# 2000 SUMMARY REPORT
# of
# VALLEY LAKE

## Lake County, Illinois

*Prepared by the*


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# LAKE IDENTIFICATION AND LOCATION

Valley Lake is a 12-acre man-made lake that was constructed in 1952. It is located within the Des Plaines River watershed, in unincorporated Lake County, about one mile east of Illinois Route 45 (T45N, R11E, S29,30). The closest major intersection is Route 45 and Gages Lake Road near Grayslake. Most of Valley Lake is owned and managed by the Wildwood Park District. Two parcels, one along the northwest side consisting of 1.37 acres of lake bottom, and the other, consisting of 0.6 acres of lake bottom at the southwest corner of the lake are listed as having unknown ownership in the Lake County tax records. The lake has a maximum depth of 9.5 feet, and an average depth of 4.75 feet, which is estimated at half of the maximum depth. The estimated volume of the lake is 57 acre-feet[1], or 18.6 million gallons. At present, volume and average depth can only be estimated because data from an accurate recent bathymetric (depth contour) map is not available. The shoreline length around Valley Lake is 0.71 miles. A spillway at the northeast corner of the lake drains to an underground stormsewer network that eventually reaches the Des Plaines River. Three stormwater inlets enter the lake from the west and south residential areas. Residential lots surround much of the lake except for two parks owned by the Wildwood Park District.

# SUMMARY OF CURRENT AND HISTORICAL LAKE USES

The Wildwood Park District has two access locations, Valley North, located on the north end of the lake, and Valley South, at the south end of the lake. A swimming beach is at Valley South. Both areas offer fishing from shore and a picnic area. Only non-motorized boating is allowed on the lake. Free access is limited to park district residents, but nonresidents can access the lake for $6.50 per person, per day. According to available records, aquatic herbicides were used last in 1970 to treat submersed aquatic plants. After the stocking of grass carp in 1988, virtually no plant life exists in Valley Lake. The lake has been treated with copper sulfate to control algae since 1989. The Illinois Department of Natural Resources (IDNR) has assisted the park district with fisheries assessments, rehabilitation and stocking.

# LIMNOLOGICAL DATA – WATER QUALITY

Water samples were taken once a month, from May through September 2000, at the deep hole location (See Figure 1). Samples were collected at three feet and seven feet deep and analyzed for a variety of parameters. See Appendix A for water quality sampling and laboratory methods. The document, “Interpreting Your Water Quality Data” explains these parameters in detail.

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[1] One acre-foot is one acre filled with one foot of water, or 325,900 gallons.

Figure 1 lake sampling map

The water clarity in Valley Lake averaged 3.2 feet during the 2000 sampling season, which is below the 5.0 foot seasonal average clarity reading for Lake County lakes[2]. Algae and sediment, which are considered total suspended solids (TSS) in the water,

[2] Water quality data is in Table 1.

were the reason for the relatively poor water clarity. The lake is shallow, and has no plants to hold sediment in place, so sediment can easily be stirred into the water column. The concentrations of TSS throughout the water column in Valley Lake are higher than the median reading for other Lake County lakes. All solids parameters were higher than the average from other Lake County lakes[3]. The conductivity readings and total dissolved solids (TDS) results in Valley Lake were also higher in 2000 than the averages for these parameters from other Lake County lakes. One source for the high TDS and conductivity is road salt entering the lake from the surrounding neighborhood.

Algae is abundant in Valley Lake because of high concentrations of phosphorus. The average total phosphorus (TP) concentration of the samples collected near the surface during 2000 was nearly four times higher than the average from other Lake County lakes. Soluble reactive phosphorus (SRP), which is the dissolved form of phosphorus readily available for use by algae for growth purposes, is normally below laboratory equipment detection limits in unstratified lakes. This is because algae uses it very quickly. However, in Valley Lake, this form of phosphorus could still be found near the surface, even with algae growth occurring. This is indicative of excessive concentrations of phosphorus.

The trophic condition of a lake indicates the overall level of nutrient enrichment. Most lakes in Lake County are eutrophic, or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae and fish. Hypereutrophic lakes are those that have excessive nutrients. Lakes with nuisance algae growth reminiscent of “pea soup” are often labeled hypereutrophic, and usually have poor water clarity. Higher total phosphorus concentrations are linked to more algae in the water and hence, lower water clarity. The condition of Valley Lake in terms of its phosphorus concentrations during 2000 was hypereutrophic.

The ratio of total nitrogen[4] (TN) to total phosphorus (TP) in the lake indicates if the lake is in shorter supply of nitrogen or phosphorus. Lakes with TN:TP ratios of more than 15:1 are usually limited by phosphorus. Those with ratios less than 10:1 are usually limited by nitrogen. The TN:TP ratio of Valley Lake during 2000 was 11:1. Phosphorus and nitrogen are both in ample supply to support nuisance algae conditions. Most lakes in Lake County are phosphorus limited. The nitrogen concentrations in Valley Lake were equivalent or slightly lower than the Lake County median or averages. Other sources of nutrients to the lake are stormwater runoff from the surrounding neighborhoods, and the large number of waterfowl around the lake.

Dissolved oxygen (D.O.) was measured from the surface down to the bottom at one-foot increments. The D.O. concentrations measured in Valley Lake were sufficient to support a bluegill/bass fishery (at least 3.0 mg/L) from the surface down to the bottom for all months during the 2000 summer season, except in July. In July, the concentrations of D.O. were greater than 3.0 mg/L from the surface down to seven feet deep. Frequently,

[3] Medians and averages were calculated with LCHD water quality data collected from 72 lakes from 1995 – 2000.
[4] Total nitrogen consists of the organic forms of nitrogen plus nitrate nitrogen.

shallow lakes like Valley Lake have enough D.O. throughout the warm weather months from wind and wave action. An aeration system with three diffusers has been in place in Valley Lake since 1981 and is used during warm weather months. A ¾ horsepower compressor, rated to deliver approximately 9.5 cfm (cubic feet per minute), operates one diffuser, and a ½ horsepower compressor, rated to deliver approximately 6.5 cfm operates two diffusers. According to destratification calculations, the compressors for an aeration system to destratify and oxygenate Valley Lake should have a total of 0.86 – 1.23 horsepower to deliver 11 – 15.6 cfm. However, weak stratification occurred July with this combined 1.5 horsepower system. The diffuser closest to the 9.5-foot deep sampling point is set at 8 feet deep and is about 75-100 feet away. If the diffuser was set in the deep point, this stratification may not occur. Other reasons for the weak stratification include damaged or clogged diffusers, an incorrect cfm rating for the diffusers in relation to the horsepower, damaged air tubing, or the compressors are not operating in their full capacity and need some maintenance. However, because this lake is shallow and does not have a history of fish kills, an aeration system may not be necessary during warm weather months. The Illinois Department of Natural Resources (IDNR) reported only one fish kill, in June of 1962, before the aeration system was installed in 1981. If small amounts of algae are treated with algicide, a properly sized system still may help supply the lake with oxygen as the algae decomposes. The system may not help if a large amount of algae rapidly decomposes. The aeration system is not run during the winter months due to safety concerns. However, if Valley Lake begins experiencing frequent winterkills a well-functioning aeration system may help prevent this from occurring. If this option were considered, signage posted around the lakeshore warning residents of thin ice would be important.

The Illinois Environmental Protection Agency has guidelines to classify Illinois lakes for their ability to support aquatic life or recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations and aquatic plant coverage. Valley Lake fully supports aquatic life according to these guidelines. However, the lack of aquatic plants is still detrimental to a healthy fishery. Valley Lake is slightly impaired for swimming uses because of the high phosphorus concentrations and low water clarity. This allows only partial support of recreational uses. This does not mean that Valley Lake has health risks due to bacteria, but rather is impaired from a perspective of swimmer safety, due to poor visibility. The Lake County Health Department (LCHD) did not collect samples for bacteria, which is only one of the parameters that can be used to determine how well a lake supports swimming uses.

# LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Each month from May through September in 2000, staff surveyed the lake for aquatic plants. Only one small piece of Chara, a macroalgae[5], and a very young sprig of a fine-leafed pondweed were found. The pondweed sprig was too small and too young to positively identify to the correct species. The unfortunate addition of grass carp in 1988 to control aquatic plants has removed virtually all plant life in Valley Lake. The recommended plant coverage for a healthy fishery in Valley Lake is 20% to 40% of the lake's surface area, or 2.5 – 5 acres. According to IDNR records, only about 2.5 acres of Valley Lake had plant coverage in 1987, consisting of elodea (90% of the plant coverage) and coontail (10% of the plant coverage). Although coontail can reach nuisance proportions in shallow lakes, the dominant plant in Valley Lake was elodea, a native, shallow-growing, beneficial plant. The stocking rates for grass carp to control elodea is 12 fish per acre[6], which would be 144 fish for Valley Lake if this plant were in nuisance proportions. The recommended number of fish to be stocked decreased from 15 fish per acre to 12 fish per acre in 1988, but this information was not known by Park District staff until just after the grass carp were stocked. Unfortunately, although the plant coverage was not in nuisance proportions, 225 grass carp were stocked into the lake. Their uncontrollable nature led to the complete removal of nearly all aquatic vegetation in Valley Lake. In the long run, complete removal of vegetation is not in the best interest for the ecological health of any lake. The loss of sediment stabilization by the plants led to increased turbidity and resuspension of nutrients. The resuspension of nutrients contributed to the overall nutrient load of the lake. This, in addition to the removal of aquatic vegetation, which competes with algae for resources such as sunlight and phosphorus, contributed to an increase in algal blooms in Valley Lake. Algae populations apparently increased since the yearly algicide treatments began in 1989. The amounts of copper sulfate used in the lake is now double that of the initial treatment in 1989.

Once in a lake, with an expected life span of 15-20 years, grass carp may keep a lake free of all vegetation for years after they have served their purpose. To remove grass carp, they either have to die naturally or be physically removed. The IDNR attempted to remove the grass carp from Valley Lake three years after they were stocked, but had little success. Only eight fish were captured over two visits to the lake. Grass carp have been known to leap out of the water to feed on overhanging tree branches. In 2000, staff noted a "browse line" on willow branches that were hanging over the water, indicating that grass carp still lived in the lake. These willow branches were cut off about three feet above the water.

