# 2002 SUMMARY REPORT
# of
# SULLIVAN LAKE

## Lake County, Illinois

*Prepared by the*


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# EXECUTIVE SUMMARY

Sullivan Lake, located in the Village of Lakemoor in Grant Township, is a shallow, natural pothole slough, almost entirely owned by the Lakemoor Golf Course. The lake is dominated by residential shoreline along the west and partially along the north sides of the lake, with the golf course making up the rest of the shoreline. Sullivan Lake has a surface area of 59.3 acres and mean and maximum depths of 2.1 and 10.5 feet, respectively. Due to its shallow nature, the lake is only used by residents and golfers for fishing, aesthetics and water hazards. However, this lake and wetland area is rich in wildlife habitat and provides a resource for many species of songbirds and waterfowl.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature and water clarity were measured and the plant community was assessed each month from May-September 2002. Sullivan Lake was too shallow to thermally stratify and the lake remained oxygenated throughout the summer. However, low dissolved oxygen concentrations were recorded in July and August, when water temperature was high and plant coverage neared its peak. The average phosphorus level was well below the county median. In conjunction with low phosphorus concentration, total suspended solids levels were also very low all summer and Secchi depths (water clarity) reached the lake bottom from May-September. Neither phosphorus nor total suspended solids concentrations have changed significantly since our last study conducted on the lake in 1995. Total Kjeldhal nitrogen (TKN) concentrations were higher than the county median and most of the nitrogen was in the form of organic nitrogen. As inorganic nitrogen entered the lake from any number of sources, it was immediately taken up and utilized by biological organisms in the water column. It, therefore, would have been detected as organic nitrogen inside the algae cells and not as nitrate in the water column.

Sullivan Lake had 100% plant coverage and a diverse and healthy plant community, with 21 different plant species observed, including American lotus, a rare species in Lake County. Only one exotic species (curly leaf pondweed) was present. This very healthy plant community maintained Sullivan Lake's low phosphorus concentrations and kept water clarity high by reducing sediment resuspension and competing with planktonic algae for resources.

Only 18% of the shoreline along Sullivan Lake was exhibiting erosion and the majority of the shoreline consisted of buffer or wetland, which provided good wildlife habitat. Wetland and buffer should be maintained as much as possible, and the replacement of manicured lawns with buffer should be encouraged. Buckthorn, purple loosestrife and reed canary grass were present along 78% of the shoreline of Sullivan Lake. Although not present in high densities, these exotic plants pose a significant threat to the shoreline habitat around Sullivan Lake, and their removal should be addressed as soon as possible.

Although Sullivan Lake cannot provide intensive recreational opportunities for its lakeshore residents, it is a quality lake/marsh area that provides habitat for a diverse collection of plants and animals.

## LAKE IDENTIFICATION AND LOCATION

Sullivan Lake is located in the Village of Lakemoor in Grant Township, just west of U.S. Hwy 12. (T 45N, R 9E, S 28, 33). It is a very shallow, natural pothole slough, with a surface area of 59.3 acres. A maximum depth of 10.5 feet was found in a dredged bay in the northern-most part of the lake, near a new subdivision. Typically, the mean depth in a lake which does not have a bathymetric map is calculated by taking half of the maximum depth. However, the northern bay is not representative of the rest of the lake, which is extremely shallow. In April, a maximum depth of 4.2 feet was found in the main body of the lake and a depth of 2.1 feet will be used as the estimated mean depth. Volume (as calculated by multiplying mean depth by surface area) is 124.5 acre-feet, and shoreline length is 2.63 miles. Sullivan Lake receives water from Volo Bog to the north and non-point runoff from Lakemoor Golf Course and a mobile home park located on the north and west sides of the lake. Water exits the lake through a stormwater pipe on the west shore and eventually drains to the Fox River. The lake is located in the Lower Chain O' Lakes sub basin, within the Fox River watershed.

## BRIEF HISTORY OF SULLIVAN LAKE

Sullivan Lake is a natural pothole slough of glacial origin, created during the last ice age. During the 1920's, the McHenry County Fish and Hunt Club was established on the lake and remained there until 1968, when the lake and surrounding property were bought by the current owner of the Lakemoor Golf Course. It is thought that mobile homes were placed on the property in the early 1960's as several homes were present on the Ports of Sullivan property at the time of purchase by Lakemoor Golf Course. The golf course owner then sold the remaining land around those homes for additional development of the mobile home park. For approximately 10 years, no development was carried out on the golf course property. In 1978, construction of the golf course began and continued for 12 years, opening in 1990. The Lakemoor Golf Course is currently responsible for management of Sullivan Lake.

## SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Access to Sullivan Lake, is open only to lakeshore residents on the north and west sides of the lake through their own properties. Lakemoor Golf Course, which surrounds the lake on three sides, owns nearly all of the lake, but does not use the lake for recreational purposes. The golf course does use the lake for aesthetics and water hazards and is in control of any lake management conducted on the lake. In the 1950's, the lake may have been somewhat deeper and was used for fishing. An Illinois Department of Natural Resources survey found that chubsuckers and bluegill were the most abundant fish species in the lake, along with northern pike and golden shiner. Largemouth bass were present in moderate abundance. No lake management is conducted by the Lakemoor Golf Course and they do not intend to manage the lake in any way in the future. Although they acknowledge the area of dense white water lily growth on the west side of the lake, they do not intend on treating the plant community with herbicides of any kind, and prefer to leave the lake in its natural state.

## LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Sullivan Lake were analyzed for a variety of water quality parameters (See Appendix B for methodology). Samples were collected at the surface from the deepest location in the main lake (Figure 1). Sullivan Lake was not thermally stratified from May-September. Thermal stratification occurs when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically becomes anoxic (dissolved oxygen = 0 mg/l) by mid-summer. Sullivan Lake was simply too shallow to stratify. Although the overall water temperature changed dramatically throughout the summer, it was relatively consistent from surface to sediment each month.

The surface waters of Sullivan Lake were well oxygenated in May and June, when water temperature was still low to moderate and plant growth had not reached its peak. However, in July, the water column reached a temperature of 28.5$^{o}$F. As water temperature increases, dissolved oxygen concentrations typically decrease. Additionally, Sullivan Lake was full of aquatic plants during this time of the summer, and, although plants produce oxygen during the day, they use oxygen at night. The combination of low water volume, high water temperature and high biological oxygen demand from plants and other aquatic organisms resulted in a drop in the dissolved oxygen (DO) concentration to 3.61 mg/l in July. DO stayed low (4.75 mg/l) into August, before increasing to 5.70 mg/l in September. DO concentrations at or below 5.0 mg/l cause aquatic organisms to become stressed and can cause fish kills to occur. Unfortunately, the characteristics of Sullivan Lake (shallow, plant dominated) make it predisposed to decreasing DO concentrations as the summer progresses, and the lake will, likely, never have a thriving sport fish community.

Phosphorus is a nutrient that can enter lakes through runoff or be released from lake sediment, and high levels of phosphorus typically trigger algal blooms or produce high plant density. The average surface total phosphorus (TP) concentration in Sullivan Lake was 0.032 mg/l, (Table 1, Appendix A). This was well below the Lake County median epilimnetic phosphorus concentration of 0.056 mg/l. This means that Sullivan Lake phosphorus concentrations were lower than the majority of the lakes studied in Lake County since 1998. Water samples were collected from Sullivan Lake in May and June, 1995. The average phosphorus concentration from these samples (0.026 mg/l) was just slightly lower than the average TP concentration of May and June 2002 (0.029 mg/l) (Table 2, Appendix A). This is very positive and is indicative of two things. Either the sources of phosphorus to the lake have not increased significantly over the past seven years, or the healthy plant community in Sullivan Lake is successfully utilizing additional phosphorus entering the lake, making it unavailable to the water column and the algae that could grow there.

Total suspended solids (TSS) is a measure of the amount of suspended material, such as algae or sediment, in the water column. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities. A large amount of material in the water column can inhibit successful predation by sight-feeding fish, such as bass and pike, or settle out and smother fish eggs. High turbidity caused by sediment or algae can shade out native aquatic plants, resulting in their reduction or disappearance from the littoral zone. This eliminates the benefits provided by plants, such as habitat for many fish species and stabilization of the lake bottom. The average epilimnetic TSS concentration in Sullivan Lake (5.2 mg/l) was just below the Lake County median concentration of 6.0 mg/l and was well below the county average of 11.9 mg/l. The low TSS values resulted in high water clarity, as evidenced by Secchi depth measurements that reached the lake bottom every month during the study (Table 1, Appendix A). A strong relationship existed between TP and TSS concentrations (Figure 2). Since total volatile solids (TVS, a measure of organic matter, such as algae, in the water column) concentrations were also positively correlated with TSS concentrations, the relationship between TSS and TP and TVS indicates that algae and other organic matter may have made up much of the TSS in the water column.

