T = Taste and odor

Table 3. Continued

Algae	Significance	Freesen	George-Town	Glenn Shoals	Hillsboro (old)	Kincaid
Blue-Green Algae						
Anabaena flos-aquae	F		99			
A.spiroides		1055		900	450	
Anacystis cyanea	T		32			
A. thermalis		207				
A.sp.						
Aphanizomenon flos-aquae	T	90	44		200	
Lyngbya digneti	P			1200		
Oscillatoria sp.						
Green Algae						
Actinastrum hatzschii	S		23	150	1200	
Ankistrodesmus falcatus	S				53	
Chlorosarcina consociata	S				140	
Coelastrum micrpporum	S	42		110	1400	53
Crucigenia rectangularis				230	120	106
C. tetrapedia						
Micractinium pusillum	S					170
Oocystis borgei	S	74	25		100	58
Pediastrum duplex	S	69				
P. simplex						
Scenedesmus carinatus			8		240	
S. dimorphus	S				53	32
Diatoms						
Cyclotella meneghiniana	F	160			390	
C. ocellata						170
Diatoma vulgare	T,F		8			
Melosira granulata	F		110			
Flagellates						
Ceratium hirundinella	T	122				16
Euglena gracilis	S,P	74			120	
E. oxyuris	P					
E. viridis	P					510
Glenodinium sp.	T					
Phacus pleuronectes	S		8			
Platydorina caudatum						
Trachelomonas crebea	F	212	13	150	140	
Total count		2110	370	2740	4610	1120
Date of sample collection (1989)		7/31	7/5	7/24	7/24	8/1

Note: Density in counts per milliliter
F = Filter clogging
P = Pollution tolerant
S = Free floating
T = Taste and odor

Table 3. Continued

Algae	Significance	Morgan	Mt. Olive (new)	Mt. Olive (old)	Mt. Sterling	New Berlin	Norris City
Blue-Green Algae							
Anabaena flos-aquae	F						
A.spiroides			3800	470	1060		
Anacystis cyanea	T						34
A.thermalis			230		74		100
A. sp.							
Aphanizomenonflos-aquae	T		410		2800		63
Lyngbya digneti	P						
Oscillatoria sp.		19			10122		32
Green Algae							
Actinastrum hatzschii	S	6					
Ankistrodesmus falcatus	S						
Chlorosarcina consociata	S		63				
Coelastrum microporum	S	8				1920	21
Crucigenia rectangularis			84	17			
C. tetrapedia							
Micractinium pusillum	S	27					
Oocystis borgei	S		330				
Pediastrum duplex	S	13				420	6
P. simplex							*2*
Scenedesmus carinatus							
S. dimorphus	S						15
Diatoms							
Cyclotella meneghiniana	F		2110				
C. ocellata							
Diatoma vulgare	T,F						
Melosira granulata	F	15					53
Flagellates							
Ceratium hirundinella	T		147		74		
Euglena gracilis	S,P			23			
E. oxyuris	P	4					
E. viridis	P						
Glenodinium sp.	T						8
Phacus pleuronectes	S				21		
Platydorina caudatum			21				
Trachelomonas crebea	F	34	220				29
Total count		130	7420	510	14160	2340	360
Date of sample collection (1989)		7/13	8/1	8/1	7/3	7/21	7/6

Note: Density in counts per milliliter
F = Filter clogging
P = Pollution tolerant
S = Free floating
T = Taste and odor

Table 3. Continued

Algae	Significance	St. Elmo	Shipman	Sparta (old)	Vermont	Virginia
Blue-Green Algae						
Anabaena						
flos-aquae F 350						
A. spiroides			32			
Anacystis cyanea	T					74
A. thermalis						
A. sp.						710
Aphanizomenon flos-aquae	T					
Lyngbya digneti	P					400
Oscillatoria sp.						
Green Algae						
Actinastrum hatzschii	S					
Ankistrodesmus falcatus	S		168			
Chlorosarcina consociata	S	4				
Coelastrum microporum	S	8		11	515	27
Crucigenia rectangularis				29		
C. tetrapedia				8		
Micractinium pusillum	S					
Oocystis borgei	S		13	11		
Pediastrum duplex	S				872	
P. simplex				4		
Scenedesmus carinatus						
S.dimorphus	S	23		38		
Diatoms						
Cyclotella meneghiniana	F					
C ocellata						
Diatoma vulgare	T,F					
Melosira granulata	F					
Flagellates						
Ceratium hirundinella	T			17		210
Euglena gracilis	S,P					32
E. oxyuris	P					
E. viridis	P				190	
Glenodinium sp.	T					
Phacus pleuronectes	S				63	
Platydorina caudatum		*6*				
Trachelomonas crebea	F			25	410	90
Total count		41	210	140	2050	1890
Date of sample collection (1989)		7/5	7/31	7/6	7/18	7/18