This lake would benefit from the removal of the remaining grass carp and the addition of native aquatic plants. The benefits of native plants include better water clarity, habitat for the fishery, (which could lead to an improved fishery) and overall, a better ecological system. This could happen only after the removal of the grass carp. There is the possibility that some native plants could return to healthy densities afterward. Although

[5] This is a large alga with a plant-like appearance.
[6] Wiley et al. 1987.

staff only found one small piece of chara, this type of algae is beneficial, and is able to stabilize sediment, resulting in better water clarity.

Table 1 lists the various historical aquatic herbicide and algicide treatments for Valley Lake.

**Table 1. Historical Plant and Algae Control Treatments**

| Year | Target: Plant or Algae | Product and Amounts |
|---|---|---|
| 1961 | Algae | 90 pounds copper sulfate |
| 1962 | Chara (algae) | copper sulfate (amount unknown) |
| 1964 | Curlyleaf pondweed | 150 gal. Sodium arsenite |
| 1966 | Curlyleaf pondweed | 150 pounds Aquathol |
| 1966 | Algae | 100 pounds copper sulfate |
| 1969 | Curlyleaf and sago pondweeds | 30 gallons Potassium endothall |
| 1970 | Curlyleaf pondweed | 15 gallons Potassium endothall |
| 1989 | Algae | 60 pounds copper sulfate |
| 1990 | Algae | 50 pounds copper sulfate |
| 1991 | Algae | 60 pounds copper sulfate |
| 1992 | Algae | 50 pounds copper sulfate |
| 1993 | Algae | 50 pounds copper sulfate |
| 1994 | Algae | 50 pounds copper sulfate |
| 1995 | Algae | 100 pounds copper sulfate |
| 1996 | Algae | 100 pounds copper sulfate |
| 1997 | Algae | 50 pounds copper sulfate |
| 1998 | Algae | 100 pounds copper sulfate |
| 1999 | Algae | 100 pounds copper sulfate |
| 2000 | Algae | 100 pounds copper sulfate |

## LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

In May 2000, LCHD staff assessed the shoreline of Valley Lake. See Appendix A for a discussion of the methods used. All of the 3,770 feet of shoreline that rings Valley Lake is classified as being developed. Nearly 70% of the shoreline (2,623 feet) is mowed turfgrass to the water’s edge. Two other major shoreline types were riprap, (7%) or 263 feet of shoreline, and seawall, (5%) or 184 feet of the shoreline. The Park District beach was approximately 161 feet, or 4% of the shoreline. Sixty-one percent (2295 feet) of the lake’s shoreline is either slightly or moderately eroding (See Figure 2). The Park District owns 665 feet of slightly eroding shoreline. Only 291.8 feet (13%) of the eroding shoreline is classified as moderately eroding. None of the shoreline is severely eroding at this time but may become severe over time. Seventy-four percent (1,708 feet) of the eroding shoreline has mowed lawn to the water’s edge. These shorelines will continue to erode as a result of wind induced wave action if protective measures are not taken. This can add sediment to the water and result in a loss of shoreline property. Erosion control alternatives can be found in “Option V. Mitigate Shoreline Erosion” on page 26.

Figure 2. Erosion map

Only eight lots had purple loosestrife, an aggressive, non-native shoreline plant. Although it is not in nuisance proportions at this time, the removal of this plant is recommended. It is easier to remove small numbers of these plants rather than to eradicate larger populations. Methods for their removal can be found in Objective V, Remove Invasive Shoreline Plant Species.

## LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

LCHD staff observed wildlife species during sampling visits to Valley Lake. Methodology is discussed in Appendix A. A listing of the wildlife can be found in Table 2. Staff noted a large number of ducks, many of which were domesticated, on each visit. Residents were probably feeding these birds. Waterfowl feces are extremely high in phosphorus, which increases algal production. Although residential areas usually do not offer good wildlife habitat, the mature trees on the lots surrounding the lake offer some songbird habitat. Because of the lack of both submersed and emergent aquatic plants, habitat for the fishery and animals such as wading birds that depend on a healthy fishery is lacking. Options for improving or increasing habitat for wildlife can be found in Objective V, "Maintain or Enhance Areas for Wildlife."

The Illinois Department of Natural Resources[7] (IDNR) has frequently assisted the homeowners of Echo Lake with fisheries management. Table 3 lists historical fisheries information. IDNR performed two fisheries rehabilitation programs for Valley Lake, one in 1979-1980 and the other in 1987-1988, just before the addition of the grass carp. The last fish assessment done by the IDNR was in 1997. The IDNR report states that the bluegill/bass populations during 1997 in Valley Lake in were experiencing poor reproduction, which was associated with the elimination of plants by the grass carp. The prediction from IDNR is that bluegill and bass would continue to experience poor reproduction until plant growth is re-established.

[7] Formerly known as the Illinois Department of Conservation (IDOC).

**Table 2. Wildlife Species Present During May-September 2000 Assessment**

***Birds***

| | |
|---|---|
| Canada Goose | *Branta canadensis* |
| Mallard | *Anas platyrhnchos* |
| Great Blue Heron | *Ardea herodias* |
| Green Heron | *Butorides striatus* |
| Spotted sandpiper | *Actitius macularia* |
| Common Tern | *Sterna hirundo* |
| Great Egret | *Casmerodius albus* |
| Ring Billed Gull | *Larus delawarensis* |
| American Coot | *Fulica americana* |
| Osprey | *Pandion haliaetus* |
| Common Flicker | *Colaptes auratus* |
| Downy Woodpecker | *Picoides pubescens* |
| American Crow | *Corvus brachyrhynchos* |
| Common Grackle | *Quiscalus quiscula* |
| Blue Jay | *Cyanocitta cristata* |
| Black-capped Chickadee | *Poecile atricapillus* |
| American Robin | *Turdus migratorius* |
| Mourning Dove | *Zenaida macroura* |
| Cedar Waxwing | *Bombycilla cedrorum* |
| Red-winged Blackbird | *Agelaius phoeniceus* |
| Starling | *Sturnus vulgaris* |
| Northern Oriole | *Icterus galbula* |
| Northern Cardinal | *Cardinalis cardinalis* |
| American Goldfinch | *Carduelis tristis* |
| Chipping Sparrow | *Spizella passerina* |
| House Sparrow | *Passer domesticus* |
| Warbling Vireo | *Vireo gilvus* |
| Red-eyed Vireo | *Vireo olivaceus* |
| Swainson's Thrush | *Catharus ustulatus* |

**Table 3. Historical Fisheries Information**

| Date | Activity |
|---|---|
| June, 1962 | Fish kill |
| June, 1965 | IDNR fish survey |
| June, 1974 | IDNR fish survey |
| 1979-1980 | IDNR fish rehabilitation |
| June, 1980 | IDNR fish survey, and stocking of 1,500 largemouth bass |
| September, 1990 | IDNR stocked 15,000 bluegill |
| July,1986 | IDNR Fish survey |
| October, 1987 | IDNR fish rehabilitation and stocking of 7,500 bluegill and 1,500 channel catfish |
| April, 1988 | Stocked 225 grass carp from private hatchery – not IDNR hatchery |
| July, 1988 | IDNR stocked 1,500 largemouth bass |
| May, October, 1988 | IDNR fish survey |
| August, 1989 | IDNR stocked 375 channel catfish |
| June, 1990 | IDNR Fish survey |
| September, 1990 | IDNR stocked 750 channel catfish |
| September, 1991 | IDNR stocked 750 channel catfish |
| July, 1991 | IDNR attempted grass carp removal |
| October, 1991 | IDNR attempted grass carp removal |
| June, 1992 | IDNR Fish survey |
| July, 1992 | IDNR stocked 750 channel catfish |
| July, 1993 | IDNR stocked 375 channel catfish |
| August, 1995 | IDNR stocked 375 channel catfish |
| August, 1996 | IDNR stocked 375 channel catfish |
| May, 1997 | IDNR Fish survey |

The latest recommendations from the IDNR are:

1. Stock 375 non-vulnerable catfish annually.
2. Conduct a standardized fish population assessment.
3. List fishing regulations in park district newsletters and signage around the lake in an effort to increase awareness and compliance.

## EXISTING LAKE QUALITY PROBLEMS

- *Nutrient concentrations are elevated, resulting in excessive algae growth.*

  Valley Lake is a nutrient rich lake system in which algae dominates. The lake has concentrations of both nitrogen and phosphorus that were higher than Lake County averages and medians.

- *Valley Lake has virtually no plant life as a result of the addition of grass carp.*

  With the elimination of aquatic plant life, algae populations increased, total phosphorus concentrations increased, the water clarity decreased, and the health of the lake's fishery as a whole decreased.

- *Valley Lake has low water clarity due to algae and sediment in the water column.*

  Because of excess phosphorus and lack of competition from plant growth, algae dominates the lake. Because the lake is shallow, sediment is easily mixed into the water column from wind, wave and carp action.

## POTENTIAL OBJECTIVES FOR VALLEY LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map
II. Remove Grass Carp from the Lake
III. Reestablish Native Aquatic Vegetation
IV. Nuisance Algae Management Options
V. Mitigate Shoreline Erosion
VI. Remove Invasive Shoreline Plant Species
VII. Water Quality Protection with Watershed Controls
VIII. Maintain or Enhance Areas for Wildlife
IX. Alleviate Excessive Numbers of Waterfowl

# ALTERNATIVES FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES FOR VALLEY LAKE[8]

**Objective I: Create a bathymetric map.**

A bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management practices such as aquatic herbicide use, fish stocking, dredging, an alum treatment or aeration were part of the overall lake management plan. Valley Lake does not have a recent accurate bathymetric map. Maps can be created by the Lake County Health Department – Lakes Management Unit or private companies for costs that vary from $3,000-$10,000, depending on lake size.

**Objective II: Remove Grass Carp from the Lake**

The Grass Carp in Valley Lake is a source of several of the lake's problems, all stemming from the elimination of aquatic plant growth by these fish. In order to improve water clarity and the fishery, aquatic plant growth should be encouraged, but only after the grass carp have been removed or they have died. They may be nearing the end of their life span, but their presence is still evident from the "browse line" that was seen on overhanging willow branches. Grass carp should not be stocked in this lake in the future.