The average May/June 2002 TSS concentration (3.1 mg/l) has remained virtually unchanged when compared to the 1995 average TSS concentration (3.7 mg/l). As with TP, this may indicate that either the sources of sediment to the lake or the causes of sediment resuspension, or algae growth have not increase since 1995. Or, it may indicate that the healthy aquatic plant community is keeping algae density low and preventing sediment resuspension in the water column.

As a result of the low TP and TSS concentrations throughout the summer, Secchi depth (water clarity) in Sullivan Lake reached the lake bottom every month during the summer of 2002. While the bottom may have only been at a depth of two feet during some months, it is significant that water clarity was good in such a shallow lake. The aquatic plants keep water clarity high by competing with algae and preventing sediment resuspension. This good water clarity, in turn, allowed the diverse plant community to thrive in Sullivan Lake. Secchi depth measurements were also recorded on the lake bottom in 1995. Differences in water clarity from year to year can result from a number of things including rainfall amounts, external phosphorus loading, percent plant coverage, or water temperature (which affects algae growth). The absence of significant change in the water clarity of Sullivan Lake is a very positive indicator that changes in the watershed over the years have not had negative impacts on the overall water quality of the lake.

Total Kjeldahl nitrogen (TKN) concentration is a measure of organic nitrogen plus ammonium ($NH_4^+$) (an inorganic form of nitrogen). Adding the concentrations of TKN and nitrate nitrogen ($NO_3^-$) (another inorganic form of nitrogen) gives an indication of the amount of total nitrogen present in the water column. Average TKN in Sullivan Lake (1.65 mg/l) was higher than the County median (TKN = 1.17 mg/l). However, ammonia-nitrogen and nitrate-nitrogen concentrations were below detection levels nearly all

summer (Table 1, Appendix A). This indicates that the majority of the nitrogen detected in the water column in 2002 was organic and in the form of algae. Although algae blooms were not apparent in Sullivan Lake, algae was still present in the water column at a low density, as evidenced by the correlation between TSS and TVS mentioned above. As inorganic nitrogen entered the lake from any number of sources (fertilizer from the golf course, the atmosphere, animal waste from the mobile home park), it was immediately taken up and utilized by plants or algae. It, therefore, would not have been detected as $NO_3^-$, but as organic nitrogen inside the plant and algae cells. These high TKN concentrations do not appear to be a problem at this time, as algae density has been kept in check by the plant community and by the low TP concentrations. However, care should be taken in limiting fertilizer use and excess animal waste (including geese waste) as much as possible on the golf course or in the residential area along the lake to prevent possible algae problems in the future. The importance of this is especially apparent, given that the May/June 2002 average TKN concentration (1.39 mg/l) is much higher than the 1995 average (0.98 mg/l). Although the number of samples being compared is small, this may be an indication of increasing nitrogen concentrations in Sullivan Lake.

Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means that one of these nutrients is in short supply relative to the other and that any addition of phosphorus or nitrogen to the lake might result in an increase of plant or algal growth. Other resources necessary for plant and algae growth include light or carbon, but these are typically not limiting. Most lakes in Lake County are phosphorus limited, but to compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate that phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate that there are enough of both nutrients to facilitate excess algal or plant growth. Sullivan Lake had an average TN:TP ratio of 51:1. This indicates that the lake is highly phosphorus limited and that a small increase in the phosphorus concentration could result in increases in the frequency of algae blooms in the future. High nitrogen concentrations relative to phosphorus concentrations resulted in this high ratio. Unfortunately, as mentioned above, nitrogen can come from many sources, including septic systems, watershed runoff, soils and the atmosphere, and is very difficult to control. It appears that the lake has maintained good water quality, despite the relatively high nitrogen concentrations. However, good water quality may not last if TP levels increase further, and care should be taken to maintain current TP concentrations as much as possible.