Note: Density in counts per milliliter
F = Filter clogging
P = Pollution tolerant
S = Free floating
T = Taste and odor

Table 3. Concluded

Algae	Significance	West Salem	White Hall
Blue-Green Algae			
Anabaena flos-aquae	F		
A. spiroides			38
Anacystis cyanea	T		
A. thermalis			
A. sp.		9100	
Aphanizomenon flos-aquae	T	1100	
Lyngbya digneti	P		
Oscillatoria sp.		2400	
Green Algae			
Actinastrum hatzschii	S		8
Ankistrodesmus falcatus	S		
Chlorosarcina consociata	S		
Coelastrum microporum	S		
Crucigenia rectangularis			
C. tetrapedia			
Micractinium pusillum	S		
Oocystis borgei	S	180	38
Pediastrum duplex	S		
P. simplex			
Scenedesmus carinatus			
S. dimorphus	S	95	
Diatoms			
Cyclotella meneghiniana	F		
C. ocellata			
Diatoma vulgare	T,F		
Melosira granulata	F		
Flagellates			
Ceratium hirundinella	T	32	
Euglena gracilis	S,P		
E. oxyuris	P		
E. viridis	P		17
Glenodinium sp.	T		
Phacus pleuronectes	S		
Platydorina caudatum			
Trachelomonas crebea	F	42	13
Total count		12900	110
Date of sample collection (1989)		7/5	7/31

Note: Density in counts per milliliter
F = Filter clogging
P = Pollution tolerant
S = Free floating
T = Taste and odor

Table 4. Morphological Data, Watershed Data, and Other Pertinent Data for Some Water Supply Impoundments in Illinois

Ashland New Lake

County: Cass
Surface area: 13.5 acres
Year constructed: 1979

Location: 3 miles west of Ashland
Maximum depth: 22 feet
Watershed area: Side-channel impoundment

Ownership: Village of Ashland
Ashland, EL 62612
Telephone: (217)476-3381

Name of tributary: The lake is fed by an unnamed creek, and also water is pumped into the lake from Little Indian Creek.

Watershed land use: -

Watershed management: Conservation tillage - 20%
Crop residue use - 50%
Moldboard plowing - 30%

Ashland Old Lake

County: Morgan
Surface area: 5.0 acres
Year constructed: -

Location: Two miles southwest of Ashland
Maximum depth: 20 feet
Watershed area: Side-channel impoundment

Ownership: Village of Ashland
Ashland, IL 62612
Telephone: (217)476-3381

Name of tributary: Water is pumped into the lake from Little Indian Creek.

Watershed land use: -

Watershed management: Terraces- 1,200 feet
Contouring -10 acres
Crop residue (20% residue) - 50%
Moldboard plowing - 50%

Ashley Reservoir

County: Washington
Surface area: 24.4 acres
Year constructed: 1941

Location: Two miles northeast of Ashley
Maximum depth: 16 feet
Watershed area: 758 acres

Ownership: City of Ashley
P.O. Box 341
Ashley, IL 62808
Telephone: (618) 485-2270

Name of tributary: Unnamed creek

Watershed land use: Cropland and pasture or grassland - 96.7%
Water - 3.3%

Watershed management: (As of September 1987)
Terraces - 6,400 feet
No-till practice -10%
Chisel/disc till (with less than 30% residues) - 35%
Mulch till -35%
Moldboard plowing - 10%

Bunker Hill New Lake

County: Macoupin
Surface area: 24.8 acres
Year constructed: -

Location: 2.5 miles northwest of Bunker Hill
Maximum depth: 29 feet
Watershed area: 4,589 acres

Ownership: City of Bunker Hill
Box 516
Bunker Hill, IL 62014
Telephone: (618) 585-4632

Name of tributary: Unnamed creek

Watershed land use: Residential - 0.7%
Cropland and pasture or grassland - 86.5
Woodland -12.3%
Water - 0.5%

Watershed management: Chisel and disc till - 75%
Moldboard plowing - 25%

Carthage City Lake

County: Hancock
Surface area: 45.8 acres
Year constructed: 1925

Location: Two miles northwest of Carthage
Maximum depth: 21 feet
Watershed area: 1804 acres

Ownership: City of Carthage
City Hall
Carthage, IL 62321
Telephone: (217)357-3119