Option 1: No Action

*Pros*

The positive aspect to following a no action management plan for grass carp removal would be the money saved by taking no action. These fish could be nearing the end of their life span. This, and the fact that there are few plants for them to eat, may shorten their projected life span of 15 – 20 years. The Park District could wait until the projected life span has passed before reintroducing aquatic plants into the lake.

*Cons*

Valley Lake would continue status quo. Improvement of the lake through the reintroduction of plants would need to wait until the grass carp are no longer living in the lake. If plants were introduced while grass carp still existed in the lake, they would need to be protected by mesh barriers.

[8] All costs within the objectives were quoted during 2000.

Option 2: Rotenone

Rotenone is a piscicide that is naturally derived from the stems and roots of several tropical plants. Rotenone is approved for use as a piscicide by the USEPA and has been used in the U.S. since the 1930's. It is biodegradable (breaks down into $CO_2$ and $H_20$) and there is no bioaccumulation. Because rotenone kills fish by chemically inhibiting the use of oxygen in biochemical pathways, adult fish are much more susceptible than fish eggs (carp eggs are 50 times more resistant). Other aquatic organisms are less sensitive to rotenone. However, some organisms are effected enough to reduce populations for several months. In the aquatic environment, fish come into contact with the rotenone by a different method than other organisms. With fish, the rotenone comes into direct contact with the exposed respiratory surfaces (gills), which is the route of entry. In other organisms this type of contact is minimal. More sensitive species include frogs and mollusks but these organisms typically recover to pretreatment levels within a few months. Rotenone has low mammalian and avian toxicity. For example, if a human consumed fish treated with normal concentrations of rotenone, approximately 8,816 lbs. of fish would need to be eaten at one sitting in order to produce toxic effects in humans. Furthermore, due to its unstable nature, it is unlikely that the rotenone would still be active at the time of consumption, and warm-blooded mammals have natural enzymes that would break down the toxin before it had any effects.

Rotenone is available in 5% and 2.5% concentrations. Both concentrations are available as synergized formulations. The synergist (piperonal butoxide) is an additive that inhibits fish detoxification of rotenone, making the rotenone more effective. Rotenone has varying levels of toxicity on different fish species. Some species of fish can detoxify rotenone quicker than it can build up in their systems. Unfortunately, concentrations to remove undesirable fish, such as carp, bullhead and green sunfish, are high enough to kill more desirable species such as bass, bluegill, crappie, walleye, and northern pike. Therefore, it is difficult to selectively remove undesirable fish while leaving desirable ones. Typically, rotenone is used at concentrations from 2 ppm (parts per million) – 12 ppm. For removal of undesirable fish (carp, bullhead and green sunfish) in lakes with alkalinities in the range found in Lake County, the target concentration should be 6 ppm. Sometimes concentration will need to be increased based on high alkalinity and/or high turbidity. Rotenone is most effectively used when waters are cooling down (fall) not warming up (spring) and is most effective when water temperatures are $<50^oF$. Under these conditions, rotenone is not as toxic as in warmer waters but it breaks down slower and provides a longer exposure time. If treatments are done in warmer weather they should be done before spawn or after hatch as fish eggs are highly tolerant to rotenone.

Rotenone rarely kills every fish (normally 99-100% effective). Some fish can escape removal and rotenone retreatment needs to occur about every 10 years. At this point in time, common carp[9] populations will have become reestablished due to reintroduction and reproduction by fish that were not removed during previous treatment. To ensure the best results, precautions can be taken to assure a higher longevity. These precautions include banning live bait fishing (minnows bought from bait stores can contain carp

[9] Grass carp purchased to control plants are sterile, and do not reproduce.

minnows) and making sure every part of the lake is treated (i.e., cattails, inlets, and harbored shallow areas). Restocking of desirable fish species may occur about 30-50 days after treatment when the rotenone concentrations have dropped to sub-lethal levels. Since it is best to treat in the fall, restocking may not be possible until the following spring. To use rotenone in a body of water over 6 acres, a *Permit to Remove Undesirable Fish* must be obtained from the Illinois Department of Natural Resources (IDNR), Natural Heritage Division, Endangered and Threatened Species Program. Furthermore, only an IDNR fisheries biologist licensed to apply aquatic pesticides can apply rotenone in the state of Illinois as it is a restricted use pesticide.

*Pros*

Rotenone is one of the only ways to effectively remove undesirable fish species. This allows for rehabilitation of the lake's fishery, which will allow for improvement of the aquatic plant community, and overall water quality. By removing common carp, sediment will be left largely undisturbed. The removal of the remaining grass carp will allow aquatic plants to grow and help further stabilize the sediment. As a result of decreased carp activity and increased aquatic plant coverage, fewer nutrients will be resuspended, greatly reducing the likelihood of nuisance algae blooms. Additionally, reestablishment of aquatic plants will have other positive effects on lake health and water quality, increases in fish habitat and food source availability for wildlife such as waterfowl.

*Cons*

There are no negative impacts associated with removing excessive numbers of common carp or grass carp from a lake. However, in the process of removing both carp species with rotenone, other desirable fish species will also be removed. The fishery can be replenished with restocking and quality sport fishing normally returns within 2-3 years. Other aquatic organisms, such as mollusks, frogs, and invertebrates (insects, zooplankton, etc.), are also negatively impacted. However, this disruption is temporary and studies show that recovery occurs within a few months. Furthermore, the IDNR will not approve application of rotenone to waters known to contain threatened and endangered fish species. Another drawback to rotenone is the cost. Since the whole lake is treated and costs per gallon range from $50.00 - $75.00, total costs can quickly add up. This can be offset with lake draw down to reduce treatment volume. Unfortunately, draw down is not an option on all lakes.

**Costs**

As with most intensive lake management techniques, a good bathymetric map is needed so that an accurate lake volume can be determined. To achieve a concentration of 6 ppm, which is the rate needed for most total rehabilitation projects (remove carp, bullhead and green sunfish), 2.022 gal/acre-foot is required. Rotenone costs between $50-$75 per gallon.

Without data from an accurate bathymetric map of Valley Lake, the lake volume and Rotenone amount can only be estimated:
Valley Lake volume[57 acre-feet (estimated)] ∗ (2.022 gallons of Rotenone / acre-foot) = 115 gallons may be needed to treat Valley Lake. The estimated total cost for Rotenone would range from $5,750-$8,625.

In waters with high turbidity and/or planktonic algae blooms, the dosage may have to be higher. An IDNR fisheries biologist will be able to determine if higher concentrations will be needed.

## Objective III. Re-establish Native Aquatic Vegetation

The reintroduction of beneficial, native aquatic plants would benefit Valley Lake. However, since the lake has poor clarity due to excessive algal growth, the algae must be controlled at the same time that a revegetation plan is in process. Without adequate light penetration, revegetation will not work. At minimum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from grass carp, waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 4 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are aquatic shoreline vegetation (rushes, cattails, etc) and deeper water plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

*Pros*

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance vegetation. This provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth is less expensive than other options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also increase due to the improvement in water quality and the suppression of weedy species.

*Cons*

There are few negative impacts to revegetating a lake. One possible drawback is the possibility of new vegetation expanding to nuisance levels and needing control. However, this is an unlikely outcome. Another drawback could be high costs if extensive revegetation is needed using imported plants. If a consultant were used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

**Costs**

Costs are listed in Table 4 on the following page. They include plants that grow in both near-shore and deepwater environments.

# Table 4. Costs for Native Aquatic Plants

| 1"-1.5' Deep | Seeding Rate | Seed Price | Planting Rate | Price/Plant |
|---|---|---|---|---|
| Arrow Arum (*Peltandra virginica*) | NA | $4-5/oz | 1000/acre | $0.40-1.00 |
| Bottle Brush Sedge (*Carex comosa*) | 0.12-0.19 lbs./acre | $6-8/oz | NA | NA |
| Chairmakers Rush (Scirpus americanus) | 0.06-0.25 lbs/acre | $8-15/oz | 1000/acre | $0.25-0.85 |
| Common Arrowhead (*Sagittaria latifolia*) | 0.06-0.125 lbs/acre | $15-16/oz | 1000/acre | $0.60-1.25 |
| Common Burreed (*Sparganium euycapum*) | 0.06-0.25 lbs/acre | $10-15/oz | 1000/acre | $0.22-0.50 |
| Common Cattail (*Typha latifolia*) | 0.06-0.5 lbs/acre | $3-15/oz | 1000/acre | $0.40-1.00 |
| Hardstem Bulrush (*Scirpus acutus*) | 0.06-0.25 lbs/acre | $8-15/oz | 1000/acre | $0.25-0.50 |
| Pensylvania Smartweed (*Polygonum pensylvanicum*) | 0.06-0.25 lbs/acre | $5/oz | NA | NA |
| River Bulrush (*Scirpus fluviatilis*) | 0.06-0.25 lbs/acre | $5/oz | NA | NA |
| Soft Rush (*Juncus effusus*) | 0.06-0.125 lbs/acre | $15-16/oz | $4-5 | $0.25-0.90 |
| Softstem Bulrush (*Scirpus validus*) | NA | $20/oz | 1000/acre | $0.25-0.90 |
| Water Plantain (*Alisma subcordatum*) | 0.06-0.25 lbs/acre | $10-15/oz | 1000/acre | $0.25-0.85 |
| Water Smartweed (*Polygonum fluitans*) | 0.06-0.5 lbs/acre | $3-25/oz | 1000/acre | $0.35-0.50 |
| White Water Buttercup (*Ranunculus longirostris*) | NA | NA | 500/acre | $0.40-0.50 |
| Yellow Water Buttercup (*Ranunculus flabellaris*) | NA | NA | 500/acre | $0.70-1.51 |
| **1.5'-3' Deep** | **Seeding Rate** | **Seed Price** | **Planting Rate** | **Price/Plant** |
| Watersheild (*Brasenia schreberi*) | NA | NA | 1000/acre | $0.65-1.49 |
| White Water Lily (*Nymphaea tuberosa*) | NA | NA | 200/acre | $0.30-0.40 |
| Yellow Water Lily (*Nuphar advena*) | NA | NA | 200/acre | $3.75 |
| **3'-8' Deep** | **Seeding Rate** | **Seed Price** | **Planting Rate** | **Price/Plant** |
| Elodea (*Elodea canadensis*) | NA | NA | 1000/acre | $0.25-0.51 |
| Large-leaved Pondweed (*Potamogeton amplifolius*) | NA | NA | 1000/acre | $0.25-0.51 |
| Richardson's Pondweed (*Potamogeton richardsonii*) | NA | NA | 250lbs/acre | $2/lb |
| Sago Pondweed (*Potamogeton pectinatus*) | NA | NA | 1000/acre | $0.35-0.50 |
| Vallisineria, Eel Grass (*Vallisineria americana*) | NA | NA | 1000/acre | $0.40-0.75 |
| Water Stargrass (*Zosterella dubia*) | NA | $4.00/lb | 1000/acre | $0.25-0.50 |

**Objective IV: Nuisance Algae Management Options**

The Park District has hired a contractor to treat Valley Lake for nuisance algae blooms since1989. One hundred pounds of copper sulfate were applied during 2000. Control of the algae may be needed to encourage plant growth in the lake.