Phosphorus levels can also be used to indicate the trophic state (productivity level) of a lake. The Trophic State Index (TSI) uses phosphorus concentrations, chlorophyll *a* (algae biomass) and Secchi depth to classify and compare lake trophic states using just one value. The TSI is set up so that an increase in phosphorus concentration is related to an increase in algal biomass and a corresponding decrease in Secchi depth. A moderate TSI value (TSI=40-49) indicates mesotrophic conditions, typically characterized by relatively low nutrient concentrations, low algae biomass, adequate DO concentrations and relatively good water clarity. High TSI values indicate eutrophic (TSI=50-69) to hypereutrophic (TSI $\geq$70) lake conditions, typically characterized by high nutrient concentrations, high algal biomass, low DO levels, a rough fish population, and low water clarity. Sullivan Lake had an average phosphorus TSI (TSIp) value of 54.2, indicating slightly eutrophic conditions. This means that the lake is an enriched system, but that the water quality is not highly degraded and phosphorus levels are only moderately high. Water quality of Sullivan Lake is higher than average. The lake ranked 34th out of 103 lakes studied in Lake County. This is most likely the result of its glacial origin, thriving plant community and shallow morphometry, which prevents recreational activity on the lake. Most man-made lakes in this geographical area fall into the eutrophic and hypereutrophic categories, while many of the glacial lakes and burrow pits rank higher (Table 3, Appendix A).

Most of the water quality parameters just discussed can be used to analyze the water quality of Sullivan Lake based on use impairment indices established by the Illinois Environmental Protection Agency (IEPA). According to this index, Sullivan Lake provides *Full* support of aquatic life and swimming, and *Partial* support of recreational activities (such as boating) as a result of a high percent plant coverage and very shallow conditions. The lake provides *Full* overall use.

## LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (See Appendix B for methodology). Shoreline plants of interest were also recorded. However, no quantitative surveys were made of these shoreline plant species and these data are purely observational). Light level was measured at one-foot intervals from the water surface to the lake bottom. When light intensity falls below 1% of the level at the water surface, plants are no longer able to grow. Using this information, it can be determined how much of the lake has the potential to support aquatic plant growth. Based on 1% light level, Sullivan Lake could have and did support plants over 100% of the lake. Twenty-one different aquatic plant species were present in Sullivan Lake during the summer of 2002 (Tables 3 & 4) and only one of these (curly leaf pondweed) was an exotic species. Additionally, American lotus, a rare aquatic plant in Lake County, was found to be part of the plant community. The very healthy plant community in Sullivan Lake helped keep water clarity high in many areas by reducing sediment resuspension in the littoral zone and competing with planktonic algae for resources. It may also have supported the limited fish community in the lake by providing habitat and oxygen.

A limited plant survey was conducted on Sullivan Lake in May and June 1995. This was a qualitative survey consisting of visual identifications from the water surface, and did not involve a rake toss to collect plants or a depth determination at each sample site. Ten plant species were found, including large leaf pondweed, which was not present in 2002. Plants observed in 2002 that were not present in 1995 included bladderwort, duckweed, floating leaf pondweed, flatstem pondweed, Illinois pondweed, American lotus, slender naiad, small pondweed, spatterdock, grass-leaved arrowhead, spiny naiad and watermeal. The increase in number of plant species in 2002 is due to a difference in sampling technique, location and sampling dates. Additionally, plant surveys were only conducted in May and June 1995, while surveys were performed from May-September 2002. Several 2002 plant species did not appear until later in the summer and, therefore, would not have been observed in early summer 1995.

White water lily (found in 73% of the sample sites throughout the summer) dominated the plant community in 2002, followed by *Chara* (59%) and sago pondweed (47%). Curly leaf pondweed, the only exotic plant found in 2002, was observed only in June and does not currently pose a threat of reaching nuisance levels in Sullivan Lake (Table 4, Appendix A). It is recommended that the "no action" plant management plan currently in place on Sullivan Lake be continued indefinitely unless a major exotic plant infestation occurred. Any treatment of aquatic plants in this lake would likely result in an explosion of planktonic or filamentous algae and water quality would be severely degraded.