Name of tributary: Unnamed creek

Watershed land use:
- Industrial/commercial - 2.8%
- Residential - 3.6%
- Cropland and pasture or grassland - 90.7%
- Woodland - 0.4%
- Water - 2.5%

Watershed management:
- No-till - 5%
- Mulch till - 35%
- Moldboard plowing - 20%
- Chisel/disc till (with less than 30% residue) - 40%
- Waterways - 20 acres

Lake Freesen

County: Macoupin
Surface area: 79 acres
Year constructed: -

Location: One mile north of Hettick
Maximum depth: 16 feet
Watershed area: 2,838 acres

Ownership: Abraham Lincoln Council
Boy Scouts of America
Fairhill Mall
Springfield, IL 62704

Name of tributary: Unnamed creek

Watershed land use:
- Cropland and pasture or grassland - 86.2%
- Woodland-11%
- Water - 2.8%

Watershed management:
- Terraces - 5,000 feet
- Waterways - 20 acres
- Grade stabilization structures - 20
- Storm detention ponds - 9
- Permanent vegetative cover - 300 acres
- Land area with slope greater than 12% remains in woodland
- No-till - 10%
- Chisel/disc - 40%
- Mulch till - 40%
- Moldboard plowing - 10%

Georgetown Reservoir

County: Vermilion
Surface area: 46.1 acres
Year constructed: -

Location: In Georgetown
Maximum depth: 9 feet
Watershed area: 17,200 acres

Ownership: City of Georgetown
208 S. Walnut
Georgetown, EL 61846
Telephone: (217) 662-2525

Name of tributary: Little Vermilion River

Watershed Land-Use:
Cropland - 60%
Pasture or grassland - 30%
Woodland -10%

Watershed management:
Terraces - 75,000 feet
Grassed waterways - 2,000 acres
Detention ponds -10
Vegetative filter strips - 25 acres
No-till -10%
Mulch till - 25%
Minimum tillage (with less than 30% residue) - 20%
Moldboard plowing - 45%

Glenn Shoals Lake

County: Montgomery
Surface area: 1,117 acres
Year constructed: 1979

Location: Two miles northeast of Hillsboro
Maximum depth: 27 feet
Watershed area: 48,514 acres

Ownership: City of Hillsboro
4477 S. Main
Hillsboro, IL 62049

Name of tributary: Shoals Creek

Watershed land use:
Residential - 0.6%
Cropland and pasture or grassland - 93.0%
Woodland-4.1%
Water - 2.3%

Watershed management:
Terraces - 40,000 feet
Grassed waterways - 250 acres
Sedimentation basin - 50 acres
Grade stabilization structures - 80
Conservation tillage - 90%
No-till - 9%
Conservation resource program - 1%

Hillsboro Old Lake

County: Montgomery
Surface area: 107 acres
Year constructed: 1930

Location: One mile northeast of Hillsboro
Maximum depth: 18 feet
Watershed area: 4,381 acres

Ownership: City of Hillsboro
4477 S. Main
Hillsboro, IL 62049
Telephone: (217) 532-5566

Name of tributary: Unnamed creek

Watershed land use:
- Industrial/commercial - 1.5%
- Residential - 6.0%
- Cropland and pasture or grassland - 81.6%
- Woodland - 8.5%
- Water - 2.4%

Watershed management:
- Grassed waterways - 25 acres
- Conservation tillage - 87%
- No-till - 4%
- Conservation reserve program - 9%

Kincaid City Lake

County: Christian
Surface area: 36.0 acres
Year constructed: -

Location: Two miles east of Kincaid
Maximum depth: 11 feet
Watershed area: 1,427 acres

Ownership: Village of Kincaid
114 Central
Kincaid, IL 62540
Telephone: (217) 237-4713

Name of tributary: South Fork Sangamon River

Watershed land use:
- Cropland and pasture or grassland - 97.5%
- Water - 2.5%

Watershed management:
- Grassed waterways - 5 acres
- Retention pond - One, 1.5 acres
- No-till - 5%
- Mulch till - 10%
- Chisel/disc (with less than 30% residue) - 85%

Mauvaise Terre Lake

County: Morgan
Surface area: 180 acres
Year constructed: 1921

Location: One mile southeast of Jacksonville
Maximum depth: 7 feet
Watershed area: 21,669 acres

Ownership: City of Jacksonville
200 W. Douglass
Jacksonville, JL 62650
Telephone: (217)243-3391

Name of tributary: Mauvaise Terre Creek

Watershed land use:
- Industrial/commercial - 0.5%
- Residential - 2.3%
- Cropland and pasture or grassland - 94.8%
- Woodland - 0.7%
- Transitional area - 0.8%
- Water - 0.9%