The growth of nuisance or excessive algae can cause a number of problems. Excessive algal growth can cause decreases in water clarity and light penetration. This can lead to several major problems such as loss of aquatic plants, decline in fishery health, and interference with recreational activities. Health hazards, such as swimmer's itch and other skin irritations have been linked to excessive algal growth. Normally, excessive algae growth is a sign of larger problems such excessive nutrients and/or lack of aquatic plants. Some treatment methods, such as copper sulfate, are only quick remedies to the problem. Solving the problem of excessive algal growth involves treating the factors that cause the excessive growth not the algae it self. Long term solutions to excessive algae typically include an integrated approach such as alum treatments, revegetation with aquatic plants, and limiting external sources of nutrients. Interestingly enough, these long-term management strategies are seldom used, typically because of their high initial costs. Instead, the cheap, quick fix of using copper sulfate, though temporary, is much more widely used. However, the costs of continually applying copper sulfate over years, even decades, can eventually far exceed the costs of a slower acting, eventually more effective, integrated approach.

As with aquatic plant management techniques, algae management practices have both positive and negative characteristics. If used properly, they can be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - negative impacts to the lake. Putting together a good management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. The plan should be based on the management goals of the lake and involve usage issues (beaches, boat ramps, etc.), habitat maintenance/restoration issues, and nutrient levels. For an algal management plan to achieve long term success, follow up is critical. The management of the lake's algae problem does not end once the blooms and/or mats have been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and treat as necessary. An association or property owner should not always expect immediate results. A quick fix of the algal problem may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly address the problem. The management options covered below are commonly used techniques and those that are coming into wider acceptance, and have been used in Lake County. There are other algae management options that are not covered below as they are not very effective, or are too experimental to be widely used.

<u>Option 1: No Action</u>

With a no action management plan nothing would be done to control the nuisance algae regardless of type and extent. Nuisance algae, planktonic and/or filamentous, could continue to grow until epidemic proportions are reached.

Growth limitations of the algae and the characteristics of the lake itself (light penetration, nutrient levels.) will dictate the extent of infestation. Unlike aquatic plants, algae are not normally bound by physical factors such as substrate type. The areas in which filamentous and thick surface planktonic blooms (scum) occur can be affected by wind and wave action if strong enough. However, under normal conditions, with no action, both filamentous and planktonic algal blooms can spread to cover 100% of the surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

*Pros*

There are positive aspects associated with the no action option for nuisance algae management. The first, and most obvious, is that there is no cost. However, if an active management plan for algae control were eventually needed, the cost would be substantially higher than if the no action plan had been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, chemicals or introduction of any organisms would take place. Use of the lake would continue as normal unless blooms worsened. In this case, activities such as swimming might have to be suspended due to an increase in health risks. Other problems such as strong odors (blue-green algae) might also increase in frequency.

*Cons*

Under the no action option, if nuisance algae becomes wide spread and able to reach epidemic proportions, there will be many negative impacts on the lake. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced predation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Fish kills can result from toxins released by some species such as some blue-green algae. Blue-green algae can also produced toxins that are harmful to other algae. This allows blue-green algae to quickly dominate a body of water. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive algae growth, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by dense growths of algae. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the turbid green waters. Additionally, some species, such as blue-green algae, are poor sources of food for zooplankton and fish.

Water quality could also be negatively impacted with the implementation of a no action option. Decomposition of organic matter and release of nutrients upon algal death is a probable outcome. Large nutrient release with algae die back could lead to lake-wide increases of internal nutrient load. This could in turn, could increase the frequency or severity of other blooms. In addition, decomposition of massive amounts of algae, filamentous and planktonic, will lead to a depletion of dissolved oxygen in the lake. This can cause fish stress, and eventually, if stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

In addition to ecological impacts, many physical lake uses will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of filamentous algae. Swimming could also become increasingly difficult and unsafe due to thick mats and reduction in visibility by planktonic blooms. Fishing could become more and more exasperating due in part to the thick mats and stunted fish populations. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by large green mats and/or blooms of algae and the odors that may develop, such as with large blue-green blooms. The combination of above events could cause property values on the lake to suffer. Property values on lakes with algae problems have been shown to decrease by as much as 15-20%.

**Costs**

No cost will be incurred by implementing the no action management option.

<u>Option 2: Algicides</u>

Algicides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algicides in use. These two compounds are sold by a variety of brand names by a number of different companies. They all work the same and act as contact killers. This means that the product has to come into contact with the algae to be effective. Algicides come in two forms, granular and liquid. Granular herbicides are spread by hand or machine over an effected area. They can also be placed in a porous bag (such as a burlap sack) and dragged though the water in order to dissolve and disperse the product. Granular algicides are mainly used on filamentous algae where they are spread over the mats. As the granules dissolve, they kill the algae. Liquid algicides, which are much more widely used, are mixed with a known amount of water to achieve a known concentration. The mixture is then sprayed onto/into the water. Liquid algicides are used on both filamentous and planktonic algae. Liquid algaecides are often mixed with herbicides and applied together to save on time and money. The effectiveness of some herbicides are enhanced when mixed with an algicide. When applying an algicide it is imperative that the label is completely read and followed. If too much of the lake is treated at any one time an oxygen crash may occur. This may cause fish kills due to decomposition of treated algae. Additionally, treatments should never be made when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections depending on the size of the lake. Larger lakes will need to be divided into more sections. Then treat the lake one section at a time allowing at least two weeks between treatments. Furthermore, application of algicides should never be done in extremely hot weather ($>90^{o}F$). This will help lessen the likelihood of an oxygen crash and resulting fish kills. When possible, treatments should be made as early in the season as possible. It is best to treat in spring or when the blooms/mats starts to appear there by killing the algae before they become a problem.

*Pros*

When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season long control with minimal applications. Another benefit of using algicides are their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This in turn would allow the native aquatic plants to return to the lake. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, are selective in the sense that they do not affect aquatic vascular plants and wildlife.

By implementing a good management plan, usage opportunities for the lake would increase. Activities such as boating and swimming would improve due to the removal of thick blooms and/or mats of algae. Health risks associated with excessive algae growth (toxins, reduced visibility, etc.) The quality of fishing may recover due to improved habitat and feeding opportunities. In addition to increased usage opportunities, overall aesthetics of the lake would improve, potentially increasing property values.

*Cons*

The most obvious drawback of using algicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error and overuse can make them unsafe and bring about undesired outcomes. By continually killing particular algal species, lake managers may unknowingly be creating a larger problem. In many instances, over use of copper is leading to selection of species tolerant to copper. As the algae are continuously exposed to copper, some species are becoming more and more tolerant. This results in the use of higher concentrations in order to achieve adequate control, which can be unhealthy for the lake. In other instances, by eliminating one type of algae, lake managers are finding that other species that are even more problematic are filling the empty gap. These species that fill the gap can often be more difficult to control due to an inherent resistance to copper products. Additionally, excessive use of copper products can lead to a build up of copper in lake sediments. This can cause problems for activities such as dredging. Due to a large amount of copper in the sediments, special permits and disposal methods would have to be utilized.

**Costs**

During the 2000 summer season, a total of 100 pounds of copper sulfate was applied in Valley Lake, which cost the Park District $1185, including labor.

In liquid form, copper sulfate is applied at a rate of 2.7 gallons per acre-foot with a cost of about $7.50 per gallon. To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. Because a recent accurate bathymetric map of Valley Lake is unavailable, the costs and amounts are only estimates. An estimate for Valley Lake is 57 acre-feet x 2.7 gallons, or 154 gallons, with a cost of $1155. A chelated copper product, such as Cutrine plus, is applied at a rate of 0.5 –1.5 gallons per acre-foot with a cost of about $35 per gallon. An estimate for Valley Lake ranges from 28.5 to 85.5 gallons, with a cost estimate of $1000- $3000.

Option 3: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom, which can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low average depth to surface area are good candidates. This encompasses many lakes within Lake County. Lakes that are thermally stratified experience longer inactivation than non-stratified lakes due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly done, there may be many detrimental side effects.

Without a recent, accurate bathymetric map of Valley Lake, calculations to determine the amount of alum necessary for phosphorus inactivation will be a rough estimate. An accurate calculation to determine the necessary alum amount is vital for the success. Unless a recent, accurate bathymetric map is available or will be created just prior to alum use, this option should not be attempted. Valley Lake may not be a perfect candidate for an alum treatment since the amount of phosphorus loading from the watershed is not known. If the watershed does deliver heavy amount of phosphorus yearly, the alum treatment would be short-lived. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long term control due to disruption of the flocculent layer. In addition, the flocculent layer can still be disturbed by carp action. During the summer season, carp were able to access depths of at least 7 feet with adequate dissolved oxygen, which would be near the bottom in much of this 9.5-foot deep lake.

*Pros*

Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. Alum treatments can last as long as 20 years. This makes alum more cost effective in the long-term compared to continual treatment with algaecides. Studies have shown reductions in phosphorus concentrations by 66% in spring and 68% in summer. Chlorophyll *a*, a measure of algal biomass, was reduced by 61%. Reduction in algal biomass caused an increase in dissolved oxygen and a 79% increase in secchi disk readings. Effects of alum treatments can be seen in as little as a few days. The increase in clarity can have many positive effects on the lake's ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations. Typically, there is a slight invertebrate decline immediately following treatment but populations recover fully by the following year.