Of the fourteen emergent plant and trees species observed along the shoreline of Sullivan Lake, three (purple loosestrife, reed canary grass, and buckthorn) are invasive species that do not provide ideal wildlife habitat and have the potential to dominate the emergent plant community. However, these three species were not found in high densities and the majority of the shoreline plants around the lake provide excellent habitat for the many wildlife species observed on the lake in 2002.

FQI (Floristic Quality Index) is a rapid assessment tool designed to evaluate the closeness of the flora of an area to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts (Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of plant species found in the lake. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2002 Lake County lakes is 14.2. Sullivan Lake has an FQI of 28.2, the 2$^{nd}$ highest of all county lakes studied from 2000-2002 (Cranberry Lake is the highest). Its high diversity of plant species places Sullivan Lake well above the average lake, by Lake County standards, and provides the lake with excellent water quality.

**Table 4. Aquatic and shoreline plants on Sullivan Lake, May-September 2002.**

| | |
|---|---|
| <u>*Aquatic Plants*</u> | |
| Chara | *Chara* sp. |
| Coontail | *Ceratophyllum demersum* |
| Elodea | *Elodea canadensis* |
| Duckweed | *Lemna minor* |
| Northern Watermilfoil | *Myriophyllum sibericum* |
| Slender Naiad | *Najas flexilis* |
| Spiny Naiad | *Najas marina* |
| American Lotus | *Nelumbo lutea* |
| Spatterdock | *Nuphar variegatta* |
| White Water Lily | *Nymphaea tuberosa* |
| Curlyleaf Pondweed | *Potamogeton crispus* |
| Illinios Pondweed | *Potamogeton illinoensis* |
| Floatingleaf Pondweed | *Potamogeton natans* |
| American Pondweed | *Potamogeton nodosus* |
| Small Pondweed | *Potamogeton pusillus* |
| Flatstem Pondweed | *Potamogeton zosterifomis* |
| White Water Crowsfoot | *Ranunculus longirostris* |
| Grass-leaved Arrowhead | *Sagittaria graminea* |
| Sago Pondweed | *Stuckenia pectinatus* |
| Common Bladderwort | *Utricularia vulgaris* |
| Watermeal | *Wolffia columbiana* |
| <u>*Shoreline Plants*</u> | |
| Marsh Milkweed | *Asclepaias incaruta* |
| Bottlebrush Sedge | *Carex comoso* |
| Bur Marigold | *Bidens mitis* |
| Queen Anne's Lace | *Daucus carota* |
| Purple Loosestrife | *Lythrum salicaria* |
| Reed Canary Grass | *Phalaris arundinacea* |
| Common Reed | *Phragmites australis* |
| Pickerel Weed | *Pontederia cordata* |
| Chairmaker's Rush | *Scirpus pungens* |
| Softstem Bulrush | *Scirups validus* |
| Rigid Goldenrod | *Solidago rigida* |
| Common Bur Reed | *Spaganium eurycarpum* |
| Common Cattail | *Typha latifolia* |
| Blue Vervain | *Verbena hastata* |
| <u>*Trees/Shrubs*</u> | |
| Common Buckthorn | *Rhamnus cathartica* |
| Glossy Buckthorn | *Rhamnus frangula* |
| Willow | *Salix* sp. |

# LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Sullivan Lake on September 18, 2002. The shoreline was assessed for a variety of criteria (See Appendix B for methods), and based on these assessments, several important generalizations could be made. Sullivan Lake's shoreline is made up of only three different types: buffer (66.1%), wetland (22.3%) and lawn (11.5%). Approximately 82% of the shoreline is developed and the majority of this developed shoreline is comprised of buffer (80.5%) (Figure 5). The remainder of the developed shoreline consists of lawn (14.0%) and wetland (5.5%). The undeveloped portions of the lake are made up entirely of wetland. Manicured lawn is considered undesirable because it provides a poor shoreline-water interface due to the poor root structure of turf grasses. These grasses are incapable of stabilizing the shoreline and typically lead to erosion. On the other hand, buffer and wetland are ideal shoreline types because they typically prevent shoreline erosion, as well as provide wildlife habitat. As a result of the dominance of buffered shoreline, 82% of Sullivan Lake's shoreline exhibited no erosion. Slight erosion was occurring on 7.5% of the shoreline, while moderate erosion was occurring on 10.5% of the shoreline (Figure 6). Because of its poor stabilization capabilities, over 90% of the manicured lawn along Sullivan Lake exhibited slight or moderate erosion. Only 11.2% of the buffered shoreline was exhibiting slight to moderate erosion and no erosion was occurring on wetland shoreline. Wetland and buffered shorelines should be maintained as much as possible, and manicured lawns should be replaced with 10-30 feet of buffer strip made up of native vegetation in order to reduce or eliminate erosion.