Watershed management:
- Grassed waterways -100 acres
- Terraces - 50,000 feet
- Retention ponds - 50
- Grade stabilization structures - 20
- Conservation tillage - 30%
- Moldboard plowing - 30%
- Chisel/disc till (with less than 20% residue) - 30%
- No-till - 10%

Morgan Lake

County: Morgan
Surface area: 24.2 acres
Year constructed: -

Location: One mile southeast of Jacksonville
Maximum depth: 4 feet
Watershed area: 1,760 acres

Ownership: City of Jacksonville
200 W. Douglass
Jacksonville, IL 62650
Telephone: (217) 243-3391

Name of tributary: Mauvaise Terre Creek

Mt. Olive New Lake

County: Macoupin
Surface area: 40.5 acres
Year constructed: -

Location: Four miles north of Mt. Olive
Maximum depth: 13 feet
Watershed area: 3,333 acres

Ownership: City of Mt. Olive
200 E. Main
Mt. Olive, IL 62069
Telephone: (217) 999-4261

Name of tributary: Panther Creek

Watershed land use:
- Residential - 0.4%
- Cropland and pasture or grassland - 69.0%
- Woodland - 26.8%
- Transitional area - 2.6%
- Water-1.2%

Watershed management:
- Terraces - 1,000 feet
- Grassed waterways - 7.5 acres
- Grade stabilization structures - 6
- Permanent vegetative cover - 15 acres
- Detention ponds - 14
- Moldboard plowing - 35%
- Chisel/disc - 40%
- Mulch till - 20%
- No-till - 5%

Mt. Olive Old Lake

County: Macoupin
Surface area: 36.3 acres
Year constructed: 1896

Location: Two miles northwest of Mt. Olive
Maximum depth: 30 feet
Watershed area: 472 acres

Ownership: City of Mt. Olive
200 E. Main
Mt. Olive, IL 62069
Telephone: (217) 999-4261

Name of tributary: Panther Creek

Watershed land use:
- Cropland and pasture or grassland - 75.8%
- Woodland-13.3%
- Recreation development - 3.2%
- Water - 7.7%

Watershed management:
- Retention pond - 1 %
- Mulch till -10%
- Chisel/disc - 50%
- Moldboard plowing - 40%

Mt. Sterling Lake

County: Brown
Surface area: 24.1 acres
Year constructed: 1938

Location: Two miles northwest of Mt. Sterling
Maximum depth: 22 feet
Watershed area: 1,264 acres

Ownership: City of Mt. Sterling
City Hall
Mt. Sterling, IL 62353
Telephone: (217) 773-2136

Name of tributary: North Fork Shelby Creek

Watershed land use: Cropland and pasture or grassland - 98.1 %
Water-1.9%

Watershed management: Grassed waterways - 4 acres
Terraces - 14,480 feet
Mulch till - 50%

New Berlin Lake

County: Sangamon
Surface area: 8 acres
Year constructed: -

Location: Six miles north of New Berlin
Maximum depth: 22 feet
Watershed area: 17,000 acres
(Side-channel impoundment)

Ownership: Village of Ashland
Ashland, IL 62612
Telephone: (217) 488-6214

Name of tributary: Spring Creek

Watershed land use: Cropland - 99%

Watershed management: Terracing - 35,000 feet
Grassed waterways -100 acres
Retention ponds -10
Stabilization structures - 8
No-till - 8%
Mulch till - 20%
Chisel/disc plowing - 47%
Moldboard plowing - 25%

Norris City Reservoir

County: White
Surface area: 29.6 acres
Year constructed: -

Location: One mile east of Norris City
Maximum depth: 20 feet
Watershed area: 457 acres

Ownership: City Hall
Norris City, IL 62869
Telephone: (618)378-3611

Name of tributary: Indian Creek

Watershed land use:
Industrial/commercial -16.7%
Residential - 8.5%
Cropland and pasture or grassland - 67.8%
Woodland - 0.5%
Water - 6.5%

Watershed management: No-till - 51 %
Chisel/disc plowing - 33%
Combination of no-till and chisel plowing - 33%

St. Elmo New City Lake

County: Fayette
Surface area: 59.2 acres
Year constructed: 1964

Location: Two miles northwest of St. Elmo
Maximum depth: 28 feet
Watershed area: 1,282 acres

Ownership: City of St. Elmo
117 W. Fourth Street
St. Elmo, IL 62458
Telephone: (618) 829-3319

Name of tributary: Sugar Creek

Watershed land use:
Industrial/commercial - 1.2%
Residential - 0.7%
Cropland and pasture or grassland - 73.4%
Woodland-20.1%
Water - 4.6%

Watershed management:
Grassed waterways - 45 acres
Grade stabilization structures - 10 acres
Bald cypress and Reed Canary grass were planted in 1987 for shoreline stabilization.