*Cons*

There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger watersheds this could prove to be physically and financially impossible. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long term control due to disruption of the flocculent layer. If alum is not properly applied toxicity problems may occur. Typically aluminum toxicity occurs if pH is below 6 or above 9. Most of Lake County's lakes, including Valley Lake, are in this safe range. However, at these pHs, special precautions must be taken when applying alum. By adding the incorrect amounts of alum, pH of the lake could drastically change. Due to these dangers, it is highly recommended that a lake management professional plans and administers the alum treatment.

**Cost**

Aluminum sulfate is applied at a rate of 40-80lbs/acre-foot at 35-60 cents/lb. A very rough estimate for Valley Lake using the estimated volume of 57 acre-feet gives a cost range of $798-$2736.

## Objective V. Mitigate Shoreline Erosion

Sixty-one percent (2295 feet) of the shoreline around Valley Lake is either slightly or moderately eroding. The Park District owns 665 feet of slightly eroding shoreline. Only 8% of the shoreline is moderately eroding. Seventy-four percent (1,708 feet) of the eroding shoreline has mowed lawn to the water's edge. Although no section of the shoreline is severely eroding at this time, these shorelines will continue to erode as a result of wind induced wave action if protective measures are not taken. This can add sediment to the water and result in a loss of shoreline property. The average privately owned lot length along the shore is 60 feet. The Park District may want to share this information about shoreline erosion with the private lot owners, even if their particular lot is not eroding or is slightly eroding at this time.

Erosion is a potentially serious problem to lake shorelines and occurs as a result of wind, wave, or ice action or from overland rainwater runoff. While some erosion to shorelines is natural, human alteration of the environment can accelerate and aggravate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses.

Option 1: No Action

*Pros*

There are no short-term costs to this option. However, extended periods of erosion may result in substantially higher costs to repair the shoreline in the future.

Eroding banks on steep slopes can provide habitat for wildlife, particularly bird species (e.g. kingfishers and bank swallows) that need to burrow into exposed banks to nest. In addition, certain minerals and salts in the soils are exposed during the erosion process, which are utilized by various wildlife species.

*Cons*

Taking no action will most likely cause erosion to continue and subsequently may cause poor water quality due to high levels of sediment or nutrients entering a lake. This in turn may retard plant growth and provide additional nutrients for algal growth. A continual loss of shoreline is both aesthetically unpleasing and may potentially reduce property values. Since a shoreline is easier to protect than it is to rehabilitate, it is in the interest of the property owner to address the erosion issue immediately.

**Costs:**

In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

<u>Option 2: Install Rock Rip-Rap</u>

Rip-rap is the term for using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. Rip-rap can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the rip-rap, fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below). Although rip-rap is suitable for the moderately eroding shorelines in Valley Lake (which are on private property), a naturalized buffer strip has the added benefit of providing habitat for wildlife.

*Pros*

Rip-rap can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the rip-rap and subsequent shoreline. Areas with severe erosion problems may benefit from using rip-rap. In all cases, a filter fabric should be installed under the rocks to maximize its effectiveness.

Fish and wildlife habitat can be provided if large boulders are used. Crevices and spaces between the rocks can be used by a variety of animals and their prey. Small mammals, like shrews can inhabit these spaces and prey upon many invertebrate species, including many harmful garden and lawn pests. Also, small fish may utilize the structure created by large boulders for foraging and hiding from predators.

*Cons*

A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. This may be difficult for the private lot owners along Valley Lake, since heavy equipment may be difficult to get in between the homes to conduct the work. Permits are required if replacing existing or installing new rip-rap and must be acquired prior to work beginning. If any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain.

While rip-rap absorbs wave energy more effectively than seawalls, there is still some wave deflection that may cause resuspension of sediment and nutrients into the water column.

Small rock rip-rap is poor habitat for many fish and wildlife species, since it provides limited structure for fish and cover for wildlife. As noted earlier, some small fish and other animals will inhabit the rocks if boulders are used. Smaller rip-rap is more likely to wash way due to rising water levels or wave action. On the other hand, larger boulders are more expensive to haul in and install.

Rip-rap may be a concern in areas of high public usage since it is difficult and possibly dangerous to walk on due to the jagged and uneven rock edges. This may be a liability concern to property owners.

**Costs:**

Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. If the Park District chooses to mitigate the slightly eroding shorelines at Valley North and on the west side of Valley South using rip rap, the approximate cost range would be $20,000 – 30,000. The average 60 foot private lot would have an approximate cost range of $1,800-$2,700 to mitigate shoreline erosion. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,000-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed, but this may not be necessary for lots along Valley Lake. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

<u>Option 3: Create a Buffer Strip</u>

Another effective method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat, which, for Valley Lake, would also assist in achieving ObjectiveVIII, Maintain or Enhance Areas for Wildlife. Cost of creating a buffer strip is quite variable, depending on the current state of the vegetation and shoreline and whether vegetation is allowed to become established naturally or if the area needs to be graded and replanted. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Non-native plants or noxious weedy species may be present and should be controlled or eliminated.

Stabilizing the shoreline with vegetation is most effective on slopes no less than 2:1 to 3:1, horizontal to vertical, or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with severe erosion problems.

Buffer strips can be constructed in a variety of ways with various plant species. Generally, buffer strip vegetation consists of native terrestrial (land) species and emergent (at the land and water interface) species. Terrestrial vegetation such as native grasses and wildflowers can be used to create a buffer strip along lake shorelines. Table 5 gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., muskrats) by placing a wire cage over the plants for at least one year.

A technique that is sometimes implemented along shorelines is the use of willow posts, or live stakes, which are harvested cuttings from live willows (*Salix* spp.). They can be planted along the shoreline along with a cover crop or native seed mix. The willows will resprout and begin establishing a deep root structure that secures the soil. If the shoreline is highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or rip-rap.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip-rap. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in Table 5 should be considered for native plantings.

**Table 5. Native Plants for Use in Buffer Strips.**

| Terrestrial-Dry soil | Seeding Rate | Seed Price | Planting Rate | Price/Plant |
|---|---|---|---|---|
| Big Bluestem Grass (*Andropogon gerardii*) | 10-25b lbs/acre | $20/lb | NA | $4-5 |
| Bluejoint Grass (*Calamagrostis canadensis*) | 2 lbs/acre | $2-4/oz | NA | $4-5 |
| Little Bluestem Grass (*Andropogon scoparius*) | 10-25 lbs/acre | $20/lb | NA | $4-5 |
| Prairie Cord Grass (*Spartina pectinata*) | 0.25-1.0 lbs/acre | $2-3/oz | 250-500/acre | $2-4 |
| Switch Grass (*Panicum virgatum*) | 0.5-2.0 lbs./acre | $6-7/oz | NA | $1-5 |
| **Terrestrial-Wet Soil** | **Seeding Rate** | **Seed Price** | **Planting Rate** | **Price/Plant** |
| Blue Flag (*Iris versicolor*) | NA | $10/oz | 1000/acre | $0.60-1.50 |
| Blue Vervain (*Verbena hastata*) | NA | $6/oz | 500-1000/acre | $0.80-1.00 |
| Blunt Spike Rush (*Eleocharis obtusa*) | NA | $30/oz | 500-1000/acre | $0.50-1.00 |
| Boneset (*Eupatorium perfoliatum*) | 0.006-0.25 lbs./acre | $6-7/oz | 500-700/acre | $1.00 |
| Water Horsetail (*Equisetum fluviatile*) | NA | NA | 1000/acre | $0.50 |
| Joe-Pye-Weed ( *Eupatorium maculatum*) | NA | $8/oz | 500-700/acre | $0.50-1.00 |
| Sweet Flag (*Acorus calamus*) | NA | $10/oz | 250/acre | $0.50-1.00 |
| Wild Rice (*Zizania aquatica*) | NA | $5.00/lb | 1000/acre | $0.50-0.20 |
| **Trees and Shrubs** | **Seeding Rate** | **Seed Price** | **Planting Rate** | **Price/Plant** |
| Bur Oak (*Quercus macrocarpa*) | NA | NA | NA | $5-6 |
| Buttonbush (*Cephalanthus occidentalis*) | NA | NA | NA | $6-7 |
| Red Osier Dogwood (*Cornus stolonifera*) | NA | $9/oz | NA | $2-5 |
| White Oak (*Quercus alba*) | NA | $5-8/oz | NA | $6-7 |
| **Seed Mixes** | **Seeding Rate** | **Seed Price** | **Planting Rate** | **Price/Plant** |
| Forb and Grass Seed Mix | 500 square ft | $20-60 | NA | NA |
| Forb and Grass Seed Mix | 1000 square ft | $66-108 | NA | NA |

*Pros*

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e. no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Occasional high mowing (1-2 times per year) for specific plants or physically removing other weedy species may be needed.

The buffer strip will stabilize the soil with its deep root structure and help filter run-off from lawns and agricultural fields by trapping nutrients, pollutants, and sediment that would otherwise drain into the lake. This may have a positive impact on the lake's water quality since there will be less "food" for nuisance algae. Buffer strips can filter as much as 70-95% of sediment and 25-60% of nutrients and other pollutants from runoff.

Another benefit of a buffer strip is potential flood control protection. Buffer strips may slow the velocity of flood waters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. Many plants can survive after being under water for several days, even weeks, while turfgrass is intolerant of wet conditions and usually dies after several days under water. This contributes to increased maintenance costs, since the turfgrass has to be either replanted or replaced with sod. Emergent vegetation can provide additional help in preserving shorelines and improving water quality by absorbing wave energy that might otherwise batter the shoreline. Calmer wave action will result in less shoreline erosion and resuspension of bottom sediment, which may result in potential improvements in water quality.