Dramatic water level fluctuation can increase shoreline erosion, especially if the fluctuations occur over short periods of time. Due to the low amount of water entering the lake from any given source, the water level in Sullivan Lake dropped dramatically throughout the summer. Between May and June, the lake level dropped 1.25 feet. In a lake whose average depth is only 2.1 feet, this can have significant impacts on shoreline erosion, as well as wildlife. In July, August and September, water levels were too low to maneuver a canoe to the pier originally used to measure water level. However, water level remained relatively stable during those months, increasing slightly in September in response to several rain events. Erosion occurs when water levels drop and newly exposed soil, which may not support emergent plant growth, is subjected to wave action. The relatively dramatic lake level fluctuations in Sullivan Lake could eventually lead to more severe erosion, especially along shorelines dominated by manicured lawn. This is another valid reason to promote buffer strips along these shorelines, as water levels will likely continue to fluctuate in the future.

Although not present in high densities, invasive plant species, including reed canary grass, buckthorn and purple loosestrife, were observed along 78% of the shoreline. These plants are extremely invasive and exclude native plants from the areas they inhabit. Buckthorn provides very poor shoreline stabilization and may lead to increasing erosion problems in the future. Reed canary grass and purple loosestrife inhabit mostly wetland areas and can easily outcompete native plants. Additionally, they do not provide the quality wildlife habitat or shoreline stabilization that native plants provide. Since the

relative density of these three invasive plants was not extremely high along Sullivan Lake (the plants were found in small patches around the lake), it would be relatively easy to eliminate these plants before they become a nuisance.

## LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Wildlife observations were made on a monthly basis during water quality and plant sampling activities (See Appendix B for methodology). Due to the large amount of wetland and buffer shoreline around Sullivan Lake, a great number of wildlife species were observed, including two Illinois threatened and two Illinois endangered bird species (Table 5). In the past, a state threatened fish species, the blackchin shiner (*Notropis heterodon*), was also found in Sullivan Lake. The low amount of residential shoreline around the lake and relatively high quality buffer around most of the shore provided high quality habitat for birds, amphibians and reptiles. Additionally, the high quality aquatic plant community provides great habitat for fish. It is, therefore, very important that the wetland, and buffer areas around the lake and the aquatic plant community in the lake be maintained to provide the appropriate habitat for birds and other animals in the future. It is also important that areas with manicured lawns adjacent to the shoreline establish a buffer strip of native plants to provide additional habitat and reduce the possibility of erosion.

**Table 6. Wildlife species observed at Sullivan Lake, May-September 2002.**

| | |
|---|---|
| <u>*Birds*</u> | |
| Pied-billed Grebe+ | *Podilymbus podiceps* |
| Mute Swan | *Cygnus olor* |
| Canada Goose | *Branta canadensis* |
| Blue-winged Teal | *Anas discors* |
| American Coot | *Fulica americana* |
| Ring-billed Gull | *Larus delawarensis* |
| Common Tern* | *Sterna hirundo* |
| Black Tern* | *Chlidonias niger* |
| Great Egret | *Casmerodius albus* |
| Great Blue Heron | *Ardea herodias* |
| Green Heron | *Butorides striatus* |
| Sandhill Crane+ | *Grus canadensis* |
| Killdeer | *Charadius vociferus* |
| Spotted Sandpiper | *Actitis macularia* |
| Mourning Dove | *Zenaida macroura* |
| Belted Kingfisher | *Megaceryle alcyon* |
| Red-bellied Woodpecker | *Melanerpes carolinus* |