Shipman City Lake

County: Macoupin
Surface area: 8.2 acres
Year constructed: 1968

Location: In Shipman
Maximum depth: 19 feet
Watershed area: 387 acres

Ownership: Village of Shipman
P.O. Box 271
Shipman, IL 62685
Telephone: (618)836-7114

Name of tributary: Coop Branch of Macoupin Creek

Watershed land use:
Industrial/commercial -10.9%
Residential - 32.9%
Cropland and pasture or grassland - 54.1%
Water-2.1%

Watershed management:
A little farm pond immediately upstream of the lake serves as a sediment basin.
Grassed waterways - 10 acres
Chisel/disc plowing - 60%
Moldboard plowing - 40%

Sparta New Reservoir

County: Randolph
Surface area: 47.3 acres
Year constructed: -

Location: Two miles northeast of Sparta
Maximum depth: 14 feet
Watershed area: 1,049 acres

Ownership: City of Sparta
132 W. Broadway
Sparta, IL 62286
Telephone: (618)443-3513

Name of tributary: Maxwell Creek

Watershed land use:
Industrial/commercial -15.4%
Residential - 3.8%
Cropland and pasture or grassland - 71.6%
Woodland - 4.7%
Water - 4.5%

Sparta Old Reservoir

County: Randolph
Surface area: 28 acres
Year constructed: 1916

Location: One mile south of Sparta
Maximum depth: 17 feet
Watershed area: 581 acres

Ownership: City of Sparta
132 W. Broadway
Sparta, IL 62286
Telephone: (618) 443-3513

Name of tributary: Unnamed creek

Watershed land use: Residential - 7.5%
Cropland and pasture or grassland - 76.9%
Woodland -10.8%
Lake - 4.8%

Vermont City Lake

County: Fulton
Surface area: 33.2 acres
Year constructed: 1938-1942

Location: Two miles northwest of Vermont
Maximum depth: 8 feet
Watershed area: 1,433 acres

Ownership: City of Vermont
City Hall
Vermont, IL 61484
Telephone: (309) 784-5242

Name of tributary: Unnamed tributary to Sugar Creek

Watershed land use: Row crop lands around the lake were converted to pasture a few years ago.
Conservation cropping system: 546 acres
Grassed waterways: 4 acres
Critical area planting: 18 acres
Diversion: 8,250 feet
Mulch till - 65%
Crop residue use - 27%
Moldboard plowing - 4%
No-till - 4%

Virginia City Lake

County: Cass
Surface area: 14.7 acres
Year constructed: -

Location: One-half mile north of Virginia
Maximum depth: 13 feet
Watershed area: 550 acres

Ownership: City of Virginia
City Hall
Virginia, IL 62691
Telephone: (217)452-7587

Name of tributary: Unnamed creek

Watershed land use:
Industrial/commercial - 0.2%
Residential-0.1%
Cropland and pasture or grassland - 94.9%
Woodland - 2.2%
Water - 2.6%

Watershed management:
Grassed waterways -10 acres
Sediment basin -1
Grade stabilization structures - 2
Terraces - 2,200 feet
No-till - 12%
Mulch till - 60%
Moldboard plowing - 40%

West Salem New Reservoir

County: Edwards
Surface area: 20.9 acres
Year constructed: 1971

Location: Two miles northwest of West Salem
Maximum depth: 14 feet
Watershed area: 439 acres

Ownership: Village of West Salem
City Hall
West Salem, IL 62476
Telephone: (618) 456-3167

Name of tributary: Unnamed creek

Watershed land use:
Residential - 0.2%
Cropland and pasture or grassland - 74.6%
Recreation development - 20.4%
Water - 4.8%

Watershed management:
Grassed waterways - 5 acres
Critical area seeding - 5 acres
No-till - 20%
Tillage with greater than 20% residue -15%
Tillage with less than 20% residue - 65%

White Hall Lake

County: Greene
Surface area: 23.9 acres
Year constructed: 1897

Location: One mile east of White Hall
Maximum depth: 22 feet
Watershed area: 609 acres

Ownership: City of White Hall
116 E. Sherman
White Hall, IL 62092
Telephone: (217) 374-2345

Name of tributary: Wolf Run Creek

Watershed land use: Cropland and pasture or grassland - 72.4%
Woodland - 23.2%
Water - 3.9%