Many fish and wildlife species prefer the native shoreline vegetation habitat. The new habitat can assist in achieving Objective VIII, "Maintain or Enhance Areas for Wildlife." This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be found thriving in vegetation along the shoreline as well. Two invertebrates of particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil (*Myriophyllum spicatum*). Weevils need proper over wintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

In addition to the benefits of increased fish and wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of various colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

*Cons*

There are few disadvantages to native shoreline vegetation. Certain species (i.e. cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

**Costs:**

If minimal amount of site preparation is needed, costs can be approximately $10 per linear foot, plus labor. The slightly eroding Park District property at Valley North and the west side of Valley South would cost approximately $6,650 for the buffer strip option. The cost of installing willow posts is approximately $15-20 per linear foot, which would cost between $9,975-$13,300 for these same locations. In the case of the private property owner with an average 60-foot lot, costs for the buffer strip would be about $600. The willow post method would have a cost range of $900-$1,200. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded, but since much of the shoreline along Valley Lake is slightly eroding and not severely eroding, grading may not be necessary. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

## Objective VI: Remove Invasive Shoreline Plant Species

Only eight lots around the Valley Lake had purple loosestrife, an aggressive, non-native shoreline plant. Although it is not in nuisance proportions at this time, the removal of this plant is recommended. It is easier to remove small numbers of these plants rather than to eradicate larger populations. Since the numbers were small, manually removing the plants by digging them out would be more cost effective than purchasing an herbicide and the equipment to apply it.

Purple loosestrife is responsible for the "sea of purple" seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants and is quick to become established on disturbed soils. Reed canary grass is an aggressive plant that if left unchecked will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

Presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself. However, problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. A monitoring program should be established, problem areas identified, and control measures taken when appropriate. This is particularly important in remote areas of lake shorelines where the spread of exotic species may go unnoticed for some time.

Option 1: No Action

No control will likely result in the expansion of the exotic species and the decline of native species. This option is not recommended if possible.

*Pros*

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. Table 5 in Objective V: "Mitigate Shoreline Erosion" lists several native plants that can be planted along shorelines.

*Cons*

Native plant and wildlife diversity will be lost as stands of exotic species expand. Exotic species are not under the same stresses (particularly diseases and predators) as native plants and thus can out-compete the natives for nutrients, space, and light. Few wildlife species use areas where exotic plants dominate. This happens because many wildlife species either have not adapted with the plants and do not view them as a food resource, the plants are not digestible to the animal, or their primary food supply (i.e., insects) are not attracted to the plants. The result is a monoculture of exotic plants with limited biodiversity.

Recreational activities, especially wildlife viewing, may be hampered by such monocultures. Access to lake shorelines may be impaired due to dense stands of non-native plants. Other recreational activities, such as swimming and boating, may not be effected.

**Costs:**

Costs with this option are zero initially, however, when control is eventually needed, costs will be substantially more than if action was taken immediately. Additionally, the eventual loss of ecological diversity is difficult to calculate financially.

Option 2: Control by Hand

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Valley Lake fits this profile since only eight lots had purple loosestrife along the shore. Purple loosestrife can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is excavated. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

*Pros*

Removal of exotics by hand eliminates the need for chemical treatments. Costs are low if stands of plants are not too large already. Once removed, control is simple with yearly maintenance. Control or elimination of exotics preserves the ecosystem's biodiversity. This will have positive impacts on plant and wildlife presence as well as some recreational activities.

*Cons*

The negative issues of this option are most apparent for large, established populations of purple loosestrife. Although large numbers of purple loosestrife are not present at this time around Valley Lake, if the numbers increase, it will be more difficult to control. In this case, this option may be labor intensive or prohibitive if the exotic plant is already well established, but costs may be high if large numbers of people are needed to remove plants. Soil disturbance may introduce additional problems such as providing a seedbed for other non-native plants that quickly establish disturbed sites, or cause soil-laden run-off to flow into nearby lakes or streams. In addition, a well-established stand of an exotic like purple loosestrife or reed canary grass may require several years of intense removal to control or eliminate.

**Costs:**

Cost for this option is primarily in tools, labor, and proper plant disposal.

Option 3: Herbicide Treatment

Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment works best on individual plants or small areas already infested with the plant. The purple loosestrife was located on 8 private lots in small numbers. Although herbicides can be used, it may be more economical to manually remove these plants than for each private homeowner to purchase the herbicide and equipment for its application. Since many of the herbicides that are used are not selective, meaning they kill all plants they contact; this may be unacceptable if native plants are found in the proposed treatment area.

Herbicides are commonly used to control nuisance shoreline vegetation such as buckthorn and purple loosestrife. Herbicides are applied to green foliage or cut stems. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. The herbicide solution is wiped on foliage, bark, or cut stems using a herbicide soaked device. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

*Pros*

Herbicides provide a fast and effective way to control or eliminate nuisance vegetation. Unlike other control methods, herbicides kill the root of the plant, which prevents regrowth. If applied properly, herbicides can be selective. This allows for removal of selected plants within a mix of desirable and undesirable plants.

*Cons*

Since most herbicides are non-selective, they are not suitable for broadcast application. Thus, chemical treatment of large stands of exotic species may not be practical. Native species are likely to be killed inadvertently and replaced by other non-native species. Off target injury/death may result from the improper use of herbicides. If herbicides are applied in windy conditions, chemicals may drift onto desirable vegetation. Care must also be taken when wicking herbicides as not to drip on to non-targeted vegetation such as native grasses and wildflowers. Another drawback to herbicide use relates to their ecological soundness and the public perception of them. Costs may also be prohibitive if plant stands are large. Depending on the device, cost of the application equipment can be high.

**Costs:**

Purple loosestrife is best controlled by herbicides containing the ingredient glyphosphate, such as Rodeo®, and Roundup™. For the purple loosestrife plants directly adjacent to the water's edge, only Rodeo® is licensed to be used in or near water. Other formulations cannot be applied to water plants. Rodeo® should be applied at a 5-8% spray solution, or a 25-30% wicking solution. The price is $65 per gallon. Hand-held and backpack sprayers cost from $25-$45 and $80-150, respectively. Wicking devices are $30-40.

## Objective VII: Maintain or Enhance Areas for Wildlife

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. Wildlife need the same four things all living creatures need: food, water, shelter, and a place to raise their young. Since each wildlife species has specific habitat requirements, which fulfill these four basic needs, providing a variety of habitats will increase the chance that wildlife species may use an area. Groups of wildlife are often associated with the types of habitats they use. For example, grassland habitats may attract wildlife such as northern harriers, bobolinks, meadowlarks, meadow voles, and leopard frogs. Marsh habitats may attract yellow-headed blackbirds and sora rails, while manicured residential lawns attract house sparrows and gray squirrels. Thus, in order to attract a variety of wildlife, a variety of habitats are needed. In most cases quality is more important than quantity (i.e., five 0.1-acre plots of different habitats may not attract as many wildlife species than one 0.5 acre of one habitat type).

It is important to understand that the natural world is constantly changing. Habitats change or naturally succeed to other types of habitats. For example, grasses may be succeeded by shrub or shade intolerant tree species (e.g., willows, locust, and cottonwood). The point at which one habitat changes to another is rarely clear, since these changes usually occur over long periods of time, except in the case of dramatic events such as fire or flood.

In all cases, the best wildlife habitats are ones consisting of native plants. Unfortunately, non-native plants dominate many of our lake shorelines. Many of them escaped from gardens and landscaped yards (i.e., purple loosestrife) while others were introduced at some point to solve a problem (i.e., reed canary grass for erosion control). Wildlife species prefer native plants for food, shelter, and raising their young. In fact, one study showed that plant and animal diversity was 500% higher along naturalized shorelines compared to shorelines with conventional lawns (University of Wisconsin – Extension, 1999).

Option 1: No Action

This option means that the current land use activities will continue. No additional techniques will be implemented. Allowing a field to go fallow or not mowing a manicured lawn would be considered an action.

*Pros*

Taking no action may maintain the current habitat conditions and wildlife species present, depending on environmental conditions and pending land use actions. If all things remain constant there will be little to no effect on lake water quality and other lake uses.

*Cons*

If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing development with manicured lawns and roads is built next to an undeveloped property, there will probably be a change in wildlife present.

Conditions in the lake (i.e., siltation or nutrient loading) may also change the composition of aquatic plant and invertebrate communities and thus influence biodiversity. Siltation and nutrient loading will likely decrease water clarity, increase turbidity, increase algal growth (due to nutrient availability), and decrease habitat for fish and wildlife.

**Costs:**

The financial cost of this option is zero. However, due to continual loss of habitats many wildlife species have suffered drastic declines in recent years. The loss of habitat effects the overall health and biodiversity of the lake's ecosystems.

Option 2: Increase Habitat Cover

This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see Appendix A for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

Occasionally high mowing (with the mower set at its highest setting) may have to be done for specific plants, particularly if the area is newly established, since competition from weedy and exotic species is highest in the first couple years. If mowing, do not mow the buffer strip until after July 15 of each year. This will allow nesting birds to complete their breeding cycle.

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets.

Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife.

*Pros*

Increased cover will lead to increased use by wildlife. Since cover is one of the most important elements required by most species, providing cover will increase the chances of wildlife using the shoreline. Once cover is established, wildlife usually have little problem finding food, since many of the same plants that provide cover also supply the food the wildlife eat, either directly (seeds, fruit, roots, or leaves) or indirectly (prey attracted to the plants).
Additional benefits of leaving a buffer include: stabilizing shorelines, reducing runoff which may lead to better water quality, and deterring nuisance Canada geese. Shorelines with erosion problems can benefit from a buffer zone because native plants have deeper root structures and hold the soil more effectively than conventional turfgrass. Buffers also absorb much of the wave energy that batters the shoreline. Water quality may be improved by the filtering of nutrients, sediment, and pollutants in run-off. This has a “domino effect” since less run-off flowing into a lake means less nutrient availability for nuisance algae, and less sediment means less turbidity, which leads to better water quality. All this is beneficial for fish and wildlife, such as sight-feeders like bass and herons, as well as people who use the lake for recreation. Finally, a buffer strip along the shoreline can serve as a deterrent to Canada geese from using a shoreline. Canada geese like flat, open areas with a wide field of vision. Ideal habitat for them are areas that have short grass up to the edge of the lake. If a buffer is allowed to grow tall, geese may choose to move elsewhere.