*Endangered in Illinois
+Threatened in Illinois

**Table 6. Wildlife species observed at Sullivan Lake, May-September 2002 (cont'd).**

| | |
|---|---|
| Great Crested Flycatcher | *Myiarchus crinitus* |
| Willow Flycatcher | *Empidonax trailii* |
| Barn Swallow | *Hirundo rustica* |
| Tree Swallow | *Iridoprocne bicolor* |
| Bank Swallow | *Riparia riparia* |
| Chimney Swift | *Chaetura pelagica* |
| American Crow | *Corvus brachyrhynchos* |
| White-Breasted Nuthatch | *Sitta carolinensis* |
| American Robin | *Turdus migratorius* |
| Cedar Waxwing | *Bombycilla cedrorum* |
| Warbling Vireo | *Vireo gilvus* |
| Yellow-rumped Warbler | *Dendroica coronata* |
| Common Yellowthroat | *Geothlypis trichas* |
| Red-winged Blackbird | *Agelaius phoeniceus* |
| Common Grackle | *Quiscalus quiscula* |
| Northern Oriole | *Icterus galbula* |
| House Sparrow | *Passer domesticus* |
| Northern Cardinal | *Cardinalis cardinalis* |
| House Finch | *Carpodacus mexicanus* |
| American Goldfinch | *Carduelis tristis* |
| Chipping Sparrow | *Spizella passerina* |
| Swamp Sparrow | *Melospiza georgiana* |
| Song Sparrow | *Melospiza melodia* |
| *Mammals* | |
| Muskrat | *Ondatra zibethicus* |
| *Amphibians* | |
| Bull Frog | *Rana catesbeiana* |
| Green Frog | *Rana clamitans melanota* |
| Leopard Frog | *Rana pipiens* |
| *Reptiles* | |
| Painted Turtle | *Chrysemys picta* |
| Snapping Turtle | *Chelydra serpentina* |
| *Insects* | |
| Dragonfly | *Odonata* spp. |

# EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool in effective lake management, especially if the long term lake management plan includes intensive treatments, such as fish stocking, dredging, chemical application or alum application. No bathymetric map currently exists for Sullivan Lake. Morphometric data obtained in the creation of a bathymetric map is necessary for calculation of equations for correct application of many types of treatments.

- *Lack of Participation in the Volunteer Lake Monitoring Program (VLMP)*

  In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, 150-200 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 250 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake. The establishment of a VLMP on Sullivan Lake would provide valuable historical data and enable lake managers to create baseline information and then track the improvement or decline of lake water quality over time.

- *Invasive Shoreline Plant Species*

  Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. The outcome is a loss of plant and animal diversity. 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. 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. Purple loosestrife, buckthorn and reed canary grass (another exotic species) are present along 78% of the shoreline of Sullivan Lake. Especially because of the high quality shoreline already present and the large number of wildlife it attracts, attempts should be made to control the spread of these exotic species before they compromise the quality of Sullivan Lake's shoreline.

- *Shoreline Erosion*

Although most of Sullivan Lake's shoreline exhibits no erosion, slight to moderate erosion is present along 91% of the manicured lawn surrounding the lake. As mentioned, manicured lawn provides poor shoreline stabilization due to its shallow root structure and it is not uncommon to see significant erosion along this type of shoreline. Buffered shoreline is much more desirable than manicured lawn and should replace lawn wherever possible. It is recommended that those residents that already have buffer strips consider widening their strips and that those residents that do not have buffer strips consider planting >10-30 feet of native plants along their shoreline.

*Low Dissolved Oxygen Concentrations*

Sullivan Lake experienced low dissolved oxygen levels in July and August. High water temperatures and high plant density in this shallow lake were probably to blame for this problem. As water temperature rises, DO drops. Temperatures reached a maximum of 28.5$^{o}$C (83.3$^{o}$F) at the lake surface during the 2002 study, a level that can lead to low DO concentrations, which can cause fish stress and, if continual, can eventually lead to a fish kill. This is especially true during the winter when ice cover is present. Snow cover on frozen lakes inhibits photosynthesis from occurring below the ice, eliminating a source of oxygen to the lake. Without a source of oxygen, respiration will quickly deplete the water of oxygen and a winter fish kill will occur. Unfortunately, without extensive and expensive dredging, Sullivan Lake may always have DO problems during both the summer and winter months. As long as lake uses are not in conflict with the absence of a quality sport fish community, no action is recommended regarding low DO concentrations at this time.