*Cons*

There are few disadvantages to this option. However, if vegetation is allowed to grow, lake access and visibility may be limited. If this occurs, a small path can be made to the shoreline. Composition and density of aquatic and shoreline vegetation are important. If vegetation consists of non-native species such as or Eurasian water milfoil or purple loosestrife, or in excess amounts, undesirable conditions may result. A shoreline with excess exotic plant growth may result in a poor fishery (exhibited by stunted fish) and poor recreation opportunities (i.e. boating, swimming, or wildlife viewing).

**Costs:**

The cost of this option would be minimal. The purchase of native plants can vary depending upon species and quantity. Based upon 100 feet of shoreline, a 25-foot buffer planted with a native forb and grass seed mix would cost between $165-270 (2500 sq. ft. would require 2.5, 1000 sq. ft. seed mix packages at $66-108 per package). This does not include labor that would be needed to prepare the site for planting and follow-up maintenance. This cost can be reduced or minimized if native plants are allowed to grow. However, additional time and labor may be needed to insure other exotic species, such as buckthorn, reed canary grass, and purple loosestrife, do not become established.

<u>Option 3: Increase Natural Food Supply</u>

This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in Table 4 should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily, sago pondweed, largeleaf pondweed, and wild celery to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

Providing a natural food source in and around a lake starts with good water quality. Water quality is important to all life forms in a lake. If there is good water quality, the fishery benefits and subsequently so does the wildlife (and people) who prey on the fish. Insect populations in the area, including beneficial predatory insects, such as dragonflies, thrive in lakes with good water quality.

Dead or dying plant material can be a source of food for wildlife. A dead standing or fallen tree will harbor good populations of insects for woodpeckers, while a pile of brush may provide insects for several species of songbirds such as warblers and flycatchers.

Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, "people food" such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks. Because Valley Lake already has a large number of waterfowl on the lake, people should avoid feeding them and allow them to find their own food sources. Encouraging these birds to congregate can lead to excessive numbers (See "Objective IX: Alleviate Excessive Numbers of Waterfowl."

*Pros*

Providing food for wildlife will increase the likelihood they will use the area. Providing wildlife with natural food sources has many benefits. Wildlife attracted to a lake can serve the lake and its residents well, since many wildlife species (i.e., many birds, bats, and other insects) are predators of nuisance insects such as mosquitoes, biting flies, and garden and yard pests (such as certain moths and beetles). Effective natural insect control eliminates the need for chemical treatments or use of electrical "bug zappers" that have limited effect on nuisance insects.

Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish. In fact, most migrating birds are dependent on food sources along their migration routes to replenish lost energy reserves. This may present an opportunity to view various species that would otherwise not be seen during the summer or winter.

*Cons*

Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks. Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake's nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exasperate a lake's excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

Finally, tall plants along the shoreline may limit lake access or visibility for property owners. If this occurs, a path leading to the lake could be created or shorter plants may be used in the viewing area.

**Costs:**

The costs of this option are minimal. The purchase of native plants and food and the time and labor required to plant and maintain would be the limit of the expense.

<u>Option 4: Increase Nest Availability</u>

Wildlife are attracted by habitats that serve as a place to raise their young. Habitats can vary from open grasslands to closed woodlands (similar to Options 2 and 3).

Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, species like tree swallows or chickadees will, in subsequent years, use a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common flicker). Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

In addition to allowing dead and dying trees to remain, erecting bird boxes will increase nesting sites for many bird species. Box sizes should vary to accommodate various species. Swallows, bluebirds, and other cavity nesting birds can be attracted to the area using small artificial nest boxes. Larger boxes will attract species such as wood ducks, flickers, and owls. A colony of purple martins can be attracted with a purple martin house, which has multiple cavity holes, placed in an open area near water.

Bat houses are also recommended for any area close to water. Bats are voracious predators of insects and are naturally attracted to bodies of water. They can be enticed into roosting in the area by the placement of bat boxes. Boxes should be constructed of rough non-treated lumber and placed >10 feet high in a sunny location.

*Pros*

Providing places were wildlife can rear their young has many benefits. Watching wildlife raise their young can be an excellent educational tool for both young and old.

The presence of certain wildlife species can help in controlling nuisance insects like mosquitoes, biting flies, and garden and yard pests. This eliminates the need for chemical treatments or electric “bug zappers” for pest control.

Various wildlife species populations have dramatically declined in recent years. Since, the overall health of ecosystems depend, in part, on the role of many of these species, providing sites for wildlife to raise their young will benefit not only the animals themselves, but the entire lake ecosystem.

*Cons*

Providing sites for wildlife to raise their young have few disadvantages. Safety precautions should be taken with leaving dead and dying trees due to the potential of falling limbs. Safety is also important when around wildlife with young, since many animals are protective of their young. Most actions by adult animals are simply threats and are rarely carried out as attacks.

Parental wildlife may chase off other animals of its own species or even other species. This may limit the number of animals in the area for the duration of the breeding season.

**Costs:**

The costs of leaving dead and dying trees are minimal. The costs of installing the bird and bat boxes vary. Bird boxes can range in price from $10-100.00. Purple martin houses can cost $50-150. Bat boxes range in price from $15-50.00. These prices do not include mounting poles or installation.

## Objective VIII: Alleviate Excessive Numbers of Waterfowl

LCHD staff noted a large number of waterfowl on Valley Lake on each visit. Waterfowl in urban areas can be undesirable primarily due to the large amount of feces they leave behind. Recreational activities on lawns and parks are impeded due to Canada goose and duck feces. Large amounts of feces may end up in the water, either directly from waterfowl on the water or rainwater runoff from lawns where feces have accumulated. Goose feces are high in organic phosphorus. High nutrient levels, particularly phosphorus, can contribute to excessive algae growth. This will inhibit other recreational activities such as boating or swimming, as well as creating poor habitat for fish and wildlife, and possibly bad odors when the algae decays.

Waterfowl become problematic for many reasons. They seek locations that have open water, adequate food supplies, and safety from predators. If these factors are present, geese may not migrate. Since geese exhibit a high level of site fidelity, they return to (or stay at) the same area each year. Thus, adults will likely come back to the same area year after year to nest. If conditions remain optimal, one pair of geese can quickly multiply causing additional problems. Increased development in Lake County has inadvertently created ideal habitat for waterfowl populations. Manicured lawns mowed to the edge of lakes and detention ponds provide geese with open areas with ample food and security.

Other conditions that encourage goose residency include open water during winter (primarily the result of aerators in lakes and ponds), mild winters, and people feeding birds with bread or similar human food.

Large populations of geese pose a potential disease threat both to resident and wild populations of waterfowl. This problem may be more serious in residential populations since these birds stay in one area for long periods of time are more likely to transmit any disease to neighboring groups of geese.  There is no threat of disease transmission to humans or domestic dogs and cats since most of the diseases are specific to birds.

Option 1:  No Action

*Pros*

This option has no costs, however, increasing numbers of geese will most likely exasperate existing problems and probably create new ones, which in the future may cost more than if the problems are addressed immediately.

*Cons*

If current conditions continue and no action is taken, numbers of Canada Geese and problems associated with them will likely increase. An increase of goose feces washed into a lake will increase the lake's nutrient load and eventually may have a detrimental impact on water quality through excessive algae growth.  One study (Manny et al. 1975) documented that each goose excretes 0.072 lbs of feces per day.  This may not seem like a significant amount, but if 100 geese are present (many lakes in the county can experience 1,000 or more at a time) that equates to over 7 lbs of feces per day! Algae blooms may negatively impact recreational uses such as swimming, boating, and fishing.  In addition, when algae dies, odor problems and depleted oxygen levels in the water occur.  Increased numbers of geese may also result in overgrazed areas of grass.

**Costs:**

There are a few short-term financial costs with this option. Costs of cleaning feces off lawns or piers are probably more psychological or physical than financial. Long-term costs may be more indirect, including increased nutrient deposition into lakes which may promote excessive algae and plants. Costs incurred may include money needed to control algae with algaecides.

Option 2:  Dispersal/Repellent Techniques

Several techniques and products are on the market that claim to disperse or deter geese from using an area.  These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellant techniques may be less effective and geese more difficult to coerce into leaving.

The goal with harassment techniques is to frighten waterfowl from an area. Various products are available that simulate natural predators (i.e., plastic hawks and owls) or otherwise make geese nervous (i.e., balloons, shiny tape, and flags). Over time these techniques may be ineffective, since the birds become acclimated to these devices. Most of these products are more effective when used in combination with other techniques.

Chemical repellents can be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese. Several products (ReJeX-iT® and GooseChase™) are made from methyl-anthranilate, a natural occurring compound, and can be sprayed on areas where geese are feeding. The spray makes the grass distasteful and forces geese to move elsewhere to feed. Another product, Flight Control™, works similarly, but has the additional benefit of absorbing ultra violet light making the grass appear as if it was not a food source. The sprays need to be reapplied every 14-30 days, depending upon weather conditions or mowing frequency. This could be used at both parks, especially the beach area at Valley South. The shoreline along Valley North is slightly eroding, which might make it harder for waterfowl to exit the water at these locations. However, the beach is not eroding, making this area easily accessible to the waterfowl. The mowed turfgrass next to the beach is a favorite habitat.

*Pros*

With persistence, harassment and/or use of repellants can result in reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. If large numbers of geese were once present, the reduction of fecal deposits into the lake may help minimize the amount of phosphorus entering the water. Less phosphorus in the water means less “food” available for plant and algae growth, which may have a positive effect of water quality. Finally, any areas overgrazed by geese may have a chance to recover.

*Cons*

The effectiveness of harassment techniques is reduced over time since waterfowl will adapt to the devices. However, their effectiveness can be extended if the devices are moved to different locations periodically, or used in conjunction with other techniques.

Repelling or chasing away geese from an area only solves the goose problem for that area and most likely moves the geese (and the problem) to another area. As long as there is suitable habitat nearby, the geese will not wander very far.

**Costs:**

The cost of ReJeX-iT® is $70/gallon, GooseChase™ is $92/gallon, and Flight Control™ costs $200/gallon. One gallon covers one acre of turf using ReJeX-iT® and, GooseChase™, and two acres using Flight Control™.