# POTENTIAL OBJECTIVES FOR THE SULLIVAN LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map, Including a Morphometric Table
II. Participate in the Volunteer Lake Monitoring Program
III. Eliminate or Control Exotic Species
IV. Control Shoreline Erosion

**Objective I: Create a Bathymetric Map, Including a Morphometric Table**

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 treatments such as fish stocking, dredging, alum application or aeration were part of the overall lake management plan. McGreal Lake does not currently have a bathymetric map. Maps can be created by the Lake County Health Department – Lake Management Unit or other agencies for costs that vary from $3,000-$10,000, depending on lake size.

**Objective II: Participate in the Volunteer Lake Monitoring Program**

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, 150-200 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 250 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake.

The VLMP relies on volunteers to gather a variety of information on their chosen lake. The primary measurement is Secchi disk transparency or Secchi depth. Analysis of the Secchi disk measurement provides an indication of the general water quality condition of the lake, as well as the amount of usable habitat available for fish and other aquatic life.

Microscopic plants and animals, water color, and suspended sediments are factors that interfere with light penetration through the water column and lessen the Secchi disk depth. As a rule, one to three times the Secchi depth is considered the lighted or euphotic zone of the lake. In this region of the lake there is enough light to allow plants to survive and produce oxygen. Water below the lighted zone can be expected to have little or no dissolved oxygen. Other observations such as water color, suspended algae and sediment, aquatic plants, and odor are also recorded. The sampling season is May through October with volunteer measurements taken twice a month. After volunteers have completed one year of the basic monitoring program, they are qualified to participate in the Expanded Monitoring Program. In the expanded program, selected volunteers are trained to collect water samples that are shipped to the Illinois EPA laboratory for analysis of total and volatile suspended solids, total phosphorus, nitrate-nitrite nitrogen and ammonia-nitrogen. Other parameters that are part of the expanded program include dissolved oxygen, temperature, and zebra mussel monitoring. Additionally, chlorophyll *a* monitoring has been added to the regiment of selected lakes. These water quality parameters are routinely measured by lake scientists to help determine the general health of the lake ecosystem.

For more information about the VLMP contact the VLMP Regional Coordinator:

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**Objective III: Eliminate or Control Exotic Species**

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. The outcome is a loss of plant and animal diversity. This section will address terrestrial shoreline exotic species.

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 seeds 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. A table in Appendix A 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.

***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. Some exotics, such as purple loosestrife and reed canary grass, 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 removed. 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, as is the case on Sullivan Lake. 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***
This option may be labor intensive or prohibitive if the exotic plant is already well established. 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.

**<u>Option 3: Herbicide Treatment</u>**

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. In some areas where individual spot treatments are prohibitive or unpractical (i.e.,, large expanses of a wetland or woodland), chemical treatments may not be an option due to the fact that in order to chemically treat the area a broadcast application would be needed. 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. Trees are normally treated by cutting a ring in the bark (called girdling). Herbicides are applied onto the ring at high concentrations. Other devices inject the herbicide through the bark. 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***
Two common herbicides, triclopyr (sold as Garlon ™) and glyphosate (sold as Rodeo® or Round-up™), cost approximately $100 and $65 per gallon, respectively. Only Rodeo® is approved for water use. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting device, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40.

**Objective IV: Control Shoreline Erosion**

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 exacerbate 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.

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

***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.

**Option 2:  Create a Buffer Strip**
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. 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. Areas where erosion is severe or where slopes are greater than 3:1, additional erosion control techniques may have to be incorporated such as biologs, A-Jacks®, or rip-rap.

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. A table in Appendix A 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., geese and 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 a Table 7, Appendix A should be considered for native plantings.

***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. 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. Cost of installing willow posts is approximately $15-20 per linear foot. 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. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

**Option 3: Install Biolog, Fiber Roll, or Straw Blanket with Plantings**
These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. In areas of severe erosion, other techniques may need to be employed or incorporated with these products.

***Pros***
Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from terrestrial sources. These factors help improve water quality in the lake by reducing the amount of nutrients available for algae growth and by reducing the sediment that flows into a lake.

***Cons***

These products may not be as effective on highly erodible shorelines or in areas with steep slopes, as wave action may be severe enough to displace or undercut these products. On steep shorelines grading may be necessary to obtain a 2:1 or 3:1 slope or additional erosion control products may be needed. If grading or filling is needed, the appropriate permits and surveys will have to be obtained.

***Costs***

Costs range from $25 to $35 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.