Option 3: Exclusion

Erecting a barrier to exclude geese is another option, but obviously, not along beaches (private or Park District) at Valley Lake. Exclusion would be better along the shoreline at Valley North. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where waterfowl are unwanted. They are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline.

*Pros*

Depending on the type of barrier used, areas of exclusion will have less fecal mess and may have higher recreational uses. Vegetation that was overgrazed by waterfowl may also be able to recover.

*Cons*

This technique will not be very effective if the geese are using a large area. Also, use of the area by people is severely limited if netting is installed. Fences can also limit recreational uses. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Finally, excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owners problem, it creates one (or makes one worse) for another. Also, problems associated with excess feces entering the lake (i.e., increased phosphorus levels) will continue.

**Costs:**

The costs of these techniques are minimal, unless a wood or wire fence is constructed. String, wire, or netting can be purchased or made from materials at local stores.

Option 4: Habitat Alteration

One of the best methods to deter waterfowl from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for waterfowl. Low vegetation near the water allows waterfowl to feed and provides a wide view with which to see potential predators. In general, waterfowl do not favor habitats with tall vegetation. To achieve this, create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn. Planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally can create buffer strips. Table 5 has a list of native plants, seeding rates, and approximate costs that can be used when creating buffer strips.

While this option would restrict access at the Valley South beach, a buffer along Valley North would double as a waterfowl deterrent and add valuable wildlife habitat for other animals. Areas where the plants are a little shorter or a thin mowed path the water would still allow people to access the shoreline for fishing.

*Pros*

Altering the habitat in an area can not only make the habitat less desirable for waterfowl, but may be more desirable for many other species of wildlife (see Objective VIII: Maintain or Enhance Areas for Wildlife). A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action (see Objective V: Mitigate Shoreline Erosion). Finally, an established buffer strip, needs little maintenance, unlike turfgrass that needs to be constantly manicured and maintained.

*Cons*

Converting a portion or all of an area to tall grass or shrub habitat may reduce the lake access or visibility. However, if this occurs, a small path can be made to the lake or shorter plants may be used at the access location in the buffer strip.

**Costs:**

If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately $10 per linear foot, plus labor. The 415 feet of shoreline along Valley North would cost about $4,150 for this option. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Once established, a buffer strip of native plants needs little maintenance.

Option 5: Do Not Feed Waterfowl!

There are few "good things," if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the "foods" (i.e., white bread) given to geese and other waterfowl are quite low. Since waterfowl are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustomed to hand feeding may become aggressive toward other geese or even the people feeding the geese.

**Costs:**

There are no costs to this option, except the public education that is needed to encourage people not to feed waterfowl. In some cases, signs could be posted to discourage waterfowl feeding.

## Table 5. 2000 Valley Lake Water Quality Data

**Epilimnion**

| DATE | DEPTH | ALK | TKN | NH3-N | NO3-N | TP | SRP | TDS | TSS | TS | TVS | SECCHI | COND | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-May-00 | 3 | 168 | 1.22 | <0.1 | 0.09 | 0.062 | 0.007 | 670 | 5.7 | 714 | 151 | 3.81 | 1.273 | 8.42 |
| 29-Jun-00 | 3 | 166 | 1.38 | <0.1 | 0.063 | 0.148 | 0.033 | 718 | 17 | 727 | 185 | 2.72 | 1.185 | 8.38 |
| 27-Jul-00 | 3 | 151 | 1.78 | <0.1 | 0.068 | 0.209 | 0.027 | 648 | 17 | 704 | 194 | 2.49 | 1.136 | 8.35 |
| 31-Aug-00 | 3 | 159 | 1.2 | 0.221 | <0.05 | 0.165 | 0.085 | 634 | 13 | 691 | 168 | 3.22 | 1.157 | 8.38 |
| 28-Sep-00 | 3 | 160 | 1.84 | 0.442 | <0.05 | 0.151 | 0.053 | 612 | 8.2 | 657 | 131 | 3.71 | 1.126 | 7.88 |
| **Average** | | 160.8 | 1.48 | 0.332[k] | 0.074[k] | 0.15 | 0.04 | 656 | 12.2 | 699 | 166 | 3.19 | 1.18 | 8.28 |

**Hypolimnion**

| DATE | DEPTH | ALK | TKN | NH3-N | NO3-N | TP | SRP | TDS | TSS | TS | TVS | SECCHI | COND | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-May-00 | 7 | 169 | 1.25 | <0.1 | 0.081 | 0.062 | 0.007 | 672 | 5.7 | 733 | 158 | NA | 1.274 | 8.4 |
| 29-Jun-00 | 7 | 166 | 0 | <0.1 | 0.059 | 0.134 | 0.021 | 700 | 16 | 723 | 184 | NA | 1.187 | 8.22 |
| 27-Jul-00 | 7 | 151 | 1.23 | <0.1 | 0.064 | 0.198 | 0.03 | 656 | 19 | 708 | 185 | NA | 1.138 | 8.28 |
| 31-Aug-00 | 6 | 160 | 1.6 | 0.2 | <0.05 | 0.156 | 0.089 | 602 | 13 | 677 | 148 | NA | 1.16 | 8.33 |
| 28-Sep-00 | 7 | 159 | 1.79 | 0.445 | 0.079 | 0.126 | 0.058 | 610 | 8.6 | 642 | 107 | NA | 1.126 | 7.89 |
| **Average** | | 161 | 1.174 | 0.322[k] | 0.07[k] | 0.1352 | 0.041 | 648 | 12.5 | 697 | 156 | NA | 1.177 | 8.22 |

**Glossary**

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH3-N = Ammonia nitrogen, mg/L
NO3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi Disk Depth, Ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

NA = Not Applicable
Note: "k" denotes that the actual value is known to be less than the value presented.

# Appendix A. Methods for Field Data Collection and Laboratory Analyses

## Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were generally at the deepest point in the lake (see sample site map), three feet below the surface, and approximately two feet off the bottom. Samples were collected with a horizontal or vertical Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. TestAmerica Incorporated, an environmental services lab, analyzed samples collected for total Kjeldahl nitrogen (TKN). The Health Department lab analyzed all other samples. Analytical methods for the parameters are listed in Table 1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Total Kjeldahl nitrogen was analyzed by method 351.2 from the Methods for Chemical Analyses of Water and Wastes (EPA 600 Series). Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every foot until reaching the bottom in lakes ≤ 15 feet deep, and every two feet in lakes >15 feet.

## Plant Sampling

Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At random locations in the littoral zone, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, any plants on the rake were identified and recorded. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling, were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation. Approximate locations of each point were drawn on an aerial photo of the lake. Locations of the plant edge were also identified and marked on the aerial photo. The plant edge was defined as the area where aquatic plants presence dissipated, typically toward the deeper portions of the lake. The number of sample locations was contingent upon lake surface area, area of littoral zone, and presence and distribution of plants.

## Shoreline Assessment

To assess the current condition of each lake's shoreline, a shoreline assessment was completed in 2000. This survey was conducted with the use of a boat, aerial photos, and county parcel maps. The shoreline along the land/water interface on each parcel was observed from a boat and various parameters were assessed (Table 2). Shorelines were first identified as developed or undeveloped. The type of shoreline was then determined and length of each type was recorded based on the parcel map or was estimated. In addition, several other parameters were measured including: the extent of shoreline vegetation, the degree of slope and erosion, and the presence of inlets, recreational structures (including boats, canoes, jetskis, boat ramps, piers, boat lifts, swimming platforms, etc.), aerators, irrigation pumps, water control structures, invasive vegetation, beaver activity, and deadfall (trees or shrubs lying in the water).

Frequently a parcel consisted of several shoreline types. For example, a parcel may have a beach, a steel seawall, and rip-rap along the its shore. In this case, the parcel was subdivided into three separate sections.

Data was entered and analyzed in ArcView 3.2 © Geographic Information System (GIS) software. Total shoreline lengths and percentages for each category were determined using Excel software.

## Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal. Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

**Table A1. Analytical Methods Used for Water Quality Parameters.**

| ***Parameter*** | ***Method*** |
|---|---|
| Temperature | Hydrolab DataSonde® 4a |
| Dissolved oxygen | Hydrolab DataSonde ®4a |
| Nitrate nitrogen | Brucine method |
| Ammonia nitrogen | Electrode method, #4500F |
| Total Kjeldahl nitrogen | EPA 600 Series, Method 351.2 |
| pH | Hydrolab DataSonde® 4a, Electrometric method |
| Total solids | Method #2540B |
| Total suspended solids | Method #2540D |
| Total dissolved solids | Method #2540C |
| Total volatile solids | Method #2540E, from total solids |
| Alkalinity | Method #2320B, titration method |
| Conductivity | Hydrolab DataSonde® 4a |
| Total phosphorus | Methods #4500-P B 5 and #4500-P E |
| Soluble reactive phosphorus | Methods #4500- P E and #4500-P B1 |
| Clarity | Secchi disk |
| Color | Illinois EPA Volunteer Lake Monitoring Color Chart |
| Photosynthetic Active Radiation (PAR) | Hydrolab DataSonde® 4a, LI-COR® 192 Spherical Sensor |

**Table A2. Shoreline Type Categories and Assessment.**

| ***Category*** | ***Assessment*** |
|---|---|
| Developed | Yes, No |
| Inlets | None, Culvert, Creek, Farm Tiles, Storm Water Outlet, Swale, Sump |
| Shoreline Vegetation | None, Light, Moderate, Heavy |
| Type | Prairie, Shrub, Wetland, Woodland, Beach, Buffer, Canopy, Lawn, Rip-rap, Seawall, Vacant |
| Slope | Flat, Gentle, Steep |
| Erosion | None, Slight, Moderate, Severe |
| Water Control Structures | None, Culvert, Dam, Spillway |
| Recreational Structures | Yes, No |
| Irrigation Present | Yes, No |
| Aerator Present | Yes, No |
| Invasive Vegetation | Yes, No |
| Beaver Activity | Yes, No |
| Deadfall | Yes, No |

**Reference:**

Manny, B. A., R. G. Wetzel, and W. C. Johnson. 1975. Annual contribution of carbon, nitrogen, and phosphorus by migrant Canada geese to a hardwater lake. Verh. Internat. Verein. Limnol. 19:949-951.

Appendix B multiparameter data